Reactor Vessel Head Penetration Embedded Flaw Repair

Background

Occasionally, examinations of the reactor vessel head penetration (RVHP) tubes and J-groove welds detect flaws, which must be dealt with before returning to operation. More recent Alloy 600 cracking has been identified in "cold," less-susceptible heads, requiring welded repairs. Westinghouse offers the embedded flaw weld repair technique, a U.S. Nuclear Regulatory Commission (NRC)-approved, permanent repair that isolates the flaw from the environment, eliminating further crack propagation due to primary water stress corrosion cracking (PWSCC).

Description

Prior to repair efforts, a plant-specific, engineered three-dimensional modeling package for the reactor vessel head is required. The computer-aided design model, including all penetrations, storage stand and bio-wall, is used to support the generation of various parameters used by the repair equipment. Repair procedures also take into account the unique head design and clearances required for specialized tooling.

Upon discovery of a repairable flaw, at the customer's request a crew comprised of project managers, welders, machinists and quality assurance (QA) personnel can mobilize to the site and complete in-processing. If a trained crew is not available, some personnel may first require full training while others may require a short refresher or proficiency training. This trained crew will complete an embedded flaw repair.

Upon request, Westinghouse will also mobilize all welding and machining equipment to arrive on site as soon as possible.

Primary mitigation tooling/equipment is capable of performing thermal sleeve and guide funnel removal and reinstallation and embedded flaw repairs on the tube outside diameter (OD), inside diameter (ID) or J-groove weld. Also available will be retaining collar or thermocouple column funnel removal tooling, as well as electrical discharge machining equipment.

The welded repair mitigation technique for any indication identified by head examination will be performed in accordance with the NRC-approved Westinghouse design, documented in WCAP-15987-NP, Revision 2-NP-A, Technical Basis for the Embedded Flaw Process for Repair of Reactor Vessel Head Penetrations. The gas tungsten arc welding technique provides a non-structural barrier to the area of interest to stop the corrosion process. An INCONEL® filler metal is applied over the cracked Alloy 600 material using multi-pass overlay welding techniques.

The thickness of the weld used to embed the flaw has been designed to provide a permanent embedment of the flaw. The embedded flaw process imparts less residual stresses than would a weld repair following the complete removal of the flaw. Since Alloy 52/152 (690) weldment is considered highly resistant to PWSCC, a new PWSCC crack should not initiate and grow through the Alloy 52/152 overlay. The resistance of the Alloy 690 material has been demonstrated by laboratory testing and more than 14 years of operational service in steam generator tubes, where no PWSCC has been found.

Should a thermal sleeve repair be required, a weld repair analysis will be completed to justify adding a partial penetration weld at some elevation determined by the repair crew. Included is a dynamic analysis of the thermal sleeve and driveline to determine loads on the thermal sleeve at the elevation of the repair weld, and a structural evaluation of the partial penetration weld. Associated drawings will be provided.

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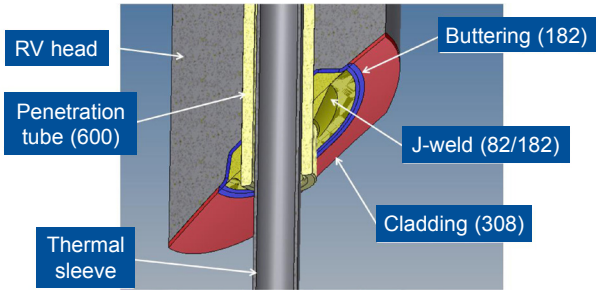
If thermal sleeves or guide funnels must be removed to facilitate head penetration repairs, or if excessive thermal sleeve wear is found, Westinghouse can supply replacement thermal sleeves and hardware, as well as guide funnels. The replacement hardware will be installed to replace the removed sections of the original equipment.

After the repair, Westinghouse will use a portion of its reactor vessel head inspection crew already onsite to perform the post-repair ultrasonic testing exam.

Westinghouse, which provides technical skill sets for welding and machining functions, has a robust quality assurance (QA) program. Having fully integrated QA programs and processes, Westinghouse can effectively support its customers.



Typical RVHP

Benefits

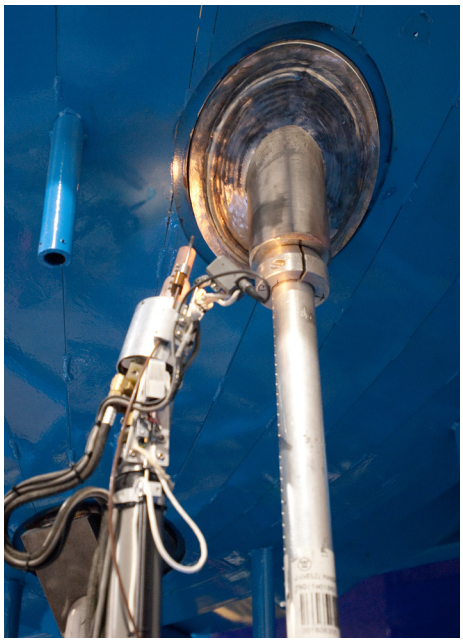
Teaming with Westinghouse reduces overall risk and effect on the plant's critical path. RVHP repairs require many specialized tools, qualified resources, and significant training and preparation time to execute, as well as up-front engineering and licensing efforts.

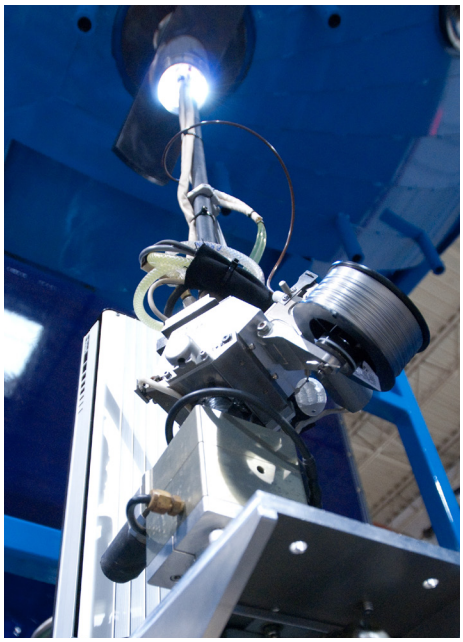
Westinghouse has fully qualified and proven welding processes and supporting documentation and procedures to support the RVHP efforts. The company provides an integrated project experience by coordinating its engineering, field and installation, and inspection organizations.

Furthermore, unlike other repair methods, the Westinghouse embedded flaw repair is permanent. The generic relief request is documented in WCAP-15987-NP, Revision 2-NP-A. A plant's reference of this generic relief request has already been approved for multiple in-service plants.

Experience

Westinghouse has completed over 40 RVHP repairs since 1997, with 80 percent of those repairs being on the OD or J-weld. In addition, nearly 120 thermal sleeves have been removed and/or replaced. Services have been successfully provided on a planned and emergent basis.


Outside diameter/J-welder


Inside diameter end effector

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