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Operating Experience Note

No. 011

January 2016

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Operator Response Affected by Inadequate Procedures

By Rebecca Sigmon

Fermi 2 - On March 19, 2015, Fermi 2 experienced a loss of reactor building closed loop cooling water and partial loss of the backup emergency equipment cooling water system. This transient required operators to trip one of the two reactor recirculation pumps. The resulting reactor conditions (45% recirculation flow, 61% reactor power) placed the plant in the "immediate exit" region of the power -to-flow map (see Figure 8). Operators entered the appropriate abnormal operating procedures (AOPs) for the plant conditions, but did not fully understand the dynamic nature of the resulting thermal-hydraulic instability (THI) that existed in the core. The AOP for loss of a reactor recirculation pump did not contain any immediate actions to lower reactor power or increase flow as long as the oscillation power range monitor (OPRM) system remained operable. Instead, actions such as monitoring for THI, and adjusting power or flow to get the plant out of the "immediate exit" region (by driving rods in to lower power or raising recirculation flow) were listed later in the procedure as subsequent actions.

As the transient progressed, the expected loss of feedwater heating that resulted caused a 10% power increase over about a ten-minute period. This drove the reactor further into the "immediate exit" region of the power-to-flow map and actuated several alarms on the OPRM system. Eventually, two channels of the OPRM system tripped, which inserted an automatic reactor scram.

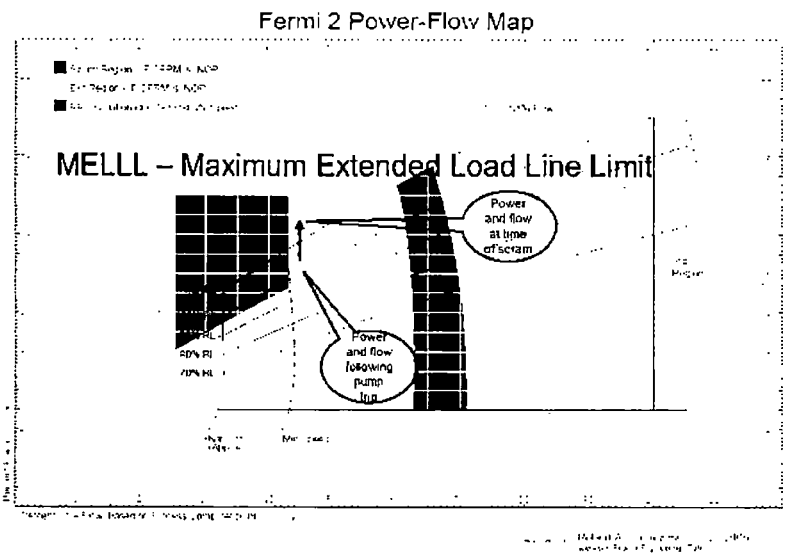

Figure 8: Fermi 2 Power to Flow Map

Post trip review of operator actions during this event showed a lack of timely response to a reactor that was operating in a condition susceptible to THI. The licensee determined that when they installed the OPRM scram feature in 2000, they had also modified the AOPs for loss of feedwater reheating and loss of recirculation pumps to remove the immediate action steps which directed operators to monitor for THI and scram the reactor if it occurred. The thought at the time was that the newly installed protection feature would be more reliable than any operator action. This dependence on automatic protective features impacted operator training and the urgency with which they took actions to get the reactor out of the "immediate exit" region of the power to flow map. In addition, simulator limitations required trainers to manually input power oscillations, and the scenarios operators had encountered in the simulator did not mimic the actual transient.

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River Bend - On December 25, 2014, River Bend experienced a scram with complications following a loss of power to the Division 2 reactor protection system bus with a pre-existing half-scram condition on Division 1. Following the scram, operators struggled to control feed flow as they found the startup feed regulating valve (FRV) unresponsive in both automatic and manual control. While a failed circuit card was responsible for the inability to manually control the startup FRV, post-event review found that automatic control was operating in accordance with design expectations. The startup FRVs were designed to gradually open, with no time response requirement for control signals. In a scram recovery, this delayed response was too slow to arrest the sudden downward trend in water level.

Procedural guidance to use the startup FRVs for scram recovery had been developed in 2010 to mitigate the effects of seat leakage through the main FRVs. The procedure change was tested in the simulator at the time, but following the 2014 scram, it was determined that the simulator response did not mimic the actual plant response.

In both the Fermi and River Bend events, procedure modifications reduced the ability of operators to respond appropriately to transient conditions. Operator training, including simulator scenarios, did not adequately prepare operators for the conditions they would encounter in the plant.

Relevant Inspection Procedures:

IP 71111.11 - "Licensed Operator Requalification Program and Licensed Operator Performance"

IP 71111.18 - "Plant Modifications"

Inspector Takeaways:

- Review changes to procedures following plant modifications
  - At Fermi, removing immediate operator actions led to dependence on an automatic protective function to protect core thermal limits.
  - At River Bend, procedure changes were made without a cross-disciplinary review by engineering that might have flagged the discrepancy between the procedure objectives and the design operating characteristics of the startup FRVs.
- Verify that the simulator accurately models expected design plant response to transients following modifications
  - At Fermi, thermal-hydraulic instability had to be manually input into simulator scenarios as an instrument malfunction, and plant alarm response differed from what operators had expected based on simulator training.
  - At River Bend, the simulator did not accurately reflect the post-scram operating characteristics of the startup FRVs.

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