OPERATIONAL RISK MANAGEMENT

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NRRC Workshop on

Risk-Informed Decision Making: A Survey of U.S. Experience

Tokyo, Japan, June 1-2, 2017

Nuclear Risk Research Center, CRIEPI

The B. John Garrick Institute for the Risk Sciences

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Operational Risk Management Overview

❑Presentation - 50 min

❑Q&A - 20 min

❑Summary of:

- Section 3.5: Component Risk Significance and Notification;
- Section 3.7: Utilizing Insights from Operating Experience;
- Section 3.8: Risk Information and Insights in Operational Decision Making;
- Section 3.14: Risk Monitoring to Integrate Risk Thinking into Daily Plant Status.

Application Strategies for Risk Management

❑Tactical (used frequently) Risk Management Approaches
- Configuration Risk Daily, Weekly, Outage (Shutdown Risk)
- Equipment Importance (Risk Significance)
- Prioritization of activities
- Risk Monitoring
- Testing & Maintenance Strategies
- Risk Communication

❑Strategic Risk Management Approaches
- Emergency Response Strategies
- Equipment Reliability trends
- Modification Risk Evaluations
- Aging management
- Risk Communication

Risk Management Approaches

❑Quantitative

❑Qualitative

❑Blended (Quantitative AND Qualitative)
- Typically uses Integrated Decision-Making Panel (IDP)

Timeframes for Assessing Risk Levels & Trends

❑ Daily Risk Evaluations – Equipment out-of-service, work activity risk

❑ Weekly Risk Evaluation – Cumulative Risk of Equipment out of service

❑ Monthly Risk Evaluation – Equipment Reliability/Availability Levels

❑ Yearly – Annual risk goal, Annual Equipment Goals

❑ Refueling (Outage risk, Outage configuration risk)

❑ Infrequent - Infrequently performed evolutions (e.g., Heavy Loads,)

❑ Long Range (yearly, Five-Year) – Modification evaluations,

❑ Time Independent - Program Level (e.g., RI-ISI, Component Risk Significance Categorization)

Process, Procedures, Training

❑ Governing Processes for implementing Company Risk Management Strategy, Risk Informed Applications and Use of Risk Information in Company/Plant Processes

❑ Manuals, Procedures and Guidance Documents are required to define expectations, requirements, responsibilities, required action criteria, acceptance criteria, documentation, etc.

❑ Corporate and Sitewide Training

- Company Risk Management Strategy (Management, Supervisory, Individual)
- Risk Management Applications (Affected Organizations)
- Quantitative Tools (PRA, others)
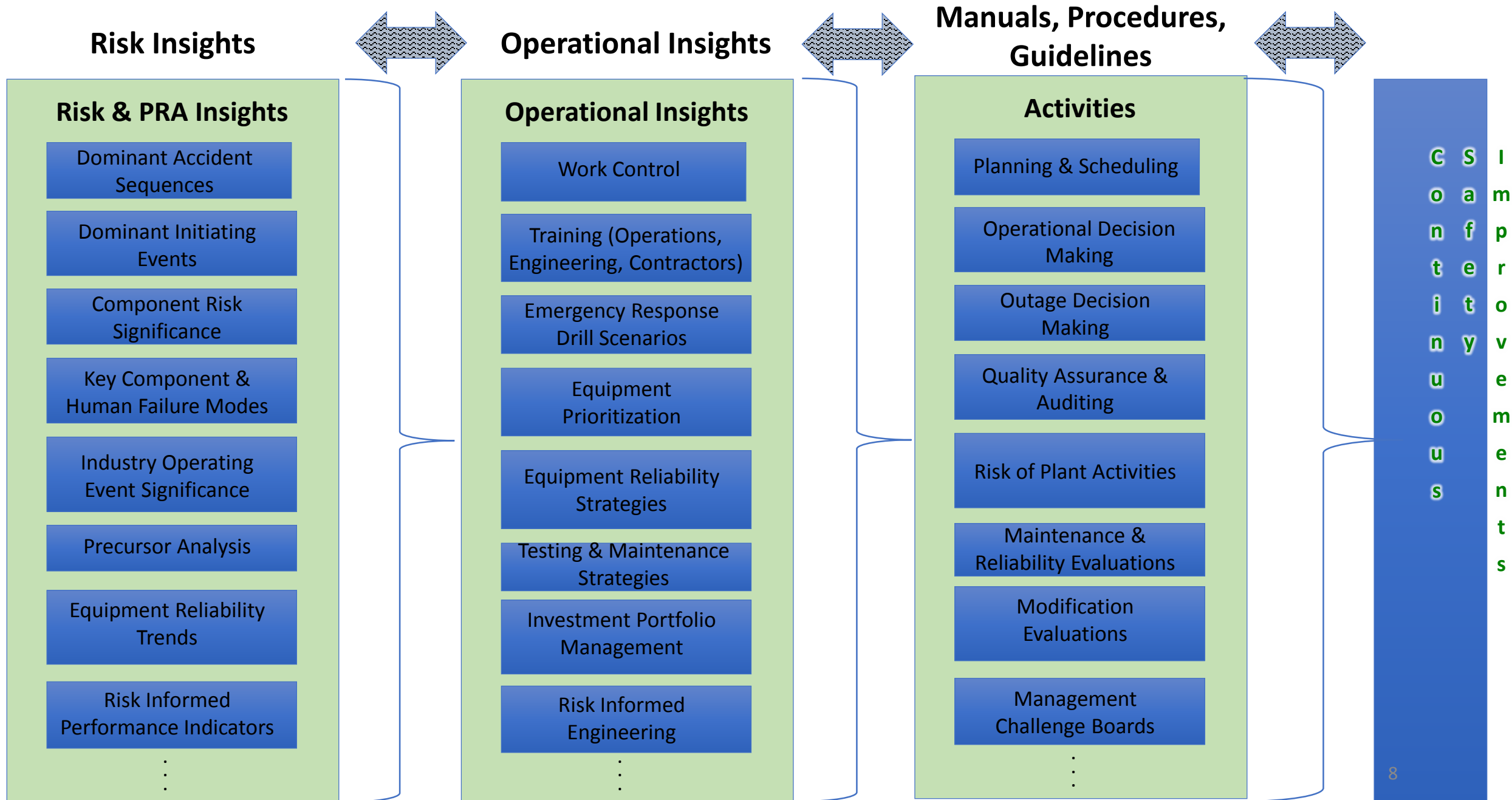- Integrated Decision Making Panel

Risk Communication Plan

❑ Essential for a successful program

❑ Communication plan to include internal and external elements

❑ Plan should include strategies for effectively communicating to all employees and contract organization employees:

- Corporate and Station specific risk objectives and goals
- Relationship of risk and safety (Safety ≠ Compliance Alone)
- Training that is or will be available for target audiences
- Identify organization specific role and contribution to risk
- Importance of data to support continuous improvement in risk knowledge and awareness
- Use all communication mechanisms (posters, company newsletters, computer based training, classroom training, management videos,
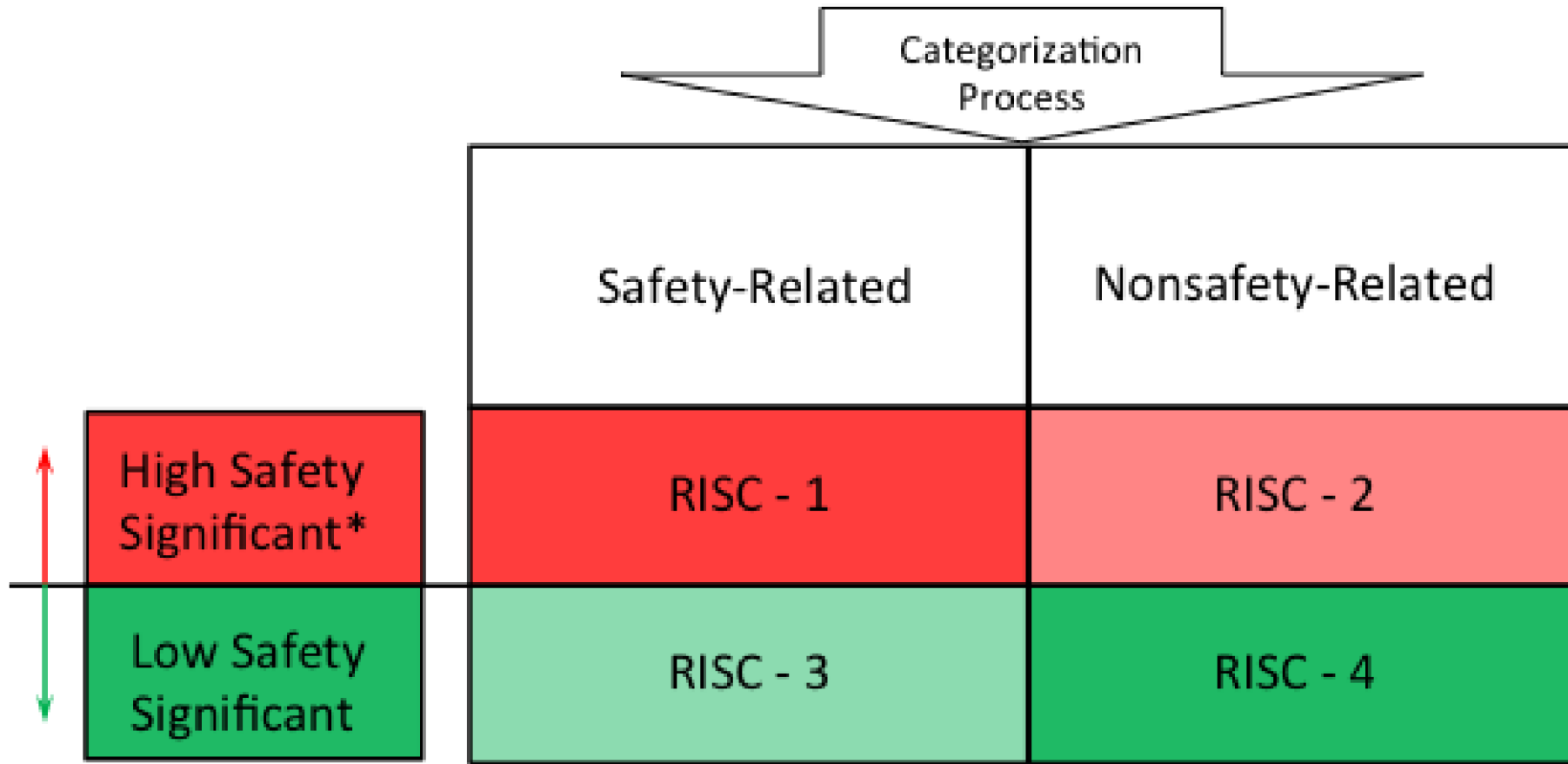
Risk Insights and Operating Experience

Risk Insights ⟷ **Operational Insights** ⟷ **Manuals, Procedures, Guidelines** ⟷

Risk & PRA Insights

- Dominant Accident Sequences
- Dominant Initiating Events
- Component Risk Significance
- Key Component & Human Failure Modes
- Industry Operating Event Significance
- Precursor Analysis
- Equipment Reliability Trends
- Risk Informed Performance Indicators
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Operational Insights

- Work Control
- Training (Operations, Engineering, Contractors)
- Emergency Response Drill Scenarios
- Equipment Prioritization
- Equipment Reliability Strategies
- Testing & Maintenance Strategies
- Investment Portfolio Management
- Risk Informed Engineering
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Activities

- Planning & Scheduling
- Operational Decision Making
- Outage Decision Making
- Quality Assurance & Auditing
- Risk of Plant Activities
- Maintenance & Reliability Evaluations
- Modification Evaluations
- Management Challenge Boards
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Continuous Safety Improvements

White Paper Examples

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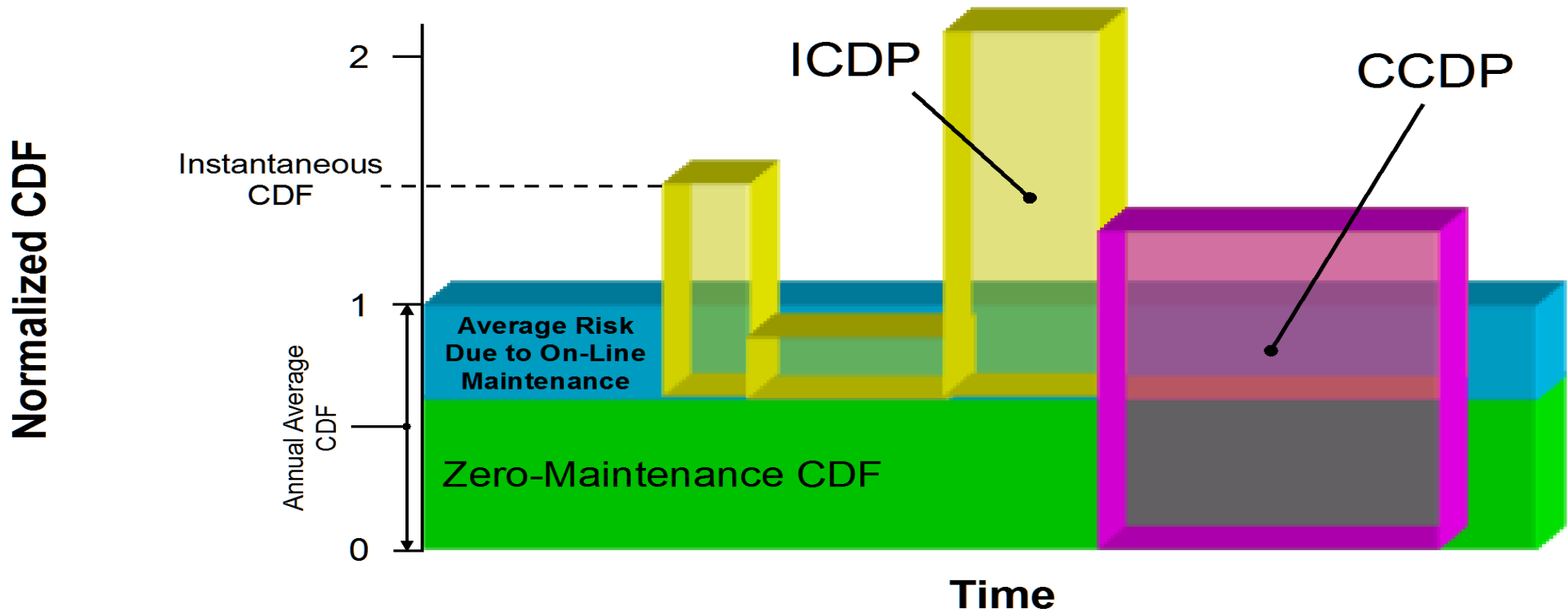
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Component Risk Significance Categorization

Component Risk Significance Categorization

NEI 00-04 Risk Significance Process
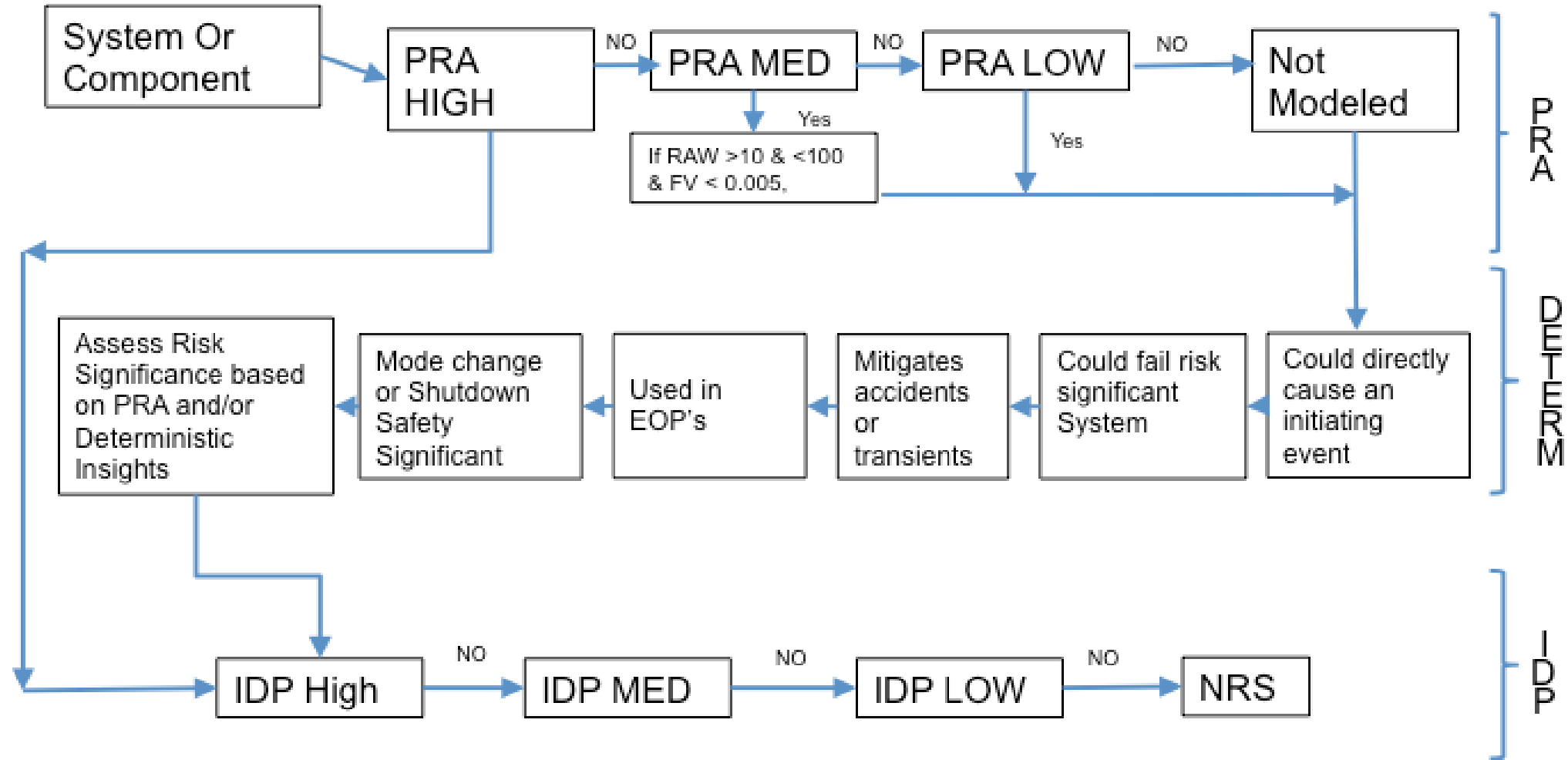
Anatomy of an On-Line Risk Profile

CCDP – Conditional Core Damage Probability
CDF – Core Damage Frequency
CDP – Core Damage Probability
ICDP – Incremental Core Damage Probability

$$CDF_{annual\ avg} = CDF_{Zero\ maint} + CDF_{Avg\ maint}$$
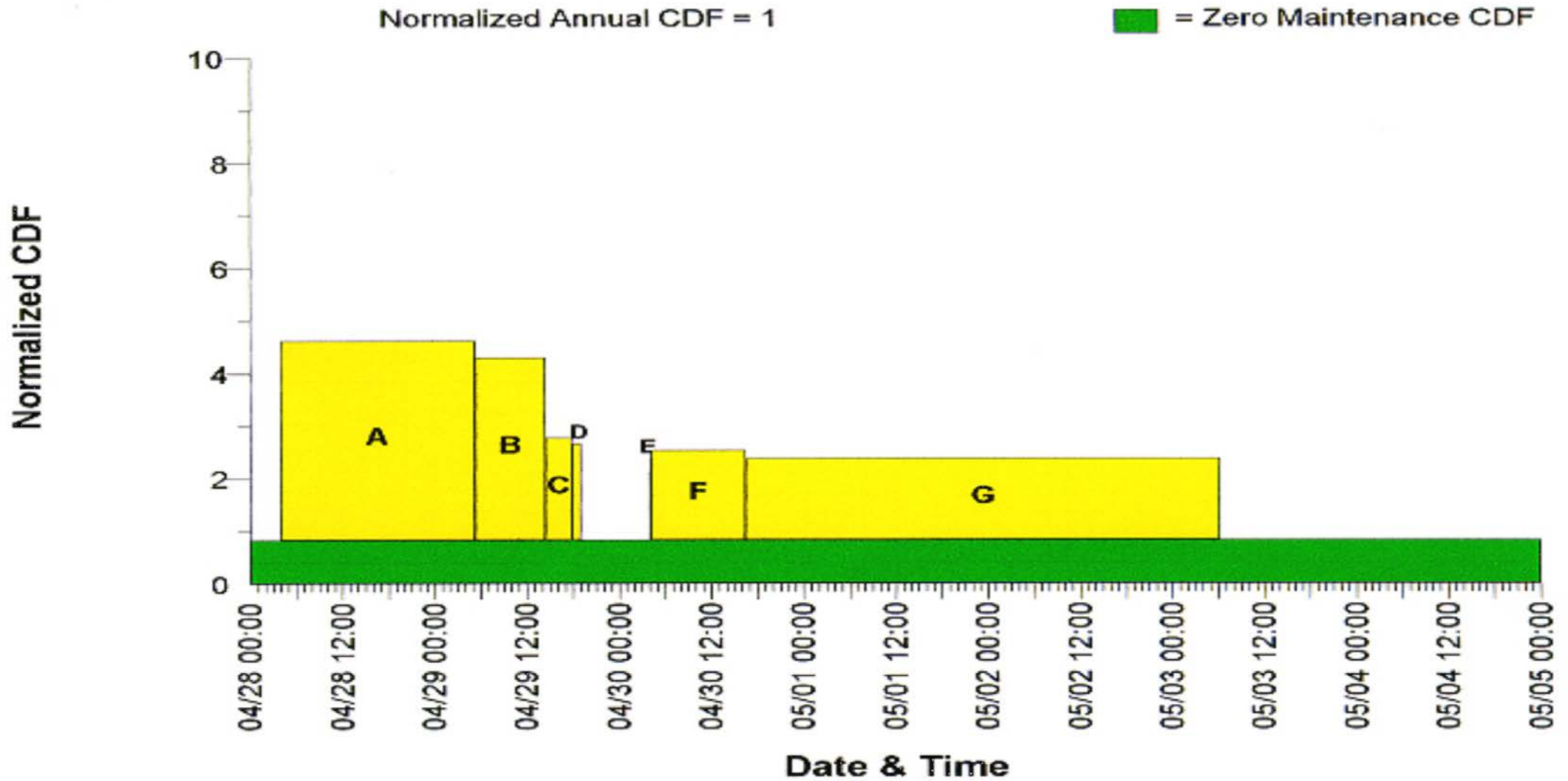
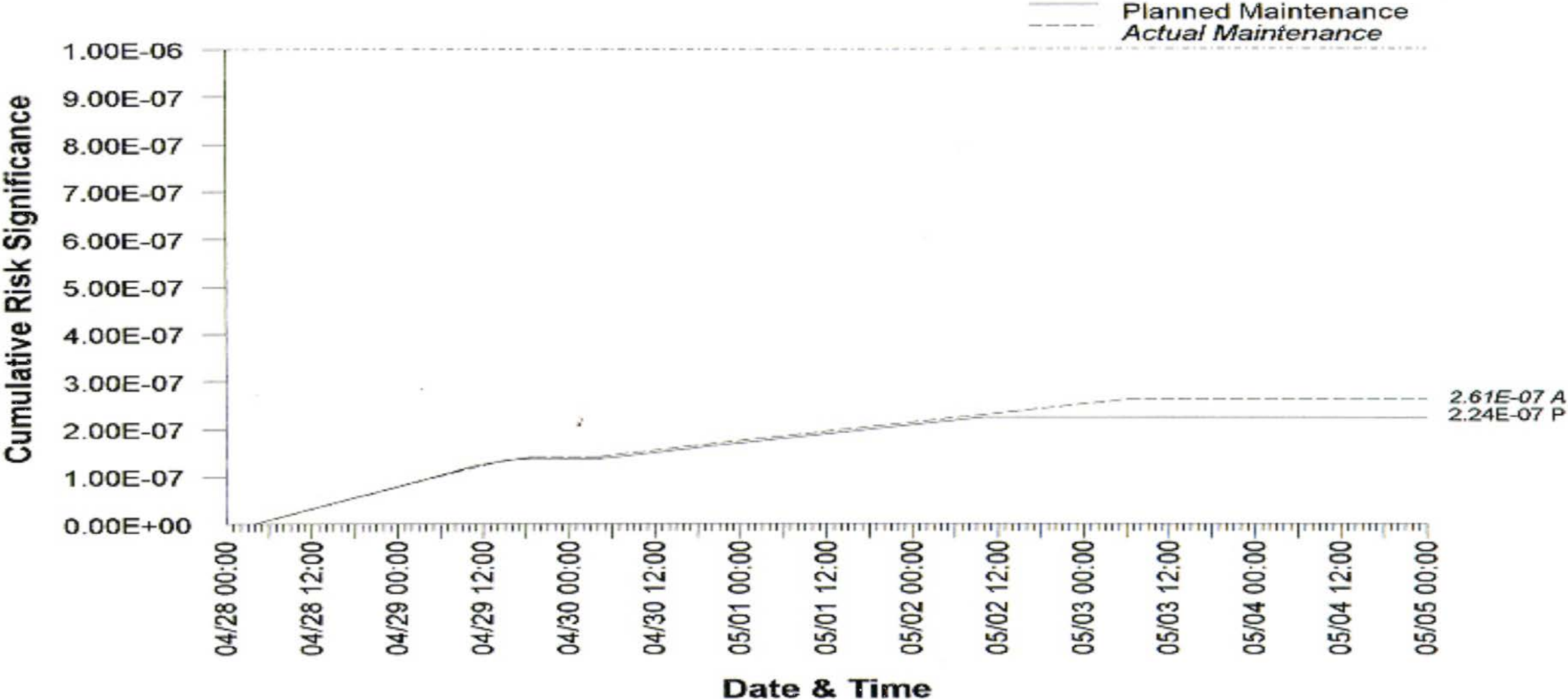$$CCDP = ICDP + CDP_{Zero\ maint}$$

NUMARC 93-01 Thresholds

PLANNED RISK PROFILE FOR UNIT 1 WEEKOF 4/27/01
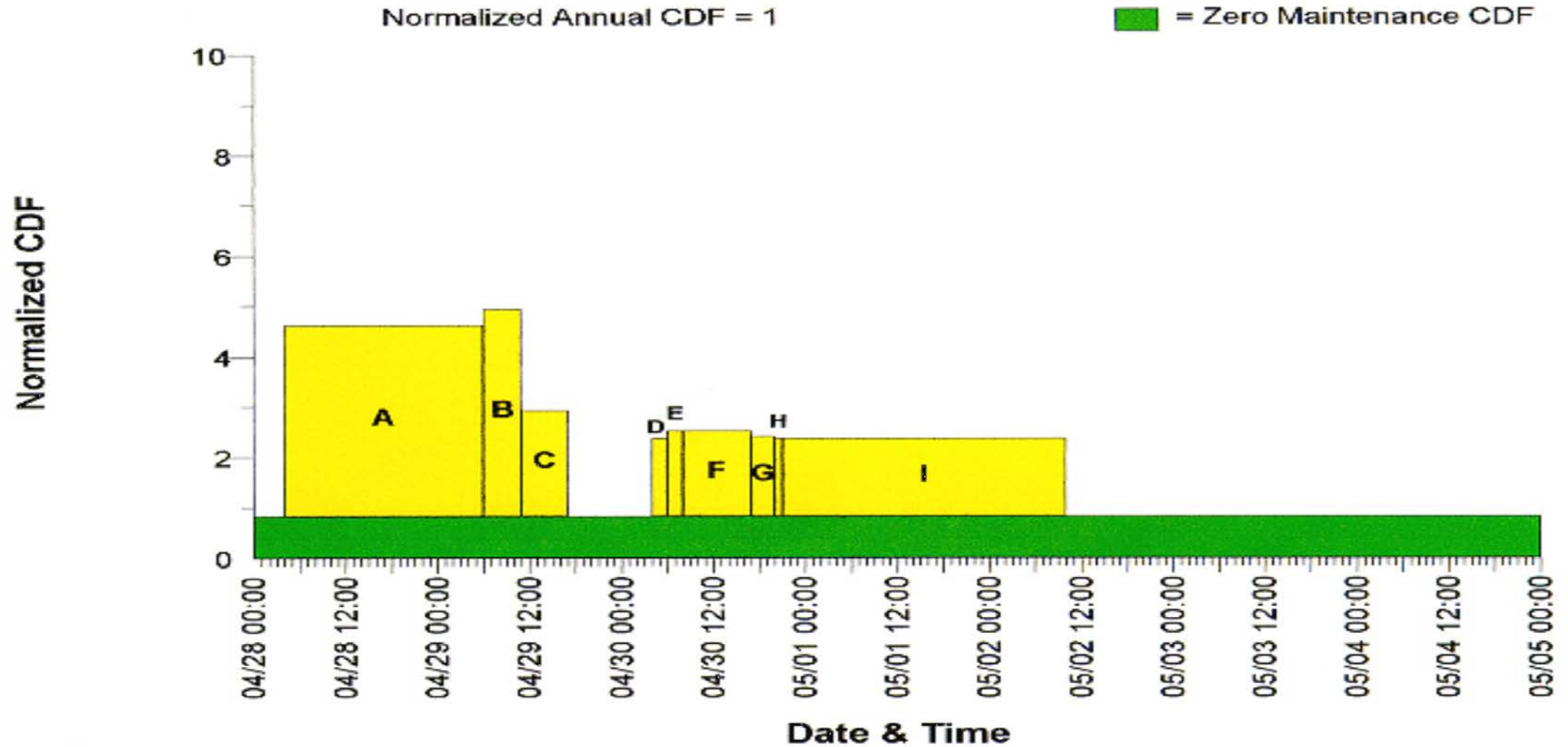
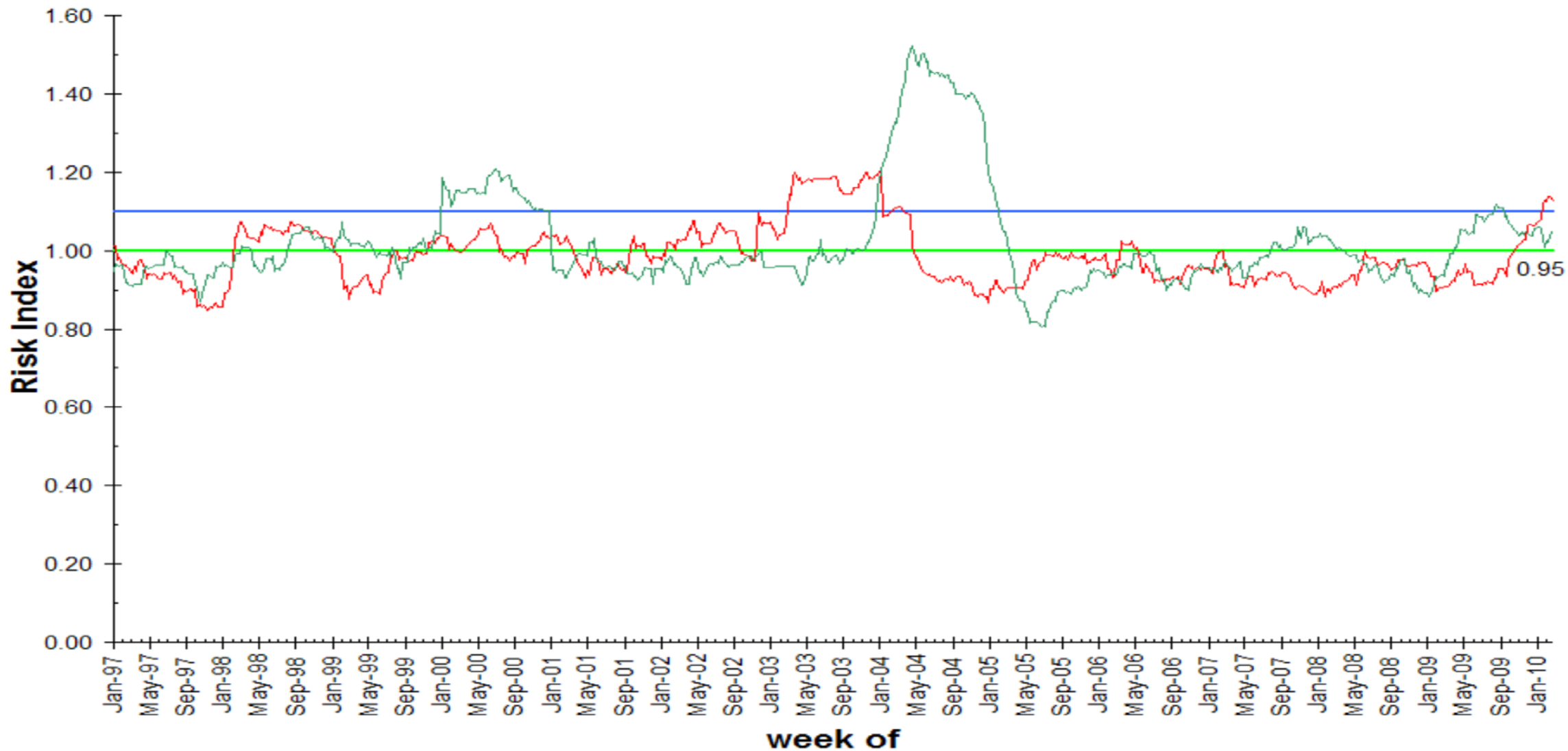# ACTUAL RISK PROFILE FOR UNIT 1 WEEKOF 4/27/01

ACTUAL RISK PROFILES FOR UNIT 1 WEEK OF 4/27/01

Historical Rolling 52-Week Risk Index

Legend: Average | CDF | RI goal | Unit 1 Risk Index | Unit 2 Risk Index

0.95

Establishing Technical Operational Risk Management

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Essential Elements for Incorporating Risk Insights into Operations

❑A company ***risk management and PRA policy*** that establishing the company's commitment to developing and using risk analysis and management for improving safety and continuous improvement

❑A PRA that reflects the ***as-built, as-operated*** station

❑A process where ***PRA data and information is categorized and linked to company processes*** that impact the same PRA data and information

❑Empowered and knowledgeable individuals who have responsibility for ***identifying and implementing*** risk insights into company processes

❑Direct management involvement to ***define and monitor expectations***

❑***Continuous site presence*** of knowledgeable risk practitioners

❑Use of ***experienced and knowledgeable*** experts to guide and teach

Summary

❑ Incorporating risk insights into Operational Risk Management is a process requiring documented and communicated expectations, goals, objectives and assigned ownerships

❑ Requires a total company commitment

❑ Must be part of the company mission

❑ Must have a commitment to continuous learning

❑ Must have a communication plan that encompasses risk insights, risk understanding, training, and risk measurement

❑ All the above is reflected in plant procedures, processes, and guidelines that are required to be adhered to by all employees and contract organization employees

BACKUP Slides

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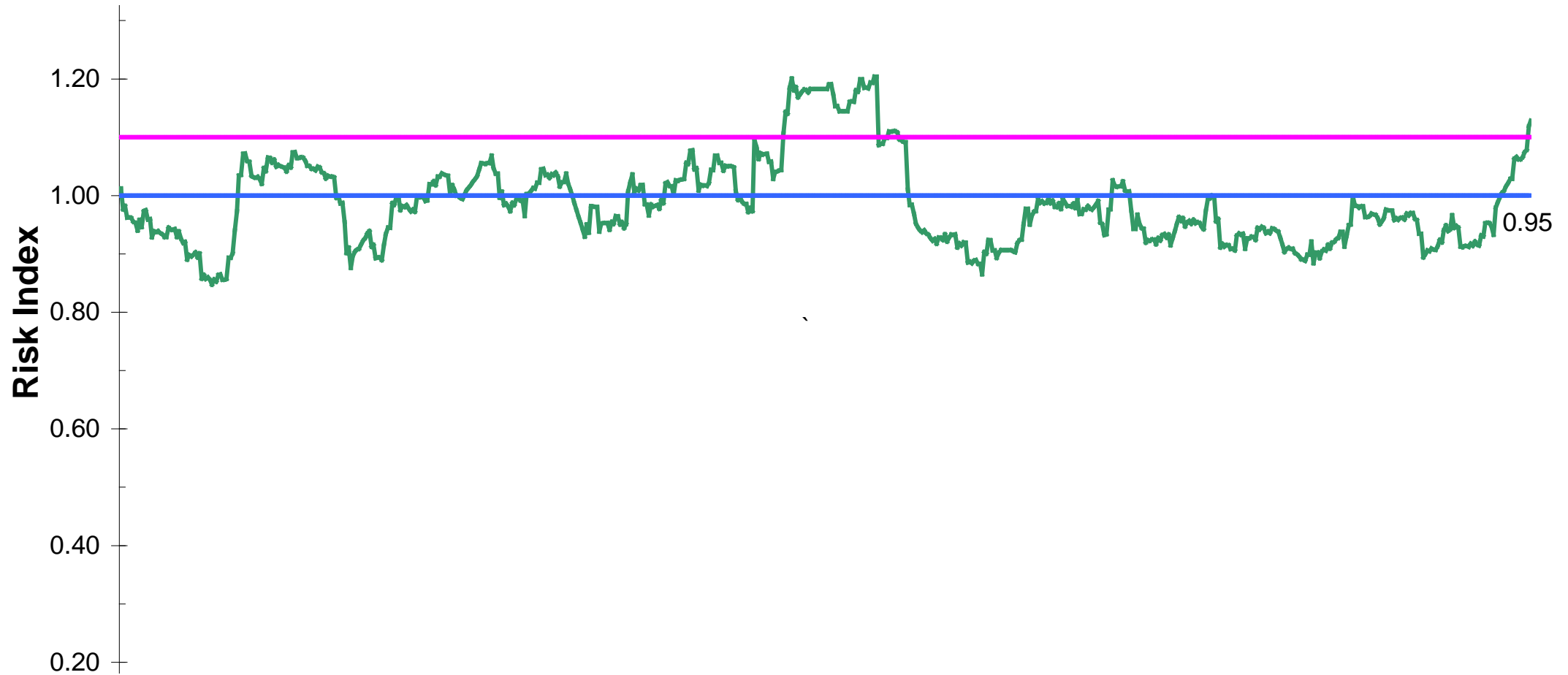*The B. John Garrick Institute for the Risk Sciences*

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Example Risk Informed Performance Indicator - STP Risk Index

Risk Index Overview

- ❏ The STP Risk Index is the top-tier measure of nuclear safety performance.
  - The Risk Index is the ratio of actual risk to expected (average) risk
  - Since PRAs are typically calculated in terms of annual risk (i.e., CDF), the STP PRA calculates risk in terms of weekly planned and actual risk
  - The Risk Index is a rolling 52-week average of the "actual" configuration risk as opposed to average annual risk.
- ❏ The Risk Index value is calculated for both On-Line and Outage conditions:
  - For On-Line Configuration Risk, the Risk Index is the ratio of the actual configuration risk as calculated by the risk monitoring software to the expected average annual risk
  - For Outage Configuration Risk, the Risk Index is the ratio of actual Outage Configuration Risk to the estimated Outage Configuration Risk as measured by the shutdown risk monitoring software
- ❏ The Risk Index is calculated for each Work Week:
  - Starts 00:00 Monday
  - Ends 00:00 the following Monday.
- ❏ The average of Unit 1 and Unit 2 Risk Index values is the used for the performance indicator.
- ❏ The Risk Index provides a display of the change in risk of equipment in or out of service and reflects the total organizational effort of plant processes, activities, interactions, and behaviors related to equipment reliability and availability for equipment within the scope of the configuration risk management program (i.e., equipment within the scope of the PRA)
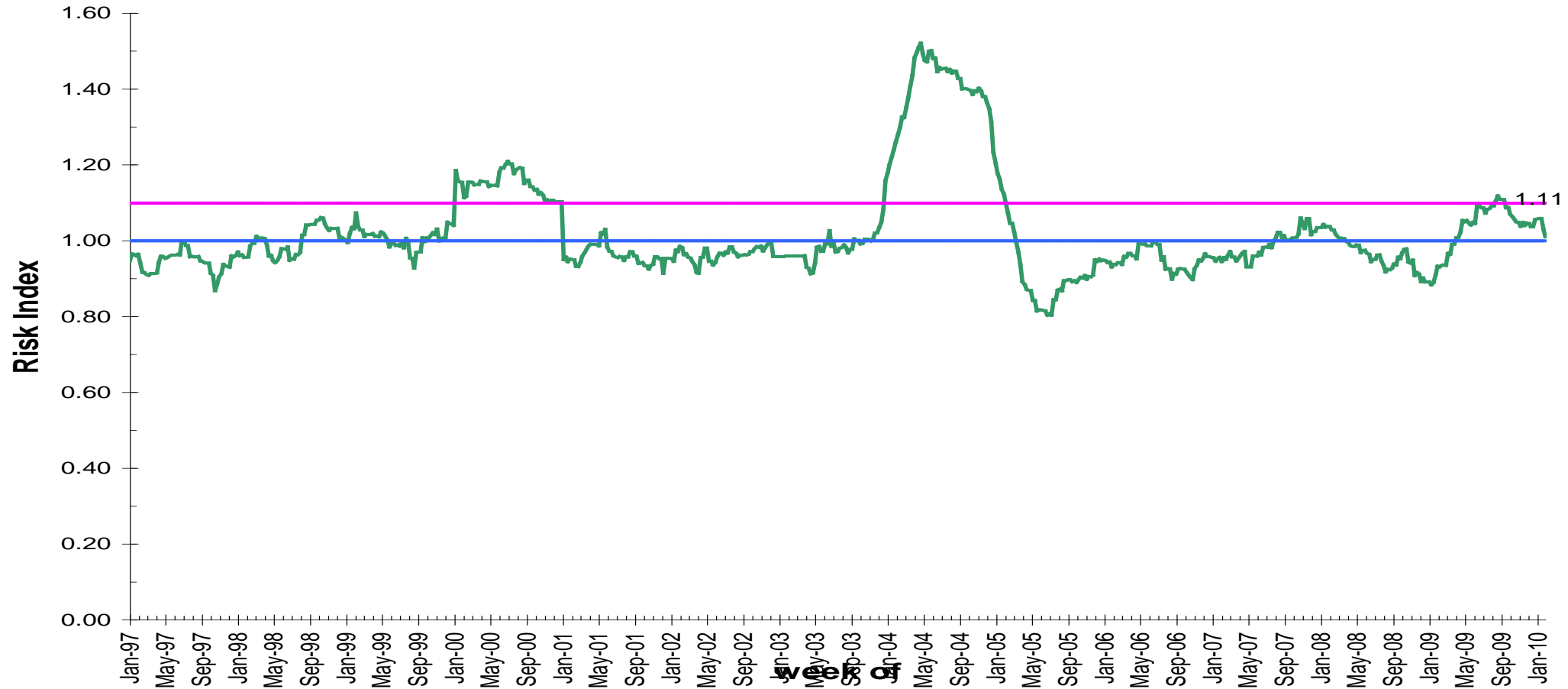
Historical Performance, Unit 1

Historical Performance, Unit 2

Unit 2 Rolling 52-Week RI

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On-Line Risk Index Calculation

RAsCal On-Line risk

For each work week, for each STP Unit On-Line, the RAsCal Weekly Risk Index, R_U^W, is calculated from the following:

$$R_U^W = A_U^W \frac{\left(ICDP_U^W + ZCDP^W\right)}{C_A}.$$

Where:

U — subscript refers to STP Unit (1 or 2)

W — arbitrary sequential superscript referring to the Work Week, sequential from first record (i.e., first week calculated).

A_U^W — is the applicable Unit's fraction of time the reactor is critical during the work week.

$ICDP_U^W$ — is the cumulative Incremental Core Damage Probability from RAsCal for the applicable work week (from midnight Sunday to midnight Sunday) for the applicable Unit.

C_A — is the plant specific STP PRA Average annual CDF (C) corrected for:
- a week duration and
- a full year's plant availability
-

where:

$$C_A = C\left(\frac{168}{8760}\right)\left(\frac{1}{f}\right) \text{ and } f \text{ is availability assumed in the PRA average model.}$$

On-Line Risk Index Calculation

Note that the Average annual CDF (C_A) applies to both STP Units (there is no difference between the Average CDF for Unit 1 or Unit 2).

$ZCDP^W$ is the zero maintenance CDF (ZCDF) (i.e., planned maintenance contribution removed), corrected for a work week.

Also, like the Average Risk (C_A), the zero maintenance risk is the same value for both STP Units:

$$ZCDP^W = ZCDF\left(\frac{168}{8760}\right).$$

Outage Risk Index Calculation

Outage risk

$ORAM_U^W$ is the actual outage risk index (Actual Shutdown Risk/Planned Shutdown Risk): where

$$ORAM_U^w = \frac{AORAM_U^W}{PORAM_U^W}\left(1 - A_U^W\right),$$

Where:

- $AORAM$ is actual outage risk from ORAM as supplied by the Risk Analyst (ENTRY FORM 1) and
- $PORAM_U^W$ is the planned outage risk from ORAM as supplied by the Risk Analyst (ENTRY FORM 1).

Weekly Total Risk

The weekly total risk index (I_U^W) for weeks during which the applicable plant is not defueled (i.e. Plant is in either MODE 1, 2, 3, 4, 5, or 6) is given by the following:

$$I_U^W = \left[A_U^W R_U^W + \left(1 - A_U^W\right)ORAM_U^W\right].$$

Final Risk Index Calculation

Risk Index

For each Unit, the 52-week rolling average of the weekly total risk, $\bar{I}_U^W$, excluding defuel windows (as applicable, Exclude Defuel Window = Y) is determined. The Risk Index is then the average of the two Unit's rolling average Risk Index:

$$I = \frac{\bar{I}_1^W + \bar{I}_2^W}{2}$$