# PERFORMANCE INDICATORS

# PHILOSOPHY

- PIs Should be Based on Objective Data
- They Should Provide a Measure of Licensee Performance
- Degree of Regulatory Response to PIs is a Function of Risk Significance
- PIs and Inspection Findings Should be treated in an Equivalent Manner

# USE OF RISK MODELS TO ESTABLISH LEVEL OF REGULATORY INVOLVEMENT

- To Establish Bands of Risk Significance for PIs and Inspection Findings.
- To Develop the Significance Determination Process for Findings Related to Initiating Events, Mitigating Systems, and Containment System.
- CDF and LERF used as risk metrics.

# RISK SIGNIFICANCE OF PIs AND INSPECTION FINDINGS FOR REACTOR SAFETY CORNERSTONES

- Intent in Setting up Scheme for Assessing Risk Significance of PIs and Inspection Findings Was to Establish Some Sort of Equivalence Using PRA Models.

- Increases in PI Values, If Maintained, Would Correspond to Increases in CDF over and above the Base CDF.

# RISK SIGNIFICANCE OF PIs AND INSPECTION FINDINGS FOR REACTOR SAFETY CORNERSTONES

- Inspection Findings That Can Be Identified with a Degradation in Performance of a Mitigating System or Can Lead to an Increased Likelihood of an Initiating Event Can Be Characterized by the Change in CDF and Possibly LERF.

- Inspection Findings That Can Be Identified with a Degradation of the Containment Function Can Be Characterized by the Change in LERF.

# RISK SIGNIFICANCE OF PIs AND INSPECTION FINDINGS FOR REACTOR SAFETY CORNERSTONES

- The Acceptance Guidelines of RG 1.174 on Changes to CDF and LERF Are Used to Establish Bands That Determine the Degree of Regulatory Involvement - the Higher the Risk Impact of the PI Value or the Inspection Finding the More Regulatory Involvement.

# THRESHOLDS FOR PIs

- The Green-White Threshold Was Determined by Experience Data Such That Only a Few Outlier Values Would Be in the White.

- The White-Yellow Threshold Was Established at a Value Such That a Change of the PI Would Result in a $\Delta$ CDF > 1E-05.

- The Yellow-Red Threshold Was Established Such That a Change in PI Value Greater than the Threshold Would Result in a $\Delta$ CDF > 1E-04.

- The Thresholds Were Established Using a Set of PRA Models with the Lower Threshold from the Set Being Used.

# Typical PWR AFW System Unavailability

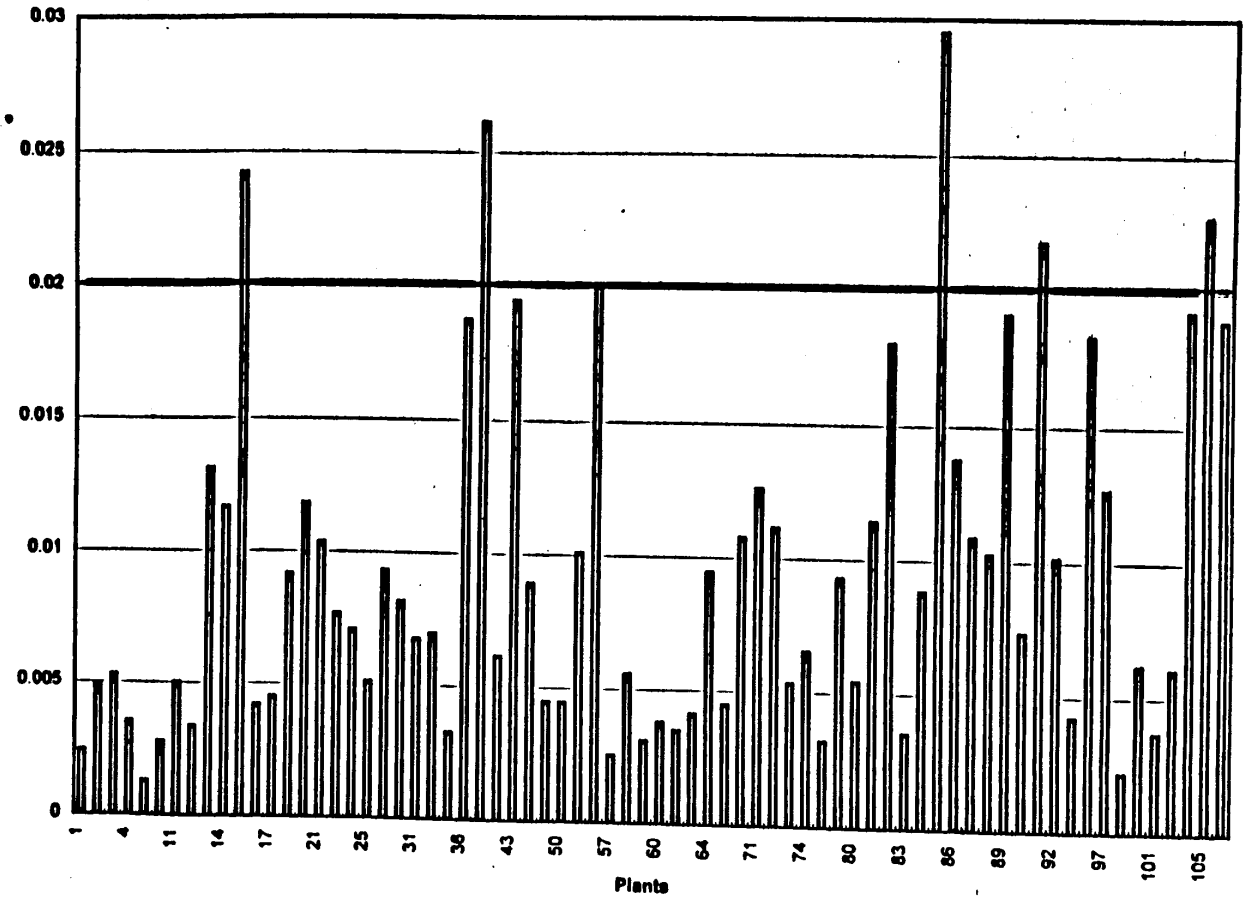


**Table 1 – PERFORMANCE INDICATORS**

| Cornerstone | Indicator | | Thresholds (see Note 1) | | |
|---|---|---|---|---|---|
| | | | **Increased Regulatory Response Band** | **Required Regulatory Response Band** | **Unacceptable Performance Band** |
| **Initiating Events** | Unplanned Scrams per 7000 Critical Hours (automatic and manual scrams during the previous four quarters) | | >3.0 | >6.0 | >25.0 |
| | Scrams with a Loss of Normal Heat Removal (over the previous 12 quarters) | | >2.0 | >10.0 | >20.0 |
| | Unplanned Power Changes per 7000 Critical Hours (over previous four quarters) | | >6.0 | N/A | N/A |
| **Mitigating Systems** | Safety System Unavailability (SSU) (average of previous 12 quarters) | **All Plants** | | | |
| | | ≤2EDG | >2.5% | >5.0% | >10.0% |
| | | >2EDG | >2.5% | >10.0% | >20.0% |
| | | Hydro Emerg. Power | TBD | TBD | TBD |
| | | **BWRs** | | | |
| | | HPCI | >4.0% | >12.0% | >50.0% |
| | | HPCS | >1.5% | >4.0% | >20.0% |
| | | RCIC | >4.0% | >12.0% | >50.0% |
| | | RHR | >1.5% | >5.0% | >10.0% |
| | | **PWRs** | | | |
| | | HPSI | >1.5% | >5.0% | >10.0% |
| | | AFW | >2.0% | >6.0% | >12.0% |
| | | RHR | >1.5% | >5.0% | >10.0% |
| | Safety System Functional Failures (over previous four quarters) | BWRs | >6.0 | N/A | N/A |
| | | PWRs | >5.0 | N/A | N/A |

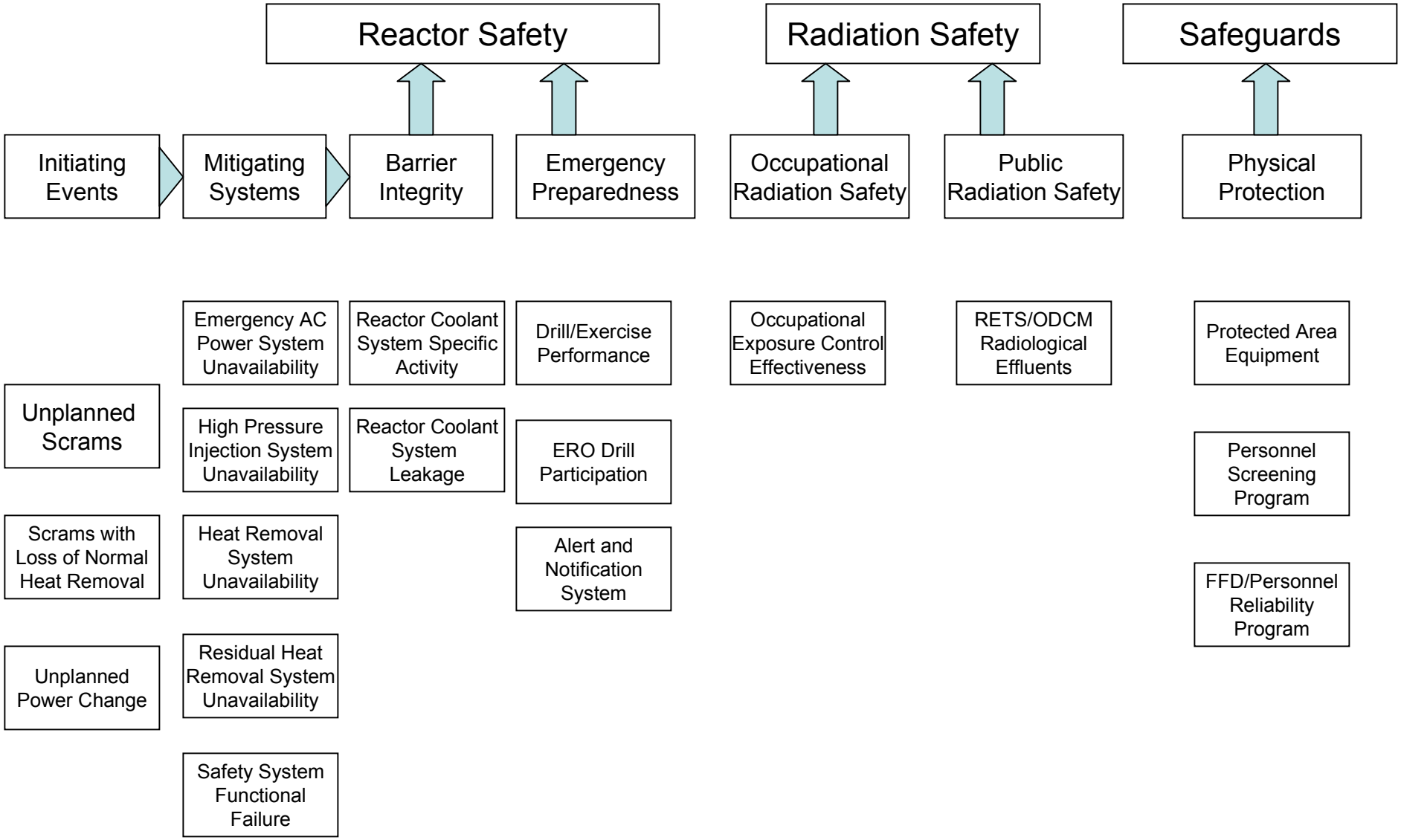
Note 1: Thresholds that are specific to a site or unit will be provided in Appendix D when identified.

# THRESHOLDS FOR INSPECTION FINDINGS

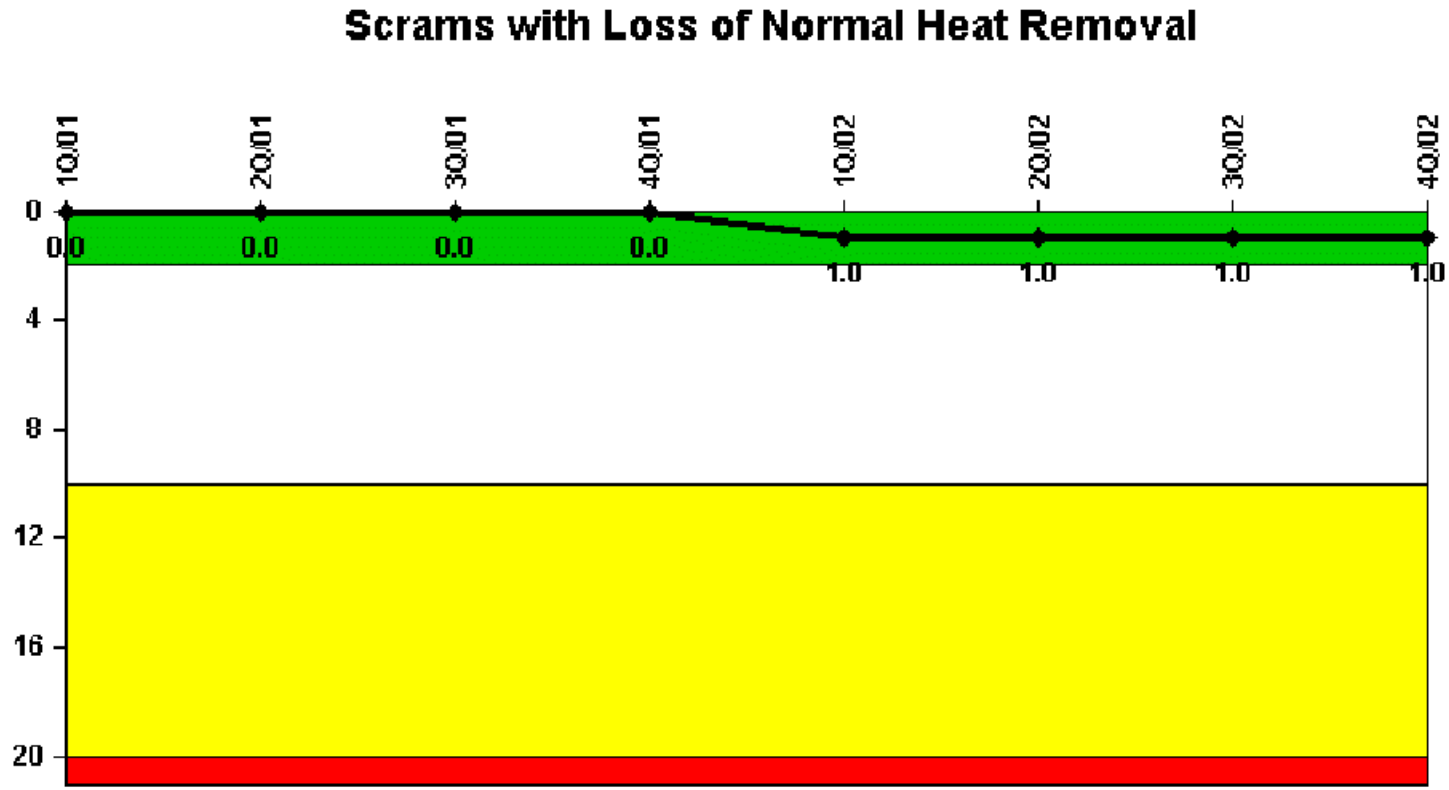
- The Green-White, White-Yellow, and Yellow-Red Thresholds Are Set to Coincide with $\Delta$ CDF > 1E-06, 1E-05, and 1E-04, Respectively.

- The Significance of an Inspection Finding Is Assessed Using the Significance Determination Process (SDP).

# Performance Indicators in the Seven Cornerstones

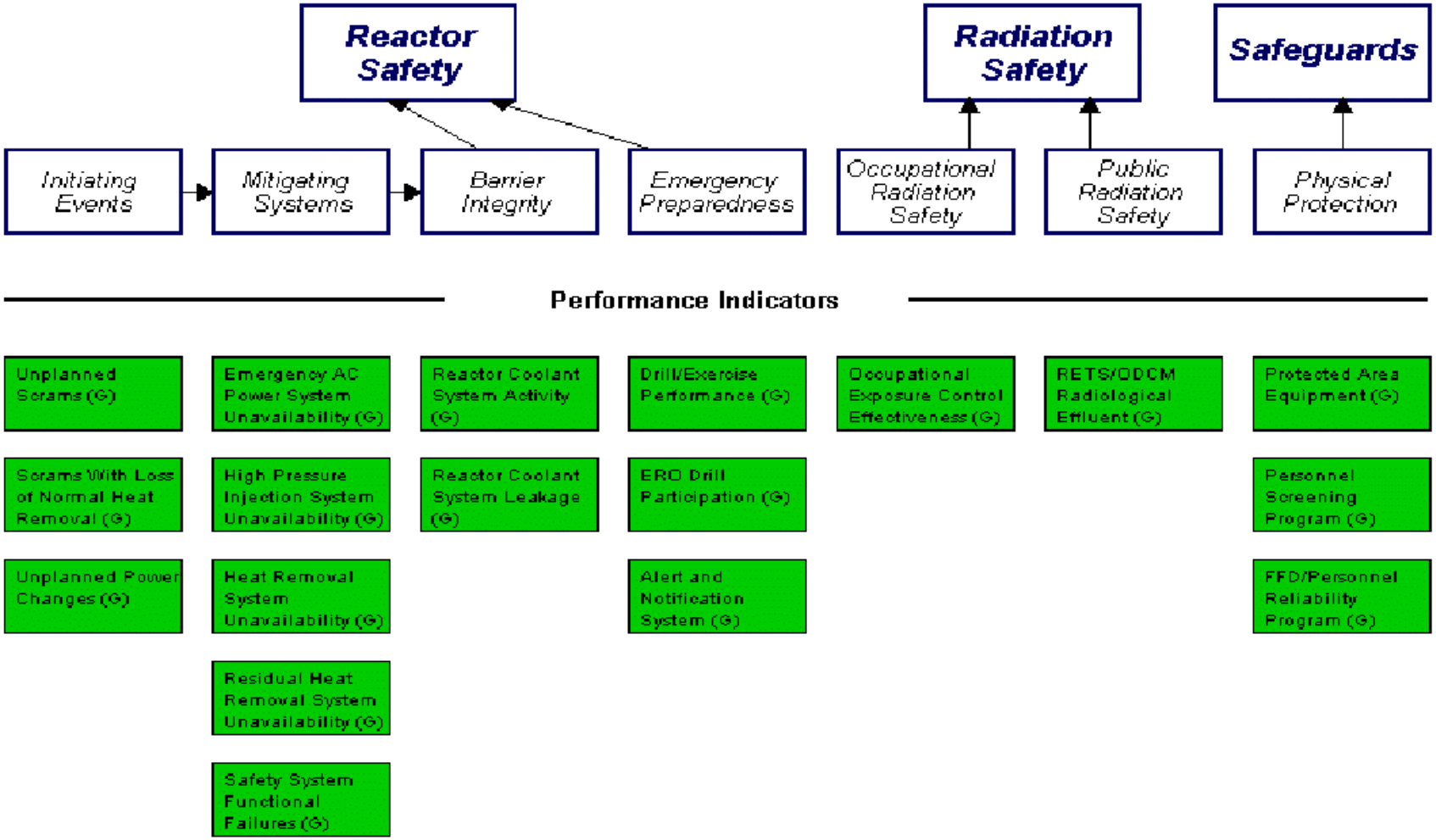


# TYPICAL PERFORMANCE INDICATOR




Thresholds: White > 2.0 Yellow > 10.0 Red > 20.0

# 4Q PERFORMANCE INDICATORS



## Performance Indicators (Risk Bases, Reporting, Measurement)

Cornerstone: Initiating Events:

• **Unplanned Scrams**

Risk Basis: White/Yellow and Yellow/Red determined using risk-sensitivity studies (SECY-99-007, Attachment 2, Appendix H)

Measurement: $\frac{\text{(total unplanned srams while critical in the previous 4 qtrs)(7000 hrs)}}{\text{(total number of hours critical in the previous 4 qtrs)}}$

The value of 7,000 hours is used because it represents one year of reactor operations at an 80.0% capacity factor.

Reporting Requirement: Quarterly

## Performance Indicators (Risk Bases, Reporting, Measurement)

Cornerstone: Initiating Events

- **<u>Unplanned Scrams with Loss of Normal Heat Removal</u>**

Risk Basis: White/Yellow and Yellow/Red determined using risk-sensitivity studies (SECY-99-007, Attachment 2, Appendix H)

Measurement: total unplanned scrams while critical in the previous 12 quarters that were either caused by or involved a loss of the normal heat removal path through the main condenser prior to establishing reactor conditions that allow use of the plant's normal long term heat removal systems.

Reporting Requirement: Quarterly

## Performance Indicators (Risk Bases, Reporting, Measurement)

Cornerstone: Initiating Events

- **Unplanned Power Changes per 7000 Critical Hours**

Risk Basis: Threshold determined using industry mean plus one standard of deviation based on data from July 1, 1995, through June 30, 1997

Measurement:

$$\frac{\text{(total \# of unplanned pwr changes during the previous 4 qtrs)(7000 hrs)}}{\text{(total number of hours critical during the previous 4 qtrs)}}$$

The value of 7,000 hours is used because it represents one year of reactor operations at an 80.0% capacity factor.

Reporting Requirement: Quarterly

## Performance Indicators (Risk Bases, Reporting, Measurement)

Cornerstone: Mitigating Systems

- **Emergency AC Power System Unavailability**
- **High Pressure Injection System Unavailability**
- **Heat Removal System Unavailability**
- **Residual Heat Removal System Unavailability**

Risk Basis: White/Yellow and Yellow/Red determined using risk-sensitivity studies (SECY-99-007, Attachment 2, Appendix H)

Measurement:

$$\frac{\text{(planned unavail hrs) + (unplanned unavail hrs) + (fault exposure unavail hrs)}}{\text{(hours train required during the previous 12 quarters)}}$$

Reporting Requirement: Quarterly

## Performance Indicators (Risk Bases, Reporting, Measurement)

Cornerstone: Mitigating Systems

- **Safety System Functional Failures**

Risk Basis: Threshold determined using industry mean plus one standard of deviation based on data from July 1, 1995, through June 30, 1997

Measurement: number of safety system failures in previous 4 qtrs

Reporting Requirement: Quarterly

## Performance Indicators (Risk Bases, Reporting, Measurement)

Cornerstone: Barrier Integrity

- **Reactor Coolant System Specific Activity**
- **Reactor Coolant System Leakage**

Risk Basis: Threshold based on regulatory basis; threshold set at 50 and 100 percent of technical specification limit.

Measurement:

$$\frac{\text{maximum monthly value of calculated activity}}{\text{Technical Specification limit}} \times 100$$

$$\frac{\text{maximum monthly value of identified leakage}}{\text{Technical Specification limit}} \times 100$$

Reporting Requirement: Quarterly

## Performance Indicators (Risk Bases, Reporting, Measurement)

Cornerstone: Emergency Preparedness

- **Drill/Exercise Performance**

Risk Basis: Threshold determined using analysis of emergency preparedness exercise inspection findings from 1994 to 1997.

Measurement:

$$\frac{\text{\# of timely \& accurate classifications, notifications, \& PARS from drills, exercises and actual events during the previous 8 quarter}}{\text{The total opportunities to perform classifications, notifications \& PARs during the previous 8 quarters}} \times 100$$

Reporting Requirement: Quarterly

## Performance Indicators (Risk Bases, Reporting, Measurement)

Cornerstone: Emergency Preparedness

- **ERO Drill Participation**

Risk Basis: Based on NRC staff and industry representative experiences

Measurement:

$$\frac{\text{\# of key ERO members that have participated in a drill, exercise or actual event during the previous 8 quarters}}{\text{Total number of key ERO members}} \times 100$$

Reporting Requirement: Quarterly

## Performance Indicators (Risk Bases, Reporting, Measurement)

Cornerstone: Emergency Preparedness

- **Alert and Notification System**

Risk Basis: Threshold determined by analysis of yearly sirens availability for 19995, 1996 and 1997 for approximately 20 plants

Measurement:

$$\frac{\text{\# of successful siren tests in the previous 4 quarters}}{\text{total number of siren tests in the previous 4 quarters}} \times 100$$

Reporting Requirement: Quarterly

## Performance Indicators (Risk Bases, Reporting, Measurement)

Cornerstone: Occupational Radiation Safety

• **<u>Occupational Exposure Control Effectiveness</u>**

Risk Basis: Threshold based on a review and analysis of quarterly occupational radiological occurrence data provided by 28 licensee sites for the period January 1996 through September 1998.

Measurement: Sum of reported number of occurrences for each of the following:

- technical specification high radiation area (> 1 rem per hour) occurrence
- very high radiation area occurrences
- unintended exposure occurrences\

Reporting Requirement: Quarterly

## Performance Indicators (Risk Bases, Reporting, Measurement)

Cornerstone: Public Radiation Safety

• **RETS/ODCM Radiological**

Risk Basis: Threshold based on a review of licensee event report data associated with process radiation monitoring system activities provided by all sites for the period from January 1995 through December 1997.

Measurement: Number of RETS/ODCM radiological effluent occurrences per site in the previous four quarters.

Reporting Requirement: Quarterly

## Performance Indicators (Risk Bases, Reporting, Measurement)

Cornerstone: Physical Protection

- **<u>Protected Area Equipment</u>**

Risk Basis: Threshold was developed and agreed to by an expert panel composed of NRC and industry representatives, based on the collection and review of historical data.

Measurement:

$$\text{IDS unavailability index} = \frac{\text{IDS Compensatory hrs in the prev. 4 quarters}}{(\text{IDS normalization factor}) \times 8760 \text{ hours}}$$

$$\text{CCTV unavailability index} = \frac{\text{CCTV compensatory hrs in the prev. 4 quarters}}{(\text{CCTV normalization factor}) \times 8760 \text{ hours}}$$

$$\text{Indicator value} = \frac{\text{IDS unavailability index} + \text{CCTV unavailability index}}{2}$$

Reporting Requirement: Quarterly

## Performance Indicators (Risk Bases, Reporting, Measurement)

Cornerstone: Physical Protection

- **Personnel Screening Program**

Risk Basis: Threshold was developed and agreed to by an expert panel composed of NRC and industry representatives, based on the collection and review of historical data.

Measurement: Number of reportable failures to properly implement the regulatory requirements

Reporting Requirement: Quarterly

## Performance Indicators (Risk Bases, Reporting, Measurement)

Cornerstone: Physical Protection

- **<u>FFD/Personnel Reliability Program</u>**

Risk Basis: Threshold was developed and agreed to by an expert panel composed of NRC and industry representatives, based on the collection and review of historical data.

Measurement: The number of reportable failures to properly implement the requirements of 10 CFR Part 26 and 10 CFR 73.56.

Reporting Requirement: Quarterly

# Overall Results
# Performance Indicators that crossed thresholds

| | WHITE | | |
|---|---|---|---|
| C/S | 4/2/00 to 4/1/01 | 4/2/01 to 12/31/01 | 1/1/02 to 9/30/02 |
| IE | 7 | 4 | 3 |
| MS | 14 | 4 | 3 |
| B | 2 | 1 | 0 |
| EP | 5 | 0 | 1 |
| RP(O) | 0 | 0 | 0 |
| RP(P) | 0 | 0 | 0 |
| PP(1) | 2 | 0 | 0 |
| Total | 30 | 9 | 6 |

| | YELLOW | | |
|---|---|---|---|
| C/S | 4/2/00 to 4/1/01 | 4/2/01 to 12/31/01 | 1/1/02 to 9/30/02 |
| IE | 0 | 0 | 0 |
| MS | 0 | 0 | 0 |
| B | 0 | 0 | 0 |
| EP | 0 | 0 | 0 |
| RP(O) | 0 | 0 | 0 |
| RP(P) | 0 | 0 | 0 |
| PP(1) | 0 | 0 | 0 |
| Total | 0 | 0 | 0 |

# INDUSTRY TRENDS

- NRC monitors PIs at the industry-level to assess whether there are any adverse trends in performance

- Annual report to Congress of any adverse trends

- Indicators posted on NRC web site

http://www.nrc.gov/reactors/operating/oversight/industry-trends.html

# PERFORMANCE INDICATOR (PI) PROGRAM CHALLENGES

- Address inconsistencies between the ROP maintenance rule, INPO, and WANO requirements (primarily the safety system unavailability PI)
- Safety System Unavailability PI
- Improve the physical protection PI
- Initiating Events PI
- Develop improved barrier integrity PIs.

# SAFETY SYSTEM UNAVAILABILITY

- Issues
  - Thresholds are the same for all plants, and do not take into account plant specific differences in risk importance
  - Failures are addressed via the ‘fault exposure time’ which can  produce step changes in PI values
- One proposed resolution is the MSPI – mitigating system performance indicator – currently under consideration