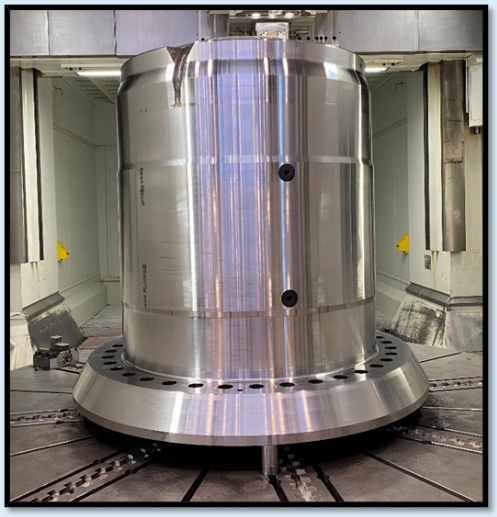
Supplemental Project Notice

Deployment of Heavy Section Electron Beam Welding (EBW) Technologies



A 110-mm thick RPV mockup with three electron beam welds: 1) flange-to-shell, 2) shell-to-head, and 3) one-half head-to-one-half head weld.
(Ref: DOE Project DE-NE0009039)

PROJECT HIGHLIGHTS

This project will remove several of the remaining hurdles preventing EBW from being fully utilized for joining heavy section components:

- Elimination of the welding keyhole attendant to EB welding
- Demonstration of nondestructive evaluation methods for EB welds
- Methods to remove magnetization in components to be joined
- Demonstration of repair methodologies for EB weld joints

Background, Objectives, and New Learnings

Over the past two decades, the nuclear industry has seen significant advances in electron beam welding (EBW) research and technology development for joining heavy section components. Advances have been realized for in- and out-of-chamber welding applications, low and high kV EB applications, low and high vacuum, and diode and triode EB gun (generator) capabilities.

To support the cost-effective deployment of the next generation of small modular and advanced nuclear reactors (SMRs and ARs), the use of advanced manufacturing and fabrication technologies will likely be necessary to reduce overall construction and assembly costs. EBW is one such technology, but it has seen limited use to-date in fabrication of heavy (thick) sections such as pressure vessel welding.

A number of hurdles must be overcome for EBW to realize its full potential. Based on feedback from many stakeholders, this project intends to address the barriers currently prohibiting EBW from being openly deployed across industry, including:

- Elimination of preheat for welding RPV steels
- Elimination of the keyhole at the termination of the circumferential weld
- Availability of repair methods for EB welds
- Availability of nondestructive evaluation methods for EB welds
- Availability of proven surface preparation methods

The results of this project will allow vessel manufacturers/ developers, EBW equipment manufacturers, and large fabricators to readily apply EBW methods and technologies, significantly reducing overall welding assembly time and costs.

Benefits

Major benefits of this project may include:

- Significantly reduced welding times (up to 90%) over conventional welding practices to join thick section components such as pressure vessels, steam generators, pressurizers, etc.
- Demonstration of one-pass welding, which reduces welding time, minimizes the heat affected zone for a weld, and reduces the possibility of welding anomalies such a lack-of-fusion or incomplete fusion
- Elimination of the need for welding consumables (wire) during the welding process, resulting in cost reductions
- Elimination of the welding keyhole at the termination of an EB weld, enabling full circumferential welds.

Project Approach and Summary

The project is targeted at elimination of barriers limiting full-scale deployment of EBW, and seeks the:

1. Development of supporting data to provide to the ASME Boiler Pressure Vessel Code Committee about the elimination of preheat for reactor pressures vessel (RPV) steels.
2. Demonstration of slope-welding methods to eliminate the keyhole at the termination of a circumferential weld across various kV machines and thicknesses.
3. Development and demonstration of various repair methods that could be applied to EB welds.
4. Development and demonstration of nondestructive evaluation methods to apply to EB welds/defects.
5. Demonstration of demagnetization methods that can be used for EB welding of large/thick components and to highlight surface preparation and cleaning methods.

Deliverables

The deliverables for this project are expected to include:

- Welding data to assess whether welding preheat is necessary in EB vacuum environments with RPV steels
- Demonstration of slope welding methods (at low and high kV) to potentially eliminate the termination keyhole
- A report on various repair methods for EB welds when a flaw or lack of fusion is encountered
- Summary descriptions of NDE methods for EB welds and defects, including data on critical flaw sizes
- Guidance on the use of demagnetization, surface preparation and cleaning methods for EB use.

The non-proprietary results of this work will be incorporated into EPRI R&D Programs and made available to the public for purchase or otherwise.

Price of Project

The price for participation in this project is $120,000 per funder, with a minimum of six funders required.

Project Status and Schedule

The project is scheduled to begin in Summer 2023 and expected to be completed in approximately 30 months.

Who Should Join

Industrial participants may include reactor and vessel manufacturers and developers, EBW equipment manufacturers, and large fabricators looking to reduce overall welding times and fully engage in the emerging advanced reactor market.

Power producers may want to participate to accelerate the development and deployment of advanced manufacturing methods that can substantially reduce overall manufacturing and/or fabrication costs.

Contact Information

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