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Regulatory Conference
NRC Region II

Turkey Point Nuclear Plant
Unit 3

Loss of Decay Heat Removal Event

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Agenda

- **Introductions**
- **Overview**
- **Topics of Discussion**
  - Event description
  - Corrective actions
  - Thermal-hydraulic analysis of event
  - Mitigating actions
  - SDP Analysis
- **Closing Remarks**

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Overview

- **FPL agrees that it did not comply with requirements of 10 CFR 50.65(a)(4)**
- **FPL has learned from the loss of decay heat removal event and has taken actions to prevent recurrence**
- **FPL evaluation concludes that the change in core damage frequency is less than 1.0E-6/yr**

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Event Description

- **Initial conditions**
  - Unit 3 in Mode 5
  - Draindown in progress to support reactor head removal
- **Sequence of events**
  - While restoring power to 3C 480V load center, spurious undervoltage signal sent to 3A load sequencer
  - 3A load sequencer de-energized 3A 4kV bus, causing loss of running 3A RHR pump
  - 3A EDG re-energized 3A 4kV bus
  - 3A load sequencer does not automatically re-start the 3A RHR pump after loss of offsite power
  - Operator started 3B RHR pump and terminated the event in approximately 9 minutes

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Causes

- **Insufficient defense in depth to prevent the event**
- **The outage risk assessment procedure was insufficient**
- **Experience in maneuvering plant was low with significant shutdown maintenance in progress**
- **Vendor human error in the configuration of auxiliary switch contacts on a 480V load center breaker that went undetected**

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Immediate Corrective Actions Taken

- **Senior management team augmented by fleet after event for additional oversight**
- **Additional reviews of remaining outage schedule performed**
- **Additional controls of protected plant and switchyard equipment implemented**
- **Outage schedule changes subject to more rigorous review and approval process**

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Long Term Corrective Actions

- **Outage risk assessment and control procedure upgraded**
  - Responsibility for procedure transferred to Operations
  - PNSC approval required for procedure changes
  - Clearly identifies required protected in-service equipment for higher risk evolutions
  - Provides logic ties for risk significant activities
- **Use of dedicated and more experienced licensed operators for outage planning and risk assessment (complete)**

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Long Term Corrective Actions (cont'd)

- **As-left auxiliary switch contact configuration to be verified by Nuclear Receipt Inspection for 4kV & 480V breakers (complete)**
- **Plant procedures for safety-related breakers revised to check auxiliary switch contact configuration on 4kV & 480V breakers (completed for procedures needed for Fall outage breaker work)**
- **Applicable plant procedure revised to defeat the sequencer during replacement of 480V load center breakers (complete)**

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Long Term Corrective Actions (cont'd)

- **Fleet peer reviews of outage schedule (complete)**
- **Management challenge of outage schedule (prior to Fall outage)**
- **Enhanced operator and staff training on shutdown risk assessment (in-progress, complete prior to Fall outage)**
- **Outage risk management improvements (perform prior to RCS draindown)**
  - Pressurizer code safety removed
  - At least two Core Exit Thermocouples available (until just prior to detensioning reactor vessel head)
  - Containment closure ability confirmed

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FPL Analysis of Loss of RHR Event

- **Thermal-hydraulic simulation to determine effects of loss of RHR scenarios**
  - Case 1 - No operator actions
  - Case 2 - HHSI feed only
  - Case 3 - HHSI feed & PORV bleed
- **Use results to develop FPL SDP event tree**
- **Using event tree and failure probabilities, calculate change in core damage frequency**

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Initial Plant Conditions

- 63 hours 50 minutes after shutdown
  - prior to shutdown reactor was at ~ 50% power for 24 hours
- RCS being drained to support reactor vessel head lift
- RCS level near reactor vessel flange
- RCS temperature ~115 ^{o}F
- RCS vented via:
  - Reactor vessel head vent line with 0.219” diameter orifice
  - Pressurizer vent line 0.742” diameter
- A-RHR in service
- B-RHR in standby

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Initial Plant Conditions (cont'd)

- SG secondary side water levels average 84 % wide range
- SG atmospheric steam dumps full open
- Both RWSTs with inventory ~295,000 gal per unit available for HHSI pump use while maintaining NPSH
- Equipment required to mitigate loss of RHR in service
- 2nd qualified Unit Supervisor supervising draindown

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Case 1 – No Operator Action

- **Conclusion:**
  - With no operator action, RHR cooling will be restored simply by starting an RHR pump within approximately 9 hours after event initiation
  - No core damage with RHR pump start anytime during first 9 hrs of event

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Case 2 – HHSI Feed Only

- **Conclusion:**
  - Able to sustain steady state condition for at least 24 hours with single RWST
  - No core damage for at least 24 hours
  - Sufficient time available to implement RWST inventory management or SG secondary water makeup

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Case 3 – HHSI Feed & PORVs Bleed

- **Conclusion:**
  - No core damage for at least 16 hrs using both RWSTs
  - Sufficient time available to restore RHR or implement RWST inventory management

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Thermal-hydraulic Analysis Conclusions

- SG reflux cooling will prevent core damage without operator action for at least 9 hours
- The minimum time to start a RHR pump is at least 9 hours (time to boil is overly conservative as the criterion for RHR pump start)
- Feed & bleed prevents core damage regardless of pressurizer PORVs position
- Managing RWST inventory is proceduralized with options to:
  - Throttle HHSI flow
  - Establish RWST makeup
  - Use opposite unit RWST

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Key Factors for Additional NRC Consideration

- Base RHR restoration time on NPSH requirements (9 hr) rather than core boiling (21 min)
- Failure of PORVs to open for feed & bleed does not result in core damage
- Late restoration of RHR based on additional time provided by SG reflux cooling and feed & bleed
- Additional RWST inventory management strategies to extend availability of HHSI suction source

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Summary of SDP Results

- Based on a more detailed SDP analysis FPL estimated the total CDF increase for this event to be approximately 2.0E-7/yr
- CDF increase below risk significance threshold of 1.0E-6/yr
- FPL concluded this violation to be GREEN

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ROP Cornerstone

- NRC ROP Cornerstone for this finding should be “Initiating Events”
  - ROP “Initiating Events” Cornerstone objective: limit frequency of events that upset plant stability and challenge critical safety functions
- Definitions: NRC Manual Chapter 0308 – ROP Basis Document
  - Initiating Events- “such events include reactor trips due to turbine trips, loss of feedwater, loss of off-site power . . .”
  - Mitigating Systems- “include those systems associated with safety injection, residual heat removal, and their support systems. . .”
- Event attributable to the loss of 3A 4kV bus normal electrical power to the running 3A RHR pump, not involving a failure attributable to the RHR System

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Conclusions

- FPL agrees that it did not comply with requirements of 10 CFR 50.65(a)(4)
- Review of SDP analysis shows low safety significance with delta CDF < 1.0E-6/yr
- FPL has taken timely and aggressive corrective actions to prevent recurrence

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Open Discussion

Questions

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Final Remarks