Plant Modification Validation using the Plant-Referenced Simulator

Power Plant Simulation Conference
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Nebraska Public Power District
Always there when you need us
~ $800,000 per day

The approximate cost to replace power to our Nebraska neighbors and other customers when the nuclear plant is not supplying electricity to the grid.

Nuclear 32%
Monday
01/7/19
Plant Modification
To Maximize Effectiveness
And Efficiency of the Operator Response during ATWS Conditions
RPV Water Level is Lowered

- Suppress neutronic oscillations
- Lower reactor power to reduce heat addition to primary containment
EOP Actions

IF RPV water level is above -60 in.
THEN suppress neutronic oscillations

Lower RPV water level to below -60 in. by stopping and preventing all injection into RPV except from:
  • boron injection systems
  • RCIC
  • CRD
(defeat interlocks if necessary, EOP 5.8.20)
Lower RPV water level by stopping and preventing all injection into the RPV except from:
  • boron injection systems
  • RCIC
  • CRD

until RPV water level is below -60 in. AND EITHER:
  • Reactor power drops below 3%
  • RPV water level reaches -158 in.
  • all SRVs remain closed
    AND
    drywell pressure remains below 1.84 psig

(disregard any reactor power or RPV water level oscillations)
(defeat interlocks if necessary, EOP 5.8.20)
History

• Feedback from Entergy Training oversight.
• Procedural guidance developed to maintain a RFP available during the "stop and prevent" and subsequent injection phases of the ATWS.
Operator Actions to Stop and Prevent Feedwater Injection

- Depress Emergency Close button to close Startup Feedwater Flow Control Valves
- Ensure Feedwater Discharge Valves, RF-MO-29 and RF-MO-30, are closed.
- Trip condensate and condensate booster pump(s) as required.
- Reduce operating RFP speed to approx. 2800rpm as necessary.
Operator Actions to Restore Feedwater Injection

• Open RFP Startup Inlet and Outlet Valves, RF-MO-32, RF-MO-31, RF-MO-34, and RF-MO-33.
• Ensure RFP Discharge Valves, RF-MO-29 and RF-MO-30, are closed.
• Select Startup Valve screen on RFPT/RVLC HMI
• Operate Preferred RFP in REACTOR PRESSURE FOLLOW MODE
• Operate Startup Flow Control Valves in AUTO or MANUAL as desired
Reason for Mod

• Resource allocation issues as well as providing distractions from the ability to continuously monitor RPV level while this strategy is being implemented resulted in challenges in the ability to control RPV level above Top of Active Fuel (TAF) during ATWS conditions.
Solution

• RVLCS Software modified to automate the operator actions to “stop” reactor feedwater injection and set-up for restoration of feedwater injection.
Solution

• To initiate the automation:

“ALEXA, Stop and Prevent”
RVLCS Logic Change
Two New Buttons

ANTICIPATED TRANSIENT W/O SCRAM

STOP AND PREVENT

ENABLE INJECTION
Stop And Prevent Automated Actions

• Close Reactor Feedwater Pump (RFP) discharge valves
• Open Startup Feedwater Control Inlet and Outlet Isolation valves
• Lower running RFP to 2000 rpm
• Emergency Close signal to Startup Feedwater Control Valves
Enable Injection
Automated Actions

- RFT transitions to Reactor Pressure Follow mode.
- Emergency close signal is removed from Startup Flow Control Valves.
- Allow RPV Level Setpoint and/or Feedwater Pump speed to be controlled by Operator.
EC Test Requirements

The following items were verified in the simulator prior to implementation of the changes into the plant:

• Press ATWS 1 button on the HMI and verify desired plant response for ATWS events with both 1 and 2 feed pumps running.

• Press ATWS 2 button on the HMI and verify desired plant response for ATWS events with both 1 and 2 feed pumps running.

• Verify RVLC System scram response remains unaffected post scram.
Procedure Enhancement

• The Emergency Operating Procedure Hard Card was modified several times based on feedback from multiple operators during the testing activities.
Joint Effort - Teamwork
Joint Effort - Teamwork

- Project Management
- System Engineering
- Design Engineering
- I&C

- Operations Support
- Operations Training
- Information Tech
- Simulator Services
Results

- RVLC software modified for automation of EOP ATWS “Stop and Prevent” injection actions successfully implemented and tested during RF 30.
- Emergency Operating Procedure Hard Card updated to provide guidance on “Stop and Prevent” injection actions.
- Operator training on the modification completed prior to plant startup.
So, is using the Plant-Referenced Simulator a good option to validate Plant Modifications?

You bet!!!