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Protecting People and the Environment

RIC 2010

Trends in Shutdown Events

Shutdown Risk – Process and Configuration Control

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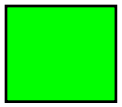
Exelon's Configuration Risk Philosophy

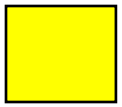
- At-Power: a blended approach
  - PRA insights complement defense-in-depth approach
  - PRA provides one perspective, but is not sufficient to address all considerations
- Shutdown: a defense-in-depth/qualitative risk approach
  - Safety function defense-in-depth (DID) monitoring
  - Broad definition of "High Risk Evolution" (HRE)
    - Activities that could disrupt safety function
  - Combination of HRE and DID provide qualitative risk perspective

Risk Management Actions

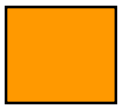
Four color risk management scheme:



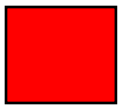
- Normal Work Controls



- Around the Clock Work
- Identify Protected Equipment



- Minimize Concurrent Activities
- Notify Plant Management
- Develop Contingency Plans



- Not Allowed to be Planned
- Expedite Exit

Key Safety Functions

- Decay Heat Removal
- Spent Fuel Pool Cooling
- Inventory Control
- Electrical Power Availability (includes both On-site and Off-site)
- Reactivity Control
- Containment
- Others as required to address site-specific features or procedures

Role of Shutdown PRA

- PRAs can provide a unique integrated perspective on plant safety
  - PRA results are numerical: only as good as the numerical inputs
  - OPEX: Shutdown risk dominated by human errors and response
    - Most difficult aspect of PRA to quantify
- Exelon developed shutdown PRA for one site in 1990s
  - Application found limited additional insights beyond DID/HRE
  - Difficulty translating plant activities into input probabilities

Review of INPO SER 2-08 Events

- INPO SER 2-08 spawned the question of whether we should have a shutdown PRA
- The 16 events/examples were reviewed to assess whether shutdown PRA would have provided any benefit, over a traditional Defense In Depth assessment, in identifying or preventing the event:
  - PRA provide no additional benefit: 13 events
  - Very detailed PRA might provide some benefit: 2 events
  - Very detailed PRA would have provided additional benefit: 1 event

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Review of INPO SER 2-08 Events

- Safety implications of plant event prior to occurrence would not have been highlighted by a detailed shutdown PRA model
- Why??
  - Process and control of the outage schedule are key attributes for the identification and implementation of risk management actions
  - The random failure or combination of failures of equipment in support of a safety function does not dominate the quantitative risk
  - The dynamic changes in schedule and plant configurations appear to contribute most to risk

Process Controls

- The Shutdown Safety Management Program (SSMP) requires that when a schedule change or emergent activity occurs, reviews are required for the change and impact on shutdown safety and to make notifications as applicable.
- At dual unit sites the shutdown and at-power schedules are linked to assure impact on the other unit is considered. Some shared systems can impact both units simultaneously and differently.

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Communications

- Communicate the unit status in a highly visible manner to each shift.
- Identification of the unit status, protected equipment, and significant shutdown safety activities on a shift basis
- Review the unit status, protected equipment, and significant shutdown safety activities at outage meetings. Reasons for status colors other than GREEN is provided to attendees.
- Control room personnel are aware of information such as, time to boil and key safety function status.

Conclusions

- Key to shutdown safety is understanding the potential consequences of activities and potential errors
- Defense-in-depth assessment is effective when coupled with
  - Challenge reviews
  - Critical assessment of potential consequences ("What if")
  - Process Controls
- Adherence to process and communication are effective means in assuring shutdown safety