Elevated Airborne Iodine Levels & Dose Rates in L2R14

LaSalle Nuclear Station

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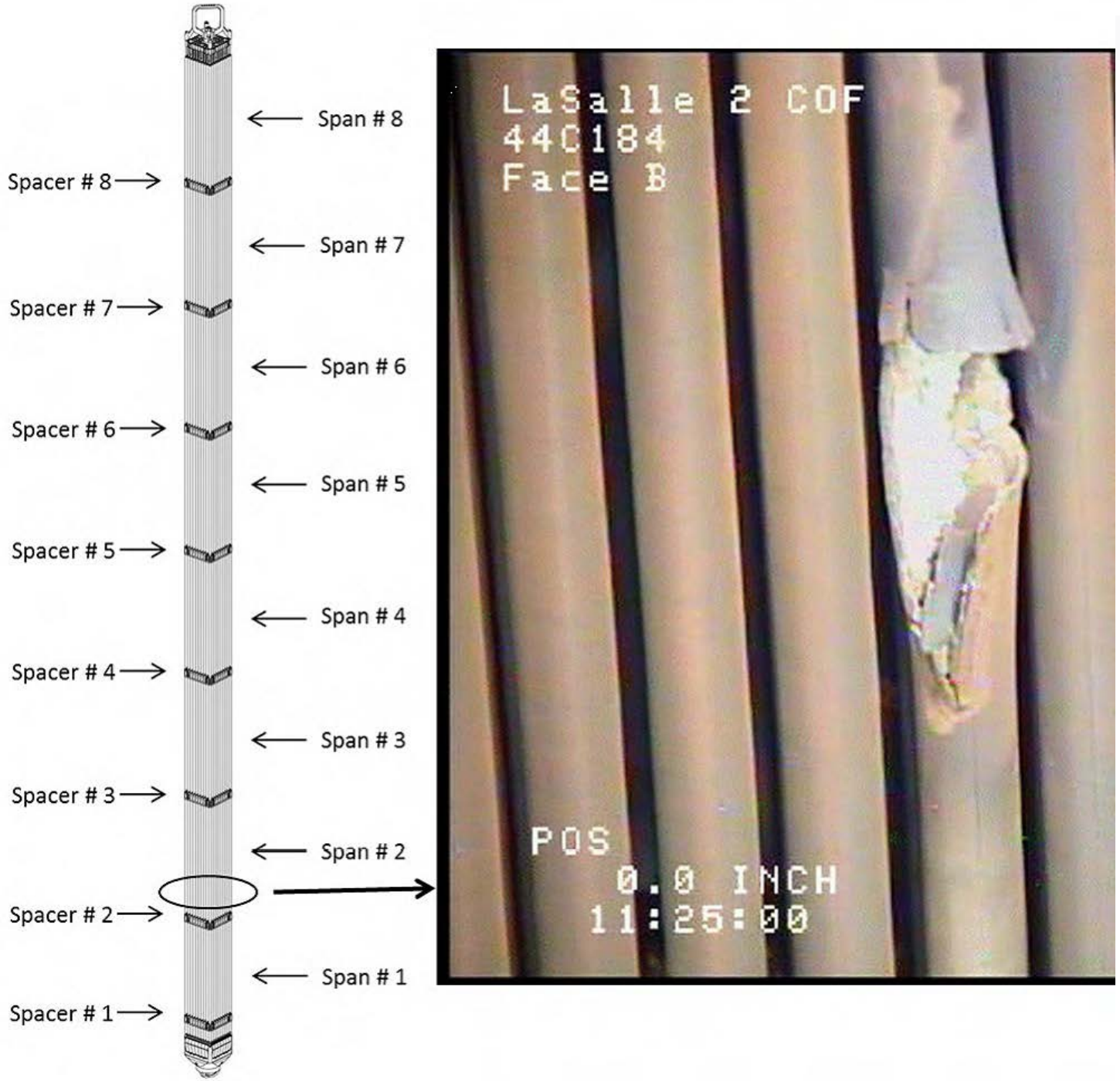
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Elevated Airborne Iodine Levels & Dose Rates in L2R14

The Investigation team included expertise from:

- Finetech, Inc.
- Radiological Solutions, Inc.
- EPRI
- Exelon Corporate Chemistry
- Exelon Corporate Radiation Protection
- General Electric Hitachi
- Global Nuclear Fuels
- Chemistry
- Radiation Protection
- Operations
- Reactor Engineering
- System Engineering
- INPO Brief/Review

Elevated Airborne Iodine Levels & Dose Rates in L2R14

Investigation identified two separate events requiring emergent responses:

- High Airborne Iodine attributable to the fuel failure.
- Elevated Dose Rates due to high Cobalt source term.

Airborne Iodine Levels in L2R14

- Root Cause – Failed Fuel
- Contributing Causes
  - Changed Iodine Volatility
  - Increased Iodine Carryover Deposition
  - Inadequate Procedural Guidance
  - Ineffective Management

Elevated Dose in L2R14

- Root Cause – High Cobalt Inventory
- Contributing Causes
  - OLNC – unexpected response
  - Increased EOC Core Flow
  - TR-81 Outage
    - HWC Trips
    - RWCU Isolation

Airborne Iodine Levels in L2R14

- Resulted in:
  - Outage Work Delays
  - Outage Work Scope Deferrals
  - Resource Burden
- Areas most affected:
  - Refuel Floor >.3 DAC (0.3 – 4 DAC)
  - Low Pressure Turbine >.3 DAC (0.3 – 90 DAC)

Airborne Iodine Levels in L2R14 Causes

- Fuel Leak – *Root Cause*
  - Source of Iodine fission products
  - Sustained operation with failed fuel caused higher End of Cycle of reactor coolant I-131 inventory than previous cycles

Airborne Iodine Levels in L2R14 Causes

- Changed Iodine Volatility – *Contributing Cause*
  - Deposition on Steam Side Components
  - Subsequent Slow Release affecting DAC
  - Potential Precursors Identified
  - Further Study Required

Airborne Iodine Levels in L2R14 Causes

- Increased Iodine Carryover Deposition (due to Cycle Operating Differences) – *Contributing Cause*
  - 2.5 x more iodine deposited on steam side components during last week of operating cycle in L2C14 vs. L2C09
  - L2R14 iodine inventory greater by a factor of 2 from L2R09 due to cycle operating differences
  - I-131 – major nuclide contributor on LP Turbine Low Pressure Blading

Airborne Iodine Levels in L2R14 Causes

- Inadequate Procedural Guidance – *Contributing Cause*
  - Inadequate guidance for assessing iodine trends for outage impact
  - Guidance needed for trending DEI and Iodine carryover for outage impact regardless of fuel integrity status.

Airborne Iodine Levels in L2R14 Causes

- Ineffective Management of L2CR14 Failed Fuel – *Contributing Cause*
  - Projections “Bounded” by L2R09
  - Based on projections, the Station lacked contingency planning to deal with the Iodine levels encountered.

Airborne Iodine Levels in L2R14
Other Causes Investigated

- Refuel Floor
  - Rx Water Temp
    - Refuted - Normal range @ 98°F at Rx Head lift
  - Rx Head Temp
    - Head not quenched but not performed for minimizing airborne iodine
    - Not contributing cause, however action to review
  - Loss of HEPA filtration
    - HEPA hose disconnected to remove insulation, hot temperatures precluded re-installation..
    - Not contributing cause, however, action to ensure plan in place for standby individual during high risk evolutions

Airborne Iodine Levels in L2R14
Other Causes Investigated

- Turbine Area
  - Noble Metals
    - Refuted – nature of noble metal having no affinity.
    - No iodine release observed in reactor coolant data.
    - May have contributed to acute increase in radio-iodines due to release of tramp fuel from out-of-core surfaces to core, but did not increase fuel leak rate.
    - Adequate time to decay prior to L2R14.

Airborne Iodine Levels in L2R14
Other Causes Investigated

- Condenser Tube Leak
  - Leak provided source of organics which could affect volatility in the condenser
    - During normal operation, most organics are broken down in the vessel
    - Determined to be very low probability of formation of Methyl Iodide (MeI)
    - MeI could affect volatility in condenser
    - Not likely to have affected deposition on LP turbine blading
    - To be included in volatility study.

Airborne Iodine Levels in L2R14
Other Causes Investigated

- Rx Water Cleanup (RT) Reject
  - Refuted - Determined little or no iodine in reject water
    - No appreciable difference in RT activity removal performance
    - Flowpath is F/D effluent to ‘A’ Condenser Hood

Airborne Iodine Levels in L2R14
Other Causes Investigated

- Moisture Carryover
  - Refuted - MCO .016% during L2C14
    - U-2 is historically below the administrative value of .024%
    - Change in MCO not a contributor, but MCO is the transport mechanism for iodine to the steam side

Airborne Iodine Levels in L2R14
Other Causes Investigated

- Condenser Venting
  - Refuted - Venting and HEPA units were adequately installed to counteract increase in iodine
    - Mechanical Vacuum Pump remained on line for 30 – 40 air turnovers

Airborne Iodine Levels in L2R14
Other Causes Investigated

- Shutdown/Soft Shutdown
  - Same shutdown template used from L2R11 thru L2R14
    - No recent changes to shutdown operation
    - No iodine spike observed in reactor coolant samples

Airborne Iodine Levels in L2R14
Other Causes Investigated

- Change in Reactor Vessel pH
  - Refuted - Possible pH related change in volatility
    - A change in pH could drive reaction for Iodine to become more volatile
    - Potential change in pH calculated to be 0.2 S.U. - Not enough to affect volatility
    - pH to be included in volatility study

Iodine related Actions

- Failed Fuel Removed
- Conduct Volatility Study with Corporate Chemistry/EPRI
- Revise Procedures for outage impact assessment
- Increase MCO measurement frequency at EOC
- Increase DEI monitoring at EOC
- Develop outage contingency plan for ↑ iodine

Elevated Dose in L2R14

- Resulted in:
  - 130 REM over BP goal
  - Outage work delays
  - Outage work scope deferrals
  - Increased worker exposure
  - Resource burden
- Areas most affected:
  - Drywell
  - RWCU
  - CRD HCUs
  - Refuel Floor

Elevated Dose Rates in L2R14
Causes Investigated

- Historically High Cobalt Inventory – *Root Cause*
  - LaSalle Unit 2 has High Cobalt Source Term
  - Last 43 OEM CRB removed during L2R14
  - Cycle 14 average soluble Co-60 was 31% higher than cycle 13 at 2.68E-04 compared to 2.04E-4
  - End of Cycle14 soluble Co-60 was 6.6E-04 compared to an EOC value of 1.7E-4 in Cycle 13

Elevated Dose Rates in L2R14
Causes Investigated

- On Line Noble Chem (OLNC) – *Contributing Cause*
  - Cobalt release observed as expected as an inherent effect of OLNC
  - Several challenge meetings on Outage Dose Goals were held including GEH input
  - EOC cobalt trends documented in IR and included in challenges
  - Anticipated reduction in shutdown BRAC dose rates not realized
  - Crud Burst mitigating actions were effective in limiting the impact of distribution (L2R12 LL)

Elevated Dose Rates in L2R14
Causes Investigated

- Increased End of Cycle Core Flow – *Contributing Cause*
  - Resulted in an increasing trend in Reactor Coolant Cobalt activity
  - Increase in core flow was necessary due to suppressed fuel to achieve max power and to minimize coast down effect
  - Recommended Improvement to Dose Predicting Tool to include core flow input

Elevated Dose Rates in L2R14
Causes Investigated

- TR-81 Outage – *Contributing Cause*
  - Hydrogen Water Chemistry (HWC) trip at the same time as Reactor Water Cleanup (RT) trip
    - Trips resulted in elevated crud component activity and resultant out of core general area dose rates
    - Insoluble activity ↑ common w/ HWC trips
    - Particulate activity settles in low flow areas and increase general area dose rates
    - L2R12 CA's effective in containing crud
  - Recommended Improvement to Dose Predicting Tool to include affect of system perturbations

Dose Related Actions

- OEM Control Rod Blades Removed
- Update Dose Predictor
- Re-assess Chemical Decontamination
- Re-assess Dose Reduction Methods
- Review the timing of OLNC applications relative to outage dates