

CENGSM

a joint venture of



**Constellation
Energy**



CALVERT CLIFFS
NUCLEAR POWER PLANT

2012 Unit 1 PZR Heater Replacement Project

Calvert Cliffs NPP



- Two Unit Combustion Engineering Site
- Commercial Operations :
Unit 1 – 1973
Unit 2 – 1975
- Two Year Fuel Cycle
- Net MW(e) – approx. 890
Mwe per unit

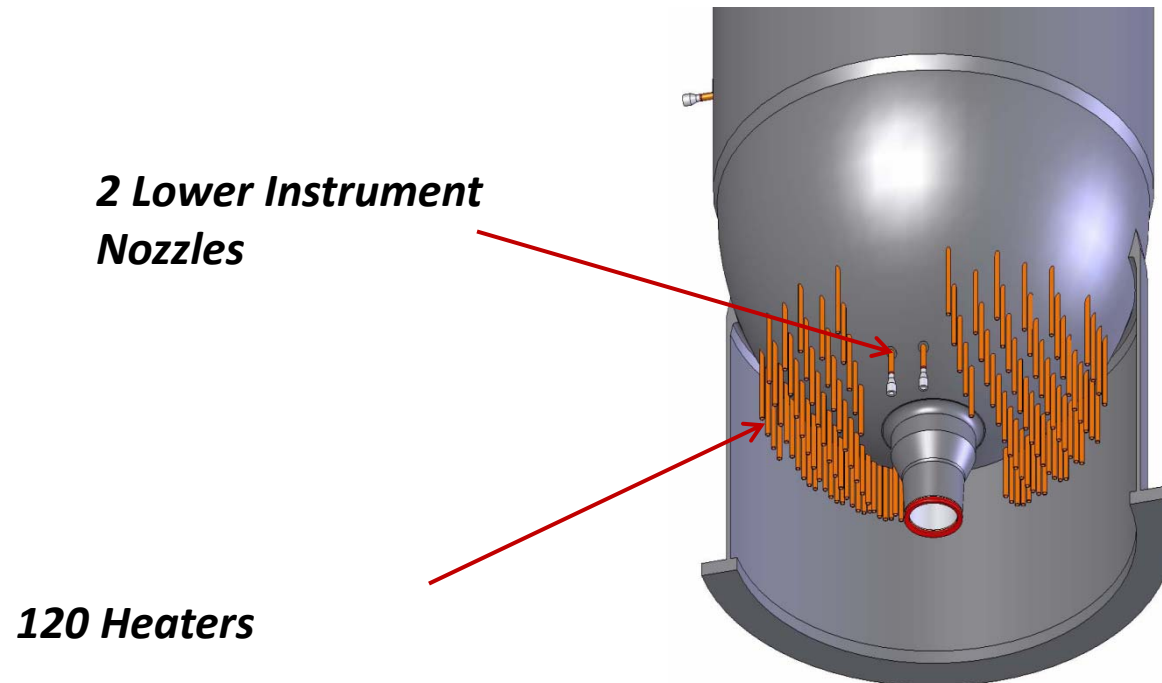
2012 U1 RFO

PZR Heater Replacement Project

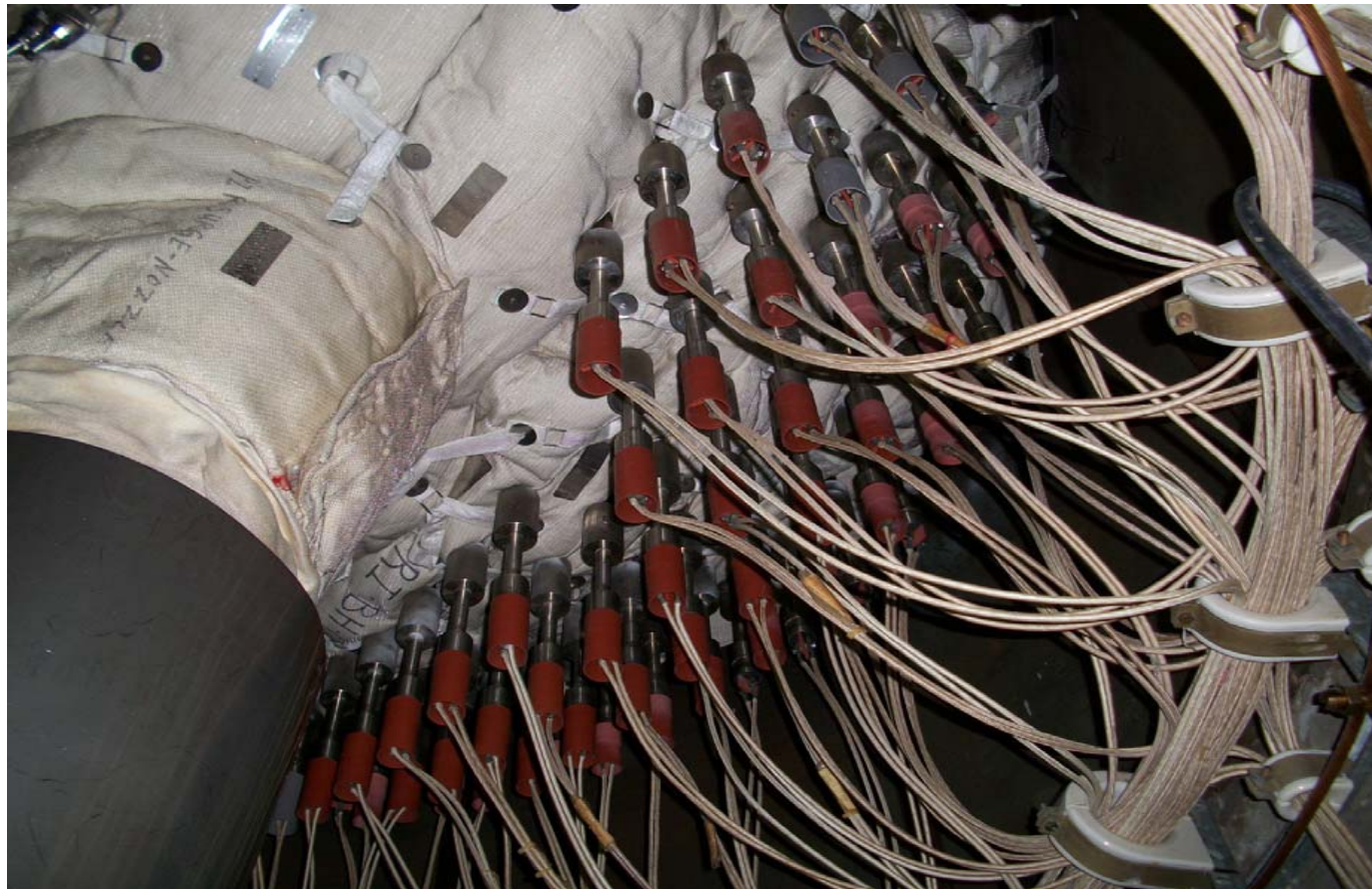
Replacement of 120 Pressurizer Heaters

- Interference Removal
- Remove 117 Old Heaters - 3 previously plugged
- Install Plugs – then Refuel Reactor
- Remove plugs and existing heater sleeves
- Tube cut and counter bore nozzles
- Insert new heaters and heater sleeves (temper bead weld)
- Mechanically prep welds
- Perform NDE (UT & PT)

Visual of Bottom of Pressurizer



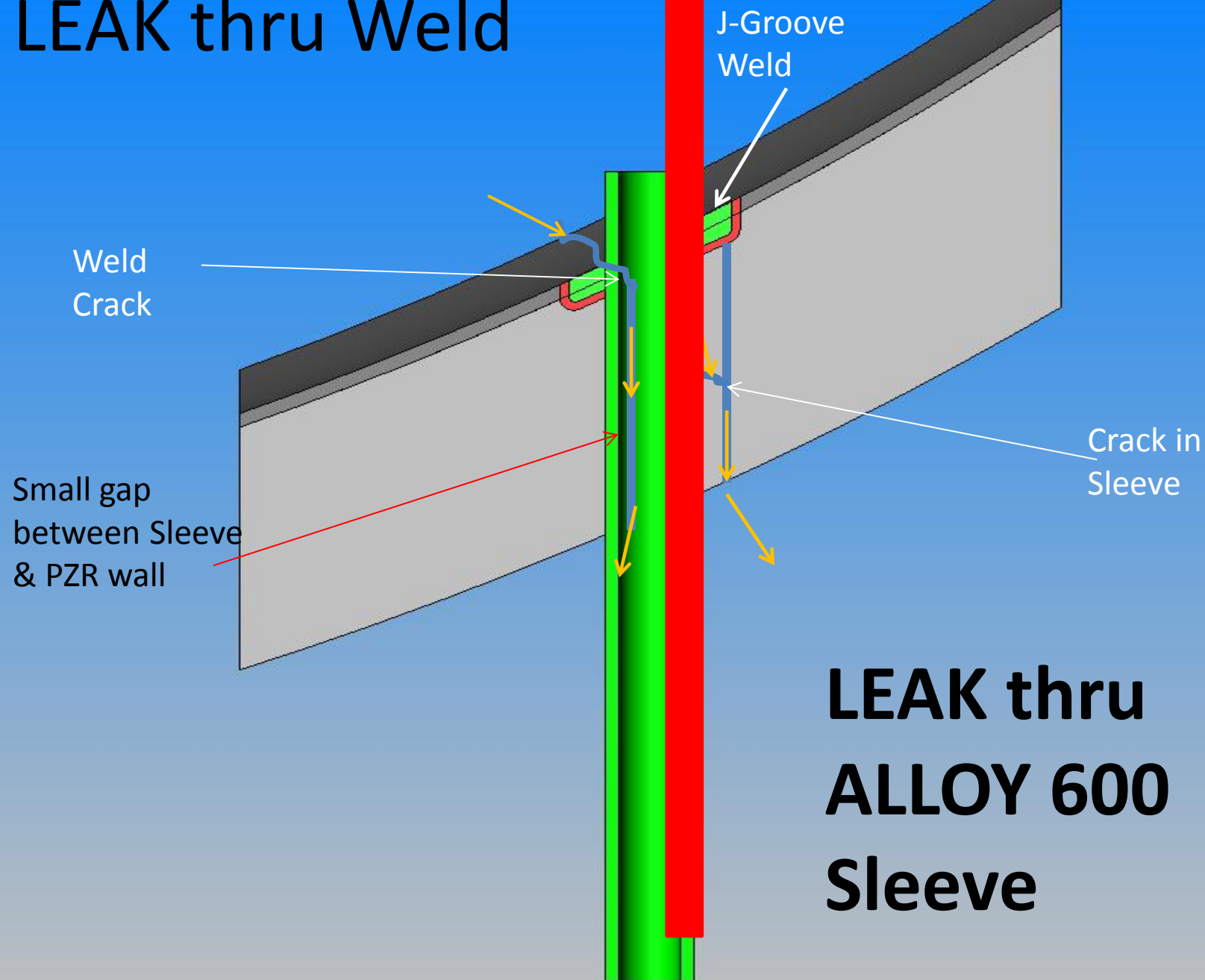
Old PZR Heater Nozzles



Alloy 600 material is susceptible to Cracking in Boric Acid environment

- **Cracks develop leading to failure**
- **Phenomenon: Primary Water Stress Corrosion Cracking (PWSCC)**
- **Choice Material: Alloy 690 and SS**
- **Choice Weld material: SS (Grade 316)**

LEAK thru Weld



Picture of MNSA Clamp



Mechanical Nozzle Seal
Assembly

Mechanically seals leaking
nozzles to prevent leakage
at potential at susceptible
nozzle sites.

A quick method to correct
small bore system nozzle
leaks.

Why replacing Alloy 600 sleeves?

- **MRP-139 mandates periodic inspections for leakage (expensive, dose)**
- **History of Alloy 600 Heater sleeve failures (expensive to fix)**

Replacement of Alloy 600 sleeves is cost effective

**Instrument -
MNSA (2)**

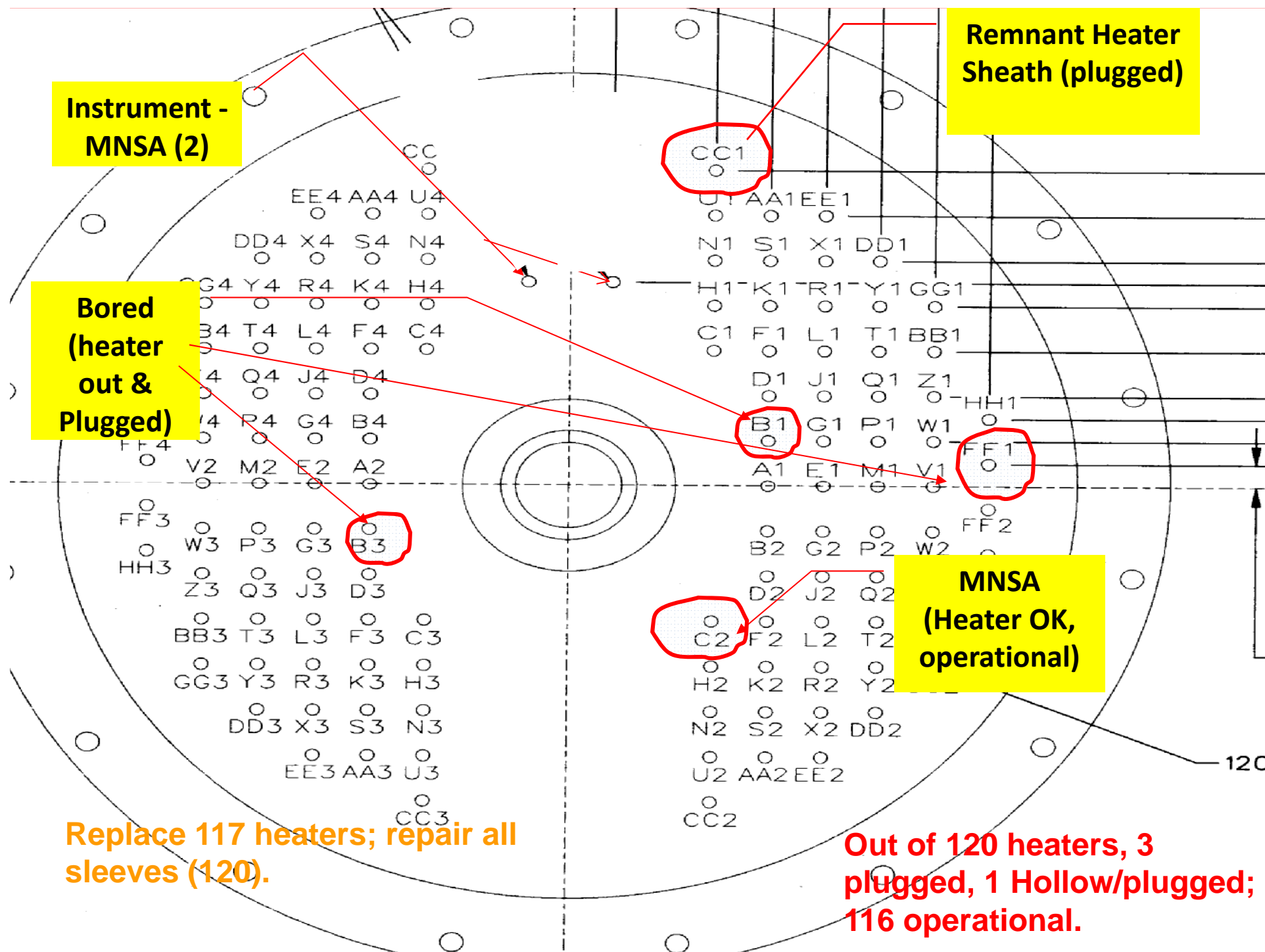
**Bored
(heater
out &
Plugged)**

**Remnant Heater
Sheath (plugged)**

**MNSA
(Heater OK,
operational)**

**Replace 117 heaters; repair all
sleeves (120).**

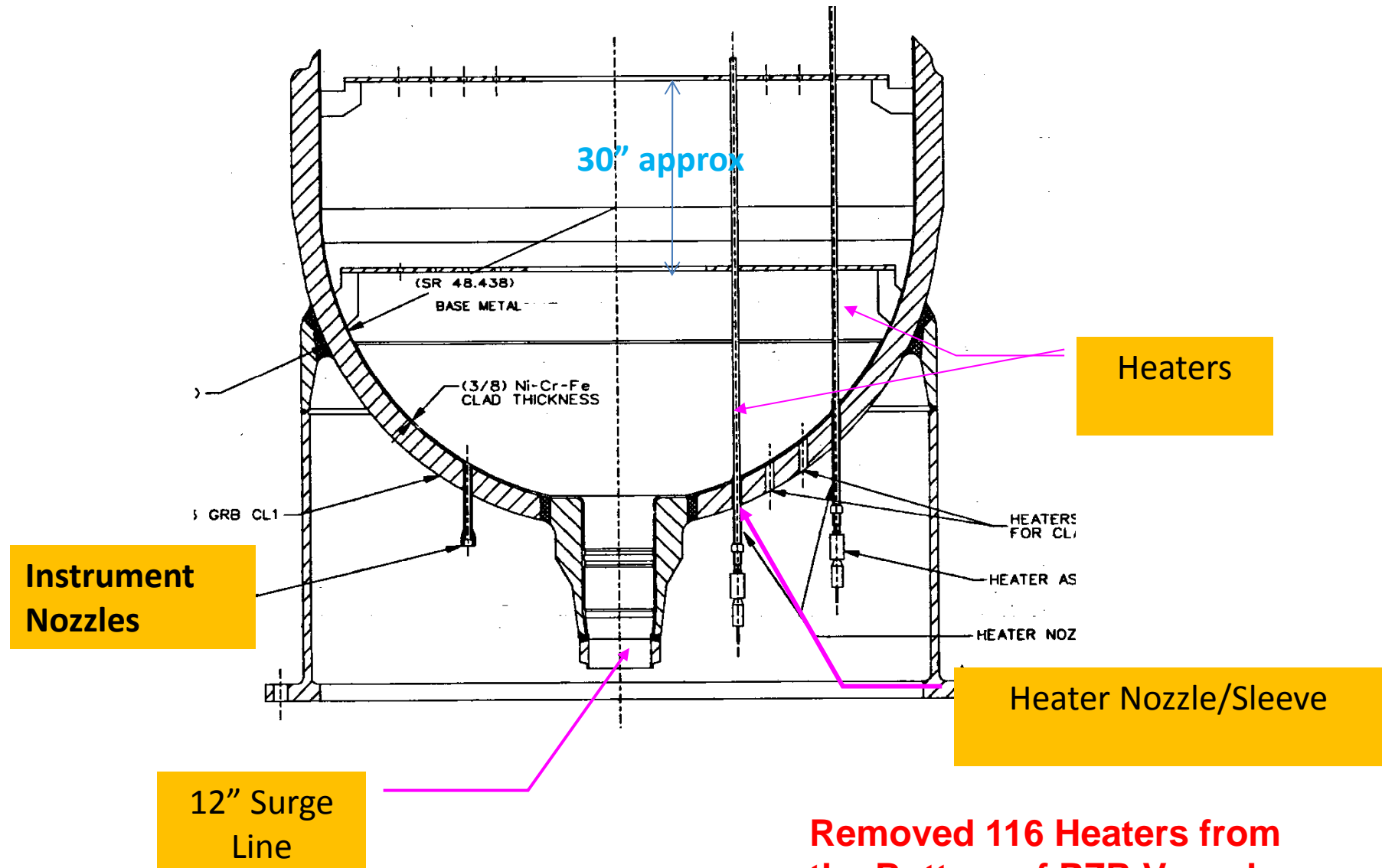
**Out of 120 heaters, 3
plugged, 1 Hollow/plugged;
116 operational.**



Replacement Materials

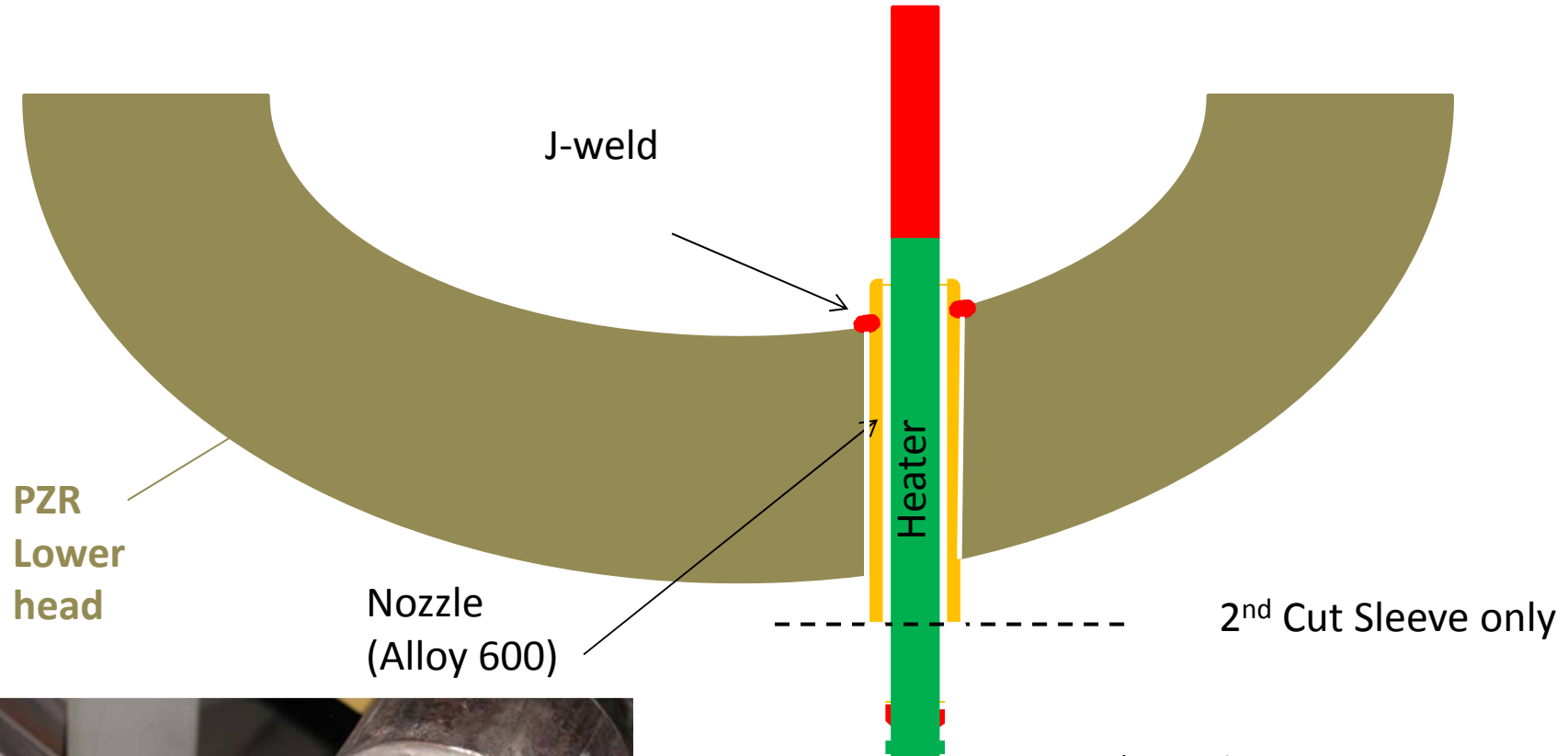
- *Replace/repair **Alloy 600** heaters sleeves with **SS** Sleeves*
- *Replace /repair **Alloy 600** lower instrument nozzles with **SS** nozzles*
- *Replace **Watlow Heaters** with **Thermocoax Heaters***

Engineering : AREVA

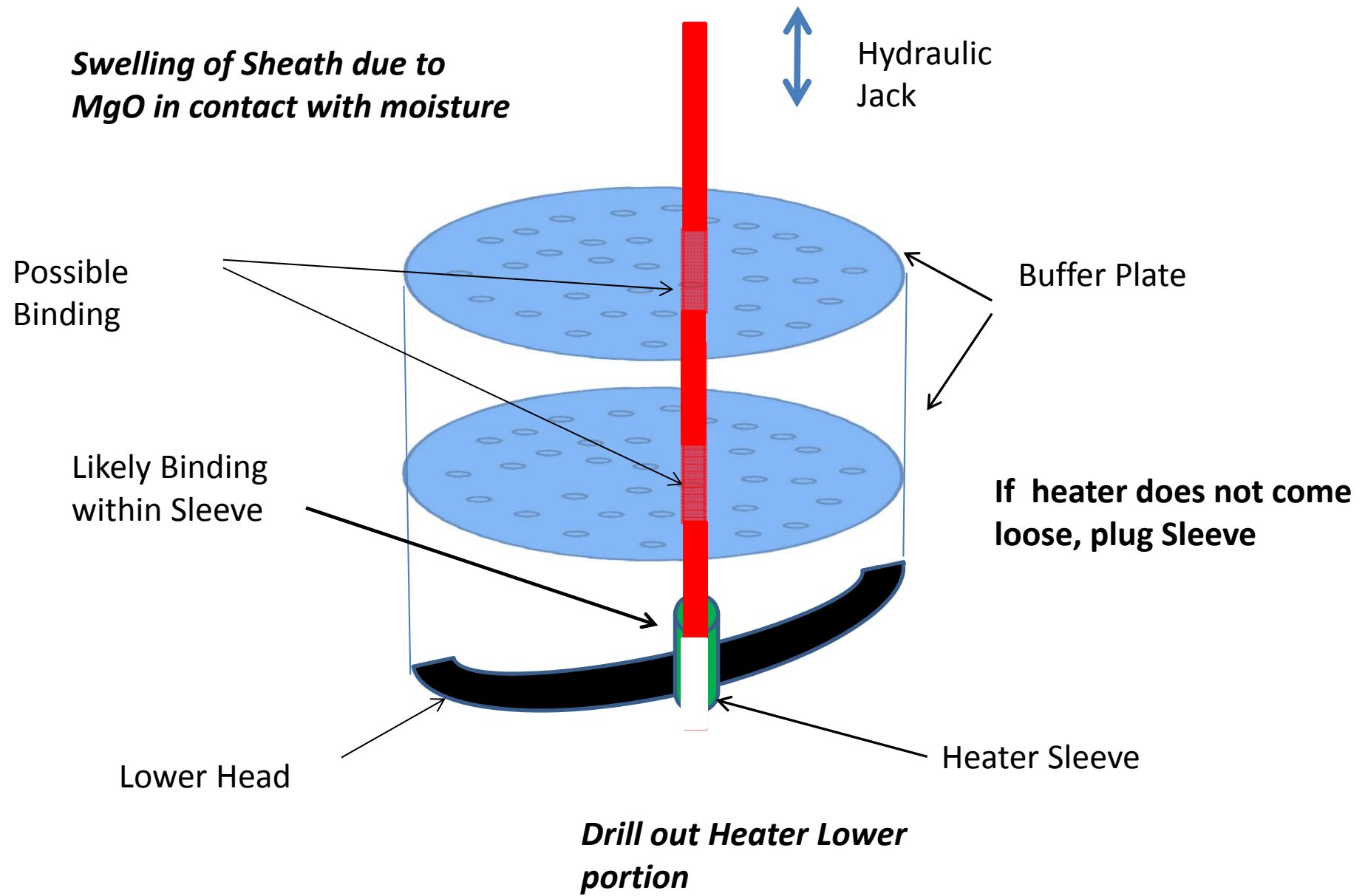


**Removed 116 Heaters from
the Bottom of PZR Vessel**

Heater Removal



Remove heater by a
hydraulic puller

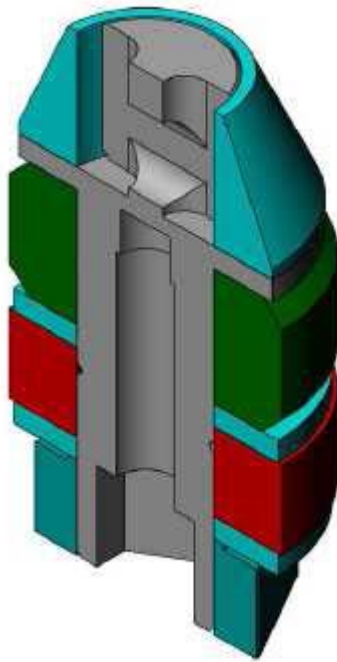


Special heaters
(9)

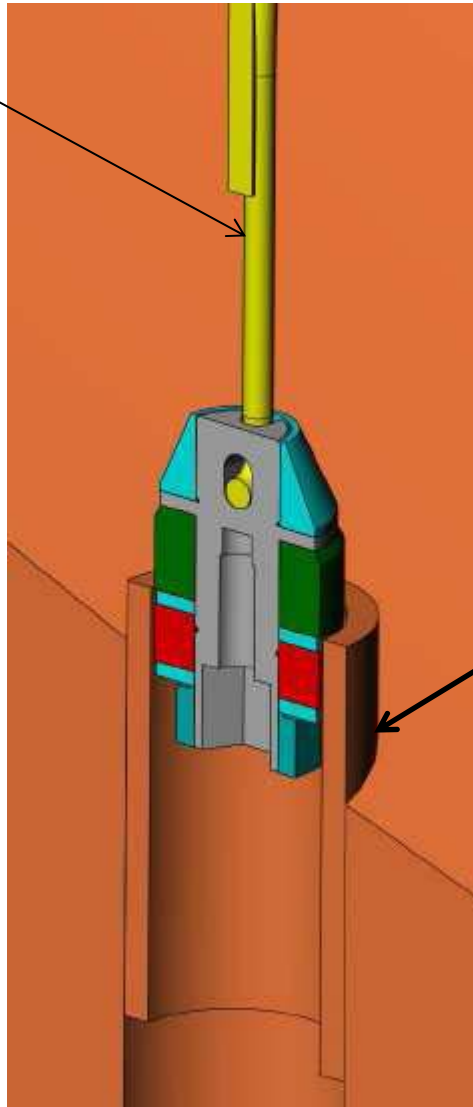
Surge Line

Surge Line

Hook to retrieve



Plug



Tested 50 psig (5 times more than actual pressure).

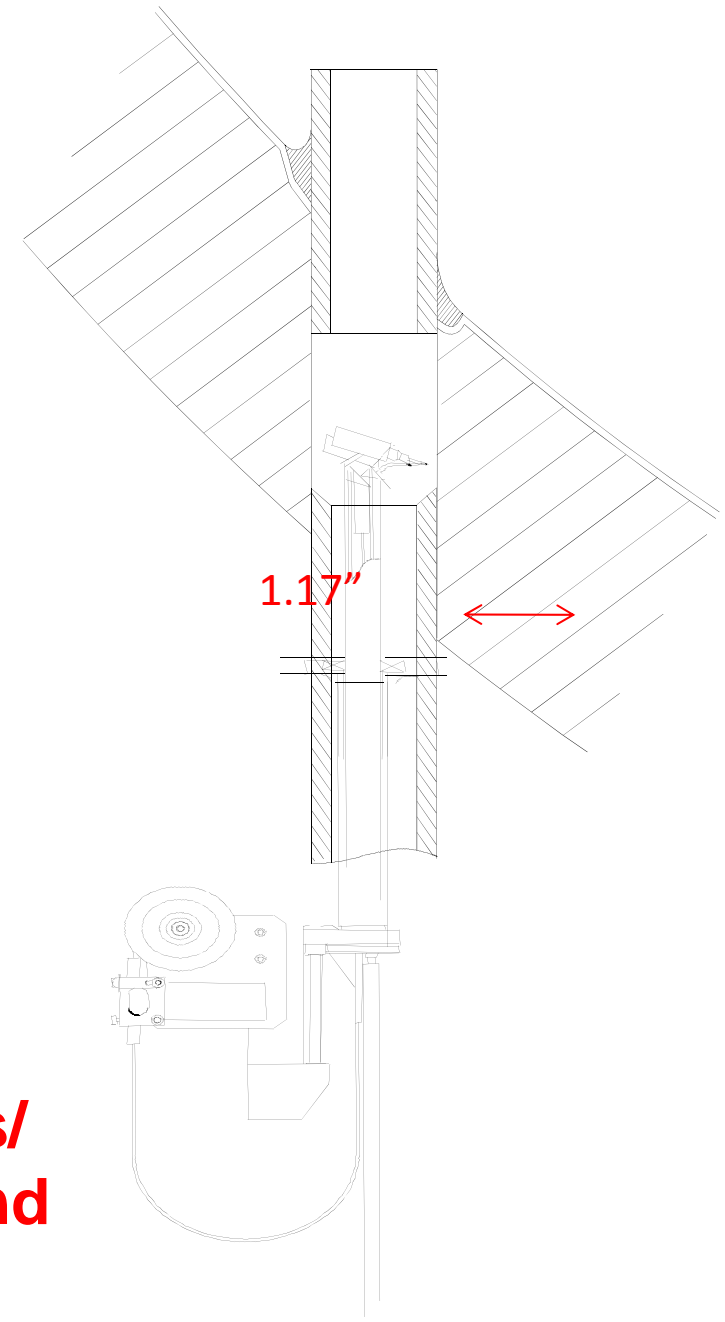
➤ Then Refuel Reactor

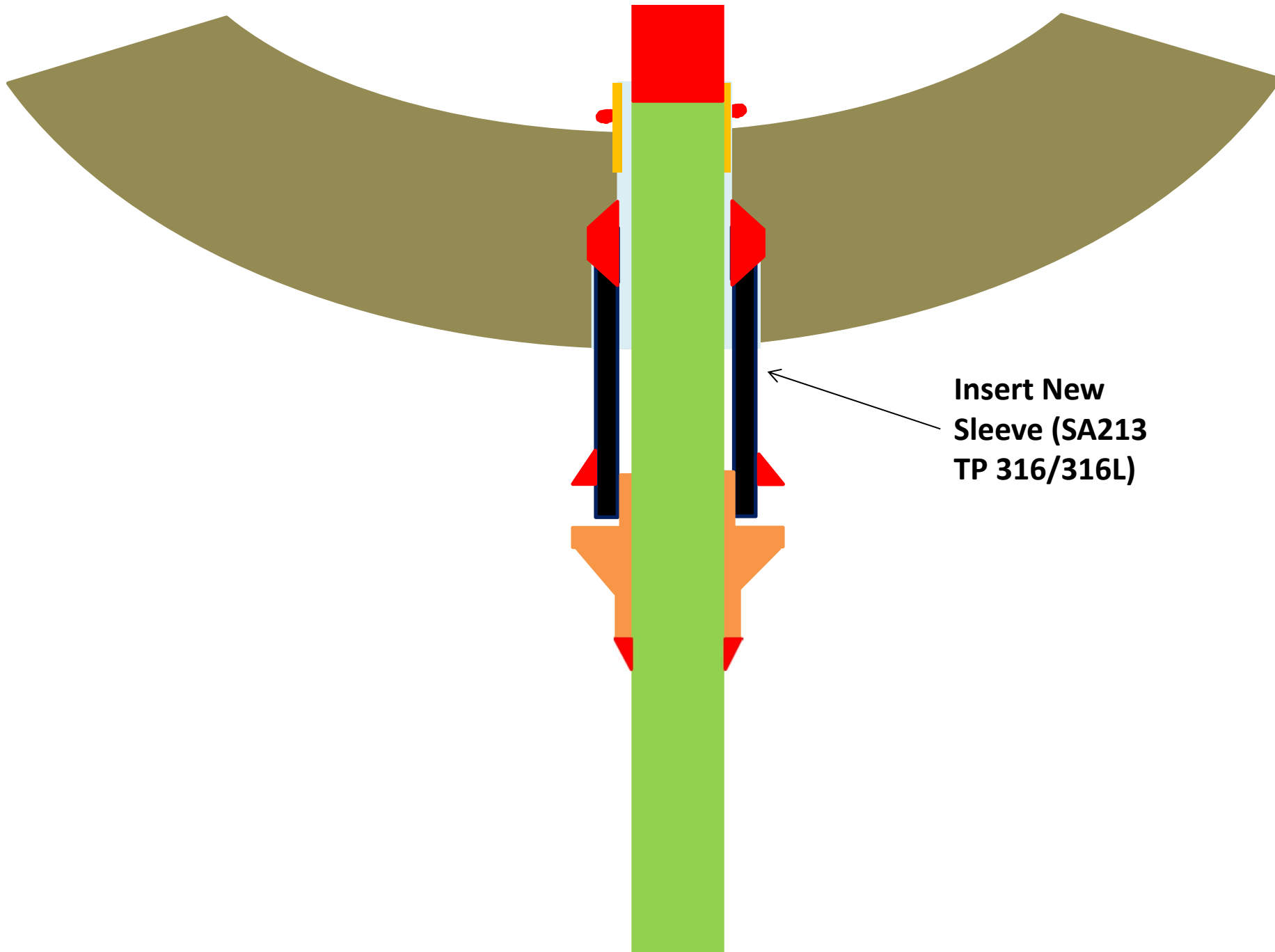
Sleeve

Welding

Automated Welding

- **Narrow Sleeve opening (ID: 1.17"):**
custom made welding machine
- 6 hours per weld
- 48 hours hold
- **Weld Flaws: If UT & PT for defects/
flaws, if found need to excavate and
start all over**





**Insert New
Sleeve (SA213
TP 316/316L)**

New Sleeve

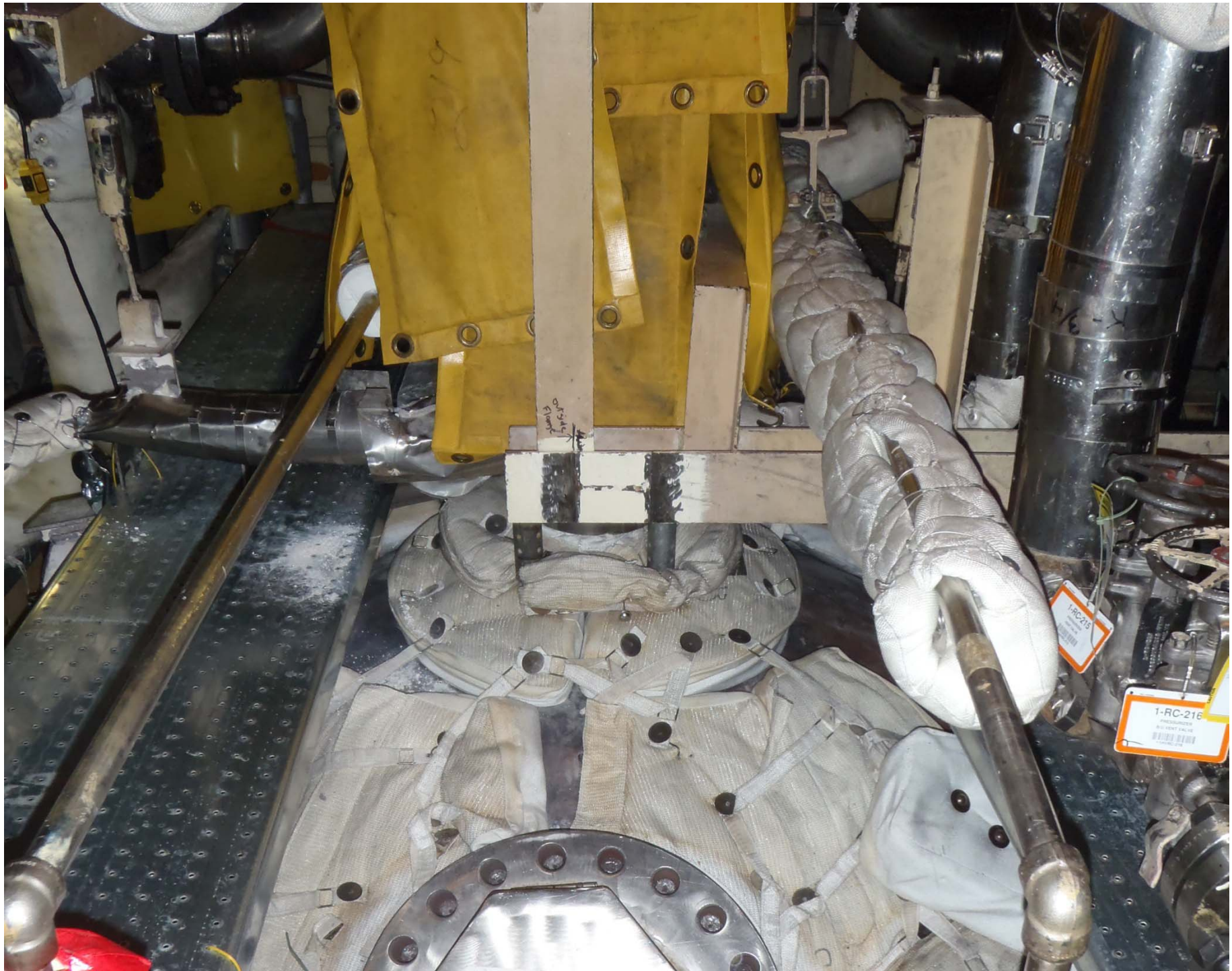


New Sleeve in Place



Weld Machine

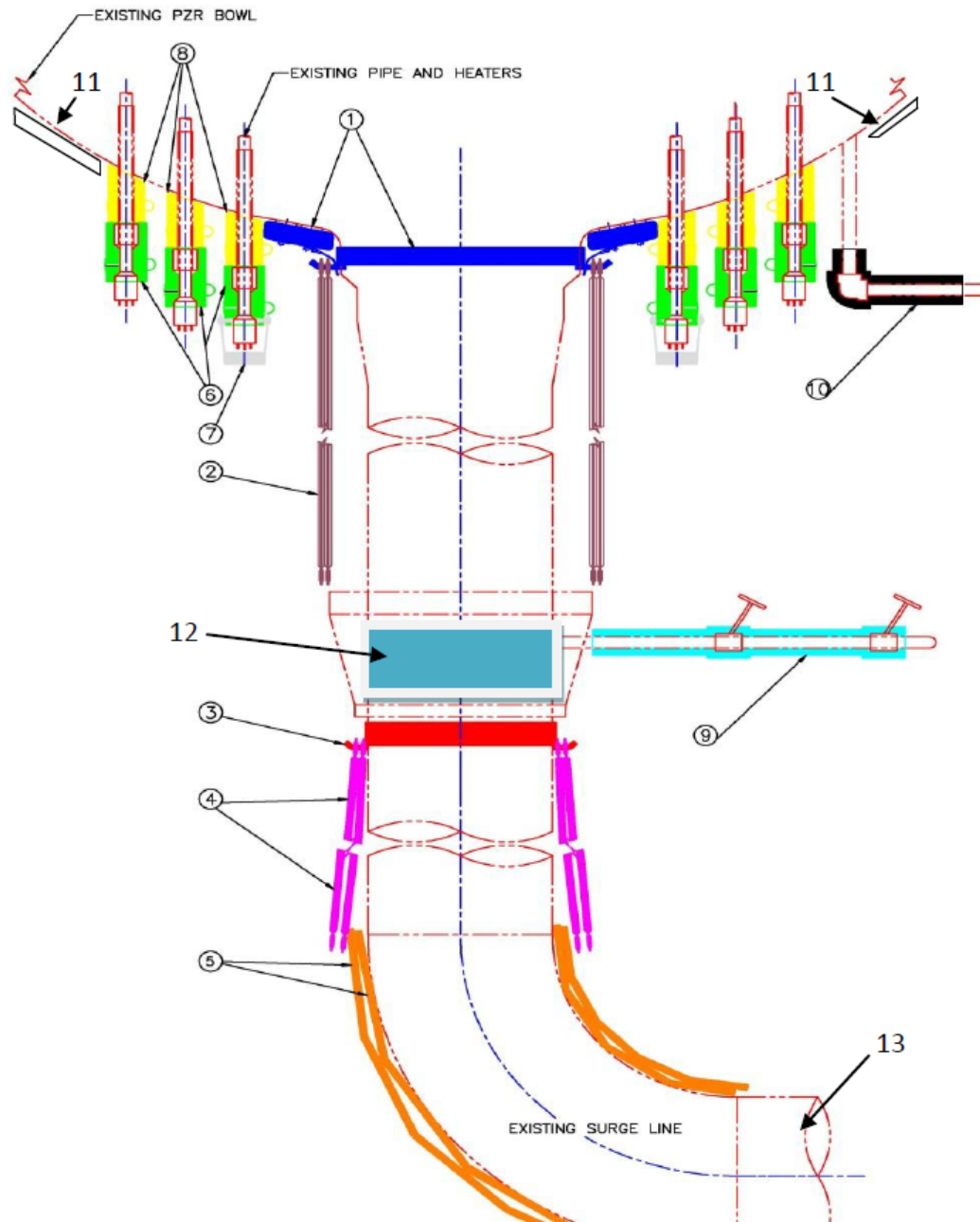




ALARA

- 2 ALARA specialists and dedicated RP techs for Project.
- Pressurizer Heater Replacement
 - Dose Estimate 61.5R, Actual 40.5 rem
 - PCI goal ≤ 10 , Actual 4

Shielding Locations



1. Shielding support ring and segmented nozzle shield

2. Upper surge line (LWB)

3. Shielding support ring

4. Surge line below tool

Support ring (LWB)

5. Surge line elbow (LWB)

6. Heaters (Molded Tungsten)

7. Not used

8. Heater sleeves (Tungsten)

9. 3/4" sample line and valves

(Molded Tungsten)

10. Two 1" level lines

Molded Tungsten)

11. Magnetic tungsten applied

After sleeves are removed

12. Tungsten wrap

13. Surge line horizontal

Shielding PZR Nozzles



Tungsten Shielding on Level Indication Instrument Lines



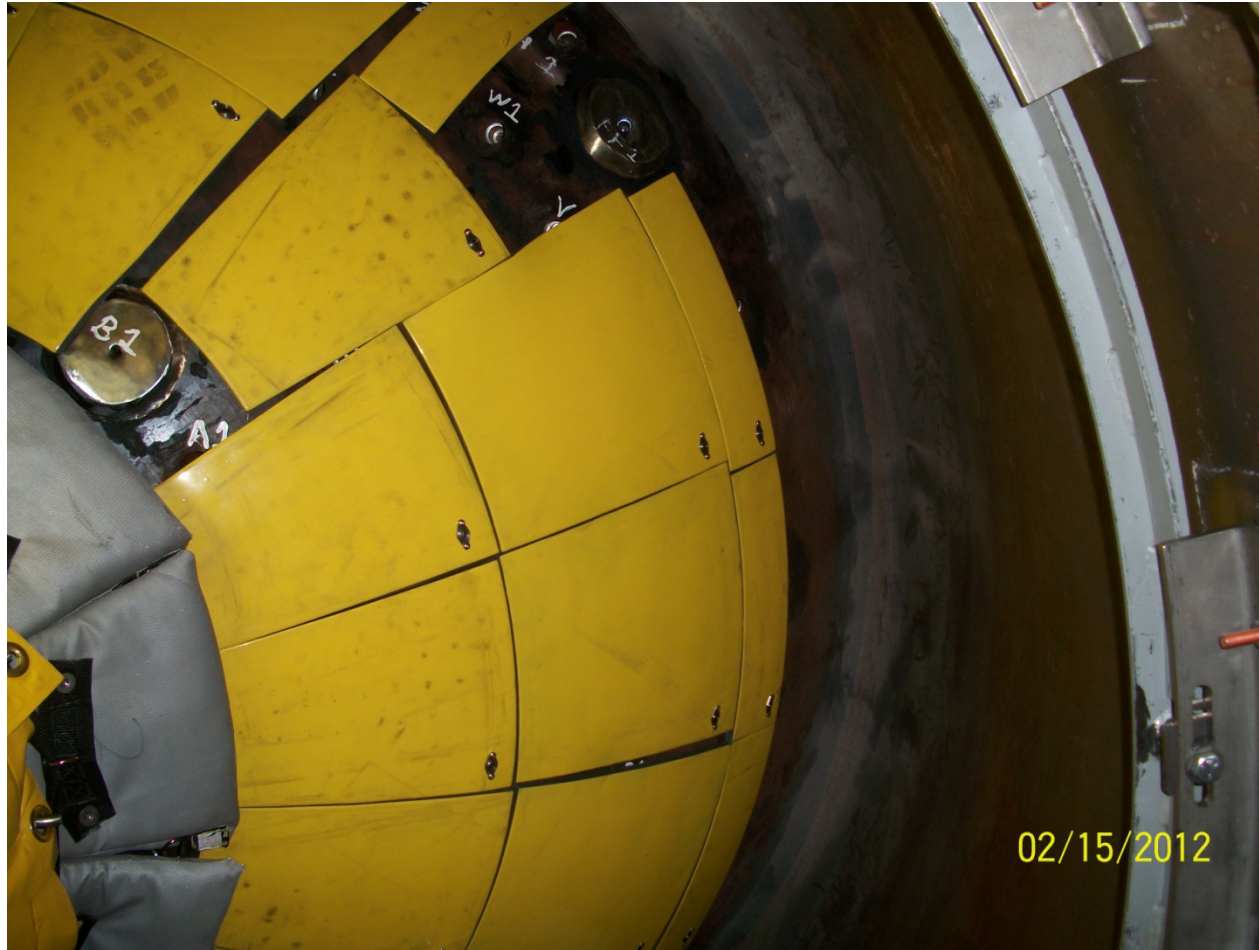
Tungsten Shielding on Sample Lines



Lead Shielding on Surge Line



Magnetic Tungsten Shielding on Bottom of PZR Bowl



Shielding Impact on Dose Rates

Pre-shielding Dose Rates

- Surge Line:
Contact - 120 to 260 mrem/h
General Area – 60 to 90 mrem/h
- Heaters: Bottom of PZR
Contact – 400 to 800 mrem/h
General Area – 40 to 80 mrem/h
- PZR Platform:
60 to 100 mrem/h

Post Shielding Dose Rates

- Surge Line:
Contact – 20 to 40 mrem/h
General Area – 10 to 15 mrem/h
- Heaters: Bottom of PZR
Contact – 350 to 700 mrem/h
General Area – 35 to 75 mrem/h
- PZR Platform:
10 – 15 mrem/h

Worker Making Repairs to Robotic Equipment



PCI's

- PCI High Impact Team (HIT).
- PCI Prevention Plan.
- Workers undressed at PZR step-off-pad in Containment and wore scrubs to the SOP outside containment for removal of booties and decontamination monitoring.

PZR Project Industry PCI's

Plant	SONGS U2	SONGS U3	St Lucie U2	Sizewell B	CCNPP
PCI's	30	55	20	63	4

PCI High Impact Team (HIT)	PCI Reduction Plan
Just In Time Training.	Bullpen and HEPA vent units to contain airborne and contaminated area.
Assistance with worker removal of PC's, lapel air samplers and respirators.	OREX Extreme PC's for high contamination work.
Continuous remote RP coverage.	Good Housekeeping and scheduled decon of platform.
General walkdowns required hardhat and faceshield.	One worker PCI from contaminated headset.
3M Visor (with Blower)	MSA Advantage PAPH

PCI Lessons Learned

- Worker performing walkdown underneath the PZR received Level 1 PCI - 4800 ncpm particle on the his scrubs. Workers were instructed to very careful during undress process to ensure that particles to not migrate from PC's to their scrubs.
- One worker PCI from contaminated headset.
- Had to stop work during heater removal due to high contamination levels on the platform due to reuse of PZR heater removal tool sleeves covers.

PZR Project Industry Dose

Plant	SONGS U2	SONGS U3	St Lucie U2	Sizewell B	CCNPP
Dose (rem)	30	64.5	11.5	22.4	40.5
# Heaters	30	30	30	80	120

Tungsten Shielding on old PZR heater sleeves, sample lines, & level indication sensing lines.	Use of EDEX – Effective Dose Equivalent – 4900 hours of work in EDEX.
Lead Blanket Shielding on Surge Line & Spray Lines.	Shielded drums for old sensing lines and sample lines.
PZR flush via initiating PZR backup heaters before planned RFO.	Three HEPAs – (1) 1600 cfm, & (1) 1000 cfm under PZR, (1) 700 cfm on PZR manway.
Remote continuous RP Coverage & Mock-up Training.	Shielded boxes for old heaters.



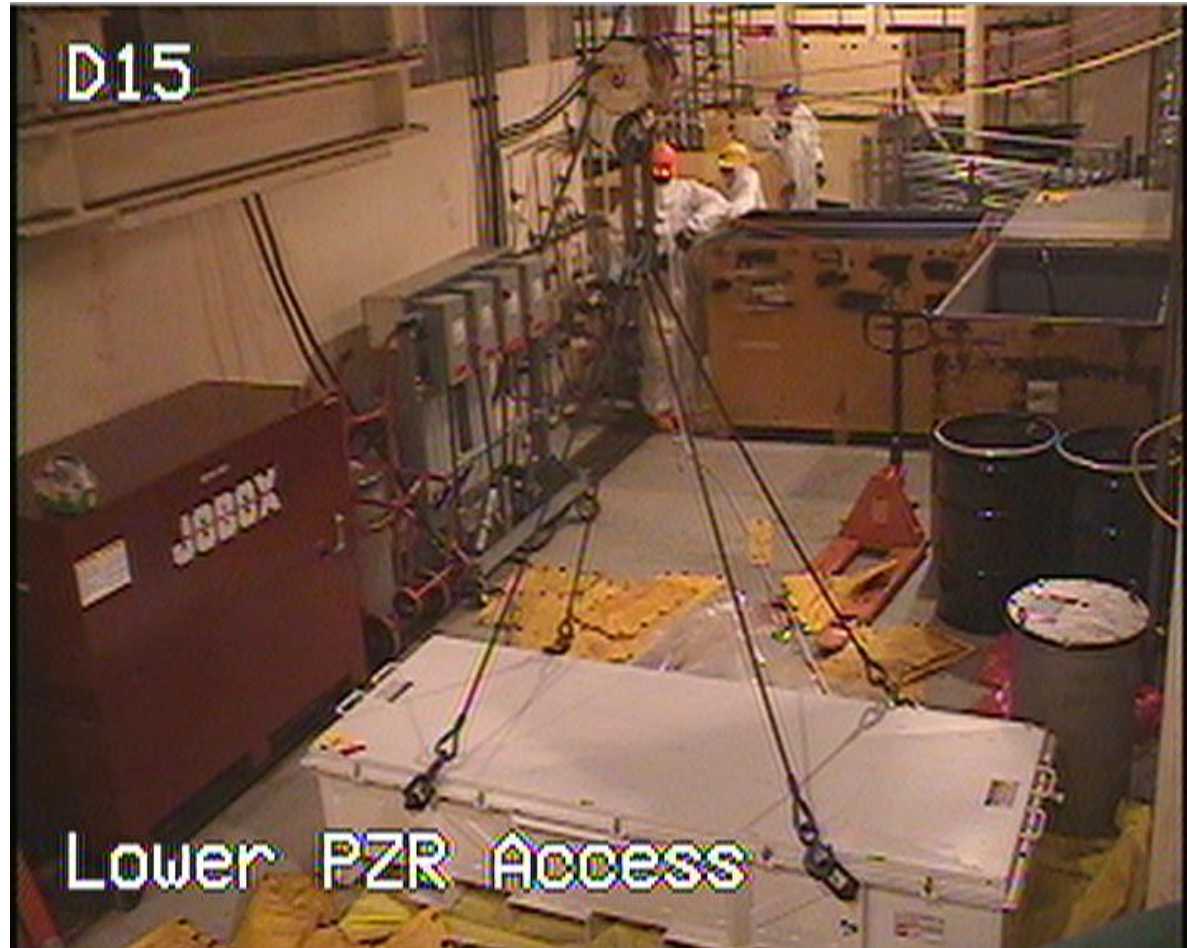
ALARA Lessons Learned

- Initial dose rates on old PZR Heaters were higher than anticipated.
- Reliability issues with automated welding equipment.
- Mid-way through the project water was removed from the surge line to support other work not related to the PZR. This increased G/A dose rates for one week.

ALARA Lessons Learned

- One PZR Plug pushed into the PZR vessel during NDE, forced out by the remote PT tooling which did not have hard stops on it to prevent contact with the plug. PZR was empty at the time.
- The plug was removed from the PZR via the upper PZR manway.

Shielded Boxes for Old Heaters



PZR Heaters Dose Rates (3) Times Higher than Expected



Questions?



Guiding the way