

# **Refueling Outage Risk Assessment at Turkey Point NPP**

International Workshop

on

**Use of PSA in Operation of NPPs and in  
Regulatory Decision-Making**

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# Outage Risk Assessment

- Outage risk at Turkey Point is managed using an administrative procedure (ADM-051) which enforces minimum requirements for key safe shutdown functions (NEI 91-06) and assigns risk levels (colors) to these functions according to their status.
- The requirements for these key safe shutdown functions change as conditions change (e.g., water level, decay heat level).

# Key Safe Shutdown Functions

- Decay Heat Removal
- Inventory Control
- Power Availability
- Reactivity Control
- Containment Integrity Control
- Instrumentation
- Fire Protection

# Outage Phases

- Phase 1 - Large Decay Heat Load and RCS Temperature Greater than 200°F
- Phase 2 - Large Decay Heat Load and RCS Temperature Less than 200°F With at Least Two RCS Loops Available
- Phase 3 - Large Decay Heat Load and RCS Temperature Less than 200°F Without RCS Loops Available
- Phase 4 - Large Decay Heat Load and Reactor Cavity Flooded Greater Than 23 Feet Above the Vessel Flange
- Phase 5 - Reduced Decay Heat Load and Reactor Cavity Flooded Greater than 23 Feet Above the Vessel Flange

# Outage Phases (cont.)

- Phase 6 - Reduced Decay Heat Load and RCS Temperature Less than 200°F Without RCS Loops Available
- Phase 7 - Reduced Decay Heat Load and RCS Temperature Less than 200°F With at Least Two RCS Loops Available
- Phase 8 - Reduced Decay Heat Load and RCS Temperature Greater Than 200 °F
- Phase 9 - Core Offloaded, Spent Fuel Pool Requirements

# Example

- Function - Decay Heat Removal
- Phase 1 - Large Decay Heat Load and RCS Temperature  $> 200^{\circ}\text{F}$
- Required Equipment: 3 of 4 HHSI pumps
  - If only two are available => Orange
  - If only one is available => Red

## Example (cont.)

- Function - Decay Heat Removal
- Phase 7 - Reduced Decay Heat Load and RCS Temperature  $< 200^{\circ}\text{F}$
- Required Equipment: 2 of 4 HHSI pumps
  - If only one is available => **Yellow**
  - If none is available => **Orange**

# Color Codes

<u>Color</u>	<u>Definition</u>
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Green	Acceptable, no action needed.
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Yellow	Degradation of a key safe shutdown function has occurred. Heightened awareness desired.
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Orange	Significant degradation of a key safe shutdown function has occurred. Heightened management awareness desired.
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Red	Unacceptable condition. All efforts focused on restoration.
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# ADM-051 Compliance Assessment

- ADM-051 compliance assessment was performed manually.
- PSA has most of the key safe shutdown functions and sub-functions modeled, complete with support system dependencies, in the PSA model to calculate core damage frequency (CDF).
- PSA Group developed a model of ADM-051 compliance.

# ADM-051 Compliance Assessment

- The plant uses a computer code (Primavera) to create the refueling outage schedule.
- Primavera considers resources required for the schedule activities, dependencies between activities, etc., but does not consider compliance with the outage safety procedure, ADM-051.

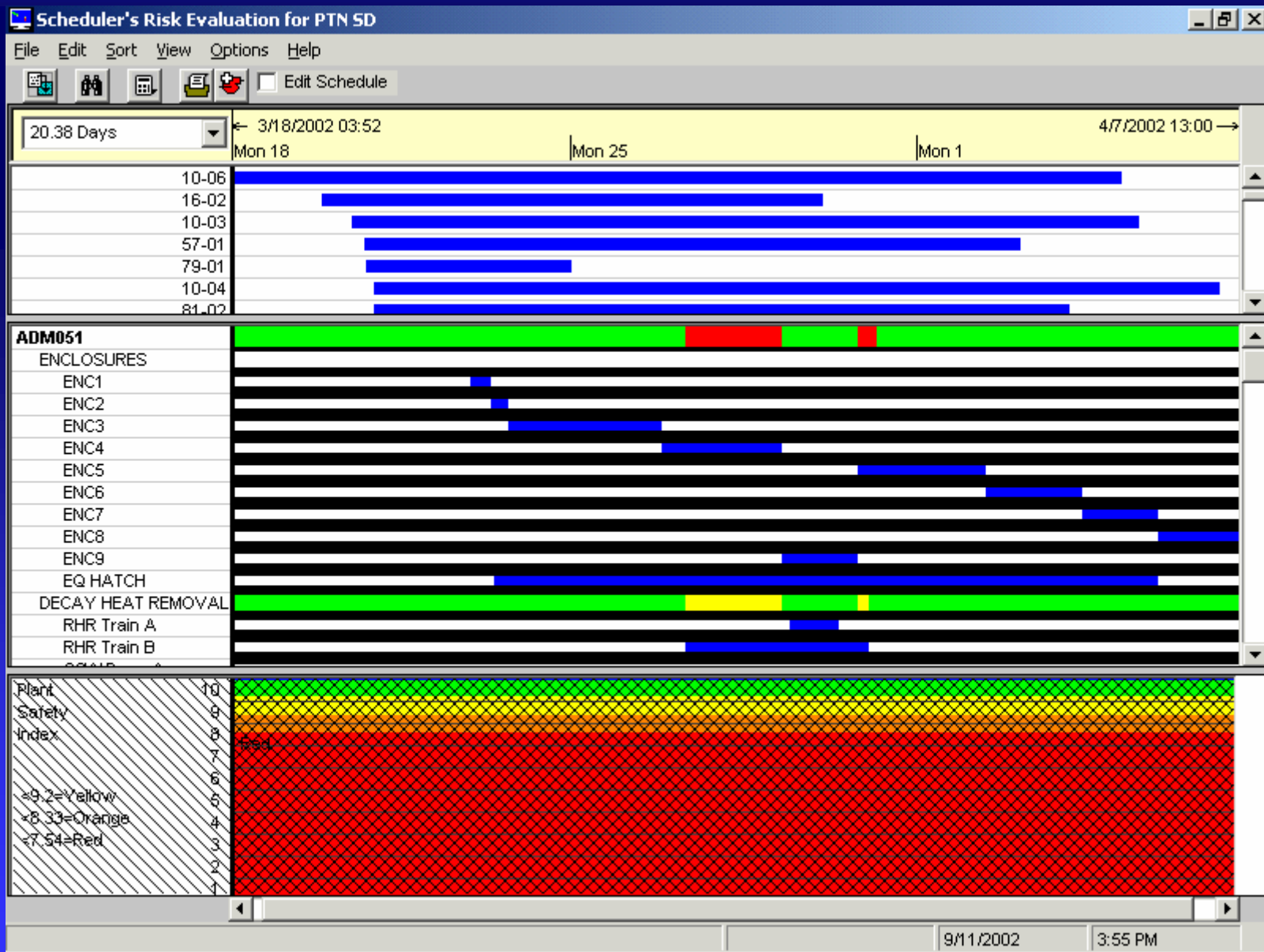
# ADM-051 Compliance Assessment

Using our PSA model of ADM-051, the PSA Group's EOOS software, with the help of a pre-processor (IMPORTER), can input information from Primavera containing the refueling outage schedule activities, determine what components are scheduled to be out-of-service and when, and produce an ADM-051 compliance assessment for the entire outage.

**Primavera → IMPORTER → EOOS**

# ADM-051 Compliance Assessment

- The EOOS compliance assessment is used to identify “non-green” places in the schedule.
- Using the EOOS software, the user can move schedule activities around to optimize safety by reducing the number of “non-green” indications.



# Demonstration

# Acceptance by Operations

- Operations was not thrilled with our initial offer to examine the refueling outage schedule.
- However, using our model, we discovered some non-compliances they had missed.
- Had these non-compliances arisen unexpectedly during the outage, there would have been unwanted management and NRC attention.

# Acceptance by Operations

- Operations now requests PSA support for each refueling outage.
- The PSA Group looks at each refueling outage schedule before and during the outage.

**PTN, Unit 4 Outage Schedule (3/25/02)  
ADM051 Minimum Requirements Status**

Period	Start Date	Start Time	End Date	End Time	Enclosure(s) in Effect	Color	ADM051 Min. Reqts. Not Met	Relevant Clearance Zones	Relevant OOS Equipment
1	3/23	0000	3/28	0200	1,2,3,4	Green	None		
2	3/28	0200	3/28	0700	4	Yellow	Decay Heat Removal, Electric Power, Risk-Significant Equipment	05-02	4B 4KV Bus
3	3/28	0700	3/28	1900	4	Yellow	Decay Heat Removal, Electric Power, Risk-Significant Equipment	05-02, 05-10, 19-05, 50-02	4B 4KV Bus, Basket Strainer 4A, RHR Pump 4B
4	3/28	1900	3/28	2000	4	Yellow	Decay Heat Removal, Electric Power, Risk-Significant Equipment	05-02, 19-05, 50-02	4B 4KV Bus, Basket Strainer 4A, RHR Pump 4B
5	3/28	2000	3/29	0900	4	Yellow	Decay Heat Removal, Electric Power, Risk-Significant Equipment	05-02, 50-02	4B 4KV Bus, RHR Pump 4B,
6	3/29	0900	3/29	2100	4	Yellow	Decay Heat Removal, Electric Power, Risk-Significant Equipment	05-02, 30-02, 50-02	4B 4KV Bus, CCW HX 4C, RHR Pump 4B
7	3/29	2100	3/31	1300	9	Green	None		
8	3/31	1300	3/31	1800	5	Orange	Inventory Control	05-12, 47-02	4B Charging Pump (Bkr 40203), 4C Charging Pump (Bkr 45008, Valve 4-270)
9	3/31	1800	4/10	1300	5,6,7,8	Green			

# The Last Slide

- For Turkey Point's next outage, the Work Controls Department will be using the outage risk assessment tool to create the "first cut" of the refueling outage schedule.
- Using Primavera and EOOS, the plant can now successfully optimize the refueling outage schedule to minimize not only outage length but also outage risk.