



UNITED STATES  
NUCLEAR REGULATORY COMMISSION

REGION IV

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AUG 12 1999

THIS LETTER DISTRIBUTED TO THE FOLLOWING DOCKET NUMBERS:

Arkansas Nuclear One, Docket Nos.: 50-313; 50-368  
Cooper Nuclear Station, Docket No.: 50-298  
Comanche Peak Steam Electric Station, Units 1 and 2, Docket Nos.: 50-445; 50-446  
Callaway Plant, Docket No.: 50-483  
Diablo Canyon Nuclear Power Plant, Units 1 and 2, Docket Nos.: 50-275; 50-323  
Fort Calhoun Station, Docket No.: 50-285  
Grand Gulf Nuclear Station, Docket No.: 50-416  
Palo Verde Nuclear Generating Station, Units 1, 2, and 3, Docket Nos.: 50-528; 50-529; 50-530  
River Bend Station, Docket No.: 50-458  
San Onofre Nuclear Generating Station, Units 2 and 3, Docket Nos.: 50-361; 50-362  
South Texas Project Electric Generating Station, Units 1 and 2, Docket Nos.: 50-498; 50-499  
Waterford Steam Electric Station, Unit 3, Docket No.: 50-382  
Wolf Creek Generating Station, Docket No.: 50-482  
Washington Nuclear Project-2, Docket No.: 50-397

SUBJECT: REGION IV RISK INFORMATION PUBLIC WORKSHOP

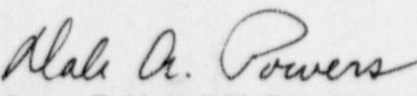
This refers to the workshop conducted in the NRC Region IV office on July 20 and 21, 1999. The workshop was held to exchange information in the area of the use of risk insights in regulatory activities.

A list of workshop attendees is provided in Enclosure 1. Enclosure 2 contains a summary of the topics and issues, which were discussed. Enclosure 3 provides a copy of the Agenda. Enclosure 4 contains copies of the handouts, which were presented during the workshop.

In accordance with Section 2.790 of the NRC's "Rules of Practice," Part 2, Title 10, Code of Federal Regulations, a copy of this letter will be placed in the NRC's Public Document Room.

Should you have any questions concerning this matter, we will be pleased to discuss them with you.

Sincerely,

*for*   
for Arthur T. Howell III, Director  
Division of Reactor Safety

Enclosures:

1. Workshop Attendees
2. Summary of the Topics and Issues
3. Agenda
4. Workshop Handouts

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## ENCLOSURE 2

### Summary of Issues Discussed During the July 20 - 21, 1999, Region IV Risk Information Counterpart Workshop

#### 1. Industry/NRC interface issues related to the use of risk information

The Region IV senior reactor analysts (SRAs) provided a recap and perspective of NRC initiatives and activities accomplished during the previous year. Communication of risk information and quantitative analyses between NRC Region IV and Region IV licensees was effective. Challenges were identified in the area of more timely exchange of information relative to notices of enforcement discretion (NOED) requests and risk significant maintenance activities.

#### 2. Use of risk information at the National Aeronautics and Space Administration (NASA)

A contractor representative from NASA provided an overview of the development and use of PRA technology in the space shuttle program. Information on the development of computer codes and modeling approaches were shared with the meeting participants. Where possible, analogies between the NASA and nuclear industry approaches were identified.

#### 3. Use of risk information in prioritizing engineering work

A representative from the Nebraska Public Power District provided an overview of the use of PRA technology in prioritizing engineering activities at Cooper Nuclear Station. The discussion centered around which engineering activities are most amenable to risk prioritization and the limitations of the use of PRA technology in this type of application.

#### 4. Changes to 10 CFR 50.65, the "Maintenance Rule"

Representatives from the Office of Nuclear Reactor Regulation (NRR) provided a summary of the status of the Maintenance Rule and the schedule for implementation of the upcoming rule change. The discussions involved the development of the new regulatory guidance and the upcoming revision to NUMARC 93-01. The NRR representatives also provided an overview of recent discussions with the Nuclear Energy Institute (NEI).

#### 5. NRR perspective on risk informed activities

The Director, Division of Systems Safety and Analysis, of NRR provided an overview of risk informed activities from a program office perspective. The presentation stimulated a discussion of the NRC's approach to uses of risk information, including approaches to revising the requirements of 10 CFR part 50. Additionally, a perspective on the quantitative thresholds associated with risk significance was provided.

6. Fire risk analysis

Representatives from NRR provided a presentation on the proposed methodology for assessing the risk of fire protection findings. The discussion included an overview of the methodology as well as a specific example to illustrate the process.

7. Roundtable discussions

Representatives from the NRC and the industry conducted roundtable discussions to explore issues of mutual interest. Of particular interest were the discussions involving the status of the industry effort to certify PRA models, methods and approaches associated with shutdown risk, use of risk information in licensee event reports, the significance determination process (SDP) associated with the new oversight and assessment process, and general NRC/Industry interface issues.

8. Risk informed changes to the inspection and assessment process

A representative from NRR provided an overview of the NRC's new oversight and assessment process. Emphasis was placed on the pilot plant activities, and in particular, the SDP. Several specific case studies were provided to illustrate how the new process is designed to operate.

9. Combustion Engineering Owners Group (CEOG) initiatives

An industry representative provided an overview of CEOG activities from a risk perspective. The discussion involved specific examples of technical specification allowed outage time extensions and other specific exemptions from the regulations being requested by CE licensees.

10. Temporary changes and transition risk

A representative from Southern California Edison's San Onofre Nuclear Generating Station provided information related to the risk implications of temporary plant changes and transition risk. The discussion involved issues related to the appropriateness of modifying various assumptions and success criteria as well as overall methodological considerations. Several specific results were quoted as case studies. The ensuing discussions involved the implications of these types of results in future NOEDs.

11. Methods of shutdown risk assessment

A representative from Entergy's River Bend Station (RBS) provided an overview of the methods of shutdown risk assessment. The discussion was centered around RBS's approach to modeling shutdown risk. Insights were provided as to the overall results of the RBS shutdown PRA as well as contributors to shutdown risk.

12. NRC Feedback on Specific Issues of Concern

During the course of the workshop, participants requested feedback on the following three issues:

- a. Can facilities other than the pilot plants provide feedback to the NRC regarding the new oversight and assessment process?

Yes. All facilities are encouraged to become familiar with and provide feedback on the new oversight and assessment process. Currently, the existing process of "regulatory feedback" via NRC management site visits is the process to be used. However, a Federal Register Notice will be published, which will describe the new process and will solicit public (and industry) feedback.

- b. What are the NRC's plans to revise the SDP to make it more plant-specific?

During the current pilot process, the published risk studies (i.e., Individual Plant Examinations (IPEs)) are being reviewed to develop plant-specific sequences to be used in the SDP. These sequences are then further reviewed by NRC risk analysts in cooperation with representatives from the pilot plants in order to ensure their accuracy. At the end of the pilot plant phase of the new oversight process, the NRC will review the results of these efforts to determine the most effective and efficient approach to apply to the remainder of the plants.

- c. Does the new requirement to assess the risk of maintenance activities in 10 CFR 50.65 a(4) apply to activities such as building scaffolding in the turbine building?

Yes, to the extent that such activities have an impact on plant risk. The requirement to assess the risk of maintenance activities is intended to envelope those plant activities that may adversely affect the probability of an initiating event and/or the availability or reliability of mitigating systems. Therefore, to the extent that building scaffolding fulfills one of these considerations, it should be considered. The NRC is developing a revised Regulatory Guide which will provide more definitive guidance on the changes to the Maintenance Rule.



### ENCLOSURE 3

#### MEETING AGENDA

Tuesday, July 20, 1999

| Time         | Discussion Topic                                                              | Discussion Leader                                                                                                                                                        |
|--------------|-------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7:30 - 8:15  | Register at 4th Floor Reception Desk                                          | Jeff Shackelford and Bill Jones, Senior Reactor Analysts, Region IV                                                                                                      |
| 8:15 - 8:45  | Welcome and Opening Remarks                                                   | Ellis Merschhoff, Regional Administrator, Region IV                                                                                                                      |
| 8:45 -10:00  | Industry/NRC Interface Issues Related to the Use of Risk Informed Information | Bill Jones and Jeff Shackelford                                                                                                                                          |
| 10:00 -10:15 | Break                                                                         |                                                                                                                                                                          |
| 10:15 -10:45 | Use of Risk Information at NASA                                               | Roger Boyer, Manager, Shuttle Risk & Reliability Analysis, SAIC, NASA Johnson Space Center Safety and Reliability and Quality Assurance Director.a                       |
| 10:45 -11:30 | Prioritizing Engineering Work                                                 | Richard Wachowiak, Nebraska Public Power District, Cooper Nuclear Station                                                                                                |
| 11:30 -12:45 | Lunch                                                                         |                                                                                                                                                                          |
| 12:45 - 1:50 | Changes to 10 CFR 50.65, "The Maintenance Rule"                               | Rich Correia, Section Chief, Reliability and Maintenance Branch, Office of Nuclear Reactor Regulation (NRR) and Pete Wilson, Probabilistic Safety Assessment Branch, NRR |
| 1:50 - 2:00  | Break                                                                         |                                                                                                                                                                          |
| 2:00 - 3:30  | NRR Risk-Informed Activities                                                  | Gary Holahan, Director Division Systems Safety and Analysis, NRR                                                                                                         |
| 3:30 - 3:45  | Break                                                                         |                                                                                                                                                                          |
| 3:45 - 4:30  | Fire Risk Analysis                                                            | J. S. Hyslop, Probabilistic Safety Assessment Branch, NRR & Pat Madden, Senior Fire Protection Engineer, NRR                                                             |
| 4:30 - 5:30  | Roundtable Discussion                                                         | Ken Bych, Pacific Gas and Electric Company, Diablo Canyon Nuclear Power Plants Units 1 and 2                                                                             |

Wednesday, July 21, 1999

| Time          | Discussion Topic                                                       | Discussion Leader                                                           |
|---------------|------------------------------------------------------------------------|-----------------------------------------------------------------------------|
| 7:30-8:15     | Follow up Questions and Conclusion of Round Table Discussion           | Jeff Shackelford and Bill Jones<br>Round Table Discussion Lead - Ken Bych   |
| 8:15 - 9:45   | Risk Informed Changes to the Inspection Program and Assessment Process | Pete Wilson, Senior Reactor Analyst, NRR                                    |
| 9:45 - 10:00  | Break                                                                  |                                                                             |
| 10:00 - 10:25 | CE Owners Group Initiatives                                            | Alan Hackerott, Omaha Public Power District/Fort Calhoun Station            |
| 10:25 - 11:15 | Temporary Changes and Transition Risk                                  | Sam Chien, Southern California Edison/San Onofre Nuclear Generating Station |
| 11:15 - 11:25 | Break                                                                  |                                                                             |
| 11:25 - 12:15 | Methods of Shutdown Risk Assessment                                    | Tom Hunt, Entergy/River Bend                                                |
| 12:15 - 12:30 | Follow up Questions Closing Remarks                                    | Art Howell, Director, Division of Reactor Safety, Region IV                 |

ENCLOSURE 4

**MEETING HANDOUTS**



# WORKSHEET FOR REACTOR AND PLANT SYSTEM DEGRADED CONDITIONS

Reference/Title (LER #, Inspection Report #, etc): **BWR Example No. 4**

**Factual Description of Identified Condition** (statement of facts known about the issue, without hypothetical failures included):

***Due to maintenance errors, the wrong lubricating oil was used in the high pressure core injection (HPCI) and reactor core isolation cooling (RCIC) turbines. Subsequently, the licensee determined that both HPCI and RCIC would have failed after running for about two hours. The errors were made 28 days prior to discovery.***

System(s) and Train(s) with degraded condition:

*HPCI and RCIC systems*

Licensing Basis Function (if applicable):

*Remove core decay heat following reactor scrams and certain size LOCAs*

Maintenance Rule category (check one): ☒ risk-significant ☐ non-risk-significant

Time degraded condition existed or assumed to exist: *28 days*

**Functions and Cornerstones affected as a result of this condition (check ✓)**

## INITIATING EVENT CORNERSTONE

☐ Transient initiator contributor (e.g., reactor/turbine trip, loss offsite power)

☐ Primary or Secondary system LOCA initiator contributor (e.g., RCS or main steam/feedwater pipe degradations and leaks)

## MITIGATION CORNERSTONE

Core Decay Heat Removal

Initial injection heat removal paths

☒ Primary (e.g. safety inj)

☐ Secondary - PWR only (e.g AFW)

☐ Long term heat removal paths (e.g contmt sump recirculation, suppression pool cooling)

☐ Reactivity control

## BARRIER CORNERSTONE

☐ RCS LOCA mitigation boundary degraded (e.g., PORV block valve, PTS issue)

☐ Containment integrity

☐ Breach or bypass

☐ Heat removal or pressure control

☐ Fuel cladding degraded

# PHASE 1 SCREENING PROCESS

Check the appropriate boxes ✓

Cornerstone(s) assumed affected:

☐ Initiating Event    ☒ Mitigation Systems    ☐ RCS Barrier    ☐ Fuel Barrier    ☐ Containment Barrier

**If more than one Cornerstone is affected, then go to Phase 2. If NO Cornerstone is affected, then the condition screens OUT as "Green" and is not assessed further by this process.**

If only one Cornerstone is affected, continue in the appropriate column below.

| <u>Initiating Event</u>                                                                                                                                                                                                                                                                                                                                                                                      | <u>Mitigation Systems</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <u>RCS Barrier</u>                                      | <u>Fuel Barrier</u>                                  | <u>Containment Barrier</u> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------|------------------------------------------------------|----------------------------|
| <p>1. Contributes to the likelihood of a Primary or Secondary system LOCA initiator?</p> <p><input type="checkbox"/> If YES → Go to Phase 2<br/>If NO, continue</p> <p>2. Contributes to both the likelihood of a reactor trip AND the likelihood that mitigation equipment will not be available?</p> <p><input type="checkbox"/> If YES → Go to Phase 2<br/><input type="checkbox"/> If NO, screen OUT</p> | <p>1. Design or Qualification issue that is still operable per GL 91-18 (rev 1)?</p> <p><input type="checkbox"/> If YES → Screen OUT<br/>If NO, continue</p> <p>2. Represents an actual Loss of Safety Function of a System?</p> <p><input checked="" type="checkbox"/> If YES → Go to Phase 2<br/>If NO, continue</p> <p>3. Represents an actual Loss of Safety Function of a Single Train for &gt; TS AOT?</p> <p><input type="checkbox"/> If YES → Go To Phase 2<br/>If NO, continue</p> <p>4. Affects equipment designated as risk-significant under the Maintenance Rule?</p> <p><input type="checkbox"/> If YES → Go To Phase 2<br/><input type="checkbox"/> If NO, screen OUT</p> | <p><input type="checkbox"/></p> <p>1. Go to Phase 2</p> | <p><input type="checkbox"/></p> <p>1. Screen OUT</p> | <p>1. TBD</p>              |

Result of the Phase 1 screening process: \_\_\_\_\_ screen OUT as "Green"    ☒ go to Phase 2

Important Assumptions (as applicable): *HPCI and RCIC systems were not available*



# PHASE 2 RISK ESTIMATION WORKSHEET FOR QUAD CITIES

ATWS

Estimated Frequency (Table 1 Row) V Exposure time 28 days Table 1 result (circle): A B C D E (F) G H

| <u>Safety Functions Needed:</u>           |                                 | <u>Full Creditable Mitigation Capability for each Safety Function:</u>                       |                       |
|-------------------------------------------|---------------------------------|----------------------------------------------------------------------------------------------|-----------------------|
| Over pressure Protection (OVERP)          |                                 | 4 or 9/13 Rvs/SRVs (1 multi-train system)                                                    |                       |
| Reactivity Control (SLC)                  |                                 | SLC (high stress operator action)                                                            |                       |
| High Press Injection (HPI)                |                                 | HPCI or RCIC (1 multi-train system) or SSMP (operator action)                                |                       |
| Depressurization (DEP)                    |                                 | 1/5 ADS valves manually opened (high stress operator action)                                 |                       |
| Low Pressure Injection                    |                                 | 1/2 RHR trains in LPCI Mode (1 multi-train system) or 1 / 2 CS trains (1 multi-train system) |                       |
| Inhibit ADS and Lvl Control (INH)         |                                 | operator inhibits ADS and controls RPV level (High stress operator action)                   |                       |
| Containment over pressure protection (LC) |                                 | 1/2 RHR trains in SPC (1 multi-train system) or SBCS (high stress operator action)           |                       |
| <u>Circle affected functions</u>          | <u>Recovery of failed train</u> | <u>Remaining Mitigation Capability Rating for each affected sequence:</u>                    | <u>Sequence Color</u> |
| ATWS - OVERP                              |                                 |                                                                                              |                       |
| ATWS - SLC                                |                                 |                                                                                              |                       |
| ATWS - HPI - DEP                          |                                 | operator action + high stress operator action                                                | green                 |
| ATWS - HPI - LPI                          |                                 | operator action + 2 multi-train systems                                                      | green                 |
| ATWS - INH                                |                                 |                                                                                              |                       |
| ATWS - LC                                 |                                 |                                                                                              |                       |

Identify any operator recovery actions<sup>1</sup> that are credited to directly restore the degraded equipment or initiating event:

**None**

Note 1. If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and ready for use.



| Row | Approx. Freq.                                 | Example Event Type                                                                                                                     | Estimated Likelihood Rating          |          |         |
|-----|-----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|----------|---------|
| I   | >1 per 1 - 10 <sup>2</sup> yr                 | Reactor Trip<br>Loss of Power Conv. Sys.<br>(loss of condenser,<br>closure of MSIVs,<br>loss of feedwater)                             | A                                    | B        | C       |
| II  | 1 per 10 - 10 <sup>2</sup> yr                 | Loss of Offsite Power<br>Small LOCA (BWR)<br>(Stuck open SRV only)<br>MSLB (outside cntmt)                                             | B                                    | C        | D       |
| III | 1 per 10 <sup>2</sup> - 10 <sup>3</sup><br>yr | SGTR<br>Stuck open PORV (PWR)<br>Small LOCA (PWR)<br>(RCP seal failures and<br>stuck open SVs only)<br>MFLB<br>MSLB (inside PWR cntmt) | C                                    | D        | E       |
| IV  | 1 per 10 <sup>3</sup> - 10 <sup>4</sup><br>yr | Small LOCA (pipe breaks)<br>ATWS-PWR (elect only)                                                                                      | D                                    | E        | F       |
| V   | 1 per 10 <sup>4</sup> - 10 <sup>5</sup> yr    | Med LOCA<br>Large LOCA (BWR)<br>ATWS-BWR                                                                                               | E                                    | F        | G       |
| VI  | <1 per 10 <sup>5</sup> yr                     | Large LOCA (PWR)<br>ATWS-PWR (mech only)<br>ISLOCA<br>Vessel Rupture                                                                   | F                                    | G        | H       |
|     |                                               |                                                                                                                                        | > 30 days                            | 30-3days | <3 days |
|     |                                               |                                                                                                                                        | Exposure Time for Degraded Condition |          |         |

Table 1 - Estimated Likelihood for Initiating Event Occurrence During Degraded Period

# ATWS - HPI - DEP

| Remaining Mitigation Capability Rating (with Examples) |                                                                                                                                               |                                                                                                    |                                                                                          |                                                                                                                                             |                                                                                                                               |                                                                                    |             |
|--------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------|
|                                                        | 6                                                                                                                                             | 5                                                                                                  | 4                                                                                        | 3                                                                                                                                           | 2                                                                                                                             | 1                                                                                  | 0           |
| Initiating Event Likelihood                            | <p>&gt;3 diverse trains</p> <p>OR</p> <p>2 multi-train systems</p> <p>OR</p> <p>1 train + 1 multi-train system + recovery of failed train</p> | <p>1 train + 1 multi-train system</p> <p>OR</p> <p>2 diverse trains + recovery of failed train</p> | <p>2 diverse trains</p> <p>OR</p> <p>1 multi-train system + recovery of failed train</p> | <p>1 train + recovery of failed train</p> <p>OR</p> <p>1 multi-train system</p> <p>OR</p> <p>Operator action + recovery of failed train</p> | <p>1 train</p> <p>OR</p> <p>Operator action</p> <p>OR</p> <p>Operator action under high stress + recovery of failed train</p> | <p>Recovery of failed train</p> <p>OR</p> <p>Operator action under high stress</p> | <p>none</p> |
|                                                        | A                                                                                                                                             | Green                                                                                              | White                                                                                    | Yellow                                                                                                                                      | Red                                                                                                                           | Red                                                                                | Red         |
|                                                        | B                                                                                                                                             | Green                                                                                              | Green                                                                                    | White                                                                                                                                       | Yellow                                                                                                                        | Red                                                                                | Red         |
|                                                        | C                                                                                                                                             | Green                                                                                              | Green                                                                                    | Green                                                                                                                                       | White                                                                                                                         | Red                                                                                | Red         |
|                                                        | D                                                                                                                                             | Green                                                                                              | Green                                                                                    | Green                                                                                                                                       | Green                                                                                                                         | Yellow                                                                             | Red         |
|                                                        | E                                                                                                                                             | Green                                                                                              | Green                                                                                    | Green                                                                                                                                       | Green                                                                                                                         | White                                                                              | Yellow      |
|                                                        | F                                                                                                                                             | Green                                                                                              | Green                                                                                    | Green                                                                                                                                       | Green                                                                                                                         | Green                                                                              | White       |
|                                                        | G                                                                                                                                             | Green                                                                                              | Green                                                                                    | Green                                                                                                                                       | Green                                                                                                                         | Green                                                                              | Green       |
|                                                        | H                                                                                                                                             | Green                                                                                              | Green                                                                                    | Green                                                                                                                                       | Green                                                                                                                         | Green                                                                              | Green       |

Table 2 - Risk Significance Estimation Matrix (rev 6/10/99)

# ATWS - HPI -LPI

| Remaining Mitigation Capability Rating (with Examples) |                                                                                                                                             |                                                                                                    |                                                                                          |                                                                                                                                             |                                                                                                                               |                                                                                    |             |
|--------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------|
| Initiating Event Likelihood                            | 6                                                                                                                                           | 5                                                                                                  | 4                                                                                        | 3                                                                                                                                           | 2                                                                                                                             | 1                                                                                  | 0           |
|                                                        | <p>≥ 3 diverse trains</p> <p>OR</p> <p>2 multi-train systems</p> <p>OR</p> <p>1 train + 1 multi-train system + recovery of failed train</p> | <p>1 train + 1 multi-train system</p> <p>OR</p> <p>2 diverse trains + recovery of failed train</p> | <p>2 diverse trains</p> <p>OR</p> <p>1 multi-train system + recovery of failed train</p> | <p>1 train + recovery of failed train</p> <p>OR</p> <p>1 multi-train system</p> <p>OR</p> <p>Operator action + recovery of failed train</p> | <p>1 train</p> <p>OR</p> <p>Operator action</p> <p>OR</p> <p>Operator action under high stress + recovery of failed train</p> | <p>Recovery of failed train</p> <p>OR</p> <p>Operator action under high stress</p> | <p>none</p> |
| A                                                      | Green                                                                                                                                       | White                                                                                              | Yellow                                                                                   | Red                                                                                                                                         | Red                                                                                                                           | Red                                                                                | Red         |
| B                                                      | Green                                                                                                                                       | Green                                                                                              | White                                                                                    | Yellow                                                                                                                                      | Red                                                                                                                           | Red                                                                                | Red         |
| C                                                      | Green                                                                                                                                       | Green                                                                                              | Green                                                                                    | White                                                                                                                                       | Yellow                                                                                                                        | Red                                                                                | Red         |
| D                                                      | Green                                                                                                                                       | Green                                                                                              | Green                                                                                    | Green                                                                                                                                       | White                                                                                                                         | Yellow                                                                             | Red         |
| E                                                      | Green                                                                                                                                       | Green                                                                                              | Green                                                                                    | Green                                                                                                                                       | Green                                                                                                                         | White                                                                              | Yellow      |
| F                                                      | Green                                                                                                                                       | Green                                                                                              | Green                                                                                    | Green                                                                                                                                       | Green                                                                                                                         | Green                                                                              | White       |
| G                                                      | Green                                                                                                                                       | Green                                                                                              | Green                                                                                    | Green                                                                                                                                       | Green                                                                                                                         | Green                                                                              | Green       |
| H                                                      | Green                                                                                                                                       | Green                                                                                              | Green                                                                                    | Green                                                                                                                                       | Green                                                                                                                         | Green                                                                              | Green       |

Table 2 - Risk Significance Estimation Matrix (rev 6/10/99)



| Type of Remaining Capability       |                  | Remaining Capability Rating |
|------------------------------------|------------------|-----------------------------|
| Operator Action Under High Stress  |                  | 1                           |
| Recovery of Failed Train           |                  | 1                           |
| Operator Action                    |                  | 2                           |
| 1 Train (diverse)                  |                  | 2                           |
| 1 Multi-Train System               |                  | 3                           |
| 2 (diverse) Trains                 | [adding example] | 4 (= 2 + 2)                 |
| 1 Train + Recovery of Failed Train | [adding example] | 3 (=2 + 1)                  |

**Table 3 - Remaining Capability Rating Values**

# PHASE 2 RISK ESTIMATION WORKSHEET FOR QUAD CITIES

## Loss of Offsite Power

|                                   |    |               |         |                          |   |   |     |   |   |   |   |   |
|-----------------------------------|----|---------------|---------|--------------------------|---|---|-----|---|---|---|---|---|
| Estimated Frequency (Table 1 Row) | II | Exposure time | 28 days | Table 1 result (circle): | A | B | (C) | D | E | F | G | H |
|-----------------------------------|----|---------------|---------|--------------------------|---|---|-----|---|---|---|---|---|

|                                                                        |                                                                                              |  |  |  |  |  |  |  |  |  |  |  |
|------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|--|--|--|--|--|--|--|--|--|--|--|
| <u>Safety Functions Needed:</u>                                        |                                                                                              |  |  |  |  |  |  |  |  |  |  |  |
| <u>Full Creditable Mitigation Capability for each Safety Function:</u> |                                                                                              |  |  |  |  |  |  |  |  |  |  |  |
| Emergency Power (EAC < 5 hrs)                                          | 1 / 2 EDGs less than 5 hrs (1 multi-train system)                                            |  |  |  |  |  |  |  |  |  |  |  |
| Emergency Power (EAC > 5 hrs)                                          | 1 / 2 EDGs more than 5 hrs (1 multi-train system)                                            |  |  |  |  |  |  |  |  |  |  |  |
| Recovery of LOOP (RLOOP)                                               | Recovery of LOOP (recovery action)                                                           |  |  |  |  |  |  |  |  |  |  |  |
| High Press Injection (HPI)                                             | HPCI or RCIC (1 multi-train system) or SSMP (operator action)                                |  |  |  |  |  |  |  |  |  |  |  |
| Depressurization (DEP)                                                 | 1/5 ADS valves manually opened (high stress operator action)                                 |  |  |  |  |  |  |  |  |  |  |  |
| Low Press Injection (LPI)                                              | 1/2 RHR trains in LPCI Mode (1 multi-train system) or 1 / 2 CS trains (1 multi-train system) |  |  |  |  |  |  |  |  |  |  |  |
| Late Containment Heat Removal (LC)                                     | 1/2 RHR trains in SPC (1 multi-train system) or SBCS (high stress operator action)           |  |  |  |  |  |  |  |  |  |  |  |

| Circle affected Functions  | Recovery of failed train | Remaining Mitigation Capability Rating for each affected sequence: | Sequence Color |
|----------------------------|--------------------------|--------------------------------------------------------------------|----------------|
| LOOP - EAC < 5 hrs - HPI   |                          | 1 multi-train system + 1 operator action                           | green          |
| LOOP - EAC > 5 hrs - RLOOP |                          |                                                                    |                |
| LOOP - HPI - DEP           |                          | 1 operator action + 1 high stress operator action                  | white          |
| LOOP - HPI - LPI           |                          | 1 operator action + 2 multi-train systems                          | green          |
| LOOP - LC                  |                          |                                                                    |                |

Identify any operator recovery actions<sup>1</sup> that are credited to directly restore the degraded equipment or initiating event:

**None**

Note 1. If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and ready for use.

| Row | Approx. Freq.                              | Example Event Type                                                                                                                     | Estimated Likelihood Rating          |          |         |
|-----|--------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|----------|---------|
| I   | >1 per 1 - 10 <sup>3</sup> yr              | Reactor Trip<br>Loss of Power Conv. Sys.<br>(loss of condenser,<br>closure of MSIVs,<br>loss of feedwater)                             | A                                    | B        | C       |
| II  | 1 per 10 - 10 <sup>2</sup> yr              | Loss of Offsite Power<br>Small LOCA (BWR)<br>(Stuck open SRV only)<br>MSLB (outside cntmt)                                             | B                                    | C        | D       |
| III | 1 per 10 <sup>2</sup> - 10 <sup>3</sup> yr | SGTR<br>Stuck open PORV (PWR)<br>Small LOCA (PWR)<br>(RCP seal failures and<br>stuck open SVs only)<br>MFLB<br>MSLB (inside PWR cntmt) | C                                    | D        | E       |
| IV  | 1 per 10 <sup>3</sup> - 10 <sup>4</sup> yr | Small LOCA (pipe breaks)<br>ATWS-PWR (elect only)                                                                                      | D                                    | E        | F       |
| V   | 1 per 10 <sup>4</sup> - 10 <sup>5</sup> yr | Med LOCA<br>Large LOCA (BWR)<br>ATWS-BWR                                                                                               | E                                    | F        | G       |
| VI  | <1 per 10 <sup>5</sup> yr                  | Large LOCA (PWR)<br>ATWS-PWR (mech only)<br>ISLOCA<br>Vessel Rupture                                                                   | F                                    | G        | H       |
|     |                                            |                                                                                                                                        | > 30 days                            | 30-3days | <3 days |
|     |                                            |                                                                                                                                        | Exposure Time for Degraded Condition |          |         |

Table 1 - Estimated Likelihood for Initiating Event Occurrence During Degraded Period



# LOOP - EAC < 5 hrs - HPI

| Remaining Mitigation Capability Rating (with Examples) |                                                                                                                                                |                                                                                                    |                                                                                          |                                                                                                                                             |                                                                                                                               |                                                                                    |             |
|--------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------|
| Initiating Event Likelihood                            | 6                                                                                                                                              | 5                                                                                                  | 4                                                                                        | 3                                                                                                                                           | 2                                                                                                                             | 1                                                                                  | 0           |
|                                                        | <p>&gt; 3 diverse trains</p> <p>OR</p> <p>2 multi-train systems</p> <p>OR</p> <p>1 train + 1 multi-train system + recovery of failed train</p> | <p>1 train + 1 multi-train system</p> <p>OR</p> <p>2 diverse trains + recovery of failed train</p> | <p>2 diverse trains</p> <p>OR</p> <p>1 multi-train system + recovery of failed train</p> | <p>1 train + recovery of failed train</p> <p>OR</p> <p>1 multi-train system</p> <p>OR</p> <p>Operator action + recovery of failed train</p> | <p>1 train</p> <p>OR</p> <p>Operator action</p> <p>OR</p> <p>Operator action under high stress + recovery of failed train</p> | <p>Recovery of failed train</p> <p>OR</p> <p>Operator action under high stress</p> | <p>none</p> |
| A                                                      | Green                                                                                                                                          | White                                                                                              | Yellow                                                                                   | Red                                                                                                                                         | Red                                                                                                                           | Red                                                                                | Red         |
| B                                                      | Green                                                                                                                                          | Green                                                                                              | White                                                                                    | Yellow                                                                                                                                      | Red                                                                                                                           | Red                                                                                | Red         |
| C                                                      | Green                                                                                                                                          | Green                                                                                              | Green                                                                                    | White                                                                                                                                       | Yellow                                                                                                                        | Red                                                                                | Red         |
| D                                                      | Green                                                                                                                                          | Green                                                                                              | Green                                                                                    | Green                                                                                                                                       | White                                                                                                                         | Yellow                                                                             | Red         |
| E                                                      | Green                                                                                                                                          | Green                                                                                              | Green                                                                                    | Green                                                                                                                                       | Green                                                                                                                         | White                                                                              | Yellow      |
| F                                                      | Green                                                                                                                                          | Green                                                                                              | Green                                                                                    | Green                                                                                                                                       | Green                                                                                                                         | Green                                                                              | White       |
| G                                                      | Green                                                                                                                                          | Green                                                                                              | Green                                                                                    | Green                                                                                                                                       | Green                                                                                                                         | Green                                                                              | Green       |
| H                                                      | Green                                                                                                                                          | Green                                                                                              | Green                                                                                    | Green                                                                                                                                       | Green                                                                                                                         | Green                                                                              | Green       |

Table 2 - Risk Significance Estimation Matrix (rev 6/10/99)

# LOOP - HPI - DEP

| Remaining Mitigation Capability Rating (with Examples) |                                                                                                                                     |                                                                                             |                                                                                   |                                                                                                                                      |                                                                                                                        |                                                                             |        |
|--------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|--------|
|                                                        | 6                                                                                                                                   | 5                                                                                           | 4                                                                                 | 3                                                                                                                                    | 2                                                                                                                      | 1                                                                           | 0      |
| Initiating Event Likelihood                            | >3 diverse trains<br><br>OR<br><br>2 multi-train systems<br><br>OR<br><br>1 train + 1 multi-train system + recovery of failed train | 1 train + 1 multi-train system<br><br>OR<br><br>2 diverse trains + recovery of failed train | 2 diverse trains<br><br>OR<br><br>1 multi-train system + recovery of failed train | 1 train + recovery of failed train<br><br>OR<br><br>1 multi-train system<br><br>OR<br><br>Operator action + recovery of failed train | 1 train<br><br>OR<br><br>Operator action<br><br>OR<br><br>Operator action under high stress + recovery of failed train | Recovery of failed train<br><br>OR<br><br>Operator action under high stress | none   |
|                                                        | A                                                                                                                                   | Green                                                                                       | White                                                                             | Yellow                                                                                                                               | Red                                                                                                                    | Red                                                                         | Red    |
|                                                        | B                                                                                                                                   | Green                                                                                       | Green                                                                             | White                                                                                                                                | Yellow                                                                                                                 | Red                                                                         | Red    |
|                                                        | C                                                                                                                                   | Green                                                                                       | Green                                                                             | Green                                                                                                                                | White                                                                                                                  | Yellow                                                                      | Red    |
|                                                        | D                                                                                                                                   | Green                                                                                       | Green                                                                             | Green                                                                                                                                | Green                                                                                                                  | White                                                                       | Red    |
|                                                        | E                                                                                                                                   | Green                                                                                       | Green                                                                             | Green                                                                                                                                | Green                                                                                                                  | White                                                                       | Yellow |
|                                                        | F                                                                                                                                   | Green                                                                                       | Green                                                                             | Green                                                                                                                                | Green                                                                                                                  | Green                                                                       | White  |
|                                                        | G                                                                                                                                   | Green                                                                                       | Green                                                                             | Green                                                                                                                                | Green                                                                                                                  | Green                                                                       | Green  |
|                                                        | H                                                                                                                                   | Green                                                                                       | Green                                                                             | Green                                                                                                                                | Green                                                                                                                  | Green                                                                       | Green  |

Table 2 - Risk Significance Estimation Matrix (rev 6/10/99)

# LOOP - HPI-LPI

| Remaining Mitigation Capability Rating (with Examples) |                                                                                                                                     |                                                                                             |                                                                                   |                                                                                                                                      |                                                                                                                        |                                                                             |        |
|--------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|--------|
|                                                        | 6                                                                                                                                   | 5                                                                                           | 4                                                                                 | 3                                                                                                                                    | 2                                                                                                                      | 1                                                                           | 0      |
| Initiating Event Likelihood                            | >3 diverse trains<br><br>OR<br><br>2 multi-train systems<br><br>OR<br><br>1 train + 1 multi-train system + recovery of failed train | 1 train + 1 multi-train system<br><br>OR<br><br>2 diverse trains + recovery of failed train | 2 diverse trains<br><br>OR<br><br>1 multi-train system + recovery of failed train | 1 train + recovery of failed train<br><br>OR<br><br>1 multi-train system<br><br>OR<br><br>Operator action + recovery of failed train | 1 train<br><br>OR<br><br>Operator action<br><br>OR<br><br>Operator action under high stress + recovery of failed train | Recovery of failed train<br><br>OR<br><br>Operator action under high stress | none   |
|                                                        | A                                                                                                                                   | Green                                                                                       | White                                                                             | Yellow                                                                                                                               | Red                                                                                                                    | Red                                                                         | Red    |
|                                                        | B                                                                                                                                   | Green                                                                                       | Green                                                                             | White                                                                                                                                | Yellow                                                                                                                 | Red                                                                         | Red    |
|                                                        | C                                                                                                                                   | Green                                                                                       | Green                                                                             | Green                                                                                                                                | White                                                                                                                  | Red                                                                         | Red    |
|                                                        | D                                                                                                                                   | Green                                                                                       | Green                                                                             | Green                                                                                                                                | Green                                                                                                                  | White                                                                       | Red    |
|                                                        | E                                                                                                                                   | Green                                                                                       | Green                                                                             | Green                                                                                                                                | Green                                                                                                                  | Green                                                                       | Yellow |
|                                                        | F                                                                                                                                   | Green                                                                                       | Green                                                                             | Green                                                                                                                                | Green                                                                                                                  | Green                                                                       | White  |
|                                                        | G                                                                                                                                   | Green                                                                                       | Green                                                                             | Green                                                                                                                                | Green                                                                                                                  | Green                                                                       | Green  |
|                                                        | H                                                                                                                                   | Green                                                                                       | Green                                                                             | Green                                                                                                                                | Green                                                                                                                  | Green                                                                       | Green  |

Table 2 - Risk Significance Estimation Matrix (rev 6/10/99)



| Type of Remaining Capability                        | Remaining Capability Rating |
|-----------------------------------------------------|-----------------------------|
| Operator Action Under High Stress                   | 1                           |
| Recovery of Failed Train                            | 1                           |
| Operator Action                                     | 2                           |
| 1 Train (diverse)                                   | 2                           |
| 1 Multi-Train System                                | 3                           |
| 2 (diverse) Trains [adding example]                 | 4 (= 2 + 2)                 |
| 1 Train + Recovery of Failed Train [adding example] | 3 (=2 + 1)                  |

**Table 3 - Remaining Capability Rating Values**

# PHASE 2 RISK ESTIMATION WORKSHEET FOR QUAD CITIES

## Transients

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                 |                                                                                              |                                                   |                       |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|----------------------------------------------------------------------------------------------|---------------------------------------------------|-----------------------|
| Estimated Frequency (Table 1 Row) <u>I</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                 | Exposure time <u>28 days</u>                                                                 | Table 1 result (circle): <u>A (B) C D E F G H</u> |                       |
| <u>Safety Functions Needed:</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                 | <u>Full Creditable Mitigation Capability for each Safety Function:</u>                       |                                                   |                       |
| Power Conversion System (PCS)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                 | 1/3 trains condensate booster pumps etc. (Operator Action)                                   |                                                   |                       |
| High Press Injection (HPI)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                 | HPCI or RCIC (1 multi-train system) or SSMP (operator action)                                |                                                   |                       |
| Depressurization (DEP)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                 | 1/5 ADS valves manually opened (high stress operator action)                                 |                                                   |                       |
| Low Press Injection (LPI)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                 | 1/2 RHR trains in LPCI Mode (1 multi-train system) or 1 / 2 CS trains (1 multi-train system) |                                                   |                       |
| Late Containment Heat Removal (LC)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                 | 1/2 RHR trains in SPC (1 multi-train system) or SBCS (high stress operator action)           |                                                   |                       |
| <u>Circle affected functions</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <u>Recovery of failed train</u> | <u>Remaining Mitigation Capability Rating for each affected sequence:</u>                    |                                                   | <u>Sequence Color</u> |
| Trans - PCS - LC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                 |                                                                                              |                                                   |                       |
| Trans - PCS - HPI - DEP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                 | 1 operator action + 1 operator action + 1 high stress operator action                        |                                                   | green                 |
| Trans - PCS - HPI - LPI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                 | 1 operator action + 1 operator action + 2 multi-train systems                                |                                                   | green                 |
| Identify any operator recovery actions <sup>1</sup> that are credited to directly restore the degraded equipment or initiating event:                                                                                                                                                                                                                                                                                                                                                                                                      |                                 |                                                                                              |                                                   |                       |
| None                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                 |                                                                                              |                                                   |                       |
| <small>Note 1: If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and ready for use.</small> |                                 |                                                                                              |                                                   |                       |

| Row | Approx. Freq.                              | Example Event Type                                                                                                                     | Estimated Likelihood Rating          |          |         |
|-----|--------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|----------|---------|
| I   | >1 per 1 - 10 <sup>3</sup> yr              | Reactor Trip<br>Loss of Power Conv. Sys.<br>(loss of condenser,<br>closure of MSiVs,<br>loss of feedwater)                             | A                                    | B        | C       |
| II  | 1 per 10 - 10 <sup>2</sup> yr              | Loss of Offsite Power<br>Small LOCA (BWR)<br>(Stuck open SRV only)<br>MSLB (outside cntmt)                                             | B                                    | C        | D       |
| III | 1 per 10 <sup>2</sup> - 10 <sup>3</sup> yr | SGTR<br>Stuck open PORV (PWR)<br>Small LOCA (PWR)<br>(RCP seal failures and<br>stuck open SVs only)<br>MFLB<br>MSLB (inside PWR cntmt) | C                                    | D        | E       |
| IV  | 1 per 10 <sup>3</sup> - 10 <sup>4</sup> yr | Small LOCA (pipe breaks)<br>ATWS-PWR (elect only)                                                                                      | D                                    | E        | F       |
| V   | 1 per 10 <sup>4</sup> - 10 <sup>5</sup> yr | Med LOCA<br>Large LOCA (BWR)<br>ATWS-BWR                                                                                               | E                                    | F        | G       |
| VI  | <1 per 10 <sup>5</sup> yr                  | Large LOCA (PWR)<br>ATWS-PWR (mech only)<br>ISLOCA<br>Vessel Rupture                                                                   | F                                    | G        | H       |
|     |                                            |                                                                                                                                        | > 30 days                            | 30-3days | <3 days |
|     |                                            |                                                                                                                                        | Exposure Time for Degraded Condition |          |         |

Table 1 - Estimated Likelihood for Initiating Event Occurrence During Degraded Period



# Trans - PCS - HPI - DEP

| Remaining Mitigation Capability Rating (with Examples) |                                                                                                                                                                   |                                                                                                                |                                                                                                      |                                                                                                                                                                 |                                                                                                                                                   |                                                                                                |                 |        |
|--------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|-----------------|--------|
|                                                        | 6                                                                                                                                                                 | 5                                                                                                              | 4                                                                                                    | 3                                                                                                                                                               | 2                                                                                                                                                 | 1                                                                                              | 0               |        |
| Initiating Event Likelihood                            | <div>&gt;3 diverse trains</div> <div>OR</div> <div>2 multi-train systems</div> <div>OR</div> <div>1 train + 1 multi-train system + recovery of failed train</div> | <div>1 train + 1 multi-train system</div> <div>OR</div> <div>2 diverse trains + recovery of failed train</div> | <div>2 diverse trains</div> <div>OR</div> <div>1 multi-train system + recovery of failed train</div> | <div>1 train + recovery of failed train</div> <div>OR</div> <div>1 multi-train system</div> <div>OR</div> <div>Operator action + recovery of failed train</div> | <div>1 train</div> <div>OR</div> <div>Operator action</div> <div>OR</div> <div>Operator action under high stress + recovery of failed train</div> | <div>Recovery of failed train</div> <div>OR</div> <div>Operator action under high stress</div> | <div>none</div> |        |
|                                                        | A                                                                                                                                                                 | Green                                                                                                          | White                                                                                                | Yellow                                                                                                                                                          | Red                                                                                                                                               | Red                                                                                            | Red             | Red    |
|                                                        | B                                                                                                                                                                 | Green                                                                                                          | Green                                                                                                | White                                                                                                                                                           | Yellow                                                                                                                                            | Red                                                                                            | Red             | Red    |
|                                                        | C                                                                                                                                                                 | Green                                                                                                          | Green                                                                                                | Green                                                                                                                                                           | White                                                                                                                                             | Yellow                                                                                         | Red             | Red    |
|                                                        | D                                                                                                                                                                 | Green                                                                                                          | Green                                                                                                | Green                                                                                                                                                           | Green                                                                                                                                             | White                                                                                          | Yellow          | Red    |
|                                                        | E                                                                                                                                                                 | Green                                                                                                          | Green                                                                                                | Green                                                                                                                                                           | Green                                                                                                                                             | Green                                                                                          | White           | Yellow |
|                                                        | F                                                                                                                                                                 | Green                                                                                                          | Green                                                                                                | Green                                                                                                                                                           | Green                                                                                                                                             | Green                                                                                          | Green           | White  |
|                                                        | G                                                                                                                                                                 | Green                                                                                                          | Green                                                                                                | Green                                                                                                                                                           | Green                                                                                                                                             | Green                                                                                          | Green           | Green  |
| H                                                      | Green                                                                                                                                                             | Green                                                                                                          | Green                                                                                                | Green                                                                                                                                                           | Green                                                                                                                                             | Green                                                                                          | Green           |        |

Table 2 - Risk Significance Estimation Matrix (rev 6/10/99)

# Trans - PCS - HPI - LPI

| Remaining Mitigation Capability Rating (with Examples) |                                                                                                                      |                                                                                     |                                                                           |                                                                                                                      |                                                                                                        |                                                                     |        |
|--------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|--------|
|                                                        | 6                                                                                                                    | 5                                                                                   | 4                                                                         | 3                                                                                                                    | 2                                                                                                      | 1                                                                   | 0      |
| Initiating Event Likelihood                            | ≥ 3 diverse trains<br>OR<br>2 multi-train systems<br>OR<br>1 train + 1 multi-train system + recovery of failed train | 1 train + 1 multi-train system<br>OR<br>2 diverse trains + recovery of failed train | 2 diverse trains<br>OR<br>1 multi-train system + recovery of failed train | 1 train + recovery of failed train<br>OR<br>1 multi-train system<br>OR<br>Operator action + recovery of failed train | 1 train<br>OR<br>Operator action<br>OR<br>Operator action under high stress + recovery of failed train | Recovery of failed train<br>OR<br>Operator action under high stress | none   |
|                                                        | Green                                                                                                                | White                                                                               | Yellow                                                                    | Red                                                                                                                  | Red                                                                                                    | Red                                                                 | Red    |
|                                                        | Green                                                                                                                | Green                                                                               | White                                                                     | Yellow                                                                                                               | Red                                                                                                    | Red                                                                 | Red    |
|                                                        | Green                                                                                                                | Green                                                                               | Green                                                                     | White                                                                                                                | Yellow                                                                                                 | Red                                                                 | Red    |
|                                                        | Green                                                                                                                | Green                                                                               | Green                                                                     | Green                                                                                                                | White                                                                                                  | Yellow                                                              | Red    |
|                                                        | Green                                                                                                                | Green                                                                               | Green                                                                     | Green                                                                                                                | Green                                                                                                  | White                                                               | Yellow |
|                                                        | Green                                                                                                                | Green                                                                               | Green                                                                     | Green                                                                                                                | Green                                                                                                  | Green                                                               | White  |
|                                                        | Green                                                                                                                | Green                                                                               | Green                                                                     | Green                                                                                                                | Green                                                                                                  | Green                                                               | Green  |

Table 2 - Risk Significance Estimation Matrix (rev 6/10/99)

| Type of Remaining Capability                        | Remaining Capability Rating |
|-----------------------------------------------------|-----------------------------|
| Operator Action Under High Stress                   | 1                           |
| Recovery of Failed Train                            | 1                           |
| Operator Action                                     | 2                           |
| 1 Train (diverse)                                   | 2                           |
| 1 Multi-Train System                                | 3                           |
| 2 (diverse) Trains [adding example]                 | 4 (= 2 + 2)                 |
| 1 Train + Recovery of Failed Train [adding example] | 3 (=2 + 1)                  |

**Table 3 - Remaining Capability Rating Values**



# PHASE 2 RISK ESTIMATION WORKSHEET FOR QUAD CITIES

SLOCA

Estimated Frequency (Table 1 Row) IV Exposure time 28 days Table 1 result (circle): A B C D (E) F G H

## Safety Functions Needed:

Full Creditable Mitigation Capability for each Safety Function:

Power Conversion System (PCS)

1/3 trains condensate booster pumps etc. (Operator Action)

High Press Injection (HPI)

HPCI or RCIC (1 multi-train system) or SSMP (operator action)

Depressurization (DEP)

1/5 ADS valves manually opened (high stress operator action)

Low Press Injection (LPI)

1/2 RHR trains in LPCI Mode (1 multi-train system) or 1 / 2 CS trains (1 multi-train system)

Late Containment Heat Removal (LC)

1/2 RHR trains in SPC (1 multi-train system) or SBCS (high stress operator action)

Circle affected functions

Recover of failed train

Sequence Color

SLOCA - PCS - LC

SLOCA - PCS - HPI - LPI

1 operator action + 1 operator action + 2 multi-train systems

green

SLOCA - HPI - DEP

1 operator action + 1 high stress operator action

green

Identify any operator recovery actions<sup>1</sup> that are credited to directly restore the degraded equipment or initiating event:

None

Note 1 If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and ready for use.

| Row | Approx. Freq.                                 | Example Event Type                                                                                                                     | Estimated Likelihood Rating          |          |         |
|-----|-----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|----------|---------|
| I   | >1 per 1 - 10 <sup>2</sup> yr                 | Reactor Trip<br>Loss of Power Conv. Sys.<br>(loss of condenser,<br>closure of MSIV's,<br>loss of feedwater)                            | A                                    | B        | C       |
| II  | 1 per 10 - 10 <sup>2</sup> yr                 | Loss of Offsite Power<br>Small LOCA (BWR)<br>(Stuck open SRV only)<br>MSLB (outside cntmt)                                             | B                                    | C        | D       |
| III | 1 per 10 <sup>2</sup> - 10 <sup>3</sup><br>yr | SGTR<br>Stuck open PORV (PWR)<br>Small LOCA (PWR)<br>(RCP seal failures and<br>stuck open SVs only)<br>MFLB<br>MSLB (inside PWR cntmt) | C                                    | D        | E       |
| IV  | 1 per 10 <sup>3</sup> - 10 <sup>4</sup><br>yr | Small LOCA (pipe break)<br>ATWS-PWR (elect only)                                                                                       | D                                    | E        | F       |
| V   | 1 per 10 <sup>4</sup> - 10 <sup>5</sup> yr    | Med LOCA<br>Large LOCA (BWR)<br>ATWS-BWR                                                                                               | E                                    | F        | G       |
| VI  | <1 per 10 <sup>5</sup> yr                     | Large LOCA (PWR)<br>ATWS-PWR (mech only)<br>ISLOCA<br>Vessel Rupture                                                                   | F                                    | G        | H       |
|     |                                               |                                                                                                                                        | > 30 days                            | 30-3days | <3 days |
|     |                                               |                                                                                                                                        | Exposure Time for Degraded Condition |          |         |

Table 1 - Estimated Likelihood for Initiating Event Occurrence During Degraded Period

# SLOCA - PCS - HP: - LPI

| Remaining Mitigation Capability Rating (with Examples) |                                                           |                                             |                                                 |                                            |                                                              |                                   |        |
|--------------------------------------------------------|-----------------------------------------------------------|---------------------------------------------|-------------------------------------------------|--------------------------------------------|--------------------------------------------------------------|-----------------------------------|--------|
|                                                        | 6                                                         | 5                                           | 4                                               | 3                                          | 2                                                            | 1                                 | 0      |
| Initiating Event Likelihood                            | >3 diverse trains                                         | 1 train + 1 multi-train system              | 2 diverse trains                                | 1 train, + recovery of failed train        | 1 train                                                      | Recovery of failed train          | none   |
|                                                        | OR                                                        | OR                                          | OR                                              | OR                                         | OR                                                           | OR                                |        |
|                                                        | 2 multi-train systems                                     | 2 diverse trains + recovery of failed train | 1 multi-train system + recovery of failed train | 1 multi-train system                       | Operator action                                              | Operator action under high stress |        |
|                                                        | OR                                                        |                                             |                                                 | OR                                         | OR                                                           |                                   |        |
|                                                        | 1 train + 1 multi-train system + recovery of failed train |                                             |                                                 | Operator action + recovery of failed train | Operator action under high stress + recovery of failed train |                                   |        |
| A                                                      | Green                                                     | White                                       | Yellow                                          | Red                                        | Red                                                          | Red                               | Red    |
| B                                                      | Green                                                     | Green                                       | White                                           | Yellow                                     | Red                                                          | Red                               | Red    |
| C                                                      | Green                                                     | Green                                       | Green                                           | White                                      | Yellow                                                       | Red                               | Red    |
| D                                                      | Green                                                     | Green                                       | Green                                           | Green                                      | White                                                        | Yellow                            | Red    |
| E                                                      | Green                                                     | Green                                       | Green                                           | Green                                      | Green                                                        | White                             | Yellow |
| F                                                      | Green                                                     | Green                                       | Green                                           | Green                                      | Green                                                        | Green                             | White  |
| G                                                      | Green                                                     | Green                                       | Green                                           | Green                                      | Green                                                        | Green                             | Green  |
| H                                                      | Green                                                     | Green                                       | Green                                           | Green                                      | Green                                                        | Green                             | Green  |

Table 2 - Risk Significance Estimation Matrix (rev 6/10/99)



# SLOCA - HPI -DEP

| Remaining Mitigation Capability Rating (with Examples) |                                                                                                                                      |                                                                                             |                                                                                   |                                                                                                                                      |                                                                                                                        |                                                                             |        |
|--------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|--------|
|                                                        | 6                                                                                                                                    | 5                                                                                           | 4                                                                                 | 3                                                                                                                                    | 2                                                                                                                      | 1                                                                           | 0      |
| Initiating Event Likelihood                            | ≥ 3 diverse trains<br><br>OR<br><br>2 multi-train systems<br><br>OR<br><br>1 train + 1 multi-train system + recovery of failed train | 1 train + 1 multi-train system<br><br>OR<br><br>2 diverse trains + recovery of failed train | 2 diverse trains<br><br>OR<br><br>1 multi-train system + recovery of failed train | 1 train + recovery of failed train<br><br>OR<br><br>1 multi-train system<br><br>OR<br><br>Operator action + recovery of failed train | 1 train<br><br>OR<br><br>Operator action<br><br>OR<br><br>Operator action under high stress + recovery of failed train | Recovery of failed train<br><br>OR<br><br>Operator action under high stress | none   |
|                                                        | Green                                                                                                                                | White                                                                                       | Yellow                                                                            | Red                                                                                                                                  | Red                                                                                                                    | Red                                                                         | Red    |
|                                                        | Green                                                                                                                                | Green                                                                                       | White                                                                             | Yellow                                                                                                                               | Red                                                                                                                    | Red                                                                         | Red    |
|                                                        | Green                                                                                                                                | Green                                                                                       | Green                                                                             | White                                                                                                                                | Yellow                                                                                                                 | Red                                                                         | Red    |
|                                                        | Green                                                                                                                                | Green                                                                                       | Green                                                                             | Green                                                                                                                                | White                                                                                                                  | Yellow                                                                      | Red    |
|                                                        | Green                                                                                                                                | Green                                                                                       | Green                                                                             | Green                                                                                                                                | Green                                                                                                                  | White                                                                       | Yellow |
|                                                        | Green                                                                                                                                | Green                                                                                       | Green                                                                             | Green                                                                                                                                | Green                                                                                                                  | Green                                                                       | White  |
|                                                        | Green                                                                                                                                | Green                                                                                       | Green                                                                             | Green                                                                                                                                | Green                                                                                                                  | Green                                                                       | Green  |

Table 2 - Risk Significance Estimation Matrix (rev 6/10/99)

| Type of Remaining Capability                        | Remaining Capability Rating |
|-----------------------------------------------------|-----------------------------|
| Operator Action Under High Stress                   | 1                           |
| Recovery of Failed Train                            | 1                           |
| Operator Action                                     | 2                           |
| 1 Train (diverse)                                   | 2                           |
| 1 Multi-Train System                                | 3                           |
| 2 (diverse) Trains [adding example]                 | 4 (= 2 + 2)                 |
| 1 Train + Recovery of Failed Train [adding example] | 3 (=2 + 1)                  |

**Table 3 - Remaining Capability Rating Values**

# PHASE 2 RISK ESTIMATION WORKSHEET FOR QUAD CITIES

Medium LOCA

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                              |                                                                        |                                                                                                                                                                    |  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| Estimated Frequency (Table 1 Row) <u>    V    </u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                              | Exposure time <u>    28 days    </u>                                   | Table 1 result (circle): <u>    A    </u> <u>    B    </u> <u>    C    </u> <u>    D    </u> <u>    E    </u> <u>    (F)    </u> <u>    G    </u> <u>    H    </u> |  |
| <u>Safety Functions Needed:</u><br><u>Full Creditable Mitigation Capability for each Safety Function:</u>                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                              |                                                                        |                                                                                                                                                                    |  |
| Early Inventory (EI)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | HPCI (1 train)                                                                               |                                                                        |                                                                                                                                                                    |  |
| Early Cont. Control (EC)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Passive operation of SP with 1/8 vacuum breakers (1 multi-train system)                      |                                                                        |                                                                                                                                                                    |  |
| Depressurization (DEP)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Operator opens 1/5 ADS valves (High stress operator action)                                  |                                                                        |                                                                                                                                                                    |  |
| Late Inventory Control (LI)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 1/2 RHR trains in LPCI mode (1 multi-train system) or 1 / 2 CS trains (1 multi-train system) |                                                                        |                                                                                                                                                                    |  |
| Late Cont. P/T Control (LC)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 1/2 RHR trains in SPC mode (1 multi-train system) or SBCS (High stress operator action)      |                                                                        |                                                                                                                                                                    |  |
| Affected Sequences (circle affected functions):                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Recover of failed train                                                                      | Remaining Creditable Mitigation Capability for each affected sequence: | Sequence Color                                                                                                                                                     |  |
| MLOCA - LI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                              |                                                                        |                                                                                                                                                                    |  |
| MLOCA - LC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                              |                                                                        |                                                                                                                                                                    |  |
| MLOCA - EI - DEP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                              | 1 high stress operator action                                          | green                                                                                                                                                              |  |
| MLOCA - EC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                              |                                                                        |                                                                                                                                                                    |  |
| Identify any operator recovery actions <sup>1</sup> that are credited to directly restore the degraded equipment or initiating event:                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                              |                                                                        |                                                                                                                                                                    |  |
| None                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                              |                                                                        |                                                                                                                                                                    |  |
| <small>Note 1: If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and ready for use.</small> |                                                                                              |                                                                        |                                                                                                                                                                    |  |



| Row | Approx. Freq.                                 | Example Event Type                                                                                                                     | Estimated Likelihood Rating          |          |         |
|-----|-----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|----------|---------|
| I   | >1 per 1 - 10 <sup>3</sup> yr                 | Reactor Trip<br>Loss of Power Conv. Sys.<br>(loss of condenser,<br>closure of MSIVs,<br>loss of feedwater)                             | A                                    | B        | C       |
| II  | 1 per 10 - 10 <sup>2</sup> yr                 | Loss of Offsite Power<br>Small LOCA (BWR)<br>(Stuck open SRV only)<br>MSLB (outside cntmt)                                             | B                                    | C        | D       |
| III | 1 per 10 <sup>2</sup> - 10 <sup>3</sup><br>yr | SGTR<br>Stuck open PORV (PWR)<br>Small LOCA (PWR)<br>(RCP seal failures and<br>stuck open SVs only)<br>MFLB<br>MSLB (inside PWR cntmt) | C                                    | D        | E       |
| IV  | 1 per 10 <sup>3</sup> - 10 <sup>4</sup><br>yr | Small LOCA (pipe breaks)<br>ATWS-PWR (elect only)                                                                                      | D                                    | E        | F       |
| V   | 1 per 10 <sup>4</sup> - 10 <sup>5</sup> yr    | Med LOCA<br>Large LOCA (BWR)<br>ATWS-BWR                                                                                               | E                                    | F        | G       |
| VI  | <1 per 10 <sup>5</sup> yr                     | Large LOCA (PWR)<br>ATWS-PWR (mech only)<br>ISLOCA<br>Vessel Rupture                                                                   | F                                    | G        | H       |
|     |                                               |                                                                                                                                        | > 30 days                            | 30-3days | <3 days |
|     |                                               |                                                                                                                                        | Exposure Time for Degraded Condition |          |         |

Table 1 - Estimated Likelihood for Initiating Event Occurrence During Degraded Period

# MLOCA - EI - DEP

| Remaining Mitigation Capability Rating (with Examples) |                                                                                                                                             |                                                                                                    |                                                                                          |                                                                                                                                             |                                                                                                                               |                                                                                                |
|--------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|
| Initiating Event Likelihood                            | 6                                                                                                                                           | 5                                                                                                  | 4                                                                                        | 3                                                                                                                                           | 2                                                                                                                             | 1 0                                                                                            |
|                                                        | <p>≥ 3 diverse trains</p> <p>OR</p> <p>2 multi-train systems</p> <p>OR</p> <p>1 train + 1 multi-train system + recovery of failed train</p> | <p>1 train + 1 multi-train system</p> <p>OR</p> <p>2 diverse trains + recovery of failed train</p> | <p>2 diverse trains</p> <p>OR</p> <p>1 multi-train system + recovery of failed train</p> | <p>1 train + recovery of failed train</p> <p>OR</p> <p>1 multi-train system</p> <p>OR</p> <p>Operator action + recovery of failed train</p> | <p>1 train</p> <p>OR</p> <p>Operator action</p> <p>OR</p> <p>Operator action under high stress + recovery of failed train</p> | <p>Recovery of failed train</p> <p>OR</p> <p>Operator action under high stress</p> <p>none</p> |
| A                                                      | Green                                                                                                                                       | White                                                                                              | Yellow                                                                                   | Red                                                                                                                                         | Red                                                                                                                           | Red                                                                                            |
| B                                                      | Green                                                                                                                                       | Green                                                                                              | White                                                                                    | Yellow                                                                                                                                      | Red                                                                                                                           | Red                                                                                            |
| C                                                      | Green                                                                                                                                       | Green                                                                                              | Green                                                                                    | White                                                                                                                                       | Yellow                                                                                                                        | Red                                                                                            |
| D                                                      | Green                                                                                                                                       | Green                                                                                              | Green                                                                                    | Green                                                                                                                                       | White                                                                                                                         | Red                                                                                            |
| E                                                      | Green                                                                                                                                       | Green                                                                                              | Green                                                                                    | Green                                                                                                                                       | Green                                                                                                                         | Yellow                                                                                         |
| F                                                      | Green                                                                                                                                       | Green                                                                                              | Green                                                                                    | Green                                                                                                                                       | Green                                                                                                                         | White                                                                                          |
| G                                                      | Green                                                                                                                                       | Green                                                                                              | Green                                                                                    | Green                                                                                                                                       | Green                                                                                                                         | Green                                                                                          |
| H                                                      | Green                                                                                                                                       | Green                                                                                              | Green                                                                                    | Green                                                                                                                                       | Green                                                                                                                         | Green                                                                                          |

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**Table 3 - Remaining Capability Rating Values**