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Reactor Trip During
Panel ED-11-2 Maintenance



ENTERGY NUCLEAR

Entergy Nuclear Operations

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Agenda

- Introduction Tony Vitale
- Objectives Tony Vitale
- Apparent Violation Tony Vitale
- Causes David Hamilton
- Key Corrective Actions David Hamilton
- Timeline David Hamilton
- Significance Frank Yanik
- Conclusions Tony Vitale

Objectives

- Discuss the apparent violation and Entergy's acceptance
- Review the causal analysis and corrective actions taken and planned
- Discuss the background and event timeline
- Provide additional insights into the safety significance of the event

Apparent Violation

- Entergy concurs with the apparent violation
- Entergy has additional information for consideration regarding the safety significance of the finding

Palisades Performance Recovery Plan

- Plan Areas
 - Leadership Effectiveness
 - Safety Culture
 - Corrective Action Program
 - Equipment Reliability
 - Refueling Outages
 - Communication Plan

Palisades Performance Recovery Plan

- Leadership Effectiveness
 - *Problem Statement* - Leaders are not sufficiently engaged and intrusive to identify and correct behavior and performance gaps at all levels of the organization.
 - *Vision Statement* - Leaders are engaged and intrusive to identify and correct behavior and performance gaps. Leaders routinely spend time in the field with eyes on the problems to provide oversight and reinforce standards. Leaders continually reinforce the principles for a strong nuclear safety culture.

Palisades Performance Recovery Plan

- Safety Culture
 - *Problem Statement* - Degradation of safety culture principles has led to site performance deficiencies
 - *Vision Statement* - All station personnel exhibit proper risk sensitivity and awareness. Mitigating strategies are consistently implemented.

Palisades Performance Recovery Plan

- Corrective Action Program
 - *Problem Statement* - The Corrective Action Program is not always valued or effectively used by Palisades leadership and personnel to identify, investigate, and correct problems in a timely manner to improve performance.
 - *Vision Statement* - Success in the implementation of a strong corrective action program is evidenced by Palisades personnel identifying and correcting issues at low levels.

Palisades Performance Recovery Plan

- Equipment Reliability
 - *Problem Statement* - Critical equipment failures have lead to plant derates, forced outages, schedule perturbations, increased radiological dose, unplanned limiting conditions for operation, rework and failed post maintenance tests. Schedule adherence and stability are improved, thus limiting risk to operation.
 - *Vision Statement* - Success in equipment reliability is evidenced by Palisades achieving top decile performance in unit capability factor (currently >94.38%), low rework rates, lower collective radiation exposure and no unplanned AOTs.



Palisades Performance Recovery Plan

- Refueling Outages
 - *Problem Statement* - Ownership of the outage preparation and execution process must be improved to support station operation and maintenance. Work must be scheduled where appropriate, planned effectively and completed when scheduled.
 - *Vision Statement* - The objective of this Recovery Plan is to provide improvement in the implementation of the outage management process at Palisades by the following:
 - Affirming and continually reinforcing ownership of the outage work management process by all Palisades employees and contractors through frequent communication, effective preparatory meetings and management interaction.
 - Establishing effective outage preparation meetings so that high accountability and team work is evident in preparations.
 - Displaying effective performance indicators to drive accountability down to the supervisor/worker level inside and outside of the Planning, Scheduling & Outage department.
 - Developing a long range schedule of coordinated self evaluation, peer evaluation and nuclear oversight to assess the adequacy of outage readiness, its implementation at all levels, and potential areas for improvement.



Palisades Performance Recovery Plan

- Communication Plan
 - *Problem Statement* - Important to ensure we communicate effectively to our employees and have them engaged in our recovery.
 - *Vision Statement* - Palisades employees are well informed of the causes, contributors and corrective actions of our current situation. Additionally, the employees are engaged and empowered in the execution of the plan. Employee ownership is evident.

David Hamilton
General Manager Plant Operations
Entergy - Palisades



Event Response

- Palisades Root Cause Evaluation Team
 - Human performance error review and event timeline
 - Focused on both direct technical cause and organization and programmatic aspects
- Corporate Event Response Team (CERT)
 - Independently reviewed event causes and contributors
 - Focused on organizational and programmatic aspects

Causal Analysis

Root Cause - Organizational

Senior leaders have not established a sufficiently sensitive culture of risk recognition and management. This resulted in the plant's managers, supervisors and workers not recognizing, accounting for, or preparing for, the industrial safety risk and plant operational nuclear risk involved with the panel ED-11-2 breaker inspection and replacement maintenance.

Causal Analysis

Contributing Cause 1 - Technical

Breaker coordination for the 125 VDC system left train was insufficient to prevent a reactor trip under the short circuit conditions experienced during ED-11-2 maintenance on 09/25/11

Contributing Cause 2 – Organizational

Work orders used for removal and inspection of breakers 72-119, 72-120, 72-121 and 72-123 did not include details appropriate for maintenance on energized, high critical electrical equipment with the plant on line

Contributing Cause 3 – Human Performance

Oversight by managers and supervisors did not result in identification and correction of the human performance errors and weaknesses in the work involving the inspection and replacement of breakers in the ED-11-2 panel

Contributing Cause 4 – Human Performance

Managers, supervisors and workers did not consistently follow approved procedures for job preparation, job execution and risk management



Corrective Actions

Key Technical Actions – short term actions to prevent recurrence

- Temporary modification was installed to raise the magnetic trip settings of breakers 72-01 and 72-02 to the highest level, coupled with removing circuits capable of exceeding trip current
- Damaged bus connectors and suspect breakers in Panel ED-11-2 were replaced

Corrective Actions

Key Organizational Actions

- Entergy Standards for procedure compliance, accountability, and intolerable behaviors reinforced via face to face communications from the COO through Individual Contributor Levels
- Management observation program structured with guidance to provide specific oversight and feedback on safety culture behaviors, risk recognition and mitigation, procedure adherence, and standards reinforcement.
- Initiated third party safety culture assessment

Corrective Actions

Key Human Performance Actions

- Ensure compliance with Entergy risk management procedures
- Issued guidance for work on all energized electrical circuits to ensure appropriate nuclear safety
- Work order quality improvements

Corrective Actions

Key Work Management Actions

- At T-5 critical evolutions meeting and T-2 technical rigor meeting, validate actions and mitigation of risk associated with work activities
 - SVP challenge of risk assessment
 - Fleet challenge up through COO of risk assessment
- Clear identification of risk activities and risk mitigators in work schedules, and daily planning meetings

Palisades Recovery Plan and Fleet Actions

- Defined intolerable leader behaviors
- Defined intolerable worker behaviors
- Review of risk activities cascaded through site and corporate management
- Structured paired management observation and intervention of worker and leader behaviors
 - Fleet observation and intervention
 - Independent observation and intervention
- Leadership assessment of organizational and safety culture competencies.

Importance of Timeline

- Extremely important to our significance determination to understand the timeline with accuracy
 - Impact on human performance assumptions
 - Impact on operator capability assumptions
 - Assumed plant conditions during various points in the event in the PRA
- Extensive validation effort to ensure accuracy for both PRA and root cause evaluation

Timeline - Event

9/25/11 (Sun): Initial conditions (prior to event)

9/25/11 15:06: Equipment actuation

9/25/11 15:06: EOP-1 Post-Trip entered

9/25/11 15:17: Generator breakers opened via relay jumper

9/25/11 15:27: EOP-9 Functional Recovery entered

*9/25/11 15:28: Pressurizer level exceeded 62.8%

*9/25/11 15:31: High S/G E-50A level @ 90%

*9/25/11 15:31: ONP-2.3 Loss of DC Power entered

*Denotes events critical to PRA discussion



Timeline - Event

- 9/25/11 15:37: ONP 24.1 and ONP 24.3 Loss of Preferred AC Bus Y-10 and Y-30 entered
- *9/25/11 15:37: High PCS pressure (2200 psia) and high pressurizer level; B channel controllers placed in service
- 9/25/11 15:42: CVCS letdown orifice stop valves closed
- *9/25/11 15:44: P-8C AFW flow to S/G E-50A isolated
- 9/25/11 15:49: Power restored to 2400V Bus 1E EA-13
- *9/25/11 15:57: Left channel SIAS; SI throttled
- *9/25/11 15:57: DC busses ED-10L & ED-10R, and preferred AC bus EY-30 reenergized

*Denotes events critical to PRA discussion

Timeline - Event

- 9/25/11 16:02: Power restored to bus 1E EA-13
- *9/25/11 16:03: Steam supply to AFW pump P-8B isolated
- *9/25/11 16:09: AFW flow to S/G E-50B isolated
- *9/25/11 16:15: Pressurizer level peaks at 101.5%
- *9/25/11 16:39: P-8C AFW flow to S/G E-50B restored
- *9/25/11 16:46: Preferred AC bus EY-10 reenergized; ADVs available
- *9/25/11 18:52: AFW pump P-8B availability restored
- *9/25/11 19:33: Battery charger #3 ED-17 placed in service

*Denotes events critical to PRA discussion



Frank Yanik
PRA Engineer
Entergy - Palisades



Significance Determination

- Overview and conclusions
- Key inputs and assumptions
- Impact on event risk characterization

Significance Determination Preface

- Event Timeline
 - Rigorous timeline validation
 - Data context important

Significance Determination

Entergy Conclusions

- Δ CCDP is 4.3E-6
- Dominant sequences involve failure to recover lost train of DC power source
- Contributing sequences involve failure to secure charging pumps prior to lifting PZR SRVs
- Stuck open PZR SRV LOCA can be mitigated with charging system (2 of 3 pumps and SIRWT suction source) and AFW

Significance Determination Entergy Conclusions (con't)

- Isolation of turbine driven auxiliary feedwater pump P-8B to avoid overfill not a significant risk contributor
 - Motor driven auxiliary feedwater pump P-8A remained available from control room throughout event
 - Restoration of P-8B simple, well-trained task, especially given EOP Supplement 19 steps already performed

Entergy Perspectives on Key Inputs and Assumptions

- Probability of recovery of DC power
- Probability of preventing challenge (lift) of pressurizer (PZR) safety relief valve (SRV)
- Probability of stuck open PZR SRV
- Availability of AFW Pump P-8A
- Normal maintenance unavailabilities

Probability of DC Power Recovery

- Time available to recover DC power is at least 2 hours (no AFW)
- Actions to restore power are simple and straightforward once the fault condition is cleared
- Two options are available to restore DC power:
 - Restoration of the connection of the DC bus segments to the battery (HEP = 0.1)
 - Alignment of the alternate charger to the DC bus segments (HEP = 0.1)
 - Total Effective HEP 0.01 ($0.1 * 0.1$)

PZR SRV Challenge Probability

- Complexity of action and time available greatly impact probability (and overall results)
- For Entergy model
 - Action is simple trip of operating charging pumps
 - Time available based on maximum charging flow for loss of DC event
 - Time available allows for recovery of failed attempts
- For NRC evaluation
 - Action is “control pressurizer level” – may be viewed as more complex
 - Time available about equal to time required – may be based on 133 gpm charging flow

PZR SRV Challenge Probability HEP Timeline

- **Time available to diagnose/execute action – 62 mins**
 - Operators determine in-service channel A to PZR level control is de-energized and change to channel B – 31 minutes (1537)
 - Time to operators confirm boration requirements met – 51 minutes (1557)
 - Operators terminated charging flow – 51 minutes (1557)
- **11 minutes remained available to complete the action to prevent a challenge to PZR safeties**

Stuck Open PZR SRV Probability

- Palisades valves tested for steam, transition & water relief (part of TMI Action Plan)
- Test conditions based on consideration of PWR FSAR transients and extended high pressure liquid injection events
- All tests found satisfactory operation
- For Entergy model
 - Palisades-specific SRV qualification testing supports use of generic failure rates
- For NRC evaluation
 - Generic bounding SRV failure probability used

AFW P-8A Availability

- P-8A remained available on manual start from the control room (or locally) throughout event
 - Loss of DC power resulted in loss of power to pump control scheme
 - However, without DC panel ED-11-1, a low suction pressure trip signal cannot trip the pump
 - ED-11A remained available; this provided DC power to the switchgear supplying AC to P-8A
- Assuming P-8A unavailable without restoration increases importance of restoration of P-8B

Conclusion

- Based on investigation and evaluation of the event, Entergy determined that the Δ CCDP is 4.3E-6
 - a. Failure to recover DC power is ~ 74% of Δ CCDP
 - b. Failure to control pressurizer level is ~ 16% of Δ CCDP

Tony Vitale
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Entergy - Palisades



Summary

- Entergy concurs with the violation
- A thorough review of the event was performed to identify all related causes
- Entergy has developed effective corrective actions for root and contributing causes
- Fleet engagement
- Welcome the opportunity for future updates with Staff