U.S. DEPARTMENT OF ENERGY | Office of NUCLEAR ENERGY

Demonstration of Advanced Manufacturing to Enable an Alternative US Supply Chain for SMR Components

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Pathway: 1 - First of a Kind Nuclear Demonstration Readiness

Abstract

Manufacturing processes have advanced significantly in the last few decades when there has been little new nuclear fabrication. These advanced manufacturing processes have the potential for reduced lead time, cost or improved quality with no impact to safety relative to traditional manufacturing. Maturing the path for these processes to meet nuclear quality standards is an opportunity for the nuclear industry and advanced manufacturing supply chain.

This project aims to demonstrate of the entire supply chain and the qualification of pressure retaining components in the context of advanced manufacturing technologies for light-water small modular reactor components. Two components will be manufactured using different advanced manufacturing methods: powder metallurgy with hot isostatic pressing (PM-HIP) will be used to manufacture an inlet/outlet header, while direct energy deposition (DED) will be used to manufacture a main steam isolation branch reducer for use in a NuScale Power reactor.

The initial task for both processes will involve process qualification and demonstration. Existing research shows the promise for both of the processes with the chosen 316L stainless steel material. To qualify parts produced with PM-HIP and DED for service in an ASME Section III application, material upgrading will be required from unqualified source material to qualified source material by an ASME Quality Systems Certificate holder. The material upgrading process will include audits of non-ASME vendors, post-production testing to verify properties, chemistry, and microstructure, and non-destructive evaluation.

Throughout the project, the material upgrading and quality assurance process will be documented for the first time on advanced manufacturing processes. Engagement with the Nuclear Regulatory Commission will ensure regulatory requirements are met as well as ASME code. The final aspect of the project will document the lessons learned, technical aspects, and economic aspects for these two processes, and comparison between the two. Value for the entire existing and future nuclear industry will be generated as the first components for an ASME

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Section III pressure retaining application are produced and qualified with PM-HIP and DED advanced manufacturing processes.

Project Objectives

Four objectives have been identified for the project:

- Demonstrate the advanced manufacturing supply chain and ASME material upgrading process for PM-HIP and GMA-DED processes with NQA-1 quality requirements
- Manufacture components with PM-HIP to be fabricated into a NuScale Power small modular reactor (SMR) and qualified for service in an ASME Section III Class 1 application
- Develop the data package and ASME Code Case for alloy 690 via PM-HIP
- Capture technical, quality assurance, and economic guidance to increase utilization of the advanced manufacturing supply chain in the nuclear industry

Project Outcomes/Impacts

The new advanced light water reactor (ALWR) fleet is being built with many of the same manufacturing/fabrication technologies that were employed for building light water reactor plants 30-50 years ago. The current Demonstration of Advanced Manufacturing to Enable an Alternative US Supply Chain for SMR Components project will look to validate two advanced manufacturing technologies for reactor fabrication which could have a dramatic impact on the cost, quality, and schedule. This would potentially be applicable to manufacture/fabrication of repair for the existing reactors, ALWRs, SMRs, and Advanced Generation IV reactors, as well as ultra-supercritical fossil and supercritical CO2 plants. Anticipated outcomes of the project include the following:

- Supply chain development that will show how to use advanced manufacturing with the ASME material upgrade process
- Compare the two advanced manufacturing techniques most relevant to large component construction in terms of cost, schedule, availability and process limitations
- Complete production of multiple components with advanced manufacturing that are ASME certified source material to be used in reactor construction