March 2, 2001

MEMORANDUM TO: ACRS Members

FROM: Maggalean W. Weston, Senior Staff Engineer
ACRS

SUBJECT: CERTIFICATION OF THE MINUTES OF THE ACRS SUBCOMMITTEE ON PLANT OPERATION, DECEMBER 6, 2000 - ROCKVILLE, MD

The minutes of the subject meeting, issued March, 2, 2000, have been certified as the official record of the proceedings of that meeting. A copy of the certified minutes is attached.

Attachment: As stated

cc: via E-mail
J. Larkins
R. Savio
S. Duraiswamy
ACRS Staff Engineers
ACRS Fellows

March 2, 2001

MEMORANDUM TO: Maggalean W. Weston, Senior Staff Engineer
ACRS/ACNW

FROM: John D. Sieber, Chairman
Plant Operations Subcommittee

SUBJECT: CERTIFICATION OF THE SUMMARY/MINUTES OF THE MEETING OF THE ACRS SUBCOMMITTEE ON PLANT OPERATIONS, DECEMBER 6, 2000, ROCKVILLE, MD

I hereby certify that, to the best of my knowledge and belief, the Minutes of the subject meeting issued March 2, 2001, are an accurate record of the proceedings for that meeting.

John D. Sieber 3/2/01
John D. Sieber, Chairman Date

February 16, 2001

MEMORANDUM TO: John D. Sieber, Chairman
Plant Operations Subcommittee

FROM: Maggalean W. Weston, Senior Staff Engineer
ACRS

SUBJECT: WORKING COPY OF THE MINUTES OF THE PLANT OPERATIONS SUBCOMMITTEE HELD ON DECEMBER 6, 2000, ROCKVILLE, MARYLAND

A working copy of the minutes for the subject meeting is attached for your review. Please review and comment at your earliest convenience. Copies are being sent to each ACRS Member who attended the meeting for information and/or review.

Attachment:
As Stated

cc: ACRS Members
J. Larkins
J. Lyons
S. Duraiswamy
ACRS Staff and Fellows

Issued 02/15/01
CERTIFIED 03/02/01

CERTIFIED

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
PLANT OPERATIONS SUBCOMMITTEE
REACTOR OVERSIGHT PROCESS
DECEMBER 6, 2000
ROCKVILLE, MARYLAND

The ACRS subcommittee on Plant Operations held a meeting on December 6, 2000, with representatives of the NRC staff. The purpose of this meeting was to discuss the changes to the Reactor Oversight Process (ROP) since the implementation of the pilot program. The meeting was open to the public. Mrs. Maggalean W. Weston was the cognizant ACRS staff engineer and Designated Federal Official (DFO) for this meeting. There were no written comments provided by the public. The meeting was convened by the Subcommittee Chairman at 8:35 a.m. December 6, 2000, and adjourned at 12:10 p.m. that day.

Attendees

ACRS Members/Staff:

J. Sieber, Chairman
G. Apostolakis, Member
M. Bonaca, Member
T. Kress, Member
G. Leitch, Member
D. Powers, Member
R. Seale, Member
W. Shack, Member
R. Uhrig, Member
G. Wallis, Member
M. W. Weston, DFO

NRC Staff:

D. Hickman, NRR
D. Coe, NRR
T. Frye, NRR
P. Castleman, NMSS
M. Johnson, NRR
W. Dean, NRR
P. Koltay, NRR

There were approximately 5 members of the public in attendance during this meeting. A listing of those attendees who registered is available in the ACRS office files. No members of the public participated in the meeting discussions.

The presentation slides and handouts used during the meeting are attached to the Office Copy of the Minutes. The presentation to the subcommittee is summarized below.

CHAIRMAN'S COMMENTS

J. Sieber, Subcommittee Chairman, convened the meeting. He noted the presence of Mr. Rich Janati, Department of Environmental Resources, State of Pennsylvania. Mr. Sieber stated that the staff has developed a power reactor licensee oversight process to implement a risk-informed, performance-based approach to regulation. Further, he indicated that this direction follows modern management concepts and that the use of these concepts in private industry has led to general improvements in productivity, safety, economic viability, and competitiveness. The subcommittee chairman also noted that the nuclear industry in general supports these concepts. The chairman asked for comments from other ACRS committee members. Dr. Apostolakis asked if the staff could provide a detailed presentation on the significance determination process (SDP). Mr. Doug Coe, the staff person discussing that issue agreed to give a presentation of an example on the reactor safety SDP.

REACTOR OVERSIGHT PROCESS (ROP)

Overview

Mr. F. Gillespie provided a general overview of the process and indicated that not much had changed since the last presentation to the ACRS. The reason for keeping the program static was because of the comments received on the pilot program. The comments were that because the sample size for the pilot program was small, nothing happened, and because nothing happened, there was no way to judge how the program would have worked in a severe case. For this reason, NRR expanded the pilot program to include the whole industry in order to assess how the process works with the entire industry and under circumstances where there is a problem.

Initial Implementation Status

Initial implementation began April 2, 2000 , thereby providing 8 months of information and the opportunity to exercise the various aspects of the ROP. As a result, almost all of the baseline procedures have been worked through and so have many of the supplemental procedures. There have also been opportunities to perform some of the special and infrequent inspections. A formal feedback process has been established and, to date, approximately 100 comments have been received, primarily from the regions. The feedback has been generally positive.

An Initial Implementation Evaluation Panel has been established to assess the implementation for the first year. The panel consists of a Regional Division Manager as chair, representatives from two States, industry, and regional and headquarters staff. They will be looking at whether the industry performance is improving, holding constant, or being degraded as a result of the new oversight process.

Performance Indicators (PIs)

The PIs use objective data to monitor performance in each of the cornerstone areas, and the PIs are built around changes in core damage frequency. Many questions have arisen about the PIs. The staff uses a process call Frequently Asked Questions to respond to the more than 230 questions that have been asked. Many of the questions are for clarification of the guidelines. A few have resulted in changes.

The following issues related to PIs resulted from the experiences gained during the pilot program and the initial implementation.

- Complicating factors

    1. The variety of plant designs (e.g., the treatment of post-accident recirculation mode differs for Westinghouse (W) and Combustion Engineering (CE) designs).

    2. The variety of technical specification requirements (e.g., the differences in the way plants measure reactor coolant leakage).

    3. The differences in operating procedures (e.g., the differences in procedures for the scram with the loss of normal heat removal indicator).

- Licensee Response

  1. Margin to Threshold - The thresholds that were established by the oversight process are being set to a lower internal threshold by the licensee to ensure that they do not exceed the ROP threshold and go white.

  2. Striving for Zero - It is appears that licensees desire to have zero events, (such as unplanned power changes or safety system function failures). The problem, of course, is that the process was not designed to work that way. It was designed for a normal operating band in which the operating plant would have a normal number of events that then would be taken care of by their corrective action programs.

- Unintended Consequences

  1. Manual Scrams - The PIs count manual scrams and there is some concern that an unintended consequence is that this will inhibit operators from making manual scrams when necessary. This is not a concern throughout the industry, but enough of a concern that it should be addressed.

  2. Unplanned Power Changes - As a result of this concern, some of the PIs were changed. However, when PIs are changed, the thresholds also have to be addressed. In light of this, a new pilot program was started at 21 utilities to try out a new PI called Unplanned Reactor Shutdowns that allows 15 minutes from the time of negative reactivity insertion until shutdown. It appears that the inclusion of time limits in PIs poses a problem because some feel that 15 minutes is too long and others feel its too short. The new PI treats unplanned reactor scrams and scrams with loss of normal heat removal the same. It, too, has a number - the 72 hour rule which simply states that if 72 hours have elapsed from the time you have identified an off-normal condition until you begin the reactor shutdown, then it is considered planned. The PI also includes a provision for power changes greater than 20 percent.

  3. Safety System Unavailability - This is probably the most contentious indicator with the most issues associated with it. The two biggest issues are the fault exposure hours and unavailable hours. Licensees who do maintenance on line can treat unavailability differently than those who do the same maintenance while shutdown. At issue are things like consistency in the oversight process and consistent measures for all utilities. This is complicated, as previously indicated, by the variety of plant designs, variations in plant TSs and differences in operating procedures. Uniform definitions would also be of help. But, there is a reluctance to have a uniform set of definitions. NRC staff has indicated the need to work on definitions.

  4. Safety System Functional Failures - This is an indicator patterned exactly after one that AEOD has used for 15 years. This correlates well with the watch list plants and declining trend plants. The biggest issue here is the reactor core isolation cooling system (RCIC), a risk-important system, which is now reported by some utilities and not by others.

- Problem PIs

  1. Barrier Integrity Cornerstone - The indicators for this cornerstone are all under review. The containment leakage performance indicator has been eliminated because of different requirements for measuring and recording leakage by different utilities.

  2. Physical Protection Cornerstone - This cornerstone has three indicators, the protected area, security equipment, and the performance index. Guard hours are used to compensate for equipment that is out of service. The PI actually addresses the operability of the equipment that is expected to be there rather than the security status of the facility.

Significance Determination Process (SDP)

The SDP resulted from the need to prioritize inspection findings from the ROP in terms of their significance to safety and to determine the appropriate action to take. In other words, it provides a methodology for equating inspection findings and PIs. It is important that inspectors be sensitive to things at a particular plant that drive risk significance at the plant so that they can find the most significant issues at the plant. The SDP provides a link between the computer based analyses that have been created over time and the need for the inspector to have at least a conceptual understanding of what drives risk at the particular plant. The SDP is used to assign risk values (colors) to inspection findings.

The SDPs are plant specific and based on input from licensees and site visits. However, the comparisons with the thresholds are generic. SDPs exist for Reactor Safety, Emergency Preparedness, Fire Protection, Occupational and Public Radiation Safety, Safeguards and Shutdown Screening. The Containment SDP is being reviewed by the Commission.

Two examples of SDPs were given for reactor safety at this point. The SDP for reactor safety is divided into three phases. Phase 1 is essentially a screening tool where those issues that are highly unlikely to reach 1E-6 CDF are identified as green. In Phase 2 - if the issue does not pass the Phase 1 screening process, additional analyses is done. In Phase 3 - the inspector passes the issue on for verification of its risk significance or to a risk analyst for assessment. The inspector will also pass an issue on because the SDP process can not accommodate the particular issue.

The levels of significance associated with performance indicators and inspection findings are as follows:

Green	-	very low risk significance	-	Δ CDF < 1E-6
White	-	low to moderate risk	-	1E-6 < Δ CDF< 1E-5
Yellow	-	substantive risk	-	1E-5 < Δ CDF< 1E-4
Red	-	high risk	-	Δ CDF < 1E-4

In the initial implementation phase, 16 greater than green issues have been processed by the SDP and Enforcement Review Panel (SERP). The SERP is a headquarters panel tasked to look at every issue that the regions sends to NRR as a white issue or greater. A yellow finding

must be carried as a yellow for four quarters. This is so that you can see when there is more than one yellow finding. The process is built so that if you have more than one yellow finding, the cornerstone is degraded, this takes you into the action matrix where you get increased regulatory attention.

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

PLANT OPERATIONS SUBCOMMITTEE MEETING

DECEMBER 6, 2000

NRC STAFF SIGN IN FOR ACRS MEETING

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NAME	BADGE NO.	NRC ORGANIZATION
D.E. Hickman	B-6241	NRR/DIPM/IIPB
~~R. Jenkins~~	~~DA~~	~~RA OCP/BPP~~
D. Coe	B-8061	IIPB
T. Frye	B 8578	IIPB
P. Castleman	A 7559	NMSS/FCSS/SSSB
M. Johnson	B 7542	NRR/IIPB
W. Dean	B C575	NRR/IIPB
P. Koltay	B 6800	NRR/IIPB

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

PLANT OPERATIONS SUBCOMMITTEE MEETING

DECEMBER 6, 2000

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

PLANT OPERATIONS SUBCOMMITTEE MEETING

DECEMBER 6, 2000

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

PLANT OPERATIONS SUBCOMMITTEE MEETING

DECEMBER 6, 2000

ATTENDEES - PLEASE SIGN BELOW

PLEASE PRINT

NAME	AFFILIATION
Rich Janati	PA DEP/BRP (717)787-2163
Nancy Chapman	SERCH/Bechtel
Tony Browning	Alliant Energy - Duane Arnold

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

PLANT OPERATIONS SUBCOMMITTEE MEETING

DECEMBER 6, 2000

ATTENDEES - PLEASE SIGN BELOW

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NAME	AFFILIATION

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STATUS OF THE REACTOR OVERSIGHT PROCESS

Inspection Program Branch

December 6, 2000

TOPICS FOR DISCUSSION

- **Initial Implementation Status**
- **Program Feedback**
- **Selected Issues**
- **Future Activities/Program Development**

INITIAL IMPLEMENTATION STATUS

- Completed 8 months of initial implementation
- Have exercised many aspects of the ROP
- Generally positive feedback
- Mid-cycle Assessments performed in November

Performance Indicators Mar 16. where

SELECTED ISSUES

- **Performance Indicator issues**
- **Significance Determination Process issues**

PROGRAM FEEDBACK

- **Steady stream of stakeholder feedback**
- **NRC/NEI Working Group activities**
- **Initial Implementation Evaluation Panel** 4 mtg chaired by Response Mgmt
- **Mid-cycle Public Forums** did end of cycle review at the ~~end~~ of period
- **Regional site visits**
- **Federal Register Notice** to be issued to solicit feedback from public
- **Public Lessons Learned Workshop**

Trying to do best to get feedback to improve process

FUTURE ACTIVITIES/DEVELOPMENT

- SDP improvements and enhancement
- Scram PI Pilot Program
- Redefine Unplanned Power Changes and Unavailability PIs
- Develop industry trends assessment process trying to do something different to determine if new oversight process help or hurts
- Risk-based Performance Indicator development
- Conduct self-assessment of initial implementation
- Lessons Learned Workshop (March 2001)
  - Internal
  - External
- Commission paper and meeting June/July 2001

Lessons Learned: PIs

- Complicating Factors
  - Variety of plant designs
  - Variations in plant technical specifications
  - Differences in operating procedures
- Licensee Response
  - Margin to threshold
  - Strive for zero
- Unintended Consequences
  - Manual Scrams
  - Unplanned Power Changes
  - Safety System Unavailability
  - Safety System Functional Failures
- Problem PIs
  - Barrier Integrity Cornerstone
  - Physical Protection Cornerstone

major discussion

flow alternate PI

most contentious

Fault exposure hours for SR test failures

2nd issue.

causing unavailability hours when you do maintenance online vs. shutdown

includes leakage

security

INITIAL IMPLEMENTATION SDP

- **16 > Green issues processed by SERP**
  - IE = initiating event **1 Red** IP2
  - MS = mitigating system 6 **White** 2 **Yellow**
    yellow inspection finding
    stay yellow for 4 qtrs
  - B Barrier
  - EP = 3 **White**
  - RP(P) = 1 **White**
  - RP (O) = 2 **White**
  - PP = 1 **White**

Cornerstones

  - **(To be reevaluated upon Commission approval of interim SDP)**

KEY ISSUES
SDP

- Phase 2 Plant-specific risk-informed notebooks
- Fire Protection working to improve
- Safeguards
- Containment commission reviewing
- Shutdown

WORKSHEET FOR REACTOR AND PLANT SYSTEM DEGRADED CONDITIONS

Reference/Title (LER #, Inspection Report #, etc): **PWR EXAMPLE #1**

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

One of four cold leg accumulators (safety injection tanks) is determined to have been less than the required Tech Spec level for a period of 90 hours (longer than Tech Spec LCO) due to a miscalibrated level instrument. Plant is otherwise in a normal full power lineup.

System(s) and Train(s) with degraded condition: ***"A" Accumulator***

Licensing Basis Function (if applicable): ***Core reflood following DBA LOCA***

Maintenance Rule category (check one): ✔ risk-significant ____ non-risk-significant

Time degraded condition existed or assumed to exist: ***90 hours***

Functions and Cornerstones degraded 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)

____ Low Pressure

____ High Pressure

____ 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, hydrogen or pressure control

____ Fuel cladding degraded

PHASE 1 SCREENING PROCESS
Check the appropriate boxes ✔

Cornerstone(s) assumed degraded:

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

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

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

Initiating Event	Mitigation Systems	RCS Barrier	Fuel Barrier	Containment Barrier
1. Does the issue contribute to the likelihood of a Primary or Secondary system LOCA initiator? ☐**If YES ➔Go to Phase 2** If NO, continue 2. Does the issue contribute to both the likelihood of a reactor trip AND the likelihood that mitigation equipment will not be available? ☐**If YES ➔Go to Phase 2** ☐If NO, screen OUT	1. Is the issue a design or qualification deficiency that does NOT affect operability per GL 91-18 (rev 1)? ☐**If YES ➔ Screen OUT** If NO, continue 2. Does the issue represent an actual Loss of Safety Function of a System? ☐**If YES ➔ Go to Phase 2** If NO, continue 3. Does the issue represent an actual Loss of Safety Function of a Single Train, for > TS AOT? ☒**If YES ➔ Go To Phase 2** If NO, continue 4. Does the issue represent an actual Loss of Safety Function of a Single Train of non-TS equipment designated as risk-significant under 10CFR50.65, for > 24 hrs? ☐**If YES ➔ Go To Phase 2** ☐ If NO, screen OUT	☐ 1. **Go to Phase 2**	☐ 1.Screen OUT	1. TBD

Result of the Phase 1 screening process: _____ screen OUT as "Green" ___✔___ go to Phase 2
Important Assumptions (as applicable):

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

PHASE 2 RISK ESTIMATION WORKSHEET FOR SALEM

Large LOCA

Estimated Frequency (Table 1 Row) VI Exposure time 90hrs Table 1 result (circle): A B C D E F **(G)** H

Safety Functions Needed:

Full Creditable Mitigation Capability for each Safety Function:

Early Inventory, Accumulators (EIAC)	4 / 4 Accumulators (< 4 accumulators will not accomplish the safety function, thus 4 accumulators = 1 train)
Early Inventory, LP Injection (EILP)	1 / 2 LPSI trains (1 multi-train system)
Low Pressure Recirc (LPR)	1 / 2 RHR trains (1 multi-train system)
Contmt Press/Temp Control (CNT)	1 / 2 CS trains (1 multi-train system) or 3 / 5 CFCU trains (4 or 5 CFCUs = 1 multi-train system, 3 CFCUs = 1 diverse train)

Circle affected functions	Recovery of failed train	*Remaining* Mitigation Capability Rating for each affected sequence	Sequence Color (0 + 0 = 0)
1 LLOCA - **EIAC**	**0**	**None (= 0)**	**Green**
2 LLOCA - EILP			
3 LLOCA - LPR			
4 LLOCA - CNT			

Identify any operator recovery actions[1] that are credited to directly restore the degraded equipment or initiating event:

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.

PHASE 2 RISK ESTIMATION WORKSHEET FOR SALEM

Medium LOCA

Estimated Frequency (Table 1 Row) VI Exposure time 90hrs Table 1 result (circle): A B C D E **(F)** G H

Safety Functions Needed:

Full Creditable Mitigation Capability for each Safety Function:

Early Inventory, Accumulators (EIAC)	2 / 4 Accumulators (2 accumulators = 1 train, 3 or 4 accumulators = 1 multi-train system)
Early Inventory, HP Injection (EIHP)	2 / 4 Charging or SI trains (2 multi-train systems)
High Pressure Recirc (HPR)	1 / 2 Charging or SI trains taking suction from 1 / 2 LPSI trains (limited by LPSI = 1 multi-train system)
Low Pressure Recirc (LPR)	1 / 2 LPSI trains (1 multi-train system)
Contmt Press/Temp Control (CNT)	1 / 2 CS trains (1 multi-train system) or 3 / 5 CFCU trains (4 or 5 CFCUs = 1 multi-train system, 3 CFCUs = 1 diverse train)

Circle affected functions	Recovery of failed train	*Remaining* Mitigation Capability Rating for each affected sequence	Sequence Color (0 + 3 = 3)
1 MLOCA - **EIAC**	**0**	**EIAC = 3 Accumulators remain = 1 multi-train system = 3 from Table 3**	**Green**
2 MLOCA - EIHP			
3 MLOCA - HPR			
4 MLOCA - LPR			
5 MLOCA - CNT			

Identify any operator recovery actions[1] that are credited to directly restore the degraded equipment or initiating event:

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.

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

WORKSHEET FOR REACTOR AND PLANT SYSTEM DEGRADED CONDITIONS

Reference/Title (LER #, Inspection Report #, etc): **PWR EXAMPLE #4**

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

Maintenance workers incorrectly enshrouded the CST vent pipe with a heavy herculite tarp while working on an unrelated system. Tarp was in place for 36 days. Upon discovery, the licensee declared AFW inoperable due to an anticipated loss of suction from the CST due to subatmospheric conditions that would be created upon any AFW actuation.

System(s) and Train(s) with degraded condition: ***All AFW trains***

Licensing Basis Function (if applicable): ***DHR when MFW not available***

Maintenance Rule category (check one): ✔ risk-significant __ non-risk-significant

Time degraded condition existed or assumed to exist: ***36 days***

Functions and Cornerstones degraded 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)

____ Low Pressure

____ High Pressure

__✔__ 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, hydrogen or pressure control

_____ Fuel cladding degraded

PHASE 1 SCREENING PROCESS

Check the appropriate boxes ✔

Cornerstone(s) assumed degraded:

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

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

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

Initiating Event	Mitigation Systems	RCS Barrier	Fuel Barrier	Containment Barrier
1. Does the issue contribute to the likelihood of a Primary or Secondary system LOCA initiator? ☐**If YES ➔Go to Phase 2** If NO, continue 2. Does the issue contribute to both the likelihood of a reactor trip AND the likelihood that mitigation equipment will not be available? ☐**If YES ➔Go to Phase 2** ☐If NO, screen OUT	1. Is the issue a design or qualification deficiency that does NOT affect operability per GL 91-18 (rev 1)? ☐**If YES ➔ Screen OUT** If NO, continue 2. Does the issue represent an actual Loss of Safety Function of a System? ☒**If YES ➔ Go to Phase 2** If NO, continue 3. Does the issue represent an actual Loss of Safety Function of a Single Train, for > TS AOT? ☐**If YES ➔ Go To Phase 2** If NO, continue 4. Does the issue represent an actual Loss of Safety Function of a Single Train of non-TS equipment designated as risk-significant under 10CFR50.65, for > 24 hrs? ☐**If YES ➔ Go To Phase 2** ☐ If NO, screen OUT	☐ 1. **Go to Phase 2**	☐ 1.Screen OUT	1. TBD

Result of the Phase 1 screening process: _____ screen OUT as "Green" ___✔___ go to Phase 2

Important Assumptions (as applicable):

Assumption: Any AFW actuation would collapse the CST, splitting it open down to its base and emptying it. Flooding could potentially be risk significant, but is not considered in this initial risk assessment.

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

PHASE 2 RISK ESTIMATION WORKSHEET FOR SALEM

Transient

Estimated Frequency (Table 1 Row) I Exposure time 36 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 / 2 Feedwater trains (operator action)
Secondary Heat Removal (AFW)	1 / 2 MDAFW trains (1 multi-train system) or 1 TDAFW train (1 diverse train)
Primary Heat Removal, Feed/Bleed (FB)	2 / 2 PORVs open for Feed/Bleed (operator action under high stress)
High Pressure Recirc (HPR)	1 / 2 Charging trains or 1 / 2 SI trains taking suction from 1 / 2 LPSI trains (LPSI = 1 multi-train system)
Low Pressure Recirc (LPR)	1 / 2 LPSI trains (1 multi-train system)
Contmt Press/Temp Control (CNT)	1 / 2 CS trains (1 multi-train system) or 3 / 5 CFCU trains (4 or 5 CFCUs= 1 multi-train system, 3 CFCUs = 1 diverse train)

Circle affected functions	Recovery of failed train	*Remaining* Mitigation Capability Rating for each affected sequence	Sequence Color
1 TRANS - **AFW** - PCS - CNT	1	**AFW = none = 0** **PCS = operator action = 2** **CNT = 1 multi-train system + 1 multi-train system = 3 + 3= 6**	**(1+0+2+6=9) Green**
2 TRANS - **AFW** - PCS - FB	1	**AFW = none = 0** **PCS = operator action = 2** **FB = operator action under high stress = 1**	**4 = Yellow**
3 TRANS - **AFW** - PCS - LPR	1	**AFW = none = 0** **PCS = operator action = 2** **LPR = 1 multi-train system = 3**	**6 = Green**
4 TRANS - **AFW** - PCS - HPR	1	**AFW = none = 0** **PCS = operator action = 2** **HPR = 1 multi-train system = 3**	**6 = Green**

Identify any operator recovery actions[1] that are credited to directly restore the degraded equipment or initiating event:

Assumption: Operator recovery of AFW can be accomplished by alignment of service water to the suction of the AFW pumps, following a reactor trip but before SG dryout. Note 1 conditions are met.

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.

PHASE 2 RISK ESTIMATION WORKSHEET FOR SALEM — LOOP

Estimated Frequency (Table 1 Row) II Exposure time 36 days Table 1 result (circle): A **(B)** C D E F G H

Safety Functions Needed: *Full* Creditable Mitigation Capability for each Safety Function:

Emergency AC Power (EAC)	2 / 3 Emergency Diesel Generators (3 EDGs = 1 multi-train system, 2 EDGs =1 diverse train) or 1 Gas Turbine Generator (1 diverse train)
Recovery of AC Power in < 2 hrs (REC)	1 TDAFW train and SBO procedures, other than GTG, implemented (operator action under high stress)
Early Inventory, HP Injection (EIHP)	1 / 2 Charging trains (1 multi-train system) or 1 / 2 SI trains (1 multi-train system)
Secondary Heat Removal (AFW)	1 TDAFW train (1 train) or 1 / 2 MDAFW trains (1 multi-train system)
Primary Heat Removal, Feed/Bleed (FB)	2 / 2 PORVs open for Feed/Bleed (operator action under high stress)
Low Pressure Recirc (LPR)	1 / 2 LPSI trains (1 multi-train system)
High Pressure Recirc (HPR)	1 / 2 Charging or 1 / 2 SI trains with suction from 1 / 2 LPSI trains (limited by LPSI = 1 multi-train system)
Contmt Press/Temp Control (CNT)	1 / 2 CS trains (1 multi-train system) or 3 / 5 CFCU trains (4 or 5 CFCUs= 1 multi-train system, 3 CFCUs = 1 diverse train)

Circle affected functions	Recovery of failed train	*Remaining* Mitigation Capability Rating for each affected sequence	Sequence Color
1 LOOP - EAC - **REC** (SBO sequence)	0	**EAC = 3 EDGs+GTG = 1 multi-train system + 1 diverse train = 3+2 = 5** **REC = none (no TDAFW available) = 0**	**0+5+0 = 5 Green**
2 LOOP - EAC - EIHP (RCP seal LOCA with recovery of AC power)			
3 LOOP - EAC - **AFW** - FB (RCP seal LOCA with recovery of AC power)	1	**EAC = 3 EDGs+GTG = 1 multi-train system + 1 diverse train = 3+2 = 5** **FB = operator action under high stress = 1, AFW = none = 0**	**7 = Green**
4 LOOP - EAC - **AFW** - LPR (RCP seal LOCA with recovery of AC power)	1	**EAC = 3 EDGs+GTG = 1 multi-train system + 1 diverse train = 3+2 = 5** **LPR = 1 multi-train system = 3, AFW = none = 0**	**9 = Green**
5 LOOP - EAC - **AFW** - HPR (RCP seal LOCA with recovery of AC power)	1	**EAC = 3 EDGs+GTG = 1 multi-train system + 1 diverse train = 3+2 = 5** **HPR = 1 multi-train system = 3, AFW = none = 0**	**9 = Green**
6 LOOP - **AFW** - FB	1	**FB = operator action under high stress = 1, AFW = none = 0**	**2 = Red**
7 LOOP - **AFW** - LPR	1	**LPR = 1 multi-train system = 3, AFW = none = 0**	**4 = White**
8 LOOP - **AFW** - HPR	1	**HPR = 1 multi-train system = 3, AFW = none = 0**	**4 = White**
9 LOOP - **AFW** - CNT	1	**CNT = 2 multi-train systems = 6, AFW = none = 0**	**7 = Green**

Identify any operator recovery actions[1] that are credited to directly restore the degraded equipment or initiating event:

Assumption: Operator recovery of AFW can be accomplished by alignment of service water to the suction of the AFW pumps, following a reactor trip but before SG dryout, except when AC power is not recovered (SBO).

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.

PHASE 2 RISK ESTIMATION WORKSHEET FOR SALEM — SGTR

Estimated Frequency (Table 1 Row) III Exposure time 36 days Table 1 result (circle): A B **(C)** D E F G H

Safety Functions Needed:	*Full* Creditable Mitigation Capability for each Safety Function:
Early Inventory, HP Injection (EIHP)	1 / 2 Charging or 1 / 2 SI trains (2 multi-train systems)
Secondary Heat Removal (AFW)	1/2 MDAFW trains (1 multi-train system) or 1 TDAFW train (1 diverse train-assuming ruptured SG isolated)
Primary Heat Removal, Feed/Bleed (FB)	2 / 2 PORVs open for Feed/Bleed (operator action under high stress)
Primary/Secondary Pressure Equalization (EQ)	Pressure equalization below SG safety setpoints (operator action under high stress) - Note: Failure to equalize is assumed to result in failure to isolate the steam generator (loss of SG inventory to atmosphere)
Makeup CST (MKCST)	Operator alignment of firemain system to CST makeup (operator action)
Makeup RWST (MKRWST)	Operator alignment of borated water sources to RWST (operator action)

Circle affected functions	Recovery of failed train	*Remaining* Mitigation Capability Rating for each affected sequence	Sequence Color
1 SGTR - EQ - **AFW** - FB	1	**EQ = operator action under high stress = 1** **FB = operator action under high stress = 1, AFW = none = 0**	**3 = White**
2 SGTR - EQ - EIHP			
3 SGTR - EQ - MKCST			
4 SGTR - EQ - **AFW** - MKRWST	1	**EQ = operator action under high stress = 1** **MKRWST = operator action = 2**	**4 = Green**

Identify any operator recovery actions[1] that are credited to directly restore the degraded equipment or initiating event:

Assumption: Operator recovery of AFW can be accomplished by alignment of service water to the suction of the AFW pumps, following a reactor trip but before SG dryout.

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.

PHASE 2 RISK ESTIMATION WORKSHEET FOR SALEM

Small LOCA

Estimated Frequency (Table 1 Row) III Exposure time 36 days Table 1 result (circle): A B **(C)** D E F G H

Safety Functions Needed:	*Full* Creditable Mitigation Capability for each Safety Function:
Early Inventory, HP Injection (EIHP)	1 / 2 Charging or 1 / 2 SI trains (2 multi-train systems)
Power Conversion System (PCS)	1 / 2 Feedwater trains (operator action)
Secondary Heat Removal (AFW)	1 / 2 MDAFW trains (1 multi-train system) or 1 TDAFW train (1 diverse train)
Primary Heat Removal, Feed/Bleed (FB)	2 / 2 PORVs open for Feed/Bleed (operator action under high stress)
High Pressure Recirc (HPR)	1 / 2 Charging or 1 / 2 SI trains with suction from 1 / 2 LPSI trains (limited by LPSI = 1 multi-train system)
Low Pressure Recirc (LPR)	1 / 2 LPSI trains (1 multi-train system)
Contmt Press/Temp Control (CNT)	1 / 2 CS trains (1 multi-train system) or 3 / 5 CFCU trains (4 or 5 CFCUs= 1 multi-train system, 3 CFCUs = 1 diverse train)

Circle affected functions	Recovery of failed train	*Remaining* Mitigation Capability Rating for each affected sequence	Sequence Color
1 SLOCA - EIHP			
2 SLOCA - **AFW** - PCS - FB	1	**PCS = operator action = 2** **FB = operator action under high stress = 1**	**4 = Green**
3 SLOCA - **AFW** - PCS - CNT	1	**PCS = operator action = 2** **CNT = 2 multi-train systems = 3 + 3 = 6**	**9 = Green**
4 SLOCA - LPR			
5 SLOCA - HPR			

Identify any operator recovery actions[1] that are credited to directly restore the degraded equipment or initiating event:

Assumption: Operator recovery of AFW can be accomplished by alignment of service water to the suction of the AFW pumps, following a reactor trip but before SG dryout.

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.

PHASE 2 RISK ESTIMATION WORKSHEET FOR SALEM

ATWS

Estimated Frequency (Table 1 Row) IV Exposure time 36 days Table 1 result (circle): A B C **(D)** E F G H

Safety Functions Needed:	*Full* Creditable Mitigation Capability for each Safety Function:
Manual Reactor Trip (RTP)	(operator action)
Turbine Trip (TTP)	(operator action)
Primary Safety Relief Valves (SRV)	3 / 3 SRVs (1 train) or [2 / 3 SRVs and 2 / 2 PORVs] (1 train)
Secondary Heat Removal (AFW)	2 / 2 MDAFW trains (1 diverse train) or 1 TDAFW train (1 diverse train)
High Pressure Injection (HPI)	1 / 2 Charging trains (1 multi-train system)

Circle affected functions	Recovery of failed train	*Remaining* Mitigation Capability Rating for each affected sequence	Sequence Color
1 ATWS - RTP - TTP			
2 ATWS - RTP - SRV			
3 ATWS - RTP - HPI			
4 ATWS - RTP - **AFW**	**0**	**RTP = operator action = 2** **AFW = none = 0**	**2 = White**

Identify any operator recovery actions[1] that are credited to directly restore the degraded equipment or initiating event:

Insufficient time to align service water to AFW suction.

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.

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