

Lessons Learned from February 3 Alert at the NIST Center for Neutron Research

Tom Newton Deputy Director Chief of Reactor Operations and Engineering NCNR

Thomas.Newton@nist.gov







Refueling

- D₂O coolant: refueling is done blind
- All 30 elements are moved each refueling
 - Each core position has its own transfer tool
 - Elements are moved via transfer arms, lowered into core, then latched into position
- Refueling done on January 4.





February 3 event

- 9:00 Normal startup to 10 MW
- 9:06 begin ascension to full power
- 9:07 sudden drop to about 7 MW
- 9:08 release of fission products
- 9:09 major scram via stack monitor reaching 50,000 cpm
- 9:16 alert declared
- 9:21 evacuation of control room due to high radiation levels
- 9:29 NRC notified







| × | | Document: | Emergency Instruct | ion 0.3 | | |
|--------|--------------------------|---|--|----------------------|-------------|--|
| NIST | Center for Assessment | Title: | e: Emergency Classification and Criteria | | | |
| | | Revision: | A | Date: | 12/14/15 | |
| Alert | | | | | | |
| 2.1. b | nitial Crite | ria - any one | of the following | | | |
| 2 | .1.1. RD | 4-2 - Level 2 | 1 | | | |
| 2 | 12. RD | 4-1 - 50.000 | CPM (EF-2 on) | | | |
| 2.2. A | Action Level Criteria | | | | | |
| 2 | .2.1. Act equ | Actual or projected measurements at the Site Boundary which equal or exceed any of the following levels: | | | | |
| | 2.2 | .1.1. Radio | logical effluent dose | : 75 mrem/24 hours | 0 | |
| | 2.2 | .1.2. Radia | tion level: 20 mrem/ | hour for 1 hour | | |
| | 2.2 | .1.3. 250 x | Effluent Concentrat | ions for Argon, Xend | on, Krypton | |
| | 2.2 | .1.4. 500 x | Effluent Concentrat | ions for other gases | | |
| | 2.2 | .1.5. Thyro | oid dose = 100 mrem | L | | |
| 2 | .2.2. Fue CPI this | Fuel Cladding failure (High Helium Sweep Activity, RD 3-2 - 50,00) CPM) which is leading to the action levels listed in part 2.2.1 of this instruction. | | | | |
| 2 | .2.3. Fue rad | Fuel handling accident outside the core with very high radiation/contamination release in accessible areas. | | | | |
| 2 | .2.4. Sec | urity breach | affecting the reactor | confinement. | | |



Dose estimates

Boundary

- Emergency Instructions are to take stack samples and samples at site boundary, then direct HP staff to assess activity levels.
- Samples taken -- charcoal/particulate, Cary chamber, Marinelli beaker:
 - 5 at 400 m site boundary: No I detected, very small amounts of Xe and Cs
 - 6 stack samples: No I detected. Multiple fission gases seen, mostly Kr and Xe.
- Large uncertainties in site boundary Cary chamber measurements made it difficult to certify that
 effluent concentrations were below Alert and NOUE levels. Eventually used stack samples and
 dilution factors.
 - 1532: Downgraded to NOUE
 - 1935: Terminated emergency

Personnel dose

- 10 staff members contaminated, no dose consequences
- Maximum dose: 1.1 Rem (some contribution from contaminated dosimetry)



Feb 23 video : Dislocated Fuel Element in Core

- Latching and latch checks were done after a refueling on Jan 4.
- After the event review showed these checks were done incorrectly.
- Routine starting and stopping of primary pumps "pushed" the element into an area outside of flow.





NRC Inspections and reports

- February 8 present: NRC SIT; physical or virtual presence at daily meetings, special evolutions
- February 16: Written report on event
- March 5: Conclusion that 450°C fuel safety limit had been exceeded
- April 14: Interim SIT report
- May 13: report of inadequacies in:
 - Training and procedures in fuel latching
 - Procedural compliance
 - Management oversight
- October 1: Root causes, corrective actions and request for permission to restart
- October 15: supplemental on safety culture issues
- October 18-21: Safety culture inspection

Event Response

Have list of ~60 lessons learned. Major ones:

- Need measurement protocols in place for determination of boundary dose.
- Need re-entry protocol to evaluate non-radiological hazards (e.g. CO₂)
- Communications!
 - NRC
 - Public Affairs Office



In the meantime...

27 fuel elements have been removed from the core, including the failed element.
Detailed dimensional measurements of core and surrounding structures made.
Contract awarded for primary system cleanup and fuel reuse evaluation.



2 OF VESSEL

Conclusion

- Feb. 3 event was unprecedented in recent U.S. research reactor history.
- NIST is committed to restart reactor when all necessary corrective actions are complete, and NRC allows.
- NCNR Operations, Health Physics, Engineering, and Safety personnel responded superbly.
- Frequent and open communications with NRC is key to recovery and restart.

