

Large Bore Nozzle Weld Overlay

Installing one of the industry's largest weld overlays



Full structural weld overlay for North Anna's steam generator hot leg nozzles

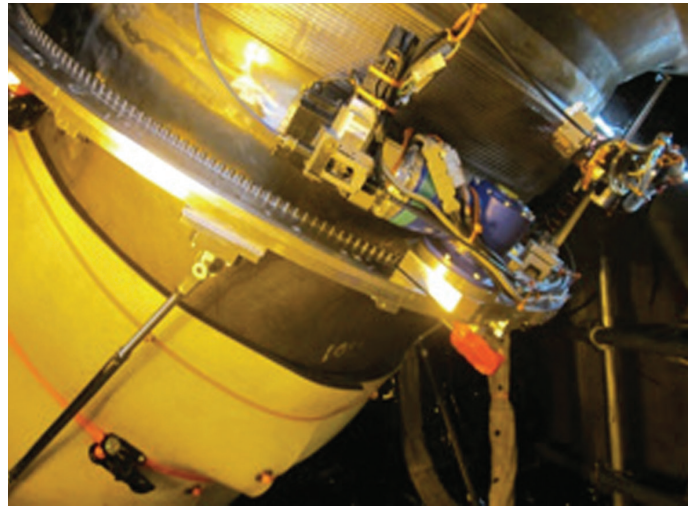
Since the first signs of Alloy 600 related issues in U.S. commercial nuclear plants, WSI – working collaboratively with Structural Integrity Associates (SI) and nuclear industry plant owners and materials experts - has consistently been at the forefront providing innovative solutions that helped to define and refine solutions to Alloy 600 challenges. The drive to provide our customers with safe, reliable and predictable performance, while alleviating concerns of future inspections and downtime due to component failures has kept WSI on the cutting edge of state-of-the-art solutions. One example is the Full Structural Weld Overlay (FSWOL) of the steam generator hot leg nozzles WSI completed at Dominion Virginia's North Anna Unit 1 during a Spring refueling outage.

As the only U.S. nuclear unit with Alloy 82/182 dissimilar metal (DM) welds joining the steam generator hot and cold leg low alloy steel nozzles to the stainless steel primary piping, the North Anna project presented several unique challenges:

- Large nozzle geometry (41-inch outside diameter having a 5-inch wall thickness requiring preparatory machining of the nozzle and DM weld prior to installation)
- Limited spatial access
- 6G orientation (45 degree angle)
- Thick overlay (~1.7" thick)
- Limited outage window for application

The Project Scope Consisted of:

- Design and construction drawings with supporting sizing analysis of the FSWOL
- Full complement of engineering analysis to support FSWOL
- Licensing support
- Mockups for process validation and crew training
- Site implementation of three SG Hot Leg FSWOLs in parallel
- Post-mitigation NDE utilizing phased array UT



Advanced custom dual weld head system for large bore weld overlays measuring 34" and larger. Photo reflects field installation of Steam Generator to Hot Leg nozzle weld overlay.

Unique project challenge

During the preparatory machining of the 'B' nozzle, leakage of primary water was noted on the machined surface over the DM weld after approximately 20% of the DM weld material thickness had been removed. Upon further examination, two throughwall flaws were identified, as well as three additional axial flaws that were approximately 50% through wall.

The team immediately shifted to a repair mode, consistent with contingency planning, on that nozzle while continuing mitigation on the other two nozzles.

Upon evaluation of the flaws, the two through-wall defects were addressed by excavating and peening the base metal and DM weld in the flaw area and applying a manual temper bead SMAW repair utilizing Alloy 152 and 182 filler metals. The manual temper bead procedure required a postweld bake and then the cavity was filled with weld filler material to provide a solid surface for the weld overlay.

These challenges were effectively met by designing an overlay that satisfied all ASME Code requirements to be applied to the steeply sloped nozzle and inspected using a PDI qualified procedure. Welding and machining equipment were modified to fit within the very tight clearances around the structural steel supporting the SGs, and to have the required welding adjustment features to accommodate the 6G weld orientation.



A dedicated testing program was conducted to define a remote welding process capable of depositing Alloy 52M filler metal at an increased rate using the machine GTAW process. WSI developed advanced welding techniques and parameters that dramatically increased the weld deposition rate two to three times greater than historic rates. A double-up welding technique was used to minimize potential for fusion defects, and low dilution welding parameters were used to minimize welding defects. Three full-size mockup coupons were constructed replicating the nozzle and DM weld. In addition, a fullscale work area environment including all interferences was built. These mockups provided invaluable training for the implementation crew - including North Anna support personnel - prior to deployment to site, ensuring the project's overall success (technical, safety, ALARA).

Application of the FSWOL was accomplished using WSI's Phase II processes and equipment employing a fully automatic, dual head machine GTAW process incorporating lessons learned from previous large bore weld overlay projects. Despite the challenges with a late design change, emergent discovery of leaking pre-existing flaws in one DM weld, and the installation of the industry's largest weld overlays to date, the WSI Dominion team was able to successfully implement the work within the schedule, dose, and safety expectations. Overall safety performance on the project was excellent – with more than 25,000 man-hours in the field, there were no reportable safety incidents.



Benefits of Using WSI

WSI is the nuclear industry expert in specialty welding solutions and Weld Overlay mitigation of dissimilar metal welds. With over 40 years nuclear industry experience, WSI provides specialty Engineered Solutions and Repair Solutions services to our U.S. and international customers either on a planned or emergent basis.

- Field resource pool of over 700 nuclear qualified, highly trained, pipefitters and boilermakers to meet demanding outage requirements. WSI uses global labor resources with specialty skills and automatic welding experience to augment local craft resources.
- Tooling inventory of 250+ automatic welding and mechanical systems capable of meeting nearly any challenging repair or access configuration, including remote video capabilities. WSI designs, manufactures, and maintains its own equipment and can respond to equipment modification demands on an emergent basis.
- WSI Nuclear QA Program meets the requirements of 10CFR50, Appendix B and NQA-1, and is a NUPIC-audited nuclear supplier.
- An ASME Welding Program with over 1000 qualified welding procedures to meet almost any material or configuration challenge. WSI can generate new weld procedures on a planned or emergent basis.
- WSI also has extensive expertise in areas of metallurgy, welding processes, repair and tooling design – with a long resume of custom tooling and first-of-akind industry repair successes.
- WSI takes pride in being the industry leader in responsiveness for projects that are "Critical to Safety, Critical to Schedule, and Critical to Quality."



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availinfra.com/wsi

WSI
560 Horizon Drive
Suite 100
Suwanee, GA 30024
T: 678.728.9100