Pressurizer Heater Sleeve Replacement
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During the San Onofre Unit 3 cycle 13 refueling outage (U3C13) in October 2004, replacement of two Pressurizer heaters and inspection of their Alloy 600 sleeves was planned. The inspection resulted in the identification of axial indications in both heater sleeves and a circumferential indication in one of the heater sleeves. None of the indications were through wall and no external leakage was detected from any heater sleeve during routine bare metal visual examinations. A pro-active decision was made to replace all 30 pressurizer heater sleeves during the Unit 3 cycle 13 refueling outage. This repair resulted in a 53-day extension to the refueling outage. San Onofre captured this industry event in INPO Operating Experience 19405.

The nozzle repair work begins by machining the external heater weld off and then securing each of the 30 heaters in place with a mechanical clamp. Once all of the heater welds are removed, all of the clamps and heaters are removed one at a time consecutively to minimize contamination of the work platform. Following heater removal, half of the original heater sleeve is removed by reaming and cutting the sleeve internally. After the partial sleeves are removed, a bare metal non-destructive examination (NDE) inspection is conducted on the Pressurizer vessel and the new weld pads, and then sacrificial plugs are installed to provide a surface for adding weld pads to facilitate the new RCS pressure boundary. Following the installation of the weld pads, the sacrificial plugs are then machined out. After the sacrificial plugs are removed, new Alloy 690 half sleeves are installed and welded. Finally, the Pressurizer heaters are inserted into the new sleeves and welded. The new primary system pressure boundary is now located on the outside of the Pressurizer.

Photo 1: Original design of NSSS CE Pressurizer

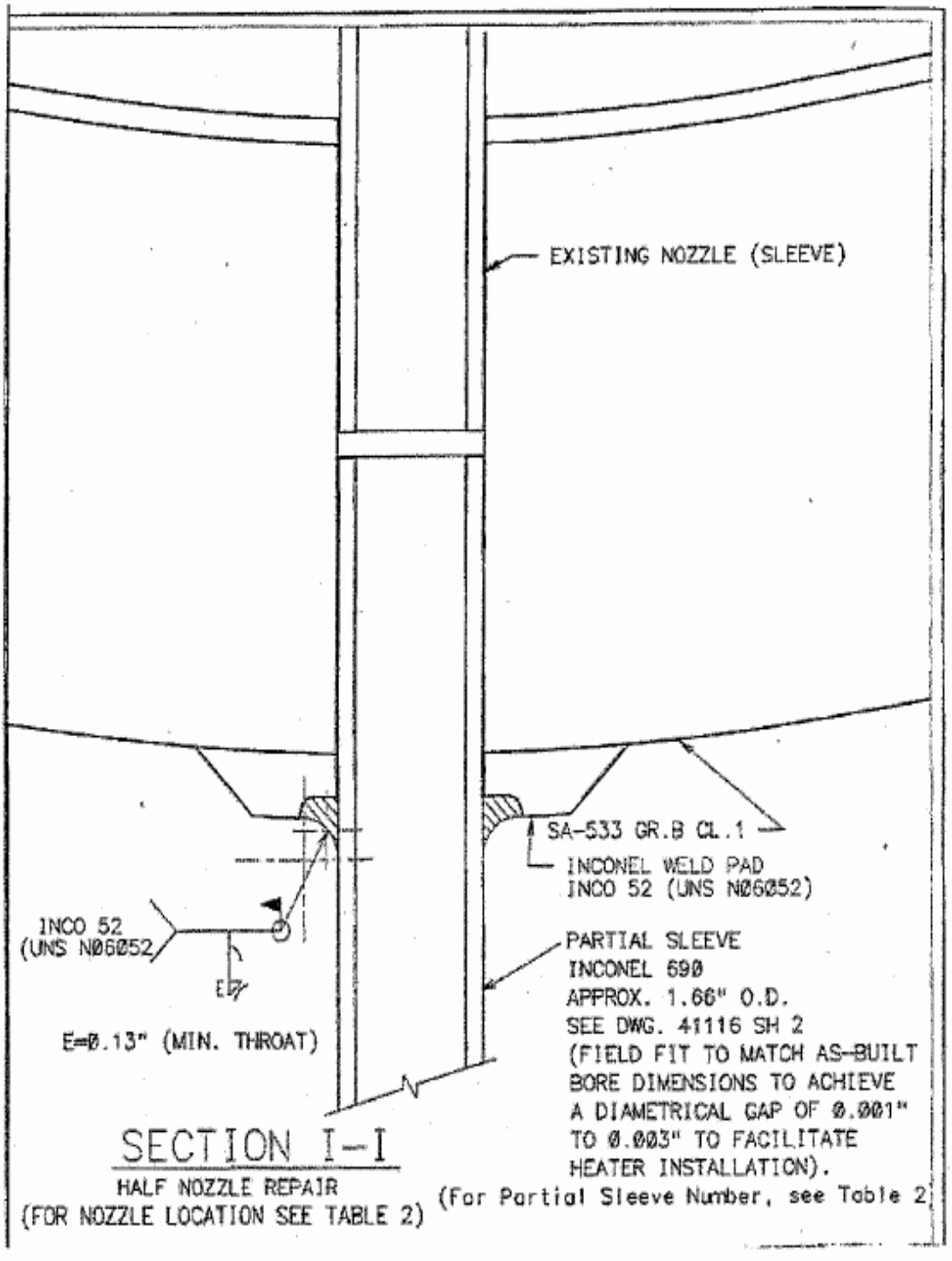
EXISTING NOZZLE (SLEEVE)
SA-533 GR.B CL.1
INCONEL WELD PAD
INCO 52 (UNS N06052)
INCO 52
(UNS N06052
E
E=0.13" (MIN. THROAT)
PARTIAL SLEEVE
INCONEL 690
APPROX. 1.66" O.D.
SEE DWG. 41116 SH 2
(FIELD FIT TO MATCH AS-BUILT
BORE DIMENSIONS TO ACHIEVE
A DIAMETRICAL GAP OF 0.001"
TO 0.003" TO FACILITATE
HEATER INSTALLATION).
SECTION I-I
HALF NOZZLE REPAIR
(FOR NOZZLE LOCATION SEE TABLE 2)
(For Partial Sleeve Number, see Table 2

Figure 1

Major challenges during the repair were radiological exposure and radioactive contamination control. Extensive engineering controls were used to reduce general area dose rates as well as surface and airborne contamination levels. Engineering controls consisted of lead shielding, HEPA ventilation, vacuums, work area containment, and sleeving. Dose gradients in the work area below the Pressurizer required the relocation of dosimetry to the worker's head. Improved work practices, teledosimetry, and temporary shielding on the sleeves, the surge line, and the work platform saved 17 Person-Rem of exposure over the originally dose estimate of 81.6 Person-Rem. Total exposure for U3C13 outage was 64.5 Person-Rem. The highest individual exposure was 1685 mRem. Lessons learned from similar work at Palo Verde were freely shared and were very helpful to SONGS.

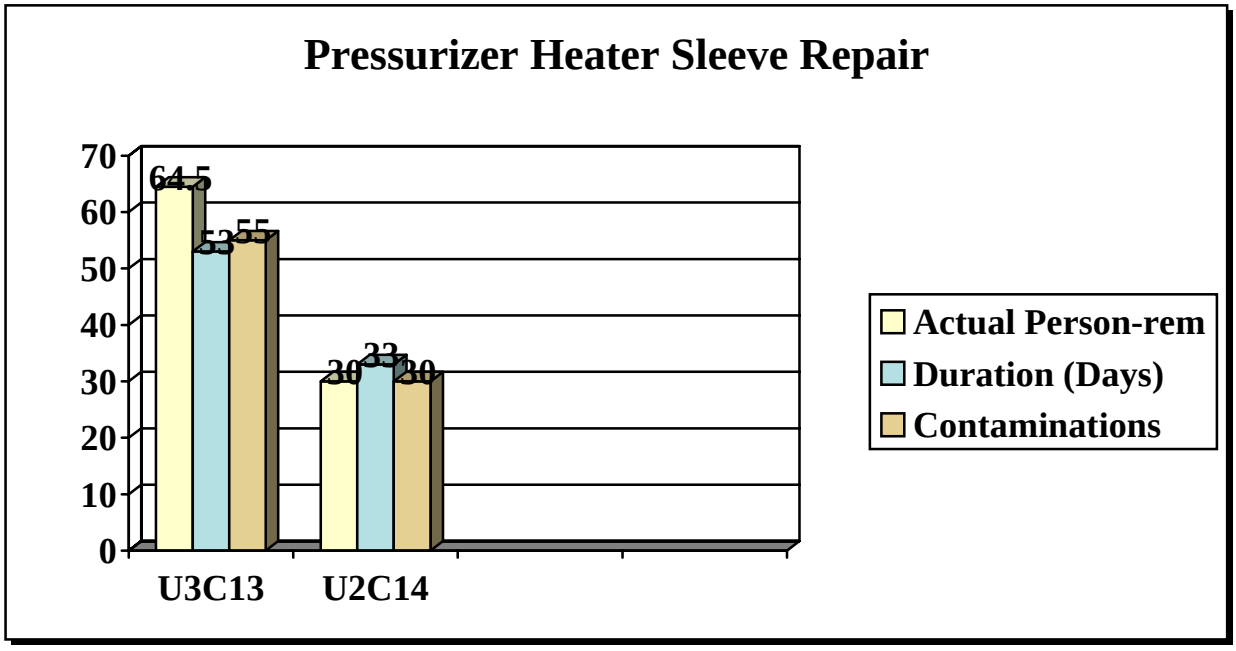

Figure 2

San Onofre U2C14 Refueling Outage began on January 3, 2006 and included the replacement of all 30 Alloy-690 Pressurizer Heater sleeves. Replacement of the Alloy-600 heater sleeves was incorporated into the U2C14 refueling outage after indications of weld cracking were found on two Pressurizer heater sleeves in the U3C13 refueling outage.

Substantial work process improvements were made between the first Pressurizer Heater Half-Sleeve Repair Project in U3C13 and the current U2C14 nozzle replacement. The person-rem estimate for U2C14 was 39 Rem, (Recall U3C13 received 64.5 Rem). With the U2C14 outage currently in progress and the repairs nearing completion, the total expected exposure will be approximately 30 Person-Rem, which will result in a reduction of more than 50% from U3C13. The key successes to a > 50% reduction of overall exposure between the 2 outages were improved tooling used by the vendor, mock-up training, experienced workers and work planning.

Improved tooling designs included the following: square weld pad (Photo: 3) machine versus the round weld pad (Photo: 2) machine, incorporation of engineering controls built into the tooling such as a containment and vacuum on the hydraulic mill (encapsulation tool) that reams out the old sleeve, and a redesign of the tool that severs the internal diameter of the sleeve using a “single point cutter” versus the “Hobby” tool.

Photo 2: U3 Round Weld Pad

Photo 4: U2 Square Weld Pad

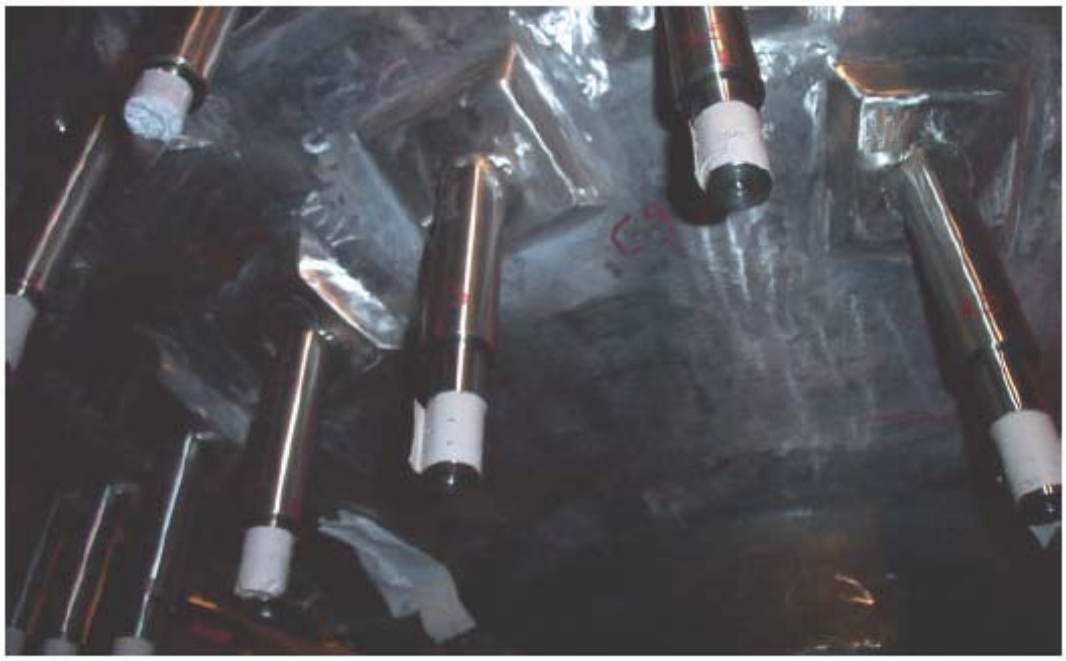

Photo 3: Pressurizer weld pads and new sleeves

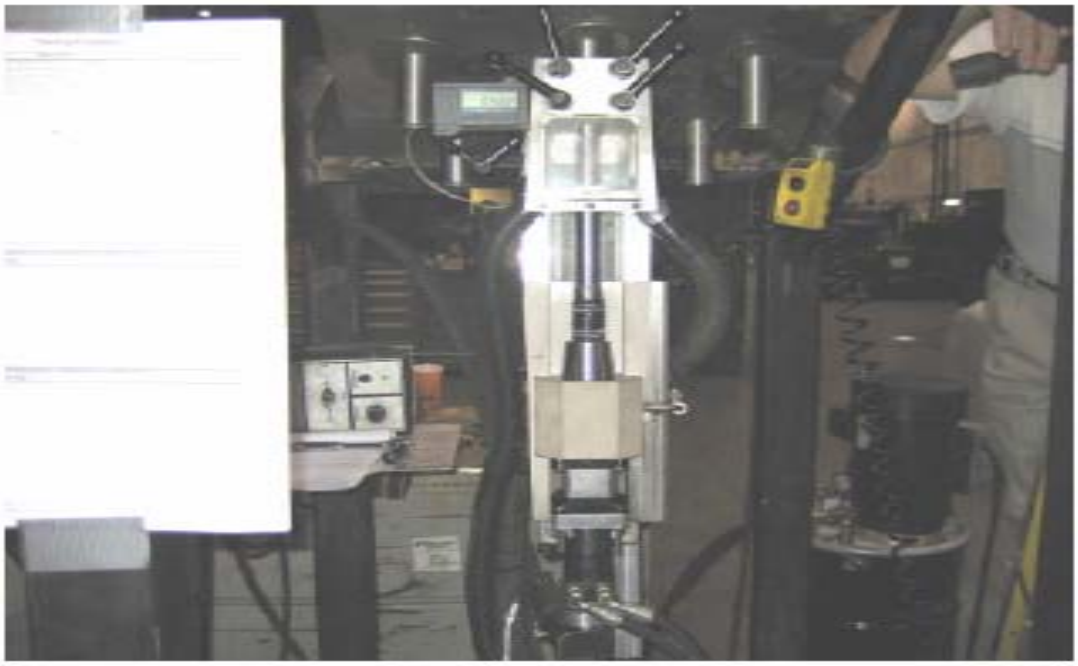

Photo 5: Encapsulation Tool (Reams out old sleeve)

Mock-up training was conducted prior to the U2C14 outage at the welding contractor's facility in Atlanta Georgia. San Onofre representatives included HP Planner's, HP Supervisor, HP Technicians, and Project Management. Welding contractor representatives included welders, machinists, planners, and supervisors. Mock-up trainees were dedicated to the San Onofre Project. Due to the emergent nature of the U3C13 Pressurizer repairs, mock up training was not able to be conducted.

Radiological worker practices by the welding contractor improved significantly from U3C13 to U2C14. A majority of the welding work force came to San Onofre U2C14 outage from the recent Palo Verde Nuclear Generating Station (PVNGS) Pressurizer Heater Sleeve Repair Project. The use of experienced workers resulted in significant radiological dose reduction. In addition to the experienced workforce, a PVNGS ALARA consultant and a contractor ALARA representative were utilized.

The Pressurizer Heater Sleeve Repair Project proved to be a very challenging radiological job. Through the use of improved tooling, which included the use of remote welding equipment, engineering controls and a well trained, experienced work force we were able to significantly improve our ALARA performance.

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