Nondestructive Examination Services

Reactor Vessel Nozzle Dissimilar Metal Weld Examination Using the SQUID™ Scanner

Background

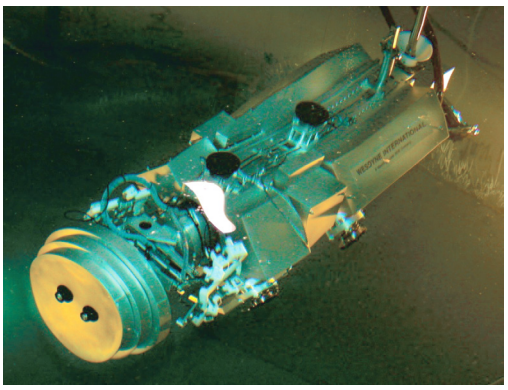
Operators of pressurized water reactors with dissimilar metal nozzle safe-end welds, which are susceptible to primary water stress corrosion cracking, are required to examine those welds with increased frequency unless mitigating actions are taken. Requirements for these examinations are specified in American Society of Mechanical Engineers (ASME) Section XI, Code Case N-770-1 as modified by 10CFR50.55a.

To meet this inspection requirement, Westinghouse developed the SQUID™ (SUPREEM™ eQuivalent safe-end Ultrasonic Inspection Device) scanner. The SQUID scanner was designed specifically for examination of reactor vessel nozzle safe-end welds and, as such, provides an alternative when the balance of the reactor vessel does not require inspection.

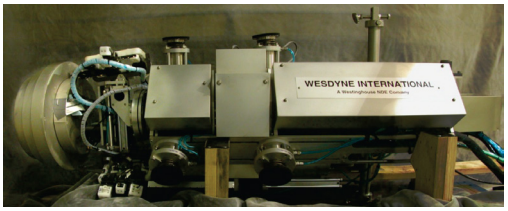
While the end-effector and transducer package delivered by the SQUID scanner is identical to that used with Westinghouse's SUPREEM reactor vessel inspection system, the SQUID scanner offers significant benefits over traditional vessel inspection systems.
The SQUID scanner requires far less time for setup and teardown, requires less laydown space and is easier to operate. The SQUID scanner was designed with safety, reliability and efficient operation in mind, and incorporates features that allow the examination to be performed quickly, with minimal impact on other plant maintenance activities.

Description

The SQUID scanner is capable of performing fully automated ultrasonic examinations of the reactor vessel nozzle safe-end welds from the inside surface of the nozzle using ultrasonic testing (UT) procedures and personnel qualified in accordance with the performance demonstration initiative (PDI) implementation of ASME Section XI, Appendix VIII.



Top view of SQUID scanner



SQUID nozzle scanner

Eddy current testing is performed concurrently with the ultrasonic examination to provide supplementary information to assist in real-time data interpretation.

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The scanner is near-neutrally buoyant, which allows it to be delivered manually to the reactor vessel and inserted into the nozzle using long-handled poles. Once in the nozzle, environmental and calibration checks are completed before the examination is performed. Once the examination is completed and data quality is verified, the SQUID scanner is manually moved to the next nozzle and the process is repeated.

The SQUID system consists of five major components:

1. The **scanner** operates under water and provides two axes of motion, axially and circumferentially in the nozzle, to manipulate the end effectors.
2. A **network-based motor control system** powers and controls the SQUID scanner and uses linear amplifiers to reduce electrical interference.
3. Westinghouse's **PDI-qualified PARAGON™ system** is used for acquisition and analysis of the ultrasonic and eddy current data and includes a patented inner diameter (ID) profiling feature, which allows for more accurate assessment of UT findings.
4. The **digital audio/video system** provides local and remote control of all the audio/video requirements for communications and visual monitoring of the tool to allow for safe tool installation and removal as well as monitoring examination performance.
5. The **pneumatic control system** operates the stabilizers, probe-sled extension and docking mechanisms, and provides purge air.

All control operations are typically performed remotely at a location outside the radiologically controlled area, but can be done locally if necessary. All tool and data acquisition operations are performed by a single operator, streamlining communications and helping to eliminate potential errors.

Benefits

- Short inspection duration minimizes dose for both customer and Westinghouse, and maximizes plant availability
- Equipment, procedures and personnel are qualified in accordance with PDI requirements to satisfy examination regulatory and licensing commitments
- Examination of hot leg nozzle welds is performed with the core barrel in place
- More accurate assessment of UT findings through ID profiling
- Concurrent eddy-current examinations facilitate real-time data interpretation
- On-board secondary calibration standard for interim calibration checks eliminates the need for tool removal
- Minimal time is required to reconfigure for different nozzle designs
- Manual manipulation of the scanner by the inspection crew minimizes site support
- Engineering support is available to disposition "off normal" results
- Integral part of nozzle dissimilar metal weld mitigation solutions

Experience

Westinghouse applied the Design Six Sigma process through its Customer 1st initiative and has used it at numerous plant sites since its first application in the fall of 2006. The Westinghouse inspection service team combines this state-of-the-art equipment and technology with highly trained and qualified personnel to deliver inspection services of the utmost quality. Westinghouse's fleet of SQUID scanners has successfully completed more than 35 examination campaigns inspecting more than 120 nozzles.

WesDyne is the nondestructive inspection branch of Westinghouse and a leading supplier of mechanized nondestructive examination (NDE) products for all inspection needs worldwide providing turnkey and one-off-type solutions with a focus on the nuclear market. WesDyne's expertise spans all aspects of remote and mechanized inspections, from problem analysis and solutions generation to development and manufacturing to field deployment of personnel and equipment. Inspection capabilities cover all key NDE areas such as ultrasonic, visual, eddy current, magnetic particle, dye penetrant and X-ray.

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