Exelon Nuclear

Risk Informed Approaches to Protect Equipment in High Risk Industries

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PSAM9 Conference, Hong Kong, May 18-23, 2008

Protecting my Heart

Where is the Defibrillator?

Objectives

- ✓ Presenting RI Approaches to Protect Equipment
- ✓ Identifying Potential - Tangible Benefits
- ✓ Details From the Nuclear Industry
- ✓ Examples From Other Industries
  - Chemical
  - Aviation / Space
  - Health Care
  - **Mining**

Risk Informed Approaches to Protect Equipment

Why to Protect Equipment?

- Helping Operators Reduce Likelihood of Human Errors
- Prioritizing Important Structures, Systems, Components (SSCs)
- Compensatory Measures to Reduce Risk
- Helping Operators Maximize Production (Avoid Initiating Events)
- An Expression of Safety Culture

✓ Protecting **ALL** High Risk (RED) Components

✓ Protecting ALL High & Medium Risk (RED & ORANGE) SSCs

✓ Protecting Only Components That May Induce Initiators

✓ Excluding Groups of Failures (Electrical-I&C…)

✓ An Issue of **Optimization**

Translating Risk into Colors

Risk Informed Acceptance Criteria Options:
(Quantitative and / or Qualitative)

1. Low Risk: GREEN
   Acceptable as is –
2. Medium Risk YELLOW
   Acceptable with Compensatory Actions
3. High Risk ORANGE
   Unacceptable, but with Exceptions
4. Very High Risk RED
   Unacceptable.

Reducing the Frequency of Human Errors

One way to reduce the frequency of human errors is to post a sign, a flag, or a "PROTECTED" signal on selected (important) equipment and guide the operators to avoid removing them from operation while posted. The purpose of "protecting" equipment is mainly to avoid human errors in the future, before they take place. We know that complete and absolute prevention of errors is not possible (especially not in realistic PSA studies). Therefore, the objective of "protecting equipment" is mainly to maintain its functional capability by reducing the probability of human errors for **inadvertently** disabling it in the future.

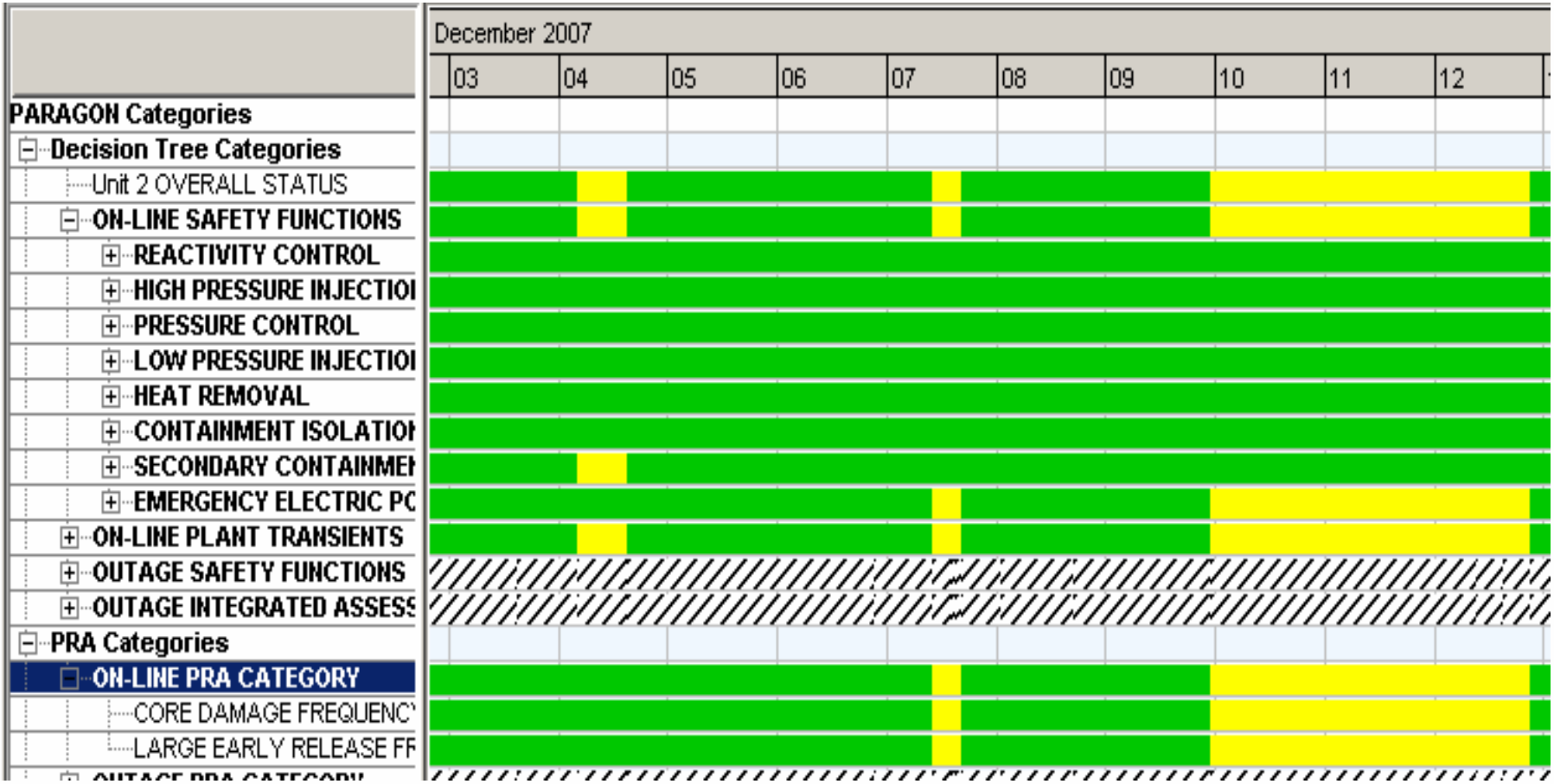
THE PROCESS OF PROTECTING EQUIPMENT

- Identifying components, which are very important to safety during specific configurations.
- Identifying specific human errors that could impact these components.
- Selecting candidate components mostly exposed to these human errors.
- Evaluating and ranking benefits from protecting some or all of the candidate components.
- Selecting a final list of components to protect.

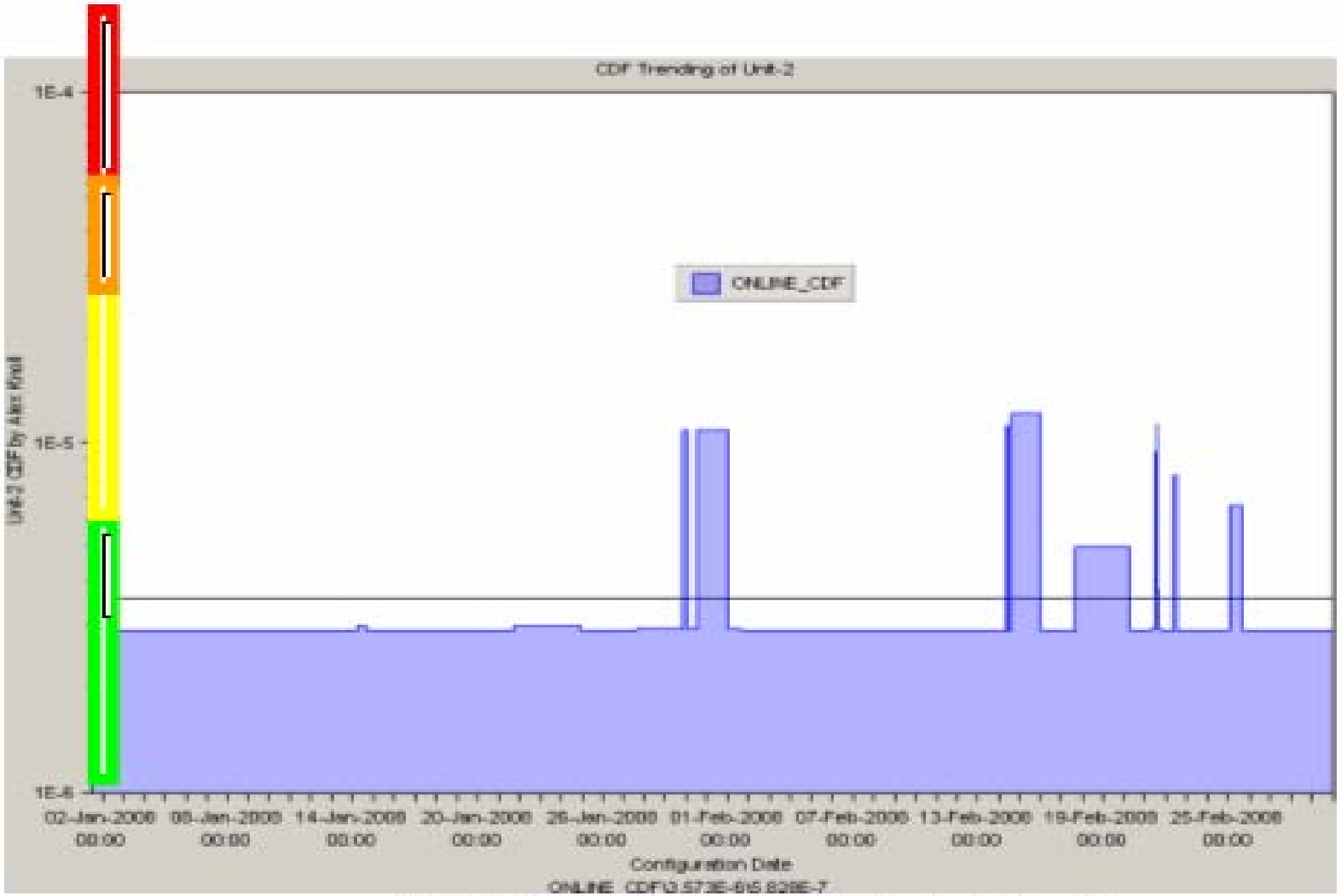
Teamwork in Nuclear Power Plants

- ✓ **Operations**. Operators are frontline workers that are exposed to operator errors. This department takes the lead and the ultimate responsibility for compliance with regulatory requirements and posting the signs of Protected Equipment, if needed.
- ✓ **Work Control of Maintenance**. This department plans, schedules, and assigns resources to do corrective and preventive maintenance, including removal of equipment from operation.
- ✓ **Risk Management**. Provides risk information to Operations and Maintenance regarding nuclear safety (potential initiating events, core damage, release from the containment, ranking of components, etc).

Quantitative & Qualitative Risk



The CDF Profile



Unit-2 On-Line CDF Trending for Jan-Feb 2008.

Dynamic List for EDG Out of Service

Component	Risk Color
U3 Startup feed to 4KV buses	RED
U2 Division 1 DC bus 1	RED
U2 Division 1 DC bus 2	RED
U2 Division 1 DC battery 1	RED
Startup transformer	RED
E3DG	RED
U2 RCIC	RED
U3 Emergency aux transformer	RED
U3 Startup 4KV bus	RED
More dynamic RED CDF/LERF SSCs	RED
U2 SPC valve 1	ORANGE
U2 SPC valve 2	ORANGE
Tie Line	ORANGE
U2 HPCI	ORANGE
Other EDGs	ORANGE
29 additional components	ORANGE
More dynamic ORANGE CDF/LERF SSCs	ORANGE
New YELLOW Components (not of interest) …	YELLOW

HUMAN ERRORS THAT IMPACT HIGH RISK COMPONENTS

- ✓ For E2DG:
  - HPCI, RCIC, E1DG, E3DG, and E4DG
  - Short AOTs
- ✓ Protecting Other Electrical Components
  - MCCs, Relays, CBs, High Voltage Buses
- ✓ Removing from Operation
  - The Wrong Component
  - In the Wrong Station
- ✓ Protecting Components (Tangible Benefits)
  - Avoid Initiating Events, Increase Availability.

IMPACT OF ENVIRONMENT (Grid, Weather,...)

No Grid Reliability Issue			Grid Reliability Issue (Including Weather)		
Remain In Service Component	CDF RAW	RAW Risk Color	Remain In Service Component	CDF RAW	RAW Risk Color
E3DG	30	RED	E3DG	60	RED
RCIC	20	RED	RCIC	50	RED
HPCI	15	ORANGE	HPCI	40	RED
E1DG	9	YELLOW	Tie Line	30	RED
Tie Line	8	YELLOW	E4DG	20	RED
E4DG	5	YELLOW	E1DG	15	ORANGE

Tangible Benefits at Peach Bottom

- ✓ **Significant Amount of Protected Equipment**
  - Started ALL RED and ORANGE
  - Reduced List by Operations
  - Risk Management Consulted
  - Focus on Avoiding Initiating Events
- ✓ **Benefits**
  - Consecutive Breaker to Breaker Runs - **Tangible**
  - Improved “Safety Culture” – Respecting Risk
  - Excellent INPO-1 Rating

Protecting Equipment in the Chemical Industry

- ✓ Risk Informed Configuration Management
  - Unplanned Explosions
  - Fires and Toxic Gas releases
  - Oil Spills
  - The Bhopal Accident
- ✓ Ranking of Structures, Systems and Components:
  - Based on **Probabilistic** Safety Assessment
  - Specific to the Chemical Factory (or Grouping)
  - Protecting Most Important SSCs

Benefits of Protecting Equipment in Mining & Chemical Industries

- ✓ Risk Informed Configuration Management
  - Defining Acceptable (GREEN and YELLOW Risk)
  - Defining Unacceptable (ORANGE and RED Risk)
  - Increasing Productivity and Profits
- ✓ Reducing the Frequency of Initiating Events
- ✓ Improving the Safety Culture

Aviation & Space Industries

(from PSAM5 paper)

Risk Informed Corrosion Ranking of Airplane SSCs

System / Structure / Component	Airplane Accident Rate (per Operation)
Engine	2.15 E-7
Landing Gear	1.89 E-7
Electrical Wiring	8.80 E-8
Flight Control Internals	7.51 E-8
Flight Control Attachments	6.53 E-8
Nacelle / Pylons	2.63 E-8
Fuselage Center	1.97 E-8
Fuel System	1.94 E-8
Fuselage Forward	9.60 E-9
Fuselage Aft	2.05 E-9
Total	7.01 E-7

Protecting Equipment in the Aviation & Space Industries

- ✓ Risk Informed Configuration Management
  - Protecting Equipment Between Missions
  - Event Statistics Per Flight Mission
- ✓ Ranking of Structures, Systems and Components:
  - Based on **Probabilistic** Safety Assessment
  - Specific to the Aircraft, Spacecraft, Airline,
  - Protecting Most Important SSCs

Protecting Equipment in the Health Care Industry

- ✓ **The main causes of many human errors are**:
  - System communications characteristics such as look-alike labels, sound-alike names
  - Fitness for Duty issues (long hours of work at heavy work loads)
  - Managerial Style of **Safety Culture**

- ✓ **Posting specific protection-warning signs**:
  - "Allergic to Medication“,
  - Specific medicine cocktails not to be prescribed or provided to specific patients
  - ……

CONCLUSIONS

- ✓ Protecting Equipment is a Tool to Reduce the Frequency of Human Errors of Omission
  - Reducing the Number of Initiating Events
  - Increasing Productivity
- ✓ Protecting Equipment Delivers a Message of Safety Culture
  - Might Reduce the Frequency of Errors of Commission
- ✓ Protecting Equipment Takes Various Forms in Different Industries
  - Posting
  - Signs
  - Warnings (Physical or Computerized)

RECOMENDATIONS

- ✓ Developing A **Standardized** Approach Might Help
  - Specific to Each Industry
  - With Concurrence from Various Stakeholders (Operations, Maintenance, Engineering, Regulation)
- ✓ A Question of **OPTIMIZATION**
  - Defining What is a Minimum Level of Protection
  - Defining What is a Maximum Achievable Level of Protection
  - Calculating a Best-Estimate Level of Protection