

Recent PWR Reactor Vessel Internals Operating Experience

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MRP-227, Revision 2 RAI Discussion Meeting
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Outline

- Clevis inserts
- Core barrel upper girth weld (UGW) flaws

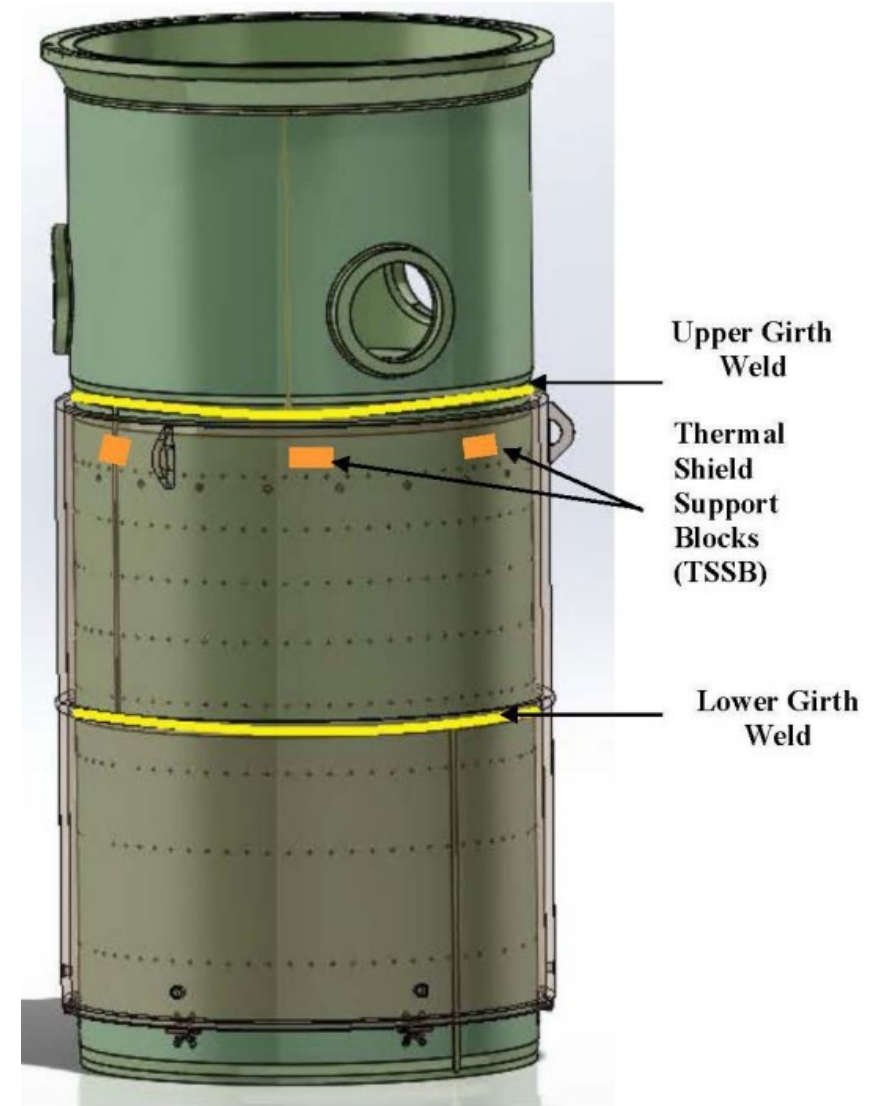
For specific details regarding in-service inspection findings and actions taken to address any observed conditions, the individual plant owner should be contacted directly.



Core Barrel Upper Girth Weld

Core Barrel Operating Experience

- An indication was detected during a general visual VT-3 ASME Section XI B-N-3 exam of a 3-loop core barrel in fall 2022:
 - Linear indication at the upper girth weld (UGW) identified on the core barrel inner diameter (ID) surface
 - Indication was circumferential and approximately 12" in length
- Extent of condition VT-1/EVT-1 was performed at the UGW:
 - 100% coverage of the UGW ID and OD surfaces
 - Identified four additional indications on the ID and no relevant indications on the OD
- UT was performed on all five indications:
 - The five indications ranged from 1.1" to 17.76" in length and 37% - 92% in through-wall depth



Plant and Industry Response to Core Barrel Indications

- Immediate plant actions:
 - One-cycle analytical disposition developed for four of the five indications
 - Crack arrest holes drilled at the ends of the longest flaw and operation justified for one cycle [Ref. ML23089A212]
- Immediate industry actions:
 - Core barrel focus group formed and tasked with information gathering, developing interim guidance, and developing a longer-term plan
 - Interim guidance developed (see next slide)
 - Multiple projects to further evaluate core barrels have been discussed and proposed and several are being initiated by EPRI and PWROG
- Future actions
 - Continued plant actions and evaluations according to their corrective action program
 - Consideration of the need for additional interim guidance

Core Barrel Interim Guidance

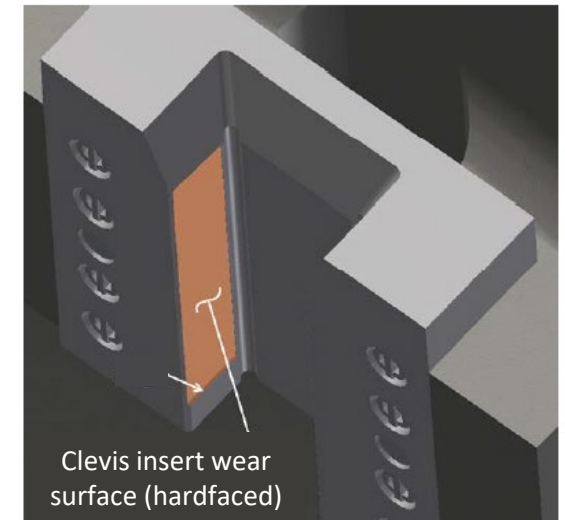
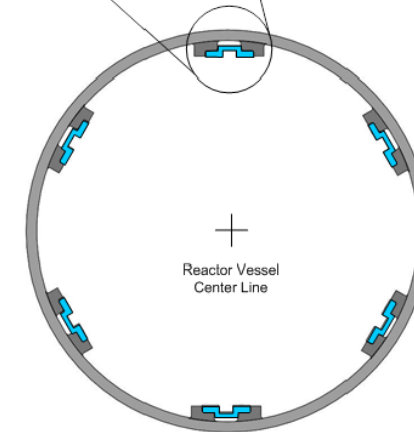
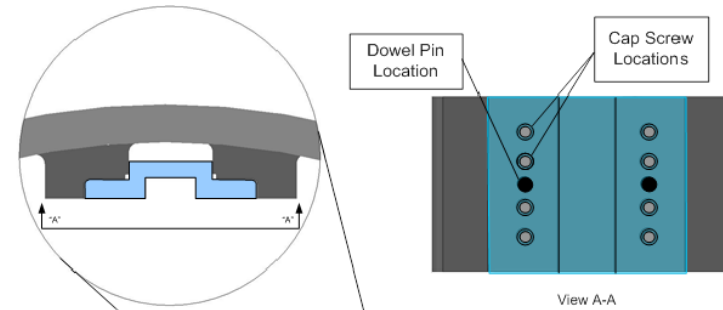
- Promulgated in MRP 2023-005 as NEI 03-08 “Needed” requirements for Westinghouse- and CE-design plants
- Effective starting May 1, 2024 for all planned MRP-227 inspections of the core barrel welds
 - UGW elevated from Expansion to Primary category
 - Eddy current (ET) and ultrasonic testing (UT) examinations added as alternative options to EVT-1
 - UFW, UGW, and UAW inspection coverage increased to 100% of both surfaces of the weld for surface exams (only one side required for a volumetric UT)
 - Expansion components from UFW added as Expansion components from the UGW
 - UAW elevated from secondary expansion to direct expansion from UFW and UGW



Clevis Inserts

Clevis Insert Assembly

- Multiple clevis inserts are bolted to the vessel clevises
 - 2-loop and 3-loop plants have 4 inserts
 - 4-loop plants have 6 inserts
- The clevis inserts allow customized gaps between the reactor vessel and the reactor internals:
 - Safety function: restrict lateral and rotational motion of the lower internals but allow axial and radial thermal expansion
 - Assembly / operational function: guide and align lower internals assembly during installation to ensure proper fit-up
- Wear surface is hardfaced
 - Weld layer of Stellite
 - Machined to the customized fit



Clevis Insert OE

- Welded hard facing can crack
 - Higher hardness and lower ductility than the base metal
 - Would have passed penetrant testing at installation but then cracked due to thermal expansion and contraction
- Operating experience
 - Cracking of hard facing of clevis inserts observed in more than one plant
 - Cracking of hard facing on other components (UCP inserts, UCP alignment pins, valve seats, etc.) observed in multiple plants
 - One plant recently observed clevis insert wear surface cracking, and evaluated in CAP for continued operation
 - Cracking appears to be confined to hard face wear pad, but could not be verified; thus, cracking was conservatively evaluated as if in base metal (design allows a range of hard facing thickness)
- Disposition
 - Hard facing cracking has been observed at multiple plants and locations without evidence of accelerated component degradation; no negative impact to component functionality to date
 - Cracking in the hard facing or in base metal relieves the stresses that could drive continued growth (weld residual stress)
 - Cracking is also expected to blunt in the more ductile base metal
 - Clevis alignment function is tolerant of cracking and wear
 - No changes necessary for MRP-227 guidance; existing guidance is adequate and is working as intended

A blue-tinted photograph of four people, two men and two women, standing together. They are dressed in professional attire, including lab coats and a hard hat. The text 'Together...Shaping the Future of Energy®' is overlaid in white on the image.

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