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Palisades Nuclear Plant
Operated by Nuclear Management Company, LLC

October 28, 2003

U S Nuclear Regulatory Commission
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PALISADES NUCLEAR PLANT
DOCKET 50-255
LICENSE No. DPR-20
SAFETY ASSESSMENT OF PRELIMINARY WHITE FINDING

By letter dated October 3, 2003, the NRC transmitted the preliminary significance assessment of a finding that was originally described in NRC Special Inspection Report 50-255/03-05. The finding involved the failure to have established controls in place for digging or excavating activities, and was preliminarily determined to be a White finding, meaning a finding of low to moderate safety significance.

Nuclear Management Company, LLC, is submitting information regarding our safety assessment of the finding. This information is provided in the four attachments to this letter.

This letter contains no new commitments and no revisions to existing commitments.

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Attachments

A001

ATTACHMENT 1

NUCLEAR MANAGEMENT COMPANY, LLC
PALISADES NUCLEAR PLANT
DOCKET 50-255

October 28, 2003

PSA EVALUATION OF DIGGING/EXCAVATING AT PALISADES
EA-PSA-LOOP-EVAL-03-12

20 Pages Follow

Committed to Nuclear Excellence

PALISADES NUCLEAR PLANT
ANALYSIS COVER SHEET

EA-PSA-LOOP-EVAL-03-12 Rev 0
Total Number of Sheets 20

Title PSA Evaluation of Digging/Excavating at Palisades

INITIATION AND REVIEW

Calculation Status	Preliminary ☐	Pending ☐	Final ■	Superseded ☐

Rev #	Description	Initiated By	Initiated Date	Init Appd By	Review Method: Alt Calc	Review Method: Detail Rev'w	Review Method: Qual Test	Technically Reviewed By	Technically Reviewed Date	Rev'r Appd By	Sup'v & S/DR Appd
0	Original Issue	RAWhite [signature]	9-26-03	[signature]		X		FJYanik [signature]	10-13-03	[signature]	[signature]

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1.0 OBJECTIVE

This Engineering Analysis (EA) determines the safety significance of an inadequate digging/excavating policy as identified in the NRC Special Inspection Report (ref 2.1). The ineffective digging/excavating policy led to a loss of off-site power (LOOP)/loss of shutdown cooling (LOSDC) event on March 25, 2003, when a signpost was pounded into the ground and struck and damaged an underground conduit. The digging/excavating scenario identified in Attachment A to EA-PSA-SWY-REC-03-10 (ref 2.2) is evaluated in this EA. The most recent plant specific PSA model is used to evaluate this scenario (ref 2.3).

2.0 ANALYSIS INPUT/REFERENCES

2.1 NRC Letter to Mr. DECooper from GEGrant, Palisades Nuclear Generating Plant, NRC Special Inspection Report 50-255/03-05, dated May 19, 2003
2.2 EA-PSA-SWY-REC-03-10, rev 0, Probability of Failing to Recover an Off-Site Power Source Following a LOOP Event Caused by Digging/Excavating
2.3 EA-PSA-CCW-HELB-02-17, rev 0, Evaluation of the Impact of a High Energy Line Break in CCW Room with either Door 167 to 590 Corridor Auxiliary Building or 167B to the West Engineered Safeguards Room Open
2.4 CAFTA 4.0b for Windows 95/98/NT/200, Control Copy #CAF-1000940CD (R0474)
2.5 NUREG/CR-2300 vol 1, "PRA Procedures Guide", January 1983 (R0834)
2.6 INEEL, "Systems Analysis Programs for Hands-on Integrated Reliability Evaluations - SAPHIRE", v6.66 (R0477)
2.7 EA-PSA-DG-REC-03-14, rev 0, Calculation of Four Human Error Recovery Events to be used in Loss of Offsite Power Scenarios
2.8 EA-PSA-1999-004, rev 0, Palisades PSA Model - Power Operations - Data Collection - Generic Data
2.9 NUREG/CR-4639 Volume 5, rev 4, Nuclear Reliability (NUCLARR) Data Manual, Part 3: Hardware Component Failure Data, EG&G Idaho Inc, March 1994 (R0006)
2.10 PLG-0500, rev 0, Database for Probabilistic Risk Assessment of Light Water Nuclear Power Plants: Failure Data, Pickard, Lowe and Garrick Inc, July 1989
2.11 EA-PSA-DATA-99-0014, rev 0, Generic MGL Demand and Mission Time Parameter Data as Applied to PSAR1 Common Cause Basic Events
2.12 Combustion Engineering Owners Group Report CE-NPSD-1029, rev 3, Comparison of PSA Inputs and Assumptions for CE PWRs, January 1998

3.0 DEFINITIONS

3.1 *CDF - core damage frequency* - probability per year for a core damage event at a nuclear power plant
3.2 *CDP - core damage probability* - probability for a core damage event at a nuclear power plant
3.3 *HEP - human error probability* - the probability that an operator will fail to correctly perform a given task or activity within the required time frame
3.4 *IE - Initiating Event* - incident that causes a change in the reactor status (i.e., steam generator tube rupture, loss of off-site power, loss of shutdown cooling during a refueling outage, etc.)
3.5 *IEF - Initiating Event Frequency* - probability per year of an initiating event
3.6 *LERF - large early release frequency* - probability per year for an early offsite radiological release from a core damage event at a nuclear power plant
3.7 *LOOP - loss of off-site power* - for this evaluation, LOOP is disconnection of the switchyard to the plant
3.8 *LOSDC - loss of shutdown cooling* - event
3.9 *Mitigation capability* - equipment used to prevent an initiating event from causing a core damage event
3.10 *PSA/PRA - probabilistic safety assessment/probabilistic risk assessment* - probabilistic model of plant systems, structures and components and their response to plant event events
3.11 *SAPHIRE* - computer code to quantify the PSA model

3.12 *SDP - Significance Determination Process* - NRC process to assess the safety significance of a finding:
Green – very low safety significance (CDF<1E-6/yr and LERF<1E-7/yr)
White – low safety significance (1E-6/yr<CDF<1E-5/yr or 1E-7/yr<LERF<1E-6/yr)
Yellow – low to moderate safety significance (1E-5/yr<CDF<1E-4/yr or 1E-6/yr<LERF<1E-5/yr)
Red – high safety significance (CDF>1E-4/yr or LERF>1E-5/yr)

4.0 ASSUMPTIONS

4.1 Major Assumptions

4.1.1 No credit is given for recovery of either diesel generator (DG) during the 2 hour or 4 hour time frame. Assuming no recovery is conservative since minor DG failure modes could be recovered within 4 hours, especially with the Technical Support Center (TSC) and Operations Support Center (OSC) fully staffed. See Section 5.10, Item 3 for more discussion.

4.2 Minor Assumptions

4.2.1 Anticipated transients without scram (ATWS) was not included in this evaluation because it is a separate initiating event.

4.2.2 The PSA currently assumes that if an AC power source is not recovered within the battery depletion time of 4 hours, core damage will occur because of lack of instrumentation. Assuming only 4 hours to recover an AC power source is conservative since time is available beyond the 4 hours to recover an AC power source and prevent core damage. See Section 5.10, Item 2 for more discussion.

4.2.3 This EA assumes that the long term recovery of off-site power (18 hours) is the same as recovery of off-site power within 4 hours. If a DG is operating and off-site power is not recovered within ~18 hours, then fuel oil makeup to the DG day tank is required. Assuming the same recovery probability is conservative since successful recovery of off-site is more likely with longer time frames.

5.0 ANALYSIS

5.1 Methodology

The methods employed to address the safety significance of an inadequate digging/excavating policy are described in each section and include methods from the CAFTA software and users manual (ref 2.4), the SAPHIRE software and users manual (ref 2.6) and NUREG/CR-2300 vol 1, "PRA Procedures Guide" (ref 2.5). All results were subsumed to obtain minimal cutsets.

5.2 Evaluation Scenario

The SDP evaluates the change in risk due to a finding or deficiency. The specific finding/deficiency evaluated by this EA is an inadequate digging/excavating policy in effect prior to March 25, 2003, as identified in the NRC Special Inspection Report (ref 2.1). To evaluate a change in risk, the PSA items affected by this finding/ deficiency need to be identified.

The plant PSA may be impacted by digging/excavating between the plant and the switchyard. This type of digging/excavating may damage underground cables/conduits. Attachment A to EA-PSA-SWY-REC-03-10 (ref 2.2) identifies the digging/excavating scenario evaluated by this EA. This scenario assumes damaging to all three cables (versus only one during the actual event) in the damaged underground conduit. Two of the cables contain control circuits for off-site power related equipment, resulting in a LOOP if damaged. No mitigating equipment failures would be affected by this scenario. Therefore, this finding/deficiency only impacts the LOOP initiating event frequency (IEF). This EA evaluates the impact of the change in LOOP IEF on the PSA model.

5.3 Change in Initiating Event Frequency

Treating this event as a new type of initiator and using a frequentist approach (# events/# operating years) is the simplest, but conservative, method for estimating the change in LOOP IEF for this finding/deficiency. Palisades received a license in March 1971. The number of Palisades operating years (March 1971 through April 2003) = 32.1 years. There has been 1 digging/excavating event causing a LOOP over the plant life. Therefore, the frequentist method results in a conservative change in LOOP IEF = 1 LOOP event/32.1 years = 3.11E-2/yr.

The use of a frequentist approach overstates the IEF and does not account for prior industry experience. This approach also implies that, prior to the event occurring, the likelihood of experiencing a LOOP event at Palisades due to digging/excavating is zero (that is no events/# operating years). Establishing an appropriate industry prior and Bayesian updating with the plant specific data provides a better estimate for the LOOP IEF due to maintenance related causes (such as digging/excavating). However, in the absence of calculating an appropriate industry prior and Bayesian updated IEF for this event, the frequentist approach will be used in this EA resulting in a bounding change in LOOP IEF = 3.11E-2/yr due to this finding/deficiency.

5.4 Core Damage Sequences Affected

As identified in Section 5.2, only the LOOP sequences are affected by the finding/deficiency. This EA uses the baseline PSA model (ref 2.3) to evaluate the LOOP sequences (without ATWS, assumption 4.2.1). Using the change in LOOP IEF from Section 5.3 as the LOOP IEF for this EA and solving only the LOOP sequences provides the change in core damage frequency (CDF) for the finding/deficiency.

This EA uses the conditional IEF for LOOP, IE_LOOP = 1.0, to get a core damage probability (CDP). The CDP can then be multiplied by the change in IEF to get the change in CDF.

This EA does not calculate the ATWS impact (assumption 4.2.1). To remove the ATWS results from the PSA results, the electrical and mechanical reactor protection system events are set to FALSE: RXC-ELEC-FAULTS and RXC-MECH-FAULTS.

5.5 Event Specific Changes

The LOOP event tree and supporting fault trees are set up for generic sequences. This EA modifies the PSA model to be event specific. The only event specific PSA model change incorporated in this EA is the reconnection of off-site power following the digging/excavating event damaging the cables/conduit. EA-PSA-SWY-REC-03-10 calculates the probability of failing to reconnect off-site power within the 2 ½ hours and 4 hours. The baseline PSA model basic event recovery terms, REC-2HR and REC-4HR, are used to represent the operator action to reconnect off-site for this event. This EA uses reconnect off-site power and recovery of off-site power interchangeably to mean operator action to reconnect following a digging/excavating event described in EA-PSA-SWY-REC-03-10, Attachment A.

The LOOP scenario caused by digging/excavating between the plant and the switchyard is identified in Attachment A to EA-PSA-SWY-REC-03-10. This scenario is a loss of rear bus (R bus), loss of front bus (F bus) and opening of main generator breakers. Based on this scenario, EA-PSA-SWY-REC-03-10 calculates the probability of failing to recover off-site power for REC-2HR = 2.3E-2 and REC-4HR = 5.6E-3. Also, recovery of off-site power within 30 minutes is assumed to fail, therefore, this recovery term, REC-30MIN, is set to TRUE. In addition, failing to recover off-site power within 18 hours (P-LOOP-FTRE-18HR) is used to determine whether fuel oil makeup to the diesel generator day tanks is required. The failure probability for this term (P-LOOP-FTRE-18HR) is set to the same probability as REC-4HR (5.6E-3) (assumption 4.2.3). These values for REC-2HR (2.3E-2), REC-4HR (5.6E-2), REC-30MIN (TRUE) and P-LOOP-FTRE-18HR (5.6E-3) will be used for this EA versus the values in the baseline PSA model.

5.6 Battery Failure Probabilities

During a review of the LOOP event tree and supporting fault trees, the battery failure probability for failure to discharge on demand was observed to be excessively high. The battery failing to discharge on demand (D-BYMB-ED-01, D-BYMB-ED-02) had a probability of 1.21E-2. A review of EA-PSA-1999-004 (ref 2.8) for the data source reveals that this failure probability came from NUREG/CR-4639, Volume 5, Part 3, rev 4 (ref 2.9). This data source is based on two failure records. EA-PSA-1999-004 also references PLG-0500 (ref 2.10). The PLG data indicates a failure probability of 4.84E-4/demand for batteries. The PLG result is based on IEEE-500 and NUREG/CR-1066 data. The IEEE-500 data is based on expert opinion. The basis for the NUREG/CR-4639 or NUREG/CR-1066 data is not known.

Palisades committed to testing/monitoring the batteries per the IEEE standard in 1987. During the past 15+ years, the batteries had monthly checks with no battery failures. These monthly checks included voltage and floating amp readings. In addition, each battery cell receives a specific gravity check once per quarter. This type of successful battery performance is not consistent with a 1.2E-2 failure probability.

The PLG data indicates the battery failure rate = 7.53E-7/hr. Applying one half the monthly detection interval to this failure rate = 2.8E-4 per demand. This failure probability is consistent with the PLG demand failure probability of 4.84E-4.

In addition, a review of other CE PWR PSA assumptions (ref 2.12) identified that the highest of the six reported (other plants did not provide data) battery demand failure probabilities for CE plants was 5.7E-4. This is consistent with the PLG data.

Therefore, use of 1.2E-2 for the battery demand failure probability would be well outside the industry expected probability and use of the PLG demand failure probability of 4.84E-4 is appropriate.

The common cause failure of both batteries is dependent on the battery failure probability. EA-PSA-DATA-99-0014 (ref 2.11) identifies that the common cause multiplier for both batteries fail on demand (D-BYCC-ED-01-02) is 4.70E-2. Therefore, the common cause failure probability for both batteries failing on demand = 2.27E-5.

5.7 Diesel Generator Recovery

To remove the DG recovery conservatisms in the PSA model, four DG failure mode specific recovery factors are applied in this EA: circuit breaker and breaker control circuit; DG room HVAC; fuel oil supply; and DGs. This EA conservatively allows 4 hours to recover these failures. Recovery of these failures at times other than 4 hours will not be evaluated in this EA. As a result of applying these specific DG recovery factors, the generic DG recovery factors, DG-REC-2HR and DG-REC-4HR, are set to TRUE.

5.7.1 DG Circuit Breaker and Breaker Control Circuit Failure Recovery

Several circuit breakers need to reposition to successfully have power from the DGs to their respective bus. The following breaker repositions need to occur:

1) breakers from the 2400VAC safeguards bus (EA-14) (powered by the switchyard front bus) to either the 2400VAC bus 1C (152-105) or bus 1D (152-203) need to open
2) breakers from the 2400VAC startup transformer 1-2 (EX-04) (powered by the switchyard rear bus) to either the 2400VAC bus 1C (152-106) or bus 1D (152-202) need to open since these breakers would attempt to close to get power from the rear bus upon undervoltage from the front bus/Safeguards bus
3) breakers from the DGs to either the 2400VAC bus 1C (152-107) or bus 1D (152-213) need to close

These breakers can be manually opened or closed from a control switch in the control room or locally at breaker cubicles. In addition, control circuit failures can be recovered through procedural actions. These actions can be performed within 4 hours. EA-PSA-DG-REC-03-14 (ref 2.7) estimates the recovery HEP for this action REC-BKR-4HR = 5.1E-3 for DG 1-1 and 7.5E-3 for DG 1-2. This EA uses the higher of the two and applies it to both, therefore, REC-BKR-4HR = 7.5E-3. The following basic events can be recovered with this HEP:

P-CBMA-152-106	startup transformer to bus 1C fails to open
P-CBMA-152-202	startup transformer to bus 1D fails to open
P-CBMA-152-105	safeguards bus to bus 1C fails to open
P-CBMA-152-203	safeguards bus to bus 1D fails to open
P-CBMB-152-107	DG 1-1 to bus 1C fails to close
P-CBMB-152-213	DG 1-1 to bus 1D fails to close
P-CBCC-SG-CD-MA	both safeguards bus breakers fail to open (common cause)
P-CBCC-SU-CD-MA	both startup transformer breakers fail to open (common cause)
P-CBCC-DG-CD-MB	both DG breakers fail to close (common cause)
P-REMD-151X-105	DG 1-1 to bus 1C control circuit
P-REMD-151X-203	DG 1-2 to bus 1D control circuit
P-REMD-162-213X	DG 1-2 to bus 1D control circuit
P-REMD-186-213O	DG 1-2 to bus 1D control circuit
P-REMD-186-107O	DG 1-1 to bus 1C control circuit
P-REMD-162-107X	DG 1-1 to bus 1C control circuit
P-REMD-383-12A	DG 1-2 to bus 1D control circuit
P-REMD-383-11A	DG 1-1 to bus 1C control circuit
P-CSMD-152213CS1	DG 1-2 to bus 1D control circuit
P-CSMD-152213CS2	DG 1-2 to bus 1D control circuit
P-CSMD-152107CS1	DG 1-1 to bus 1C control circuit
P-CSMD-152107CS2	DG 1-1 to bus 1C control circuit
P-HSMC-HS107RLTS	DG 1-1 to bus 1C control circuit

5.7.2 DG Room HVAC Failure Recovery

Failure of the DG room HVAC can lead to room heatup and, ultimately, DG failure. Failure of the DG room HVAC can be recovered within 4 hours by opening DG room doors to initiate alternate ventilation. EA-PSA-DG-REC-03-14 estimates the recovery HEP for this action REC-HVAC-4HR = 9.4E-2. The following basic events can be recovered with this HEP:

E-FNME-V-24A	DG 1-1 room HVAC fan fails to start
E-FNME-V-24B	DG 1-1 room HVAC fan fails to start
E-FNME-V-24C	DG 1-2 room HVAC fan fails to start
E-FNME-V-24D	DG 1-2 room HVAC fan fails to start
E-FNMG-V-24A	DG 1-1 room HVAC fan fails to run
E-FNMG-V-24B	DG 1-1 room HVAC fan fails to run
E-FNMG-V-24C	DG 1-2 room HVAC fan fails to run
E-FNMG-V-24D	DG 1-2 room HVAC fan fails to run
E-FNCC-V24AB-ME	2 DG room HVAC fans fail to start (common cause)
E-FNCC-V24AC-ME	2 DG room HVAC fans fail to start (common cause)
E-FNCC-V24AD-ME	2 DG room HVAC fans fail to start (common cause)
E-FNCC-V24BC-ME	2 DG room HVAC fans fail to start (common cause)
E-FNCC-V24BD-ME	2 DG room HVAC fans fail to start (common cause)
E-FNCC-V24CD-ME	2 DG room HVAC fans fail to start (common cause)
E-FNCC-V24ABC-ME	3 DG room HVAC fans fail to start (common cause)

E-FNCC-V24ABD-ME	3 DG room HVAC fans fail to start (common cause)
E-FNCC-V24ACD-ME	3 DG room HVAC fans fail to start (common cause)
E-FNCC-V24BCD-ME	3 DG room HVAC fans fail to start (common cause)
E-FNCC-V24AB-MG	2 DG room HVAC fans fail to run (common cause)
E-FNCC-V24AC-MG	2 DG room HVAC fans fail to run (common cause)
E-FNCC-V24AD-MG	2 DG room HVAC fans fail to run (common cause)
E-FNCC-V24BC-MG	2 DG room HVAC fans fail to run (common cause)
E-FNCC-V24BD-MG	2 DG room HVAC fans fail to run (common cause)
E-FNCC-V24CD-MG	2 DG room HVAC fans fail to run (common cause)
E-FNCC-V24ABC-MG	3 DG room HVAC fans fail to run (common cause)
E-FNCC-V24ABD-MG	3 DG room HVAC fans fail to run (common cause)
E-FNCC-V24ACD-MG	3 DG room HVAC fans fail to run (common cause)
E-FNCC-V24BCD-MG	3 DG room HVAC fans fail to run (common cause)
E-FNCC-V24ALL-ME	all 4 DG room HVAC fans fail to start (common cause)
E-FNCC-V24ALL-MG	all 4 DG room HVAC fans fail to run (common cause)
E-C2MC-52-2435	DG 1-2 room HVAC fan circuit breaker fails to remain closed
E-C2MC-52-2425	DG 1-2 room HVAC fan circuit breaker fails to remain closed
E-C2MC-52-2545	DG 1-1 room HVAC fan circuit breaker fails to remain closed
E-C2MC-52-2535	DG 1-1 room HVAC fan circuit breaker fails to remain closed
E-CSMC-52-2435CS	DG 1-2 room HVAC fan control circuit failure
E-CSMC-52-2425CS	DG 1-2 room HVAC fan control circuit failure
E-CSMC-52-2545CS	DG 1-1 room HVAC fan control circuit failure
E-CSMC-52-2535CS	DG 1-1 room HVAC fan control circuit failure
E-FUMK-B2435-1	DG 1-2 room HVAC fan control circuit failure
E-FUMK-B2425-1	DG 1-2 room HVAC fan control circuit failure
E-FUMK-B2545-1	DG 1-1 room HVAC fan control circuit failure
E-FUMK-B2535-1	DG 1-1 room HVAC fan control circuit failure
E-OLMK-49-2435	DG 1-2 room HVAC fan control circuit failure
E-OLMK-49-2425	DG 1-2 room HVAC fan control circuit failure
E-OLMK-49-2545	DG 1-1 room HVAC fan control circuit failure
E-OLMK-49-2535	DG 1-1 room HVAC fan control circuit failure
E-REMB-42-2435	DG 1-2 room HVAC fan control circuit failure
E-REMB-42-2425	DG 1-2 room HVAC fan control circuit failure
E-REMB-42-2545	DG 1-1 room HVAC fan control circuit failure
E-REMB-42-2535	DG 1-1 room HVAC fan control circuit failure
E-REMC-42-2435	DG 1-2 room HVAC fan control circuit failure
E-REMC-42-2425	DG 1-2 room HVAC fan control circuit failure
E-REMC-42-2545	DG 1-1 room HVAC fan control circuit failure
E-REMC-42-2535	DG 1-1 room HVAC fan control circuit failure
E-T3MT-EX-2435	DG 1-2 room HVAC fan control circuit failure
E-T3MT-EX-2425	DG 1-2 room HVAC fan control circuit failure
E-T3MT-EX-2545	DG 1-1 room HVAC fan control circuit failure
E-T3MT-EX-2535	DG 1-1 room HVAC fan control circuit failure

5.7.3 DG Fuel Oil Failure Recovery

Failure of the fuel oil supply to the DGs can be recovered using procedures in response to alarms or continuous or frequent monitoring activities. Operating Procedures provide alternate fuel oil supply paths to the DGs. The belly tank has sufficient volume for 4 hours of DG operation. The day tanks have sufficient volume for >18 hours of DG operation.

EA-PSA-DG-REC-03-14 estimates the recovery HEP for the belly tank action REC-FUELOIL-4HR = 8.4E-3. The following basic events can be recovered with this HEP:

E-KVMB-SV-1470	DG 1-1 belly tank supply solenoid fails to open
E-KVMB-SV-1471	DG 1-2 belly tank supply solenoid fails to open
E-KVMC-SV-1470	DG 1-1 belly tank supply solenoid fails to remain open
E-KVMC-SV-1471	DG 1-2 belly tank supply solenoid fails to remain open
E-KVCC-1470-71MB	both DG belly tank supply solenoids fail to open (common cause)

EA-PSA-DG-REC-03-14 estimates the recovery HEP for the day tank action REC-FUELOIL-18HR = 2.2E-3. The following basic events can be recovered with this HEP:

E-PMME-P-18A	fuel oil transfer pump fails to start
E-PMMG-P-18A	fuel oil transfer pump fails to run
E-LSMB-LS-1472	DG 1-1 belly tank supply solenoid level control switch fails
E-LSMB-LS-1473	DG 1-2 belly tank supply solenoid level control switch fails
E-LSMC-LS-1472	DG 1-1 belly tank supply solenoid level control switch fails
E-LSMC-LS-1473	DG 1-2 belly tank supply solenoid level control switch fails
E-LSCC-1472-73MB	both DG belly tank supply solenoid level control switches fail (common cause)

5.7.4 DG Failure Recovery

No DG hardware failures, such as failure to start or failure to run, are recovered in this EA. This EA conservatively applies a recovery factor for DG hardware REC-DG-4HR = 1.0.

5.8 PSA Quantification

The results of Sections 5.4, 5.5 and 5.6 were incorporated into the PSA model via addition to the Project Rules File in Attachment A and the following change set (named LOOP in the SAPHIRE PSA model):

Basic Event	Probability
RXC-ELEC-FAULTS	FALSE
RXC-MECH-FAULTS	FALSE
REC-30MIN	TRUE
REC-2HR	2.3E-2
REC-4HR	5.6E-3
P-LOOP-FTRE-18HR	5.6E-3
DG-REC-2HR	TRUE
DG-REC-4HR	TRUE
D-BYMB-ED-01	4.84E-4
D-BYMB-ED-02	4.84E-4
D-BYCC-ED-01-02	2.27E-5

The DG recovery factors described in Section 5.7 were added as basic events with their HEP:

Basic Event	Probability
REC-BKR-4HR	7.5E-3
REC-FUELOIL-4HR	8.4E-3
REC-FUELOIL-18HR	2.2E-3
REC-HVAC-4HR	9.4E-2
REC-DG-4HR	1.0E-0

The above changes were incorporated into the SAPHIRE PSA model. The following change sets were used in this order:

HEVENTS(LGCLS-NRML-CNF)
IE-CONDITIONAL
LOOP

The LOOP sequences (50 sequences) were evaluated at a truncation level of 1E-9. The cutsets were subsumed and resulted in CDP = 1.8E-5. There is a potential for over-recovery of some cutsets where successful off-site power recovery (sequences 21-4, 21-5, 21-6, 21-7, 21-25, 21-26, 21-27, 21-28) and successful DG recovery may occur. These 8 sequences have 114 cutsets, of which 81 cutsets have both off-site power and DG failures recovered. For the 8 sequences identified above, the DG recovery factors were reset to a probability = 1.0.

To remove the DG recovery from the cutsets, the cutset probability was divided by the DG recovery event probability. All of the over-recovery sequences occurred when off-site power was recovered within 2 hours (none were identified when off-site power was recovered within 4 hours). The following table summarizes the results:

Combination	# cutsets	base probability	adjusted probability
/REC-2HR * REC-BKR-4HR	50	7.0E-10	9.3E-8
/REC-2HR * REC-HVAC-4HR	20	3.1E-9	3.3E-8
/REC-2HR * REC-FUELOIL-4HR	4	6.8E-11	8.1E-9
/REC-2HR * REC-FUELOIL-18HR	0	-------	-------
/REC-2HR * REC-DG-4HR	7	1.5E-8	1.5E-8
total	81	1.9E-8	1.5E-7

Incorporating the over-recovery adjustment results in CDP = 1.8E-5 (1.8E-5 - 1.9E-8 + 1.5E-7). Therefore, there was no change to the CDP due to this issue.

Multiplying the CDP by the change in LOOP IEF from Section 5.3 results in a change in CDF = 5.6E-7/yr (1.8E-5 * 3.11E-2/yr).

5.9 Contribution to LERF

The dominant contributors to the large early release frequency (LERF) come from initiating events that are containment bypass scenarios. These initiating events are steam generator tube ruptures and interfacing system loss of coolant accidents. Based on this, the LOOP sequences are expected to have a smaller impact on LERF than on CDF. Since the change in CDF <1E-6/yr, the change in LERF is expected to be <1E-7/yr.

5.10 Conservatisms in the Results

1) Fuel oil transfer from Fuel Oil Storage Tank T-10A to the diesel generator day tanks is accomplished using Fuel Oil Transfer Pumps P-18A or P-18B. The PSA model does not include P-18B, which requires manual action to align and operate. Crediting both pumps would reduce the risk impact due to failure of fuel oil supply.

2) No credit is given for recovery of either DG during the 2 ½ hour or 4 hour time frame. Minor DG failure modes could be recovered within 4 hours, especially with the Technical Support Center (TSC) and Operations Support Center (OSC) fully staffed. If off-site power was not available and both DGs were not operating, resources from the TSC, OSC and maintenance department would concentrate on DG recovery. However, major failures would not be recovered. Assuming no recovery is conservative. Recovering either DG within 4 hours would reduce the risk impact due to DG failure.

3) The PSA currently assumes that, if an AC power source is not recovered within the battery depletion time of 4 hours, core damage will occur because of lack of instrumentation. However, there is time available beyond the 4 hours to recover an AC power source and prevent core damage since core damage is not expected to occur immediately after loss of instrumentation. EA-PSA-SWY-REC-03-10 (ref 2.2) indicates that there is an additional 4 hours beyond battery depletion to recover an AC power source to prevent core damage by restoring instrumentation and AFW control or initiating OTC. Having more time than the assumed 4 hours results in more time to recover the DGs or off-site power. More time to recover would reduce the risk impact of a LOOP.

4) The change in LOOP IEF used in this EA is conservative. Treating this event as a new type of initiator and using the frequentist approach (# events/operating years) to calculate the change in IEF due to this finding/deficiency overstates the IEF and does not account for prior industry experience. This approach also implies that until an event occurs, the likelihood of experiencing the event is zero (no events/# operating years). Establishing an appropriate industry prior and Bayesian updating with plant specific data provides a better estimate. For the Palisades March 25, 2003, LOOP event, industry maintenance related events causing a LOOP are applicable for calculating an appropriate industry prior. Identifying an industry prior and Bayesian updating with plant specific data would reduce the change in LOOP IEF, which would also reduce the risk impact of a LOOP caused by digging/ excavating.

6.0 CONCLUSIONS

Using a conservative change in LOOP IEF for this finding/deficiency results in a change in CDF = 5.6E-7/yr. This change in CDF is <1E-6/yr. Also, since LOOP is not a major contributor to LERF (Section 5.9), the expected LERF contribution is <1E-7/yr. These results are conservative based on the discussions in Section 5.10. Therefore, the inadequate digging/excavating policy identified in the NRC Special Inspection Report (ref 2.1) should be classified as very low safety significance or green in the NRC SDP (see definition 3.12).

Recovery Rules

The following recovery rules were added to the existing recovery rules:

```
|
| Recovery of the EDG's is seqeunce dependent and modeled in the *.SQY file.
|
| Recovery of Fuel Oil Failures
|
if E-KVMB-SV-1470 +
  E-KVMB-SV-1471 +
  E-KVMC-SV-1470 +
  E-KVMC-SV-1471 +
  E-KVCC-1470-71MB then
recovery=REC-FUELOIL-4HR;
elsif
  E-PMME-P-18A +
  E-PMMG-P-18A +
  E-LSMB-LS-1472 +
  E-LSMB-LS-1473 +
  E-LSMC-LS-1472 +
  E-LSMC-LS-1473 +
  E-LSCC-1472-73MB then
recovery=REC-FUELOIL-18HR;
elsif
|
| Recovery of DG HVAC Failures
|
  E-FNME-V-24A +
  E-FNME-V-24B +
  E-FNME-V-24C +
  E-FNME-V-24D +
  E-FNMG-V-24A +
  E-FNMG-V-24B +
  E-FNMG-V-24C +
  E-FNMG-V-24D +
  E-FNCC-V24AB-ME +
  E-FNCC-V24AC-ME +
  E-FNCC-V24AD-ME +
  E-FNCC-V24BC-ME +
  E-FNCC-V24BD-ME +
  E-FNCC-V24CD-ME +
  E-FNCC-V24ABC-ME +
  E-FNCC-V24ABD-ME +
  E-FNCC-V24ACD-ME +
  E-FNCC-V24BCD-ME +
  E-FNCC-V24AB-MG +
  E-FNCC-V24AC-MG +
  E-FNCC-V24AD-MG +
  E-FNCC-V24BC-MG +
  E-FNCC-V24BD-MG +
  E-FNCC-V24CD-MG +
  E-FNCC-V24ABC-MG +
  E-FNCC-V24ABD-MG +
  E-FNCC-V24ACD-MG +
  E-FNCC-V24BCD-MG +
  E-FNCC-V24ALL-ME +
```

```
  E-FNCC-V24ALL-MG +
  E-C2MC-52-2435 +
  E-C2MC-52-2425 +
  E-C2MC-52-2545 +
  E-C2MC-52-2535 +
  E-CSMC-52-2435CS +
  E-CSMC-52-2425CS +
  E-CSMC-52-2545CS +
  E-CSMC-52-2535CS +
  E-FUMK-B2435-1 +
  E-FUMK-B2425-1 +
  E-FUMK-B2545-1 +
  E-FUMK-B2535-1 +
  E-OLMK-49-2435 +
  E-OLMK-49-2425 +
  E-OLMK-49-2545 +
  E-OLMK-49-2535 +
  E-REMB-42-2435 +
  E-REMB-42-2425 +
  E-REMB-42-2545 +
  E-REMB-42-2535 +
  E-REMC-42-2435 +
  E-REMC-42-2425 +
  E-REMC-42-2545 +
  E-REMC-42-2535 +
  E-T3MT-EX-2435 +
  E-T3MT-EX-2425 +
  E-T3MT-EX-2545 +
  E-T3MT-EX-2535 then
recovery=REC-HVAC-4HR;
elsif
|
| Recovery of Breakers 152-106, 152-202, 152-105
| 152-203, 152-107, 152-213 and their control circuits.
|
  P-CBMA-152-106 +
  P-CBMA-152-202 +
  P-CBMA-152-105 +
  P-CBMA-152-203 +
  P-CBMB-152-107 +
  P-CBMB-152-213 +
  P-CBCC-SG-CD-MA +
  P-CBCC-SU-CD-MA +
  P-CBCC-DG-CD-MB +
  P-REMD-151X-105 +
  P-REMD-151X-203 +
  P-REMD-162-213X +
  P-REMD-186-213O +
  P-REMD-186-107O +
  P-REMD-162-107X +
  P-REMD-383-12A +
  P-REMD-383-11A +
  P-CSMD-152213CS1 +
  P-CSMD-152213CS2 +
  P-CSMD-152107CS1 +
  P-CSMD-152107CS2 +
```

```
  P-HSMC-HS107RLTS then
recovery=REC-BKR-4HR;
elsif
|
| Recovery of DG Failures
|
  E-DGME-K-6A +
  E-DGME-K-6B +
  E-DGMG-K-6A +
  E-DGMG-K-6B +
  E-DGCC-K-6AB-ME +
  E-DGCC-K-6AB-MG then
recovery=REC-DG-4HR;
endif
```

PALISADES - NUCLEAR GENERATING PLANT		
TITLE:	ENGINEERING PRE-JOB BRIEFING	Revision Draft

Type of Task: Prepare Engineering Analysis EA-PSA-LOOP-EVAL-03-12, PSA Evaluation of Digging/Excavating at Palisades, in accordance with Admin Procedure 9.11, Engineering Analysis.	Date:	9-29-03
	Time:	0930
	Assigned To:	RAW

Task Description:
Use the latest version of the PSA model to evaluate the safety significance of an inadequate digging/excavating policy prior to March 25, 2003.

Objectives/ Expectations:
Determine the safety significance of the inadequate digging/excavating policy. Use the latest version of the Palisades PSA model. Include event specific aspects (such as initiating event frequency and recovery of off-site power). The results of this EA will be used in the NRCs Significance Determination Process (SDP) to determine the safety significance of the inadequate digging/excavating policy deficiency resulting from the March 25, 2003, LOOP/loss of shutdown cooling event at Palisades.

CHECKLIST

X Scope/expectations understood	X Reqd Information in Hand	KEY STRATEGIES TO PREVENT GROUP THINK
X Documentation format reqmts clear	☐Applicable directives reviewed	1. Open Climate
X Validation reqmts for data clear	☐Contingency Plans discussed	2. Avoid Isolation of Group
X Communication reqmts clear	X Approp Engineering tools used	3. Assign member Role of critical evaluator
X Reqd completion date/time clear	X Approp groups involved	4. Avoid being too directive
X Approp time included for checking	X Lateral Communications occurring	EIGHT SYMPTOMS OF GROUP THINK
X Knowledge/Skills/Training approp	X Task sched to minimize fatigue	1. Illusion of invulnerability 5. Rationalization
X Time pressure minimized	X Questioning attitude emphasized	2. Belief in inherent morality 6. Mind Guards
X Distractions minimized	☐Operating Experience Considered (list above)	3. Stereotypes of out Groups 7. Self Censorship
		4. Illusion of Unanimity 8. Direct Pressure

Estimated Time to Complete: 80 hours	Due Date/Time: 10-10-03

TWIN ANALYSIS

Task Demands	Work Environment	Individual Capabilities	Human Nature
X Time/Schedule pressure	X Distractions / Interruptions	X Unfamiliarity with task / First time	☐Stress - Work/Home
X High Workload	☐Changes from routine	☐Lack of Knowledge	☐Habit patterns
X Multiple simultaneous tasks	☐Confusing displays / Controls	X New techniques not used before	X Assumptions
☐Repetitive Actions / monotony	☐Work arounds / OOS equipt	☐Imprecise communications habits	☐Complacence
☐Unrecoverable/Irreversible actions	☐Hidden system responses	☐Lack of Proficiency / Inexperience	X Overconfidence
☐Interpretation requirements	☐Unexpected equip conditions	☐Unsystematic problem solving skills	X Mind Set
☐Unclear goals, roles, responsibilities	☐Lack of alternative indication	☐"Unsafe" attitude for critical tasks	X Inaccurate risk perceptions
☐Lack of /or unclear Standards	☐Adverse physical conditions	☐Illness / Fatigue / General Health	X Mental shortcuts
	☐Vague or incorrect guidance		☐Limited short term memory
	☐Identical and adjacent controls		☐Apparent emotional health
			☐Backshift/recent shift change
			☐First day back from days off

<u>Describe the Risk Basis:</u> (1. Factors that increase the likelihood of making a mistake and 2. Worsen the consequences of an error).

Schedule/time pressure

Infrequently performed tasks

Addressing the CEOG Peer Review comments related to LOOP event tree

<u>What are the Critical Steps?</u>	
Identifying the correct references and input Clearly stating assumptions with justification and/or impact on conclusions Address CEOG Peer Review comments on LOOP event tree Incorporate event specific data from EA-PSA-SWY-REC-03-10 Provide clear documentation for possible NRC review Discuss conservatisms in the analysis	1. Critical Safety Issues 2. Operability Concerns 3. When and who to call for help. 4. Contingency Plans 5. Important Error Reduction Tools for this Task

Activity Performer:	RAWhite RAW	Date:	9-29-03
Supervisor:	JBKingseed JBK	Date:	9-29-03

PALISADES NUCLEAR PLANT
ENGINEERING ANALYSIS CHECKLIST

EA-PSA-LOOP-EVAL-03-12 REV 0

SECTION I Identification of Items Affected By This EA		Affected Yes	Affected No	Revision Required	Identify*	Closeout
1.0	Other EAs	☐	■			
2.0	Design Documents Electrical E-38 through E-49	☐	■			
3.0	Design Documents Mechanical M240 - M246, M257 - M261, M664 - M666, M1600	☐	■			
4.0	LICENSING DOCUMENTS					
4.1	Final Safety Analysis Report (FSAR)	☐	■			
4.2	Technical Specifications	☐	■			
4.3	Operating Requirements Manual	☐	■			
5.0	PROCEDURES					
5.1	Administrative Procedures	☐	■			
5.2	Operating Procedures (SOP, EOP, ONP, etc)	☐	■			
5.3	Working Procedures	☐	■			
5.4	Tech Spec Surveillance Test Procedures	☐	■			
6.0	OTHER DOCUMENTS					
6.1	Q-List	☐	■			
6.2	Plant Drawings	☐	■			
6.3	Equipment Data Base	☐	■			
6.4	Spare Parts (Stock/MMS)	☐	■			
6.5	Fire Protection Program Report (FPPR)	☐	■			
6.6	Design Basis Documents	☐	■			
6.7	Operating Checklists	☐	■			
6.8	SPCC/PIPP Oil and Hazardous Material Spill Prevention Plan	☐	■			
6.9	EEQ Documents	☐	■			
6.10	MOV/AOV Program Documents (Voltage, thrust, weak link, etc)	☐	■			
6.11	Engineering Programs, Component Engineering Documents	☐	■			
6.12	Work Instructions	☐	■			
6.13	Other	☐	■			

* Identify Section No., Drawing, Document, etc

SECTION II

Do any of the following documents need to be generated?

		Yes	No		
1.	Corrective Action Document?	☐	■	Reference	
2.	50.59 Review?	☐	■	Reference	EA's that are not used in the FSAR Analysis and do not involve the designbasis of a system, structure or component do not require a 50.59 Review per Admin 9.11, r14, pg 21
3.	Verification Test Procedure (for changes to the Design Basis)?	☐	■	Reference	

Completed by RAWhite *[signature]* Date 10-1-03

Technical Reviewed by FJYanik *[signature]* Date 10-13-03

<u>TECHNICAL REVIEW CHECKLIST</u>

EA-PSA-LOOP-EVAL-03-12 REV 0

This checklist provides guidance for the review of engineering analyses. Answer questions Yes or No, or N/A if they do not apply. Document all comments on an EA Review Sheet. Satisfactory resolution of comments and completion of this checklist is noted by the Technical Review signature at the bottom of this sheet.

		(Y, N, N/A)
1.	Have the proper input codes, standards and design principles been specified?	Y
2.	Have the input codes, standards and design principles been properly applied?	Y
3.	Are all inputs and assumptions valid and the basis for their use documented?	Y
4.	Is Vendor information used as input addressed correctly in the analysis?	Y
5.	If the analysis argument departs from Vendor Information/ Recommendations, is the departure justification documented?	Y
6.	Are assumptions accurately described and reasonable?	Y
7.	Are the design basis changes permitted by this EA bounded by the applicable 50.59 Review?	N/A
8.	Are all constants, variables and formulas correct and properly applied?	Y
9.	Have all comments been documented on an EA Review Sheet and resolved, or have any minor (insignificant) errors been identified and their insignificance justified? (Indicate "No Comments," if none were made.)	Y
10.	If the analysis involves welding, is the following information accurately represented on the analysis drawing (Output document)? • Type of Weld • Size of Weld • Material Being Joined • Thickness of Material Being Joined • Location of Weld(s) • Appropriate Weld Symbology	N/A
11.	Has the objective of the analysis been met?	Y
12.	Have administrative requirements such as numbering, format, and indexing been satisfied?	Y

Technical Reviewer FJYanik [signature] Date 10-13-03

ENGINEERING ANALYSIS REVIEW SHEET

Title PSA Evaluation of Digging/Excavating at Palisades	EA Number EA-PSA-LOOP-EVAL-03-12	Revision Number 0	Page 1 of 1

Item Number	Page,Line,or Section Number	Comments	Response or Resolution
1	4.0	Add assumption about using 4 hours versus having 8 hours prior to core damage for a SBO with AFW available. Battery depletion occurs in 4 hours, however, core damage does not occur immediately and needs SG dryout to heatup PCS to cause core damage.	Added assumption 4.2.2 and enhanced the discussion in Section 5.10, item 3.
2	4.0	Add assumption about using the same probability for failing to recover off-site power within 18 hours as calculated for recovering within 4 hours. Having more time available (18 hours vs 4 hours) would reduce the probability of failing to recover off-site power.	Added assumption 4.2.3 discussing this conservatism.
3	4.0	Add assumption that diesel generator recovery prior to 4 hours is not credited.	Added assumption 4.1.1 and enhanced the discussion in Section 5.10, item 2.
4	5.3	Add more discussion about why the frequentist method is conservative.	Enhanced discussion Sections 5.3 and 5.10, item 4.
5	5.6	Add CEOG comparison of PSA inputs as another reference why E-4 for battery demand failure probability is more appropriate than E-2.	Added CEOG report to the references and discussion in Section 5.6.
6	General	Ensure that the recovery rules added to SAPHIRE do not over-recover by recovering both off-site power and DGs (only one would be recovered).	Performed a review of cutsets and identified over-recovery of sequences with successful off-site power recovery within 2 hours. No over-recovery was identified for sequences with successful off-site power recovery within 4 hours. Added review results and correction in Section 5.8.

Technical Reviewer	Organization	Date	Initiator	Date	Technical Reviewer of Supervisor	Date
FJYanik	Program Eng	10-7-03	RAWhite	10-13-03	FJYanik	10-13-03

Engineering Analysis Placekeeping Tool

1/10/03

Ref: Admin Proc 9.11, "Engineering Analysis" - **EA-PSA-LOOP-EVAL-03-12**

Section	Y or N/A	Task
Need Identified for Engineering Analysis		
6.1.1	Y	Reason identified for engineering analysis
Assign Engineering Analysis Initiator		
6.1.2	Y	Initiating engineer assigned
6.1.2	Y	Supervisor initials "Initiator Approved By" box on analysis cover sheet
4.4	Y	Responsible engineer assigned
	Y	Pre-job brief performed
Access Record Management System		
4.2	Y	Identify existing design information relative to the Engineering Analysis
4.2	Y	Identify analysis inputs
4.2	N/A	Verify that analysis inputs are consistent with the Design Basis
4.2	Y	Identify document(s) affected by the engineering analysis
4.2	N/A	Notify the sponsor of the affected document(s)
6.1.3	N/A	Search RECTRAK for existing analyses relevant to the subject of the analysis to be prepared
6.1.3	N/A	Search CalcXRef to identify any other documents which may provide input to the analysis to be prepared or use the results of the analysis
Revise Existing Engineering Analysis		
6.1.5	N/A	Identify if revision to an existing analysis is necessary
6.1.5.a	N/A	Identify method of revision Yes | No [ ] | [ ] (1) Revision to a microfilmed analysis [ ] | [ ] (2) Revision to an original analysis [ ] | [ ] (3) Revision to an electronic file
6.1.5.b	N/A	Identify and describe changes in the revised engineering analysis
6.1.5.d	N/A	Determine whether the revision impacts a stress/serial package. If so, refer to EM-18-03.
6.1.5.c	N/A	If an existing analysis bounds the situation in question and does not require revision, prepare a disposition and link to the existing calculation
Prepare New Engineering Analysis		
6.1.4.c	Y	Engineering analysis number selected
6.1.4.d	Y	Engineering analysis title selected
6.2.3	Y	Prepare EA Checklist
6.2.4	N/A	Perform Walkdown
6.1.4.d.1	Y	Each sheet of engineering analysis uniquely numbered
6.1.4.d.1	Y	Total number of sheets indicated on cover sheet
6.1.4.d.2(a)	Y	Prepare objective statement
6.1.4.d.2(b)	Y	Identify analysis inputs
6.1.4.d.2(c)	Y	State assumptions and reference them where they are used in the analysis
6.1.4.d.2(c) (1)	Y	Identify major assumptions and their bases
6.1.4.d.2(c) (2)	Y	Identify minor assumptions and their bases
6.1.4.d.2(d)	Y	Prepare analysis section
6.1.4.d.2(d) (1)	Y	Document result of reference searches and their applicability to the analysis
6.1.4.d.2(d) (2)	Y	Describe the methodology used
6.1.4.d.2(d) (3)	Y	Discuss each aspect of the problem
6.1.4.d.2(d) (4)	N/A	Identify impact of analysis on test requirements
6.1.4.d.2(d) (5)	N/A	Consider the effects of system degradation over time on design margins
6.1.4.d.2(d) (6)	N/A	Ensure that computer codes used for design are controlled by Admin 9.14
6.1.4.d.2(d) (7)	Y	Identify the Basis of any engineering judgment

Engineering Analysis Placekeeping Tool

1/10/03

6.1.4.d.2(d) (8)	Y	Verify that calculated values are within allowable ranges
6.1.4.d.2(d) (9)	Y	Identify as a reference the source of equations used in the analysis
6.1.4.d.2(d)(10)	Y	Describe formulas used in analysis and provide units for calculated values.
6.1.4.d.2(d)	Y	Prepare a conclusion
6.1.4.d.2(d)	Y	Verify that the conclusion supports the stated objective
6.1.4.d.2(d)	N/A	Consider writing a condition report if the conclusion does not support the stated objective
4.4	N/A	If the Engineering Analysis is generated by a vendor, ensure that it conforms to Administrative Procedure 9.11 requirements
4.4	N/A	If there are any changes to piping systems, coordinate with the Piping and Stress Package Custodian
Technical Requirements		
6.2.1	N/A	Prepare 50.59 Review
6.2.2	N/A	Prepare EEQ Review
6.1.4.d.2(f)(1)	Y	Attach EA Checklist
6.1.4.d.2(f)(5)	N/A	Attach Preliminary EA item list (Section 6.2.5)
6.1.4.d.2(f)(6)	N/A	Attach 50.59 Review (Section 6.2.1)
6.1.4.d.2(f)(7)	N/A	Attach EEQ Review (Section 6.2.2)
Perform Required Reviews		
4.1	Y	Supervisory review performed
4.1, 6.3.1	Y	Technical reviewer assigned by Safety/Design Review Supervisor
6.3.2	Y	Technical Reviewer performs technical review
4.3	Y	Technical Reviewer verifies that the affected documents are properly identified
6.3.3	Y	Technical Reviewer documents review comments
6.3.4	Y	Technical Reviewer prepares technical review checklist
6.3.6	N/A	Safety Design/Review approval required if reviewed by vendor
Resolve Review Comments		
6.3.3	Y	Resolve comments
6.1.4.d.2(f)(2)	Y	Attach Technical Review Checklist and EA Checklist
6.1.4.d.2(f)(3)	Y	Attach EA Review Sheets
6.1.4.d.2(f)(4)	N/A	Attach technical review standard design evaluation or alternate calculations (Section 6.3.2a)
Calculation Approved		
6.3.5	Y	Obtain all necessary approvals
Complete Record Indexing Form & Submit to ERC		
6.4		Prepare Record Indexing Form and attach to front of calculation
6.4		Forward analysis to ERC or PSPC

ATTACHMENT 2

NUCLEAR MANAGEMENT COMPANY, LLC
PALISADES NUCLEAR PLANT
DOCKET 50-255

October 28, 2003

CPMAAP ANALYSIS OF THE 3/25/2003 LOSS OF SHUTDOWN COOLING EVENT
EA-PSA-LOSDC-03-11

120 Pages Follow

NMC
Committed to Nuclear Excellence

PALISADES NUCLEAR PLANT
ANALYSIS COVER SHEET

Total no of pages ~~115~~ 120

Title CPMAAP Analysis of the 3/25/2003 Loss of Shutdown Cooling Event											
INITIATION AND REVIEW											
Calculation Status		**Preliminary Pending Final Superseded**									
Rev #	**Description**	**Initiated**		**Init Appd By**	**Review Method**			**Technically Reviewed**		**Revr Appd By**	**Supv & SD/R Appd**
		By	**Date**		**Alt Calc**	**Detail Review**	**Qual Test**	**By**	**Date**		
0	Original Issue	BABrogan [illegible]	9/17/2003	[illegible]		X		[illegible]	9/22/03	[illegible]	[illegible] DMK

Table Of Contents

	Page
1.0 Objective	3
2.0 Analysis Inputs/References	3
3.0 Definitions	4
4.0 Assumptions	4
5.0 Methodology	5
6.0 Analysis	6
7.0 Results	8
8.0 Conclusions	10

Attachment 1: List of CPMAAP Input Files – 6 pages
Attachment 2: ISFILE15, OSFILE15 and Userfunc.pal Listings – 16 pages
Attachment 3: CPMAAP Parameter File 15r2 – 47 pages
Attachment 4: Emergency Operating Procedure Validation Form – EOP-9.0 – 6 pages
Attachment 5: Emergency Operating Procedure Validation Form – EOP Supplement 22 – 7 pages
Attachment 6: Emergency Operating Procedure Validation Form – EOP Supplement 29 Section 4.0 - 10 pages
Attachment 7: Comparison of the "K:\Eng_prgm\Rel_Eng\PSA\CPMAAP\02-24-1994\Cp3b1615.exe" and the "K:\Eng_prgm\Rel_Eng\PSA\CPMAAP\CPMAAP v7-30-02\CPMAAP_Final.exe" code versions – 6 pages
Attachment 8: Administrative Required Documents
Engineering Analysis Place keeping Checklist – 2 pages
Engineering Analysis Checklist – 1 page
Pre-Job Brief – 2 pages
Engineering Analysis Review Sheet – 1 page
Technical Review Checklist – 1 page
Attachment 9: ERIN Memorandum, Technical Review of EA-PSA-LOSDC-03-11 r0 – 5 pages

1.0 OBJECTIVE

This EA estimates the available time for ac power recovery for certain Station Blackout (SBO) sequences. The amount of time to recover ac power is a key input in determining whether or not Once Through Cooling (OTC) can be initiated to preclude core damage. The analysis has investigated the impact of steam driven auxiliary feedwater pump (P-8B) availability on the time to recover ac power. The calculation has included the observed operator recovery times from the 9-17-2003 simulator exercise (Attachments 4, 5, and 6) in the evaluation. The simulator exercise was performed to pace the operators through an SBO sequence assuming auxiliary feedwater failure. The rationale for this exercise and analysis is further explained in the following.

Background

The impetus for performing this EA is to support the Palisades examination of the 3/25/2003 loss of shutdown cooling event. This event occurred during the 2003 refueling outage and resulted from a digging incident that created an electrical fault separating both safety and non-safety related ac power buses from the grid. This loss of local power resulted in a loss of shutdown cooling.

There are several generic assumptions in the LOOP worksheet that can be modified to reflect the event specific circumstances. Specifically, there are two sequences identified that can be modified to be event specific that could reduce the issue significance. Both of these sequences are station blackout (SBO) sequences that are dependent on recovering off-site power. One sequence is an SBO where the turbine driven auxiliary feedwater pump (TDAFWP) fails and recovery of off-site power is needed within 1 hour to prevent core damage. The other sequence is an SBO scenario where the TDAFWP is successful and recovery of off-site is needed within 4 hours to prevent core damage. Two aspects of these sequences can be changed to be event specific: the use of plant specific recovery probabilities for 1 hour and 4 hours as well as whether or not the 1 hour and 4 hour times are the appropriate duration for the Palisades design. Therefore, the purpose of this EA is to examine the validity of the 1 and 4 hour screening criterion in the context of the actual plant response by analyzing the plant event with the Modular Accident Analysis Program (MAAP).

2.0 ANALYSIS INPUTS/REFERENCES

2.1 The final CPMAAP source and control files created to support the Reference 2.5.1 analysis are located on the K drive in the following path: K:\Eng_prgm\Rel_Eng\PSA\CPMAAP\02-24-1994 (Cp3b1615.exe). The CPMAAP executable (Cp3b1615.exe) was originally created with the LAHEY DOS compiler. Subsequent to the creation of Cp3b1615.exe, the Digital Visual FORTRAN compiler v6a was employed to create a Windows version of CPMAAP located on the K drive in the following path: K:\Eng_prgm\Rel_Eng\PSA\CPMAAP\CPMAAP v7-30-02 (CPMAAP_Final.exe). This version of the code includes a few minor modifications performed to support the Palisades PTS analysis. These modifications allowed added code flexibility during the recirculation phase of the transient (recirculation was not evaluated in this calculation).

The "CPMAAP_Final.exe" executable was used in this analysis. The "Cp3b1615.exe" executable was employed as a validation of the "CPMAAP_Final.exe" model.

The Palisades Information Technology Department will be migrating the K drive to the J drive in the near future.

2.2 The CPMAAP input files are defined in the following attachments:

- Attachment 1 lists the input files,
- Attachment 2 catalogs the ISFILE15.PAL, OSFILE15.PAL and USERFUNC.pal input files, and
- Attachment 3 presents the parameter file used in this calculation.

2.3 The HPSI degraded system head curves were employed in this analysis (Reference 2.5.3).

2.4 9-17-2003 simulator exercise – Attachments 4, 5 and 6.

2.5 References

2.5.1 CPCo to NRC Letter, January 29, 1993, Palisades Plant Individual Plant Examination for Severe Accident Vulnerabilities (IPE), [F341/1523] (R0481).
2.5.2 BABrogan, "Containment Sump NPSH Evaluation", EA-C-PAL-01-03563-02 r0.
2.5.3 SDWinter, "Generation of Minimum and Maximum HPSI/LPSI System Performance Curves Using Pipe-Flo", EA-SDW-95-001 r2 November 1996.
2.5.4 SDWinter, "Engineered Safeguards System Injection Mode Flow Rate and Recirculation Mode NPSH Margin Predictions for Containment Sump Check Valve Past Operability Evaluations Using Pipe-Flo ®", EA-C-PAL-01-03563-03 r0.
2.5.5 DBD-1.03, Revision 6.

3.0 DEFINITIONS

3.1 *HPSI* – high pressure safety injection.
3.2 *PCT* – peak clad temperature.
3.3 *PSA* – Probabilistic Safety Analysis.
3.4 *risk* - risk encompasses what can happen (scenario), its likelihood (probability), and its level of damage (consequences).
3.5 *SDP* – safety determination process i.e., the new NRC reactor oversight process.
3.6 *SIRWT* – Safety Injection Refueling Water Storage Tank.
3.7 *station blackout (SBO)*- an accident sequence initiated by loss of all off-site power with failure of onsite emergency AC power (diesel generators), and failure of timely recovery of off-site power and onsite emergency AC power.

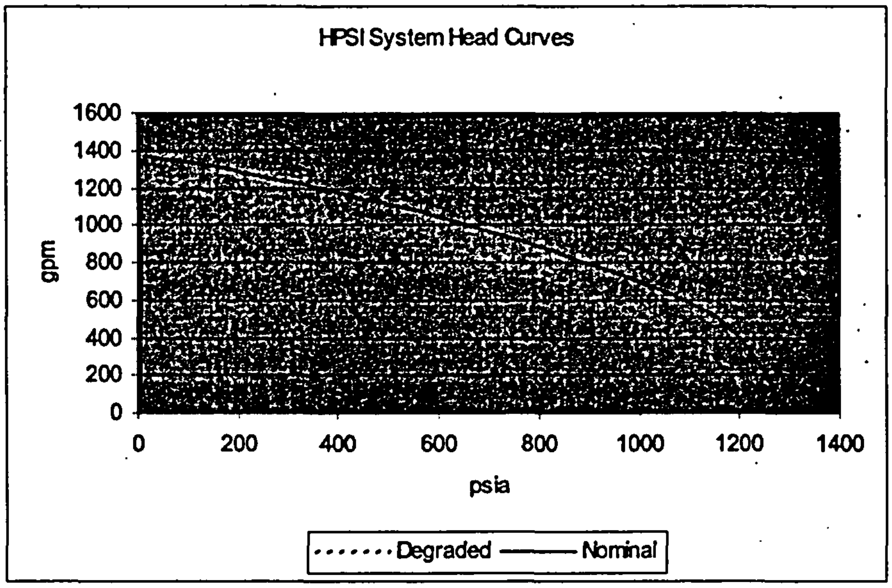
4.0 ASSUMPTIONS

Major Assumptions

4.1 The CPMAAP model created to support the Palisades IPE analysis (Reference 2.5.1) is not a NRC licensed code. The code employs realistic models that have been benchmarked against available experiments and tests. The CPMAAP parameter file (code input data) developed to support the Reference 2.5.1 submittal is based on nominal input data. The Palisades specific parameter file has been a part of the long-term internal/external tech review program completed in support of the development of CPMAAP; however, the parameter file has not been formerly processed according to Admin 9.11.

4.2 The HPSI degraded pump data were used in this evaluation. This is a conservative application of the expected system flow rates. The degraded pump data are used in the design basis analysis of record. Degraded data are applied to demonstrate additional margin (refer to Section 5.2 for additional discussion regarding the degraded data). Figure 4.2 shows the differences between the degraded (Reference 2.5.3) and nominal (Reference 2.5.4) system head curves assuming two operable HPSI pumps.

Figure 4.2



4.3 The core damage success criterion was conservatively defined as the hot rod peak clad temperature less than or equal to 2200°F.

4.4 In the CPMAAP SBO-003 case, only one charging pump, one HPSI pump (assuming degraded flow) and one PORV were credited.

Minor Assumptions

4.4 The ADV control set points were not changed from their original nominal values. During the Simulator Exercise, the operators intermittingly increased the ADV high temperature bandwidth to preserve secondary side inventory. It is considered that the difference in the nominal versus controlled cool down with respect to the SG inventory boil off time is minimal as the same amount of heat is removed in either case.

4.5 The LPSI pumps were conservatively not credited in this analysis.

4.6 From Reference 2.5.2, the nominal SIRWT inventory of 883,752 kg was employed, initial temperature of 87.9°F and a nominal HPSI pump delay time of 40 seconds were also modeled. In performing PSA analyses employment of nominal conditions is allowed.

5.0 METHODOLOGY

5.1 CPMAAP

As previously discussed in the Introduction, in order to evaluate the available time to recover ac power, the Modular Accident Analysis Program (MAAP) Version 3.0B was employed. The MAAP 3.0B code was prepared as part of the IDCOR (Industry Degraded Core Rulemaking) program to investigate the progression of hypothetical accidents. MAAP models a wide variety of primary system and containment phenomena including;

core heatup, cladding oxidation, hydrogen evolution, vessel failure, core-concrete interactions, combustible gas behavior and fission product release, transport and deposition. A Palisades specific version of the MAAP code referred to as CPMAAP (Reference 2.5.1) was developed to allow the evaluation of the integrated effect of plant specific features on overall containment performance and fission product release. Some of the enhancements included: thermal-creep induced rupture modeling of the PCS, modeling of core relocation to the Auxiliary Building after vessel failure, detonation cell width determination, auxiliary building concrete decomposition model, MACCS fission product grouping etc.

The MAAP code has been benchmarked to a variety of calculations and data sources. These comparisons have included plant data, integral experiments, separate effects tests and the results of more detailed codes.

5.2 HPSI System Curve

The CPMAAP modeling of HPSI does not account for the network hydraulic losses. To provide a more accurate modeling of flow rates from this system, the Pipe-Flo-calculated HPSI system curve, which provides the flow rate versus pressure was employed for the injection phase of the calculation.

The degraded HPSI system curve used in this analysis was compared to the nominal HPSI data in the Figure 4.2 above. This curve incorporates a minimum water temperature of 40F (e.g., μ increases as the temperature drops therefore the ΔP rises), increased pump recirculation flow, minimum pump curves (w/ assumed degradation) and a minimum SIRWT level (chosen to minimize the suction head to the pumps).

6.0 ANALYSIS

Four CPMAAP runs were performed. The first case compared the "K:\Eng_prgm\Rel_Eng\PSA\CPMAAP\02-24-1994\Cp3b1615.exe" and the "K:\Eng_prgm\Rel_Eng\PSA\CPMAAP\CPMAAP v7-30-02\CPMAAP_Final.exe" code versions.

The next three calculations evaluated the SBO-001, -002 and –003 cases described below. The input files SBO-001.inp, SBO-002.inp and SBO-003.inp are listed in Attachment 1.

6.1 SBO-001

The first case evaluated the simulator scenario described in Attachments 4, 5 and 6. At time zero all equipment were failed assuming an SBO event with a concurrent failure of the AFW steam driven pump P-8B. The recorded times from the simulator exercise (Attachment 4) were employed to define the CPMAAP Stopwatch Control time. Table 6.1 below lists the recorded times:

Table 6.1 Recorded Event Times

Eastern Standard Time	Clock[1] (hr:min:sec)	Lapsed Time (hr:min:sec)	Lapsed Time (hr)	CPMAAP Stopwatch Control (seconds)	Comments
2:53 PM	14:53:36				Start of the exercise
3:54 PM	15:54:00	1:00:24	1.01		Start back feed EOP-9 (AC 3)
4:38 PM	16:38:09	1:44:33	1.74		Energize bus 1D
4:42 PM	16:42:08	1:48:32	1.81	6512	Start right channel HPSI (P-66A)
4:46 PM	16:46:50	1:53:14	1.89	6794	Start 2 charging pumps (P-55A, P-55B)
4:47 PM	16:47:41	1:54:05	1.90	6845	Open PORV (PRV-1043A)
4:58 PM	16:58:00	2:04:24	2.07		Energize bus 1C

Table 6.1 Recorded Event Times					
Eastern Standard Time	Clock[1] (hr:min:sec)	Lapsed Time (hr:min:sec)	Lapsed Time (hr)	CPMAAP Stopwatch Control (seconds)	Comments
5:00 PM	17:00:00	2:06:24	2.11	7584	Start left channel HPSI (P-66B)
5:01 PM	17:01:25	2:07:49	2.13	7669	Start 3rd charging pump (P-55C)
5:02 PM	17:02:23	2:08:47	2.15	7727	Open PORV (PRV-1042A)

Notes: [1] The clock times reported in Attachment 4 (page 6) are rounded as compared to the values listed here. For example, Attachment 4 lists the charging pump alignment at 16:47 whereas Table 6.1, 6.2 and 6.3 use a value of 16:47:41. Such rounding has no effect on the results.

6.2 SBO-002

The second CPMAAP case involved running several parametric calculations to determine the existing margin available to the operator in performing the recorded Table 6.1 tasks. Although a PCT of 2200°F was defined as the initial acceptance criterion, the analysis stopped when the PCT began approaching 1600°F in order to minimize the number of required analyzed cases in an effort to meet schedule. Therefore the PCT of 1600°F was used as defining the final set of operator action times.

These final determined set of 'times' are listed in Table 6.2 under the CPMAAP Stopwatch Control column.

Table 6.2 Recorded Event Times				
Eastern Standard Time	Clock (hr:min:sec)	Lapsed Time (hr:min:sec)	CPMAAP Stopwatch Control (seconds)	Comments
2:53 PM	14:53:36			Start of the exercise
3:54 PM	15:54:00	1:00:24		Start back feed EOP-9 (AC 3)
4:38 PM	16:38:09	1:44:33		Energize bus 1D
4:42 PM	16:42:08	1:48:32	8500	Start right channel HPSI (P-66A)
4:46 PM	16:46:50	1:53:14	8782	Start 2 charging pumps (P-55A, P-55B)
4:47 PM	16:47:41	1:54:05	8833	Open PORV (PRV-1043A)
4:58 PM	16:58:00	2:04:24		Energize bus 1C
5:00 PM	17:00:00	2:06:24	9572	Start left channel HPSI (P-66B)
5:01 PM	17:01:25	2:07:49	9657	Start 3rd charging pump (P-55C)
5:02 PM	17:02:23	2:08:47	9715	Open PORV (PRV-1042A)

6.3 SBO-003

The third CPMAAP case credited the AFW P-8B pump at the start of the transient. The pump was assumed available for four hours given the plant's battery capacity and instrumentation capability. As noted in Reference 2.5.5, in the event of loss of both offsite power and onsite diesel power (Station Blackout), the turbine driven AFW pump is relied upon to provide secondary side heat removal. P-8B receives an auto start signal when P-8A and P-8C fail to start. The three valves required to start and run P-8B are CV-0522B, CV-0727 and CV-0749. These valves have Class 1E battery backed power. Although the air supply would not be available during an SBO scenario, these valves are backed up by a nitrogen system. Nitrogen backup is not needed for CV-0727 and CV-0749 as they are air-to-close. However, the nitrogen system has sufficient capacity to control the valves for 12 hours. Therefore, the limiting SBO coping time for this transient is the battery capacity that provides S/G instrumentation that is limited to 4 hours. Failure to isolate AFW after 4 hours would eventually lead to P-8B failure as water ingress from an overfilled generator would result in P-8B turbine damage.

Again, several parametric calculations were performed to determine the time at which operator recovery is required. As stated in Assumption 4.4, only 1 charging pump, 1 HPSI pump and 1 PORV were considered. Table 6.3 defines the times available to the operator in performing the recovery actions. The PCT of 2200°F was used as the acceptance criterion in defining the final set of operator action times. These final determined set of 'times' are listed in Table 6.3 under the CPMAAP Stopwatch Control column.

Table 6.3 Recorded Event Times

Eastern Standard Time	Clock (hr:min:sec)	Lapsed Time (hr:min:sec)	CPMAAP Stopwatch Control (seconds)	Comments
2:53 PM	14:53:36			Start of the exercise
3:54 PM	15:54:00	1:00:24		Start back feed EOP-9 (AC 3)
4:38 PM	16:38:09	1:44:33		Energize bus 1D
4:42 PM	16:42:08	1:48:32	30500	Start left channel HPSI (P-66B)
4:46 PM	16:46:50	1:53:14	30782	Start 1 charging pumps (P-55C)
4:47 PM	16:47:41	1:54:05	30833	Open PORV (PRV-1042A)
4:58 PM	16:58:00	2:04:24		
5:00 PM	17:00:00	2:06:24		
5:01 PM	17:01:25	2:07:49		
5:02 PM	17:02:23	2:08:47		

7.0 RESULTS

Attachment 7 compares the results from comparing the "K:\Eng_prgm\Rel_Eng\PSA\CPMAAP\02-24-1994\Cp3b1615.exe" and the "K:\Eng_prgm\Rel_Eng\PSA\CPMAAP\CPMAAP v7-30-02\CPMAAP_Final.exe" code versions. As can be seen in the Figure the PCT's are nearly identical as well as the summary files. The event code occurrence in the summary files differ by about 3 seconds until steam generators boil dry. At later times, differences of 30 to 40 seconds were observed in the occurrence of the event codes. Even with differences of 30 to 40 seconds, the two different compiled codes operating on different PC platforms compared very well.

Sections 7.1 and 7.2 below summarize the results of the different SBO evaluated transients.

7.1 SBO-001 and SBO-002

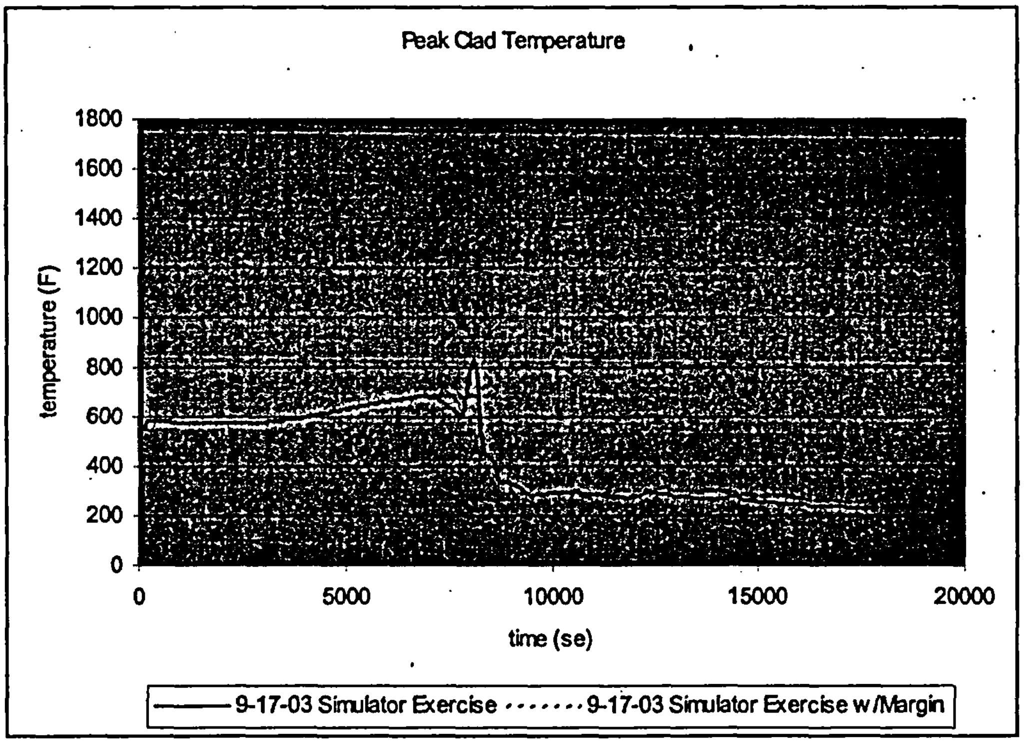
Table 7.1 summarizes the available margin to perform the specific operator actions. Figure 7.1 presents the PCT for both cases. By including both sets of results on the same plot a better perspective regarding the available margin is achieved. In the case of the simulator exercise (the solid trace), OTC was initiated in about 1.9 hours (Refer to Table 6.1). The calculated PCT was about 830°F.

The margin analysis (Case SBO-002 dotted line), represents the same operator response time sequence as the simulator exercise; however, each action was delayed for over another 30 minutes in order to determine the additional available time for the operators to commence OTC. The calculated PCT in this instance was approximately 1570°F. Although the delayed time could have been extended past 30 minutes and still satisfy the PCT acceptance criterion of 2200°F, as discussed in Section 6.2, no new additional cases were run in order to meet schedule.

Table 7.1 Recorded Event Times

Eastern Standard Time	Clock	Lapsed Time	CPMAAP Stopwatch Control (seconds)	Available Margin (min)	Comments
2:53 PM	14:53:36				Start of the exercise
3:54 PM	15:54:00	1:00:24			Start back feed EOP-9 (AC 3)
4:38 PM	16:38:09	1:44:33			Energize bus 1D
4:42 PM	16:42:08	1:48:32	8500		Start right channel HPSI (P-66A)
4:46 PM	16:46:50	1:53:14	8782	33	Start 2 charging pumps (P-55A, P-55B)
4:47 PM	16:47:41	1:54:05	8833	33	Open PORV (PRV-1043A)
4:58 PM	16:58:00	2:04:24		33	Energize bus 1C
5:00 PM	17:00:00	2:06:24	9572		Start left channel HPSI (P-66B)
5:01 PM	17:01:25	2:07:49	9657	33	Start 3rd charging pump (P-55C)
5:02 PM	17:02:23	2:08:47	9715	33	Open PORV (PRV-1042A)

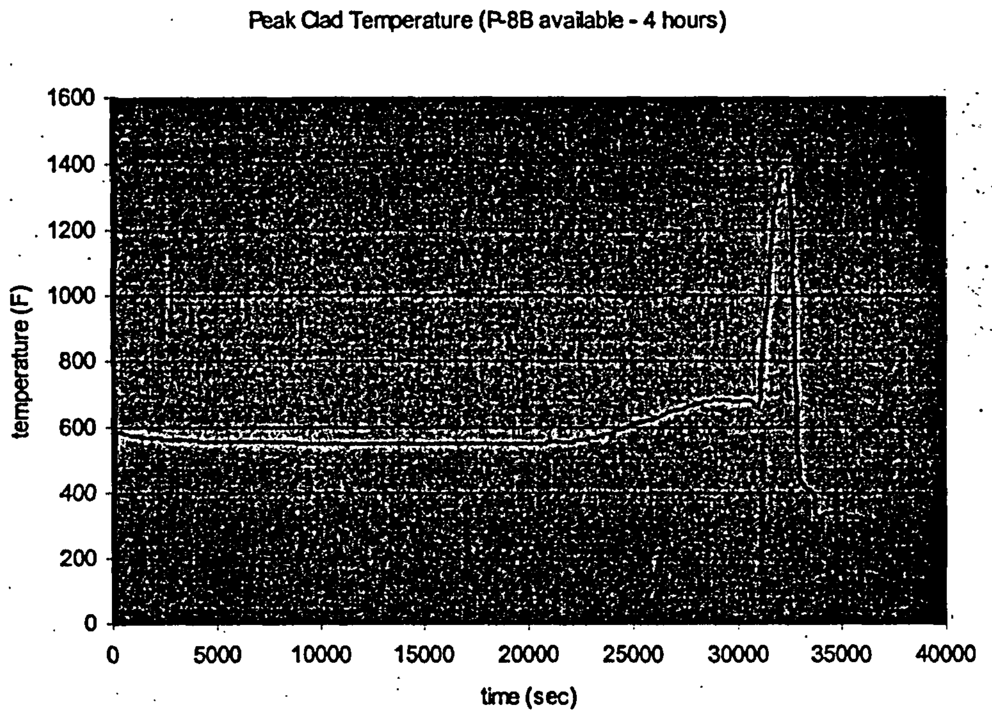
Figure 7.1



7.2 SBO-003

Figure 7.2 presents the PCT assuming P-8B is available for 4 hours.

Figure 7.2



From the above figure, the operator has well over 8 hours before recovery of vessel makeup is necessary. Refer to Table 6.3 for the assumed operator recovery times.

8.0 CONCLUSIONS

The above conservative parametric analyses have demonstrated that the operator would have over 30 minutes of additional time to perform the recovery actions as demonstrated in the 9-17-2003 simulator exercise. The calculated PCT temperature for the simulator exercise (830°F) and for the margin calculation (1570°F) was well below the 2200°F acceptance criterion. Moreover, the operator would have over 4 hours of additional recovery time (~8.5 hours total) if P-8B were available. The calculated PCT of 1380°F for this case was also well below the 2200°F acceptance criterion.

In summary, this EA has shown that ac power recovery of the digging/excavating event is plant specific and that the SDP worksheet screening recovery times can be changed from the 1 and 4-hour screening values. The screening values are changed by utilizing the Table 6.2 and 6.3 operator-timing values in the Human Error Probability (HEP) analysis. The HEP analysis, which is not part of this evaluation, subsequently determines the new 1 and 4 hour screening values.

CASE SBO-001

```
VERBOSE

SENSITIVITY RUN

TITLE
CASE SBO-001 9/17/2003 Simulator Exercise
SBO, EDG failure, P-8B Failure, Degraded HPSI system data
END TITLE

SYMBOL TABLES
       INPUT  SYMBOLS ARE IN ISFILE15.PAL
       OUTPUT SYMBOLS ARE IN OSFILE15.PAL
END

ATTACH USERFUNC.PAL

PARAMETER FILE pal15r2.par NOLIST

PLOT FILE
       WGRV
       WWRV
       TCRHOT
       PPS
       WHPSI
       WVCHP
       ZWCPS
END OF PLOT FILE SPECIFICATION

PARAMETER CHANGES
C MODEL PRESSURIZER PORV'S
       NPORV 1
C TIME DELAY FOR CONT SPRAY, HPSI, LPSI Pps (Nominal)
       TDHPI 40 S
C SIRWT INITIAL MASS NOMINAL
       MRWSTO 9.76275E5 KG
C SIRWT INITIAL TEMPERATURE NOMINAL (87.9F)
       TRWST 304.2 K
C # HPSI PUMPs
       NHPI 1
C # CHARGING PUMPs
       NCHP 1
END OF PARAMETER CHANGES AND NOLIST

NOT A RESTART

PRINT TIME  1.0 HOUR

FINAL TIME 5.0 HRS

PARALLEL

C INTERVENTION #1

WHEN BEGIN
C INITIATORS
C WHEN POWER IS TURNED OFF, MAAP TURNS OFF BOTH AC AND DC POWER
C SINCE THE PZR PORVS REQUIRE POWER, THIS PREVENT THEM FROM OPENING
C IF "POWER OFF" IS USED AS THE INITIATOR
C THEREFORE MUST TURN OFF EVERY THING SEPERATELY
        CCW/SWS OFF
        HPSI PUMPS OFF
        LPSI PUMPS OFF
        PCP'S OFF
        CONT AIR COOLERS OFF
        CONT SPRAY OFF
        AUX FEED OFF
        PZR HEATERS OFF
        MANUAL SCRAM TRIP
        MAIN FEED OFF
```

```
        CHARGING PUMPS OFF
        MSIV'S CLOSE
        PCS MAKE UP OFF
        PCS LETDOWN OFF
        PZR PORV CLOSE
END

WHEN SCRAM IS TRUE
     SET STOPWATCH 1
END
WHEN STOPWATCH 1 > 6512.0 S
C 1 HPSI PUMP RECOVERED(P-66A)
         HPSI PUMPS ON
END
WHEN STOPWATCH 1 > 6794.0 S
  PARAMETER CHANGES
C BUS 1D RECOVERED, 2 CHARGING PUMPS RECOVERED (P-55A, P-55B)
C CHARGING PUMP FLOW RATE FOR 2 PUMPS
         WVCHP(1) 0.005867 M**3/S
  END PARAMETER CHANGES
  CHARGING PUMPS ON
END
WHEN STOPWATCH 1 > 6845.0 S
C RIGHT CHANNEL SIS RECOVERED (PRV-1043A RECOVERED)
        PZR PORV OPEN
END
WHEN STOPWATCH 1 > 7584.0 S
  PARAMETER CHANGES
C BUS 1C RECOVERED, 2nd HPSI PUMP RECOVERED (P-66B)
C # HPSI PUMPs
        NHPI 2
    END PARAMETER CHANGES
END
WHEN STOPWATCH 1 > 7669.0 S
    PARAMETER CHANGES
C # 3rd CHARGING PUMP RECOVERED (P-55C)
C CHARGING PUMP FLOW RATE
        WVCHP(1) 0.00839 M**3/S
    END PARAMETER CHANGES
END
WHEN STOPWATCH 1 > 7727.0 S
C LEFT CHANNEL SIS RECOVERED (PRV-1042A RECOVERED)
    PARAMETER CHANGES
        NPORV 2
   END PARAMETER CHANGES
END
```

CASE SBO-002

```
VERBOSE

SENSITIVITY RUN

TITLE
CASE SBO-002 9/17/2003 Simulator Exercise
SBO, EDG failure, P-8B Failure, Degraded HPSI system data
END TITLE

SYMBOL TABLES
       INPUT  SYMBOLS ARE IN ISFILE15.PAL
       OUTPUT SYMBOLS ARE IN OSFILE15.PAL
END

ATTACH USERFUNC.PAL

PARAMETER FILE pal15r2.par NOLIST

PLOT FILE
       WGRV
       WWRV
       TCRHOT
       PPS
       WHPSI
       WVCHP
       ZWCPS
END OF PLOT FILE SPECIFICATION

PARAMETER CHANGES
C MODEL PRESSURIZER PORV'S
       NPORV 1
C TIME DELAY FOR CONT SPRAY, HPSI, LPSI Pps (Nominal)
       TDHPI 40 S
C SIRWT INITIAL MASS NOMINAL
       MRWST0 9.76275E5 KG
C SIRWT INITIAL TEMPERATURE NOMINAL (87.9F)
       TRWST 304.2 K
C # HPSI PUMPs
       NHPI 1
C # CHARGING PUMPs
       NCHP 1
END OF PARAMETER CHANGES AND NOLIST

NOT A RESTART

PRINT TIME  1.0 HOUR

FINAL TIME 5.0 HRS

PARALLEL

C INTERVENTION #1

WHEN BEGIN
C INITIATORS
C WHEN POWER IS TURNED OFF, MAAP TURNS OFF BOTH AC AND DC POWER
C SINCE THE PZR PORVS REQUIRE POWER, THIS PREVENT THEM FROM OPENING
C IF "POWER OFF" IS USED AS THE INITIATOR
C THEREFORE MUST TURN OFF EVERY THING SEPERATELY
        CCW/SWS OFF
        HPSI PUMPS OFF
        LPSI PUMPS OFF
        PCP'S OFF
        CONT AIR COOLERS OFF
        CONT SPRAY OFF
        AUX FEED OFF
        PZR HEATERS OFF
        MANUAL SCRAM TRIP
        MAIN FEED OFF
```

```
        CHARGING PUMPS OFF
        MSIV'S CLOSE
        PCS MAKE UP OFF
        PCS LETDOWN OFF
        PZR PORV CLOSE
END

WHEN SCRAM IS TRUE
     SET STOPWATCH 1
END
WHEN STOPWATCH 1 > 8500.0 S
C 1 HPSI PUMP RECOVERED(P-66A)
         HPSI PUMPS ON
END
WHEN STOPWATCH 1 > 8782.0 S
  PARAMETER CHANGES
C BUS 1D RECOVERED, 2 CHARGING PUMPS RECOVERED (P-55A, P-55B)
C CHARGING PUMP FLOW RATE FOR 2 PUMPS
         WVCHP(1) 0.005867 M**3/S
  END PARAMETER CHANGES
  CHARGING PUMPS ON
END
WHEN STOPWATCH 1 > 8833.0 S
C RIGHT CHANNEL SIS RECOVERED (PRV-1043A RECOVERED)
        PZR PORV OPEN
END
WHEN STOPWATCH 1 > 9572.0 S
  PARAMETER CHANGES
C BUS 1C RECOVERED, 2nd HPSI PUMP RECOVERED (P-66B)
C # HPSI PUMPs
        NHPI 2
    END PARAMETER CHANGES
END
WHEN STOPWATCH 1 > 9657.0 S
    PARAMETER CHANGES
C # 3rd CHARGING PUMP RECOVERED (P-55C)
C CHARGING PUMP FLOW RATE
        WVCHP(1) 0.00839 M**3/S
    END PARAMETER CHANGES
END
WHEN STOPWATCH 1 > 9715.0 S
C LEFT CHANNEL SIS RECOVERED (PRV-1042A RECOVERED)
    PARAMETER CHANGES
        NPORV 2
   END PARAMETER CHANGES
END
```

CASE SBO-003

```
VERBOSE

SENSITIVITY RUN

TITLE
CASE SBO-003 9/17/2003 Simulator Exercise
SBO, EDG failure, P-8B Failure, Degraded HPSI system data
END TITLE

SYMBOL TABLES
       INPUT  SYMBOLS ARE IN ISFILE15.PAL
       OUTPUT SYMBOLS ARE IN OSFILE15.PAL
END

ATTACH USERFUNC.PAL

PARAMETER FILE pal15r2.par NOLIST

PLOT FILE
       WGRV
       WWRV
       TCRHOT
       PPS
       WHPSI
       WVCHP
       ZWCPS
       WAFWXU
       WAFWXB
END OF PLOT FILE SPECIFICATION

PARAMETER CHANGES
C MODEL PRESSURIZER PORV'S
       NPORV 1
C TIME DELAY FOR CONT SPRAY, HPSI, LPSI Pps (Nominal)
       TDHPI 40 S
C SIRWT INITIAL MASS NOMINAL
       MRWST0 9.76275E5 KG
C SIRWT INITIAL TEMPERATURE NOMINAL (87.9F)
       TRWST 304.2 K
C # HPSI PUMPs
       NHPI 1
C # CHARGING PUMPs
       NCHP 1
END OF PARAMETER CHANGES AND NOLIST

NOT A RESTART

PRINT TIME  1.0 HOUR

FINAL TIME 10.0 HRS

PARALLEL

C INTERVENTION #1

WHEN BEGIN
C INITIATORS
C WHEN POWER IS TURNED OFF, MAAP TURNS OFF BOTH AC AND DC POWER
C SINCE THE PZR PORVS REQUIRE POWER, THIS PREVENT THEM FROM OPENING
C IF "POWER OFF" IS USED AS THE INITIATOR
C THEREFORE MUST TURN OFF EVERY THING SEPERATELY
        CCW/SWS OFF
        HPSI PUMPS OFF
        LPSI PUMPS OFF
        PCP'S OFF
        CONT AIR COOLERS OFF
        CONT SPRAY OFF
  C     AUX FEED OFF
```

```
        PZR HEATERS OFF
        MANUAL SCRAM TRIP
        MAIN FEED OFF
        CHARGING PUMPS OFF
        MSIV'S CLOSE
        PCS MAKE UP OFF
        PCS LETDOWN OFF
        PZR PORV CLOSE
END

WHEN SCRAM IS TRUE
     SET STOPWATCH 1
END

WHEN STOPWATCH 1 > 14400 S
     AUX FEED OFF
END
WHEN STOPWATCH 1 > 30500.0 S
C 1 HPSI PUMP RECOVERED(P-66B)
         HPSI PUMPS ON
END
WHEN STOPWATCH 1 > 30782.0 S
  PARAMETER CHANGES
C BUS 1C RECOVERED, 1 CHARGING PUMPS RECOVERED (P-55C)
C CHARGING PUMP FLOW RATE FOR 1 PUMPS
         WVCHP(1) 0.002933 M**3/S
  END PARAMETER CHANGES
  CHARGING PUMPS ON
END
WHEN STOPWATCH 1 > 30833.0 S
C LEFT CHANNEL SIS RECOVERED (ONLY 1 PORV - PRV-1042A RECOVERED)
        PZR PORV OPEN
END
```

ISFILE15.PAL

```
C THIS IS THE INPUT PARAMETER SYMBOL TABLE

C REMEMBER THAT ONLY THE FIRST 20 CHARACTERS IN THE SYMBOLS COUNT
C THIS DOESN'T PREVENT YOU FROM ENTERING NAMES IN THIS TABLE
C THAT ARE LONGER THAN 20 CHARACTERS
C NOR DOES IT PREVENT YOU FROM USING NAMES IN YOUR INPUT
C DECKS THAT ARE LONGER THAN THE ONES SHOWN BELOW, IE.
C               # AUX NODES IS
C CAN BE USED IF THE ENTRY BELOW IS
C               # AUX NODES

C ALSO REMEMBER THAT THE SYMBOLS SHOULD NOT BE TOO SHORT, LEST
C THEY BE CONFUSED WITH A LONGER SYMBOL THAT BEGINS THE SAME WAY
C SEE APPENDIX A OF USER'S MANUAL FOR MORE DETAILS

C THE CHARACTERS $ AND % HAVE SPECIAL MEANING TO MIPS AND SHOULD
C NOT BE INCLUDED IN PARAMETER NAMES; ALSO
C COMMAS AND COLONS SHOULD NOT BE AT THE END OR BEGINNING OF NAMES

C CAN USE MAAP VARIABLE NAMES TO DEFINE ALIASES--THIS IS THE *BEST* APPROACH
BREAK AREA
ABB
UNBROKEN BREAK AREA
AUB
BREAK ELEV
ZBB
UNBROKEN BREAK ELEV
ZUB
# AUX NODES
INODRB
SURGE NODE
FSR
CONTMT FAILURE PRESS
PCF
CONTMT FAILURE AREA
ACFPR
BREAK DISCHARGE COEF
FCDBRK
BREAK NODE
FBB
UNBROKEN BREAK NODE
FUB
AUX FILE TO READ
IAUXR
AUX JUNCTION
20 1
AUX FAILURE JUNCTION
20 2
AUX CONTMT INTERFACE
20 3
MAX TIMESTEP
TDMAX
CONTMT FAILS IN
FCFA
EUTECTIC TEMPERATURE
TEU
# LPI
NLPI
# HPI
NHPI
# CHARGING
NCHP
# CONTMT SPRAY
NSPA
# FANS
NFN
SG PORV SETPOINT
PSGRV
DCH FRAGMENTATION
```

```
FCMDCH
C NOTE THERE IS NO REASON THERE CAN'T BE TWO NAMES FOR THE SAME
C QUANTITY:
NORMAL LEAK AREA
ALKNOM
VENT AREA
ALKNOM
# FP GROUPS
INPGRP
NORMAL HEAT LOSS
QC0
B SG LEVEL CONTROL
ZWCTLB
U SG LEVEL CONTROL
ZWCTLU
SGTR BREAK AREA
ASB
SGTR BREAK NODE
NSB
SGTR BREAK ELEV
ZSB
CORE DROP FRAC
FCRDR
# RHR SPRAY
NLPSP0
# PLOT POINTS
IPTSMX
# AVERAGE PLOT POINTS
IPTSAV
RWST REFILL FLOW
WRWSTX
THROTTLED HPI FLOW
WHPIX
RCP TRIP VOID FRACT
VFCPMX
B SG STEAM DUMP FRAC
FARVBX
U SG STEAM DUMP FRAC
FARVUX
SG INITIAL MASS
MWSG0
MSLB FLAG
FMSLB
MSLB AREA
AMSLB
MIN TIMESTEP
TDMIN
RPV FAILURE TIME
TTRX
DEBRIS COOLABILITY
FCHF
CORE BLOCKAGE FLAG
FCRBLK
CORE POWER
QCR0
MSIV RAMP
TDMSIV
PRI SIDE HT COEFF
HTSTAG
SCRAM DELAY
TDSCRM
U SG MAX AFW
WAFWXU
B SG MAX AFW
WAFWXB
AFW TEMP
TAFW
AFW DELAY
TDAFW
DCH FRACTION
18 14
```

```
REFUEL POOL AREA
7 2
TUNNEL AREA
5 5
TUNNEL EX AREA
5 19
CAVITY CURB H
8 3
SUMP FAILURE TIME
99 7
ADV SETPOINT
PSGRV
TCPFAL
18 55
C TOTAL CONTROL ROD WORTH IN $
REACCRO
98 4
C FUEL TEMPERATURE REACTIVITY (DOPPLER) COEFFICIENT IN DELTA-RHO/K
ALPFT
ALPF 4
```

OSFILE15.PAL

```
C THIS IS THE OUTPUT PARAMETER SYMBOL TABLE
C REMEMBER THAT ONLY THE FIRST 20 CHARACTERS IN THE SYMBOLS COUNT
C EXCEPT FOR EQUIPMENT TYPE CODES ASSOCIATED WITH 200 EVENT CODES

C ALSO REMEMBER THAT THE SYMBOLS SHOULD NOT BE TOO SHORT, LEST
C THEY BE CONFUSED WITH A LONGER SYMBOL THAT BEGINS THE SAME WAY
C SEE APPENDIX A OF USER'S MANUAL FOR MORE DETAILS

C THIS DOESN'T PREVENT YOU FROM SUPPLYING NAMES BELOW THAT ARE LONGER
C THAN 20 CHARACTERS NOR DOES IT PREVENT YOU FROM USING NAMES IN YOUR
C DECKS THAT ARE LONGER THAN THE ONES SHOWN BELOW, IE.
C               PRI SYS PRESSURE
C CAN BE USED IF THE ENTRY BELOW IS
C               PRI SYS PRESS

C THE CHARACTERS $, %, AND ! HAVE SPECIAL MEANING TO MIPS AND SHOULD
C NOT BE INCLUDED IN NAMES; ALSO
C COMMAS AND COLONS SHOULD NOT BE AT THE END OR BEGINNING OF NAMES

C THE NEXT FEW SYMBOLS ARE MANDATORY!!!!!!!!!
TIME
TIM
STOPWATCH 1
128 1 12
STOPWATCH 2
128 2 12
STOPWATCH 3
128 3 12
STOPWATCH 4
128 4 12
STOPWATCH 5
128 5 12
COUNTER(1)
132  1  4
USER FUNCTION(1)
129 1 4
MAPPED VARIABLE(1)
131 1  4
EVENT CODE(1)
101 1 0
IEVNT(1)
99 1 0
XMIPS(1)
130 1 4
C END OF MANDATORY SYMBOLS!!!!!!!!!!!

C REMEMBER THAT IF YOU POINT TO THE FIRST ENTRY OF AN ARRAY
C YOU CAN THEN REFER TO SUCH ENTRIES AS "CORE TEMP(25)"
CORE TEMP(1)
TCRN(1)

C THE BEST PROCEDURE IS TO USE MAAP VARIABLE NAMES TO DEFINE SYMBOLS:
PRI SYS PRESS
PPS
C IF YOU DO THIS, SOME NEED UNITS:
PRI SYS H2 MASS
MH2PS  8
PORV GAS FLOW
WGRV  15
BROKEN LOOP NC FLOW
WHLBL 15
HOTTEST CORE TEMP
TCRHOT
CONTMT H2 PROD
MH2CB1
BREAK GAS FLOW
WGBB 15
LOWER COMPT WALL TEMP
TOWB(1)  13
```

DECAY HEAT
QDECAY
CORE H2 FLOW
WH2CR
LC INERT AERO REL RATE
WFPRB(1)
CAV INERT AERO REL RATE
WFPRC(1)
BREAK WATER FLOW
WWBB 15
PRI SYS-CONTMT HEATING
QPSC 11
B SG PRESS
PBS
B SG LEVEL
ZWBS
U SG LEVEL
ZWUS
B SG GAS TEMP
TGBS
UPPER PLENUM GAS TEMP
TGUP 13
CORE WATER LEVEL
ZWV
PZR LEVEL
ZWPZ
RPV FAILED
IEVNT(3)
CORE SLUMPED
IEVNT(2)
CORE UNCOVERED
IEVNT(49)
CONTMT FAILED
IEVNT(104)
SCRAM
IEVNT(13)
PZR GAS TEMP
TGPZ
HOT LEG TEMP
TBH(2,1) 13
B SG PLENUM GAS TEMP
TSGBHP 13
PRI SYS COLLAPSED LEVEL
ZWCPS
IN-VESSEL H2 GENERATION
MH2CR1
SURGE LINE TEMP
TSR 13
B SG MAIN STEAM FLOW
WGBST
B SG MSLB FLOW TO LOWER COMPARTMENT
WSTBSB
CAVITY TEO2 RELEASE RATE
WFPRC(3) 15
CAVITY TUNNEL GAS FLOW
WGTN 15
CAVITY BYPASS GAS FLOW
WGCB 15
RPV-CAVITY GAS FLOW
WGVP 15
CORE WATER TEMP
TWCR
PZR RELIEF VALVES GAS FLOW
WGRV 15
PZR RELIEF VALVES WATER FLOW
WWRV 15
BROKEN LOOP WATER FLOW
WWBL
PRI SYS FP MASS(1)
MFPPST(1) 8
CONTMT FP MASS(1)

```
MFPCOT(1)  8
B SG FEEDWATER FLOW
WWFWBS 15
U SG FEEDWATER FLOW
WWFWUS 15
SIRWT LEVEL
ZWRWST
CONTMT PRESS
PA

C MOD15 ADDITIONS FOR KINETICS MODEL
C CONTROL ROD REACTIVITY IN $
REACTCR
156 19 4
C TOTAL REACTOR MODERATOR REACTIVITY IN $
REACTMOD
156 20 4
C TOTAL FUEL REACTIVITY IN $
REACTFUEL
REACFT 4
C INITIAL CORE REACTIVITY IN $
REACT0
REAC0 4
C CORE REACTIVITY IN $
REACTTOT
156 26 4
C POINT KINETIC MODEL INITIAL PRIMARY SYSTEM PRESSURE
INITPRES
156 15 9
C POINT KINETIC MODEL INITIAL AVERAGE CORE WATER TEMPERATURE
INITWTEMP
156 16 13
C POINT KINETIC MODEL INITIAL AVERAGE FUEL TEMPERATURE
INITFTEMP
156 17 13
C AVERAGE FUEL TEMPERATURE
TFAVG
156 18 13
C MODERATOR TEMPERATURE REACTIVITY IN $
RMT
156 21 4
C MODERATOR PRESSURE REACTIVITY IN $
RMP
156 22 4

C USER FUNCTIONS START HERE (TYPE CODE 129)
FZRRCT
129 1 4
WRSITLVL
129 2 4
NRSITLVL
129 3 4
TSUBCL
129 4 23
PZRLVL
129 5 4
PSBSDP
129 6 9
PSUSDP
129 7 9
SIRWTLVL
129 8 4
BSGLVL
129 9 4
USGLVL
129 10 4
NFSTA
129 11 4
NFH2A
129 12 4
NFO2A
```

129 13 4
NFCOA
129 14 4
NFC2A
129 15 4
NFN2A
129 16 4
MPLUG
129 17 8
QCSPTOT
129 18 10
TAVG
129 19 13
PZDEVLVL
129 20 4
PZSETLVL
129 21 4
TAVERR
129 22 23
HIC0780A
129 23 4
PIC0511
129 24 4
PM0511
129 25 4
PSBSDT
129 26 23
PSUSDT
129 27 23
PSHCDT
129 28 23
WVCHP
129 29 20
WVFWBS
129 30 20
WVFWUS
129 31 20
HPRISEC
129 32 6
ITOTBRKFLO
129 33 8
ITOTBRKENG
129 34 11
IFWBS
129 35 8
IFWUS
129 36 8
USCONTDP
129 37 9
TOTBRKFLO
129 38 15
TOTBRKENG
129 39 10
IBSBRKFLO
129 40 8
IBSBRKENG
129 41 11
IUSBRKFLO
129 42 8
IUSBRKENG
129 43 11
BSBRKENG
129 44 10
USBRKENG
129 45 10
QPSVHTSNK
129 46 10
IQPSVHTSNK
129 47 11
IQTOTCSP
129 48 11

```
IQTOTFC
129 49 11
HPSINPSH
129 50 4
POOLVAP
129 51 4
POOLH
129 52 4

C MIPSX VARIABLES START HERE (TYPE CODE 130)
C MFRELOC IS THE "FRACTION CORE RELOCATED METER"
MFRELOC
130 1 4
ZWBSC
130 2 16
ZWUSC
130 3 16
ZWSITC
130 4 16
C MFMOLT IS THE "FRACTION CORE MOLTEN METER"
MFMOLT
130 5 4
C MCSIVP IS THE MASS OF CSI VAPOR IN PRI+PRZ+BSG
MCSIVP
130 6 8
C MCSIAP IS THE MASS OF CSI AEROSOL IN PRI+PRZ+BSG
MCSIAP
130 7 8
C MCSIDP IS THE MASS OF CSI DEPOSITED IN PRI+PRZ+BSG
MCSIDP
130 8 8
C MCSIVC IS THE MASS OF CSI VAPOR IN CONT
MCSIVC
130 9 8
C MCSIAC IS THE MASS OF CSI AEROSOL IN CONT
MCSIAC
130 10 8
C MCSIDC IS THE MASS OF CSI DEPOSITED IN CONT
MCSIDC
130 11 8
C MCICR IS THE MASS OF CSI STILL IN THE CORE
MCSICR
130 12 8
C FQ___s ARE THE ENERGY RELEASE RATES FROM THE MACCS ROUTINE
FQBS
130 13 10
FQPS
130 14 10
FQCONT
130 15 10
FQAUX
130 16 10
C FQREL IS THE SUM OF THE PREVIOUS FOUR
FQREL
130 17 10
C QREL IS THE INTEGRATED ENERGY RELEASE
QREL
130 18 11
C FMACCS IS AN ARRAY OF 10 FOR THE 10 MACCS ISOTOPE GROUPS
FMACCS(1)
130 19 4
C NEXT AVAILABLE COMMON/MIPSX/XMIPS(100) IS 29

C DEFINE VARIABLES START HERE (TYPE CODE 131)

C XPLTX VARIABLES START HERE (TYPE CODE 151)
C CHARGING FLOW RATE
WCHP
151 1 15
C HPSI FLOW RATE
WHPSI
```

```
151 2 15
C LPSI FLOW RATE
WLPSI
151 3 15
C ENTHALPY OF SI WATER
HSI
151 4 5
C SAT TEMP AT PSATSI
TRH
151 5 13
C SPRAY WATER ENTHALPY
HSPA
151 6 5
C TOTAL FAN COOLER HEAT REMOVAL RATE
QTOTFC
151 7 10
C WGCF IS THE GAS FLOW RATE INTO AUX NODE I FROM CONTAINMENT
C WHEN FLASHING IS ACCOUNTED FOR
WGCF(1)
151 8 15
C HEAT REJECTION TO ENVIRONMENT THROUGH OUTER WALL OF ACOMPT
QOWA
151 18 10
C FRACTION OF DECAY HEAT REJECTED THROUGH OUTER WALL OF ACOMPT
FQOWA
151 19 4
C HEAT REJECTION TO ENVIRONMENT THROUGH OUTER WALL OF DCOMPT
QOWD
151 20 10
C FRACTION OF DECAY HEAT REJECTED THROUGH OUTER WALL OF DCOMPT
FQOWD
151 21 4
C HEAT ABSORBED BY OUTER WALL OF BCOMPT
QOWB
151 22 10
C FRACTION OF DECAY HEAT ABSORBED BY OUTER WALL OF BCOMPT
FQOWB
151 23 4
C BROKEN STM GEN SEC SIDE HEAT TRANS COEFF
KSECBS
151 24 4
C UNBROKEN STM GEN SEC SIDE HEAT TRANS COEFF
KSECUS
151 25 4
C HEAT TRANSFER AREA OF STM GEN TUBES
ATUBSG
151 26 1
C DECAY HEAT FRACTION
FQU2
151 27 4
C FRACTIONAL NEUTRON POWER
FQNEUT
151 28 4
C TOTAL CONT SPRAY HEAT REMOVAL RATE
QTOTCSP
151 29 10
C BORON CONCENTRATION IN THE PRIMARY SYSTEM IN PPM
FBRPSPPM
151 30 4
C BORON CONCENTRATION IN THE PRESSURIZER IN PPM
FBRPZRPPM
151 31 4
QGPSSVA
151 32 10
QGPSSVB
151 33 10
QGPSSVC
151 34 10
QGPSSVD
151 35 10
QPSSVA
```

```
151 36 10
QPSSVB
151 37 10
QPSSVC
151 38 10
QPSSVD
151 39 10

C NEXT AVAILABLE COMMON/XPLTX/PLOTX(500) IS 63

C THESE ARE THE 200 EVENT CODES THAT CONTROL EQUIPMENT/MODELS

C IEVNT(203)
CCW/SWS
5 0 0

C IEVNT(205)
AC AND DC POWER
7 0 0
POWER
7 0 0

C IEVNT(206) - CPMAAP ---> NOTE LOGIC IS REVERSED. WILL BE FIXED
SPRAY HEADER VALVE
99 206 0

C IEVNT(209)
PCS BREAKS
1 0 0

C IEVNT(210)/IEVNT(211)/IEVNT(225)
PZR PORV
9 0 0

C IEVNT(212)/IEVNT(216)
HPSI PUMPS
10 0 0

C IEVNT(213)/IEVNT(217)
LPSI PUMPS
11 0 0

C IEVNT(214)
SIT BLOCK VALVES
13 0 0

C IEVNT(215)
PRIMARY COOLANT PUMPS
14 0 0
PCP'S
14 0 0

C IEVNT(218)/IEVNT(221)
CONT AIR COOLERS
16 0 0

C IEVNT(219)/IEVNT(222)
CONT SPRAY
17 0 0

C IEVNT(220)
RECIRC MODE
18 0 0

C IEVNT(223)/IEVNT(246)
PZR SPRAYS
19 0 0

C IEVNT(224)
AUX FEED
20 0 0
```

C IEVNT(226)
PZR HEATERS
22 0 0

C IEVNT(227)
MANUAL SCRAM
23 0 0

C IEVNT(228)/IEVNT(245)
MAIN FEED
24 0 0

C IEVNT(229)
RV UPPER HEAD VENT
25 0 0

C IEVNT(230)
TBV
99 230 0

C IEVNT(231)/IEVNT(232)
CHARGING PUMPS
12 0 0

C IEVNT(233) - CP/MAAP--> WILL OPEN BRKN AND UNBRKN. WILL BE CHANGED
S/G ADV'S
26 0 0

C IEVNT(235)/IEVNT(236)
MSIV'S
28 0 0

C IEVNT(237)
SIRWT REFILL
29 0 0

C IEVNT(238)
ISLOCA
30 0 0

C IEVNT(239)
BRKN S/G SRV
99 239 0

C IEVNT(241) - CPMAAP ---> ALSO ACTIVATE H2/CO SOURCE SINK
CAV INJ SYSTEM
32 0 0
H2/CO EXTERNAL SOURCE/SINK
32 0 0

C IEVNT(242)
PCS MAKE UP
33 0 0

C IENVT(243)
PCS LETDOWN
34 0 0

C IEVNT(249) - CPMAAP ---> WILL BE CHANGED.
HPSI SUBCOOLING VALVE
35 0 0

C MAK 3/02--add capability to adjust fan cooler cooling water inlet temperature
TCWFC
130 14 13

USERFUNC.PAL

```
C CLADDING OXIDATION FRACTION
FUNCTION FZRRCT
        $MH2CRT$*22.805/%MZR0%
END

C WIDE RANGE PERCENT ACCUMULATOR WATER LEVEL
FUNCTION WRSITLVL
        ((($ZWSITC$-26.759)*19.685) > (-0.09) ) < 159.0
END

C NARROW RANGE PERCENT ACCUMULATOR WATER LEVEL
FUNCTION NRSITLVL
        ((($ZWSITC$-30.544)*78.740) > 0.0 ) < 100.0
END

C PRIMARY SYSTEM SUB-COOLING
FUNCTION TSUBCL
        (t($PPS$)-$TWCR$) > 0.0
END

C PERCENT PRESSURIZER LEVEL (APPROXIMATE)
FUNCTION PZRLVL
        ((($ZWPZ$-0.3247)*14.288) > 0.0 ) < 100.0
END

C PRIMARY-SECONDARY DIFFERENTIAL PRESSURE - BROKEN S/G
FUNCTION PSBSDP
        $PPS$-$PBS$
END

C PRIMARY-SECONDARY DIFFERENTAIL PRESSURE - UNBROKEN S/G
FUNCTION PSUSDP
        $PPS$-$PUS$
END

C PERCENT SIRWT LEVEL
FUNCTION SIRWTLVL
        ($ZWRWST$-0.4572)*14.5815 > 0.0
END

C PERCENT STEAM GENERATOR LEVEL - BROKEN S/G
FUNCTION BSGLVL
        ((($ZWBSC$-6.7612)*21.8723) < 100.0) > (-138.0)
END

C PERCENT STEAM GENERATOR LEVEL - UNBROKEN S/G
FUNCTION USGLVL
        ((($ZWUSC$-6.7612)*21.8723) < 100.0) > (-138.0)
END

C CONTAINMENT GAS MOLE FRACTOINS

C STEAM
FUNCTION NFSTA
     ($MFSTA$/18.0)/(($MFSTA$/18.0)+($MFH2A$/2.0)+($MFO2A$/32.0)
                    +($MFCOA$/28.0)+($MFC2A$/44.0)+($MFN2A$/28.0))
END

C HYDROGEN
FUNCTION NFH2A
     ($MFH2A$/2.00)/(($MFSTA$/18.0)+($MFH2A$/2.0)+($MFO2A$/32.0)
                    +($MFCOA$/28.0)+($MFC2A$/44.0)+($MFN2A$/28.0))
END

C OXYGEN
FUNCTION NFO2A
     ($MFO2A$/32.0)/(($MFSTA$/18.0)+($MFH2A$/2.0)+($MFO2A$/32.0)
                    +($MFCOA$/28.0)+($MFC2A$/44.0)+($MFN2A$/28.0))
END
```

```
C CARBON MONOXIDE
FUNCTION NFCOA
     ($MFCOA$/28.0)/(($MFSTA$/18.0)+($MFH2A$/2.0)+($MFO2A$/32.0)
                    +($MFCOA$/28.0)+($MFC2A$/44.0)+($MFN2A$/28.0))
END

C CARBON DIOXIDE
FUNCTION NFC2A
     ($MFC2A$/44.0)/(($MFSTA$/18.0)+($MFH2A$/2.0)+($MFO2A$/32.0)
                    +($MFCOA$/28.0)+($MFC2A$/44.0)+($MFN2A$/28.0))
END

C NITROGEN
FUNCTION NFN2A
     ($MFN2A$/28.0)/(($MFSTA$/18.0)+($MFH2A$/2.0)+($MFO2A$/32.0)
                    +($MFCOA$/28.0)+($MFC2A$/44.0)+($MFN2A$/28.0))
END

C AEROSOL PLUGGING OF FAN COOLERS
FUNCTION MPLUG
   (i(($MFPB(1,2)$+$MFPB(2,2)$+$MFPB(3,2)$+$MFPB(4,2)$+
    $MFPB(5,2)$+$MFPB(6,2)$+$MFPB(7,2)$+$MFPB(8,2)$+
    $MFPB(9,2)$+$MFPB(10,2)$+$MFPB(11,2)$+$MFPB(12,2)$)*%WVFN0%/$VOLGB$))
END

C HEAT REMOVAL RATE BY CONTAINMENT SPRAYS
FUNCTION QCSPTOT
   ($HSPA$-$HSI$)*$WSPTA$
END

C TAVG
FUNCTION TAVG
    ($TWHPS$+$TWLPS$)/2.0
END

C PRESSURIZER LEVEL SET POINT DEVIATION
FUNCTION PZDEVLVL
       (((($ZWPZ$-0.3247)*14.288) > 0.0 ) < 100.0)
     - ((((%ZWPZ0%-0.3247)*14.288) > 41.99 ) < 57.01)
END

C PRESSURIZER LEVEL SET POINT
FUNCTION PZSETLVL
      ((((%ZWPZ0%-0.3247)*14.288) > 41.99 ) < 57.01)
END

C TAVG ERROR SIGNAL FOR STEAM DUMP CONTROLLER
FUNCTION TAVERR
    (($TWHPS$+$TWLPS$)/2.0)-550.9477
END

C HIC-0780A OUTPUT
FUNCTION HIC0780A
(((((((($TWHPS$+$TWLPS$)/2.0)-550.9477)-1.6667)*3.2727)+10.0) > 10.0)
 < 50.01) * (b($IEVNT(13)$)))
END

C PIC-0511 OUTPUT
FUNCTION PIC0511
(((($PBS$-%PTBV%)*0.00058016)+10.0) > 10.0 ) < 50.01)
END

C PM-0511 AUCTIONEER OUTPUT
FUNCTION PM0511
(((($PBS$-%PTBV%)*5.8016E-4)+10.0) > 10.0 ) < 50.01) >
(((((((($TWHPS$+$TWLPS$)/2.0)-550.9477)-1.6667)*3.2727)+10.0) > 10.0)
 < 50.01) * (b($IEVNT(13)$)))
END

C COLD LEG WATER - BROKEN STEAM GENERATOR WATER TEMPERATURE DIFFERENCE
```

```
FUNCTION PSBSDT
    $TWLPS$-$TWBS$
END

C COLD LEG WATER - UNBROKEN STEAM GENERATOR WATER TEMPERATURE DIFFERENCE
FUNCTION PSUSDT
    $TWLPS$-$TWUS$
END

C HOT LEG WATER - COLD LEG WATER TEMPERATURE DIFFERENCE
FUNCTION PSHCDT
    $TWHPS$-$TWLPS$
END

C VOLUMETRIC CHARGING FLOW RATE
FUNCTION WVCHP
    $WCHP$*(v($TRWST$))
END

C TOTAL BROKEN STM GEN FEED WATER VOLUMETRIC FLOW RATE
FUNCTION WVFWBS
    $WWFWBS$*(v($TFW$))
END

C TOTAL UNBROKEN STM GEN FEED WATER VOLUMETRIC FLOW RATE
FUNCTION WVFWUS
    $WWFWUS$*(v($TFW$))
END

C EFFECTIVE TOTAL PRIMARY TO SECONDARY SIDE HEAT TRANSFER COEFFICIENT
C
C    q = h A (T2-T1)
C
C WHERE:
C
C   q = TOTAL HEAT TRANSFERRED FROM THE PRIMARY WATER TO THE STM GEN
C       (BOTH STM GENS), W
C
C   q = QSGTOT
C
C   A = TOTAL HEAT TRANSFER AREA IN BOTH STM GENS, M**2
C
C   A = 2.0*ATUBSG
C
C T2 = INLET PRIMARY WATER TEMPERATURE (IE, THOT), K
C
C T2 = TWHPS
C
C T1 = STM GEN WATER TEMPERATURE, K
C
C T1 = (TWBS+TWUS)/2.0
C
C   h = EFFECTIVE TOTAL HEAT TRANSFER COEFFICIENT, W/M**2/K
C
C   h = q/(A*(T2-T1))
C
FUNCTION HPRISEC
     $QSGTOT$/($ATUBSG$*2.0*($TWHPS$-(($TWBS$+$TWUS$)/2.0)))
END

FUNCTION ITOTBRKFLO
 (i($WSTBSB$+$WSTUSB$))
END

FUNCTION ITOTBRKENG
 (i(($WSTBSB$*$HSTBS$)+($WSTUSB$*$HSTUS$)))
END

FUNCTION IFWBS
 (i($WWFWBS$))
END
```

```
FUNCTION IFWUS
 (i($WWFWUS$))
END

FUNCTION USCONTDP
 ($PUS$-$PA$)
END

FUNCTION TOTBRKFLO
  ($WSTBSB$+$WSTUSB$)
END

FUNCTION TOTBRKENG
 (($WSTBSB$*$HSTBS$)+($WSTUSB$*$HSTUS$))
END

FUNCTION IBSBRKFLO
 (i($WSTBSB$))
END

FUNCTION IBSBRKENG
 (i($WSTBSB$*$HSTBS$))
END

FUNCTION IUSBRKFLO
 (i($WSTUSB$))
END

FUNCTION IUSBRKENG
 (i($WSTUSB$*$HSTUS$))
END

FUNCTION BSBRKENG
 ($WSTBSB$*$HSTBS$)
END

FUNCTION USBRKENG
 ($WSTUSB$*$HSTUS$)
END

FUNCTION QPSVHTSNK
 ($QPSSVA$+$QPSSVB$+$QPSSVC$+$QPSSVD$)
END

FUNCTION IQPSVHTSNK
 i($QPSSVA$+$QPSSVB$+$QPSSVC$+$QPSSVD$)
END

FUNCTION IQTOTCSP
 i($QTOTCSP$)
END

FUNCTION IQTOTFC
 i($QTOTFC$)
END

C
C SI to English to SI(m) Conversion for following Functions
C
C 1/6894.8(lb/in2/PA)*144(in2/ft2)*1/0.06243(lb/ft3/kg/m3)*0.3048(m/ft)
C (note NSPH converted to 'm' as EXCEL plot routing converts 'm' to 'ft')
C

FUNCTION HPSINPSH
 (($PSSI$-$PSATSI$)*$VWB$*0.102)
END

FUNCTION POOLVAP
 (p($TWB$))
END
```

```
FUNCTION POOLH
 (h($TWB$))
END
```

```
*************************************************************************
*************************************************************************
**
**             PALISADES MAAP/3.0B REFERENCE PARAMETER FILE
**                            REVISION 15r2
**                              12/11/01
**
*************************************************************************
*************************************************************************
**
** BASED ON THE ZION-LIKE (LARGE, DRY PWR) REV 16 PARAMETER FILE
** FOR: CPMAAP 3.0B, REV 16, MOD 15 (CP3B1615.EXE)
**
*************************************************************************
**
** DOCUMENTAION FOR THE PARAMETER VALUES CAN BE FOUND IN:
**
**  PALISADES NUCLEAR PLANT MAAP/3.0B PARAMETER FILE DOCUMENTATION:
**
**References:
**
**  [1] EA-P-MAAP-071589, REV 15 - Original CPMAAP Parameter File (not filmed or
**      reviewed).
**  [2] EA-PSA-CPMAAP-01-31 Documents Review of Reference [1].  This EA provides a
**      roadmap to EA-P-MAAP-071589 as well as selected random data checks.  EA-PSA-
**      CPMAAP-01-31 is used as the new EA reference number for the parameter file.
**  [3] EA-C-PAL-01-03563-02 r0 Documents 4 changes to the Reference [1] parameter
**      file made on 11/12/01).  These changes are incorporated into v15r1.
**
*************************************************************************
**
** THE PALISADES REFERENCE PARAMETER FILE WAS DEVELOPED ASSUMING THAT ALL
** ENGINEERED SAFEGUADS EQUIPMENT WOULD FUNCTION NORMALLY.  THEREFORE, THE
** PARAMENTER FILE HAS TWO HPSI'S, TWO LPSI'S, FOUR SIT'S, THREE CHARGING
** PUMPS, THREE AFW PUMPS AND AN UNLIMITED SUPPLY OF AUX FEEDWATER.
**
** THIS PARAMTER FILE CONTAINS THE PARAMETERS FOR CP-MAAP/3.0B AND MAAP/3.0B:
**
**       COMMENTS STARTING '**CPCO...CP-MAAP ONLY' ARE CP-MAAP SPECIFIC
**
** ALL OTHER PARAMETERS ARE APPLICABLE TO BOTH CODES
**
** PARAMETER FILE REVISIONS ARE IDENTIFIED BY (STARTING WITH REV07):
**                 **-REVnn-START----------
**                         .
**                         .
**                         .
**                 **-REVnn-END------------
**
*************************************************************************
**
**THIS DECK IS IN SI UNITS (M-KG-SEC-DEGK)
*SI
**
*****************************************************************
*CONCRETE AND CONTAINMENT SHELL
*****************************************************************
**UNLESS OTHERWISE STATED, CONCRETE PROPERTIES ARE FOR "PURE"
**(UNREINFORCED) CONCRETE
01  1076.0    AVERAGE SPECIFIC HEAT OF CONCRETE
02  1750.0    MELTING TEMPERATURE OF CONCRETE
03  1.00E+06  ENERGY ABSORBED IN ENDOTHERMIC CHEMICAL REACTIONS
**            DURING CONCRETE DECOMPOSITION
04  8.00E+05  LATENT HEAT OF MELTING
**ALL THE CONCRETE MASS FRACS SHOULD ADD UP TO ROUGHLY 1.;
05  0.07420        MASS FRACTION OF CONCRETE THAT IS SIO2
06  0.29610        MASS FRACTION OF CONCRETE THAT IS CAO
07  0.01959        MASS FRACTION OF CONCRETE THAT IS AL2O3
08  0.00400        MASS FRACTION OF CONCRETE THAT IS K2O
09  0.00062        MASS FRACTION OF CONCRETE THAT IS NA2O
10  0.18477        MASS FRACTION OF CONCRETE THAT IS MGO,MNO,OR TIO2
```

```
11  0.00900        MASS FRACTION OF CONCRETE THAT IS FE2O3
12  0.00001        MASS FRACTION OF CONCRETE THAT IS FE
13  0.00001        MASS FRACTION OF CONCRETE THAT IS CR2O3
14  0.06520        MASS FRACTION OF CONCRETE THAT IS H2O
15  0.34200        MASS FRACTION OF CONCRETE THAT IS CO2
**16  NOT A USER INPUT
17  323.7       REBAR DENSITY (MASS OF REBAR PER UNIT VOLUME OF
**              REINFORCED CONCRETE)
**REMAINDER OF THE QUANTITIES ARE USED IN THE CONTAINMENT FAILURE MODEL
**AND NEED NOT BE SUPPLIED IF THE "SIMPLE" MODEL IS USED (SEE ACOMPT SECTION)
**NOTE: FOR FREE-STANDING STEEL CONTAINMENTS, YOU NEED SUPPLY ONLY
**REBAR PROPERTIES AND THE STEEL THICKNESS (STEEL THICKNESS IS INPUT AS
**"LINER" THICKNESS AS DESCRIBED BELOW)
18  2.9992E+11   ELASTIC YOUNGS MODULUS FOR TENDONS
19  1.9995E+11   ELASTIC YOUNGS MODULUS FOR REBAR
20  2.8908E+09   PLASTIC YOUNGS MODULUS FOR TENDONS
21  2.1121E+09   PLASTIC YOUNGS MODULUS FOR REBAR
22  9.5147E+08   PRESTRESS ON HOOP TENDONS
23  9.8594E+08   PRESTRESS ON AXIAL TENDONS
24  1.3772E+09   TENDON YIELD STRESS
25  4.1368E+08   REBAR YIELD STRESS
26  1.6547E+09   TENDON ULTIMATE STRESS
27  6.2052E+08   REBAR ULTIMATE STRESS
28  1.9995E+11   ELASTIC YOUNGS MODULUS FOR LINER
29  1.6639E+09   PLASTIC YOUNGS MODULUS FOR LINER
30  2.2063E+08   LINER YIELD STRESS
31  5.5158E+08   LINER FAILURE STRESS
**
***********************************************************************
*PRIMARY SYSTEM
***********************************************************************
**UNLESS OTHERWISE NOTED, ALL ELEVATIONS IN THIS SECTION SHOULD BE
**REFERENCED TO THE LOWEST POINT OF THE INSIDE OF THE RV HEAD
**WHEN A PARAMETER SUCH AS THE VOLUME OF THE DOWNCOMER IS CALLED FOR,
**THE ACTUAL DOWNCOMER VOLUME SHOULD, OF COURSE, BE USED EVEN THOUGH THE
**MAAP NODALIZATION LUMPS OTHER VOLUMES WITH THE DOWNCOMER VOLUME (THE
**LUMPING IS DONE INTERNALLY IN THE CODE)
01  4           NUMBER OF COLD LEGS
02  1.071       INNER DIAMETER OF A HOT LEG PIPE
03  2.178       INSIDE RADIUS OF THE CYLINDRICAL PART OF THE REACTOR VESSEL
04  11.08       VOLUME WHICH IS INSIDE THE CORE BARREL AND LIES BETWEEN
**              THE BOTTOM OF THE CORE AND THE LINE WHICH DENOTES THE TOP
**              OF THE RV LOWER HEAD (THE LAST IS THE SAME AS THE BOTTOM
**              OF THE RV CYLINDRICAL SECTION)
05  6.937       FLOW AREA OF CORE PLUS CORE BYPASS AREA
06  3.065       VOLUME OF HORIZONTAL RUN OF PIPE IN ONE COLD LEG FROM
**              THE REACTOR VESSEL OUT TO THE MAIN COOLANT PUMP
**-REV12-START-----------------------------------------------------------------
** CHANGE TO MEDIAN VALUE USED IN IPE
**07  0.40        RADIUS OF VESSEL PENETRATION--IF NO VESSEL PENETRATION
07  0.45        RADIUS OF VESSEL PENETRATION--IF NO VESSEL PENETRATION
**-REV12-END-------------------------------------------------------------------
**              (EG SOME CE PLANTS) USE THE ASSUMED INITIAL RADIUS OF
**              FAILURE WHEN THE RV LOWR HEAD FAILS DUE TO CORIUM ATTACK
**              AND SUPPLY 1 FOR THE NO. OF FAILED PENETRATIONS IN *MODEL
08  3.750E+06   ENERGY INPUT FROM ONE PRIMARY SYSTEM PUMP (WHEN RUNNING)
09  0.0         TOTAL MAKEUP FLOW TO THE PRIMARY SYSTEM--UNDER NORMAL
**              OPERATION SHOULD EQUAL LETDOWN FLOW BELOW;THIS IS USED
**              MAINLY IN THE TMI SCENARIO AND MOST USERS WILL INPUT ZERO;
**              THIS WATER IS NOT SUBTRACTED FROM THE RWST AND CONTINUES
**              (IF POWER IS AVAILABLE) UNTIL MANUALLY SHUT OFF
10  525.0       TEMPERATURE OF MAKEUP WATER, IF ANY, GIVEN IN 09
11  0.7650      INNER DIAMETER OF A COLD LEG PIPE
12  9.133       ELEVATION OF THE NOZZLE WHICH ATTACHES THE SURGE LINE
**              TO THE HOT LEG--THIS MUST BE GREATER THAN ITEM 47
**NOTE: IT IS HELPFUL IN LOCAS (ESP SMALL BREAKS) TO AVOID
**PUTTING THE BREAK ELEVATION IN THE VICINITY OF THE SURGE LINE;
**ARTIFICIALLY INCREASING THE
**ELEVATION OF THE SURGE LINE 0.5-1 METER OR SO ABOVE THE BREAK IS SUGGESTED
**FURTHER, IT IS HELPFUL TO AVOID PUTTING BREAKS NEAR THE ELEVATION OF THE
**TUBESHEET IN U-TUBE TYPE S/G PRIMARY SYSTEMS--BOTH OF THESE MEASURES
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**HELP AVOID WATER SLOSHING INTO AND OUT OF NODES (WHICH CRANKS THE TIME STEP
**DOWN) AND WILL GREATLY DECREASE RUNNING TIME AT NEGLIGIBLE LOSS OF ACCURACY
13  6           ENTER BROKEN LOOP BREAK LOCATION KEY (NODE NO.):
**              3--BROKEN HOT LEG NODE
**              4--BROKEN HOT LEG "TUBE" NODE (B AND W ONLY)
**              6--BROKEN INTERMEDIATE LEG NODE (BETWEEN PUMP AND COLD SIDE OF
**                 S/G)
**              7--BROKEN COLD LEG NODE (HORIZ PART OF COLD LEG)
**              8--DOWNCOMER NODE (IE DOWNCOMER PLUS LOWER HEAD)
14  0.0         BROKEN LOOP BREAK AREA (FT**2)
15  7.694       BROKEN LOOP BREAK ELEVATION--SEE NOTES ABOVE
16  7.764E+04   MASS OF S/G HEAD AND TUBESHEET (BOTH HEADS AND TUBESHEETS FOR
**              OTSGS)
17  1.0652      MAX VOLUME OF WATER IN ONE COLD LEG WHICH WILL STILL ALLOW
**              GAS TRANSFER TO OCCUR PAST THE LOWEST PART OF THE COLD LEG
**-REV12-START-------------------------------------------------------------------
** CORRECT NOZZLE VOLUME ASSIGNMENT
**18  7.821       TOTAL VOLUME OF ONE COLD LEG
18  8.1008      TOTAL VOLUME OF ONE COLD LEG
**-REV12-END---------------------------------------------------------------------
19  5.608       TOTAL VOLUME OF ONE HOT LEG
**-REV12-START-------------------------------------------------------------------
** ACCOUNT FOR NEW STM GEN PRIMARY SIDE VOLUME AND
** CORRECT NOZZLE VOLUME ASSIGNMENT
**20  144.15      TOTAL FLUID VOLUME OF THE RX VESSEL, IE THE VOLUME NOT
20  138.8645    TOTAL FLUID VOLUME OF THE RX VESSEL, IE THE VOLUME NOT
**-REV12-END---------------------------------------------------------------------
**              INCLUDING THE CORE ITSELF OR INTERNAL STRUCTURES
**21              GAS FLOWRATE OF REACTOR HIGH POINT VENT(S),IF ANY, AT
**              NOMINAL SYSTEM PRESSURE
**DOWNCOMER IS MODELLED AS ENDING AT THE POINT WHERE THE LOWER HEAD
**OF THE RV MEETS THE CYLINDRICAL SECTION--NOTE THE CORE BARREL IS
**ALSO ASSUMED TO STOP AT THIS POINT
22  25.50       TOTAL VOLUME OF DOWNCOMER
23  18.10       PORTION OF DOWNCOMER VOLUME WHICH IS BELOW THE
**              ELEVATION OF THE BOTTOM OF THE COLD LEG NOZZLES
24  3           ENTER A 3 FOR PZR TO BE IN BRKN LOOP; 9 FOR UNBROKEN
**              LOOP FOR U-TUBE GEOMETRIES; USE 4 AND 10 RESPECTIVELY FOR
**              B AND W PLANTS (NODE NO. OF PRIMARY SYSTEM SURGE LINE NOZ)
25  2           NUMBER OF HOT LEGS
26  0.050       VOID FRACTION AT WHICH REACTOR COOLANT PUMPS TRIP OR FAIL
**SCRAM SETPOINTS: IF A GIVEN TRIP DOES NOT EXIST, INPUT A VALUE WHICH THE
**CODE WILL NEVER CROSS
27  1.191E+07   LOW PRESSURIZER PRESSURE TRIP POINT
28  1.570E+07   HIGH PRESSURIZER PRESSURE TRIP POINT
29  300.0       HIGH LOOP DELTA-T SCRAM SETPOINT
30 -20.0        LOW PRESSURIZER LEVEL TRIP
31  20.0        HIGH PRESSURIZER LEVEL TRIP
32  3.10        REACTOR TRIP DELAY TIME
33  6.5714      LOW S/G WATER LEVEL SCRAM SETPOINT
34  5           NUMBER OF POINTS IN MAIN COOLANT PUMP COAST-DOWN CURVE
**              (5 MAX)
**-REV12-START-------------------------------------------------------------------
** NEW FLOW RATES DUE TO NEW STEAM GENERATORS
**35  3937.0      FIRST MASS FLOWRATE IN MCP COAST-DOWN CURVE(MUST BE THE
****              ONE PUMP FLOW UNDER NOMINAL CONDITIONS)
**36  2953.0      SECOND FLOWRATE
**37  1575.0      NEXT FLOWRATE
**38   787.5      NEXT FLOWRATE
**39   393.7      NEXT FLOWRATE
**
35  4712.0      FIRST MASS FLOWRATE IN MCP COAST-DOWN CURVE(MUST BE THE
**              ONE PUMP FLOW UNDER NOMINAL CONDITIONS)
36  3534.0      SECOND FLOWRATE
37  1885.0      NEXT FLOWRATE
38  942.4       NEXT FLOWRATE
39  471.2       NEXT FLOWRATE
**-REV12-END---------------------------------------------------------------------
40  0.0         FIRST TIME IN COAST-DOWN CURVE--MUST BE 0
41  80.0        NEXT TIME
42  94.0        NEXT TIME
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43  118.0       NEXT TIME
44  153.0       NEXT TIME
45  10.6923     ELEVATION OF TOP OF S/G TUBESHEET ABOVE BOTTOM OF RV
46  0.1175      THICKNESS OF RV LOWER HEAD
47  7.694       ELEVATION OF THE BASE OF THE COOLANT LOOP NOZZLES (DIST.
**              FROM BOTTOM OF NOZZLES TO BOTTOM OF RV LOWER HEAD)
48  1.905       VERTICAL DISTANCE FROM LOWEST POINT OF A COLD LEG TO THE
**              ELEVATION OF THE BASE OF THE COLD LEG NOZZLE ON THE RV
49  5.608       VOLUME OF THE HORIZONTAL RUN OF A HOT LEG PIPE
50  0.0         TOTAL LETDOWN FLOW--SEE NOTE NEAR MAKEUP FLOW ENTRY ABOVE
51  1.586E+05   NORMAL DIFFERENTIAL PRESSURE FROM CORE INLET TO HOT LEG
**              SIDE OF OUTLET NOZZLES WHEN MAIN COOLANT PUMPS ARE ON
**MOST USERS WILL USE THE "UNBROKEN" LOOP BREAK ONLY FOR PUMP SEAL LOCAS
**IN TMLB SEQUENCES; IT CAN ALSO BE USED FOR SPECIAL PURPOSES (EG LOFT FP/2
**SIMULATION)
**THIS BREAK, ALONG WITH THE BROKEN LOOP BREAK IS CONTROLLED BY EVENT CODE
**209; ONE CAN TURN THE BREAKS ON AND OFF SEPERATELY BY USING A PARAMETER
**CHANGE-TYPE INTERVENTION (CODE 1000---SEE VOL 1 OF USER'S MANUAL)
52  9             LOCATION KEY FOR UNBROKEN LOOP BREAK, IF ANY
**              9 --UNBROKEN HOT LEG NODE
**              10--UNBROKEN HOT LEG "TUBE" NODE (B AND W ONLY)
**              12--UNBROKEN INTERMEDIATE LEG NODE--
**                  NOTE UNBROKEN LOOP BREAK IN UNBROKEN LOOP COLD LEG OR
**                  DOWNCOMER NODE NOT ALLOWED AT THE PRESENT--FOR BREAKS
**                  IN DOWNCOMER USE BROKEN LOOP BREAK KEY ABOVE
53  0.0             AREA OF UNBROKEN LEG BREAK--PUT IN ZERO IF NONE
54  8.613         ELEVATION OF UNBROKEN LOOP BREAK (SEE NOTES PERTAINING
**                  TO BREAK ELEVATION ABOVE
**THE "DOME" REFERS TO THE REGION ABOVE THE UPPER PLENUM
**THE "DOME PLATE" IS THE PERFORATED PLATE THAT DIVIDES THE UPPER PLENUM
**FROM THE DOME (SOMETIMES REFERRED TO AS THE UPPER CORE SUPPORT PLATE)
**--SEE DRAWINGS IN THE PRISYS SECTION OF THE USER'S MANUAL
55  10.03         ELEVATION OF THE RV DOME PLATE
56  11.93         ELEVATION OF THE INSIDE OF THE TOP OF THE RV CLOSURE
**                  HEAD
57  10.03         ELEVATION OF THE RV FLANGE (CLOSURE STUDS)
**                  (NOTE THAT THIS ELEVATION IS
**                  TAKEN TO BE THE TOP OF THE CORE BARREL)
58  35.49        OUTSIDE AREA OF THE DOME EXTERIOR WALL
59  2.308E+04    MASS OF THE CORE BARREL BELOW THE ELEVATION OF THE TOP OF
**               THE CORE ("LOWER CORE BARREL")--LUMP IN THE BAFFLE,
**               THERMAL SHIELDS, AND FORMER PLATES
60  1.477E+04    MASS OF THE CORE BARREL ABOVE THE ELEV OF THE TOP OF THE CORE
**               ("UPPER CORE BARREL")
61  1.067E+04    MASS OF UPPER PLENUM INTERNALS
62  7.636E+03    MASS OF THE RV DOME PLATE
63  7.106E+04    MASS OF THE WALL FORMING THE EXTERIOR OF THE DOME (IE
**               INCLUDES THE RV CLOSURE HEAD)
64  1.356E+04    TOTAL MASS OF ONE HOT LEG; SEE NOTE IN S/G SECTION AT
**               ITEM 37
65  2.279E+04    TOTAL MASS OF ONE COLD LEG; SEE NOTE IN S/G SECTION AT
**               ITEM 37
66  2.947E+05    MASS OF THE RV WALL (BELOW THE RV FLANGE; THE DOME WALL
**               MASS ENTERED ABOVE STARTS AT THE FLANGE)
**-REV12-START-------------------------------------------------------------------
** REVISED AREA BASED ON CORRECTED RV VOLUME
**67  11.0         WATER LINE FLOW AREA IN THE UPPER PLENUM (ABOVE THE
67  9.9132       WATER LINE FLOW AREA IN THE UPPER PLENUM (ABOVE THE
**-REV12-END---------------------------------------------------------------------
**               CORE AND BELOW THE DOME PLATE)--THE PRODUCT OF THIS AND
**               THE DIFFERENCE IN ELEVATIONS OF THE TOP OF THE CORE AND
**               THE DOME PLATE DEFINES THE UPPER PLENUM VOLUME
**-REV12-START-------------------------------------------------------------------
** REVISED VALUE BASED ON CORRECTED VALUE OF AGUP
**68  0.3326         HYDRAULIC DIAMETER IN THE UPPER PLENUM
68  0.2997        HYDRAULIC DIAMETER IN THE UPPER PLENUM
**-REV12-END---------------------------------------------------------------------
69  462.8        TOTAL HEAT TRANSFER AREA OF THE UPPER PLENUM INTERNALS
70  1.35E+06       CONVECTIVE (NON-RADIATIVE) HEAT LOSSES UNDER NOM CONDITIONS
**                  FROM STEAM GENERATORS, PRESSURIZER, AND REST OF PRIM. SYS.
**                  NOTE: DETAILED CALCULATIONS INDICATE THAT UNDER NORMAL
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**                  OPERATION, THE PRIMARY SYSTEM HEAT LOSS IS DUE VIRTUALLY
**                  ENTIRELY TO UNINSULATED PARTS OF THE SYSTEM (LOSS THROUGH
**                  INSULATION IS NEGLIGBLE); THUS THIS NUMBER
**                  SHOULD BE APPROXIMATELY THE TOTAL NOMINAL PRIMARY
**                  SYSTEM HEAT LOSS (SEE IDCOR REPORT 85-2 FOR DISCUSSION)
71  11              NO. OF PLATES IN PRIMARY SYSTEM REFLECTIVE INSULATION OR:
**                  ENTER 0 FOR CALCIUM SILICATE BULK INSULATION OR
**                  ENTER -1 FOR ROCK WOOL INSULATION--IF YOU HAVE A
**                  DIFFERENT TYPE OF INSULATION YOU SHOULD CONSIDER MODIFYING
**                  FUNCTION THCBUL WHICH SUPPLIES THE THERMAL CONDUCTIVITY
72  0.07625         TOTAL THICKNESS OF INSULATION--USED ONLY IF BULK
**                  INSULATION (NOT IF REFLECTIVE)
73  1.759           ELEVATION OF THE BASE OF THE CYLINDRICAL PART OF THE RV
74  21.75           VOLUME OF THE LOWER HEAD OF THE RV
75  290.0           TOTAL HEAT TRANSFER AREA OF LOWER CORE BARREL/THERMAL
**                  SHIELDS/BAFFLE ETC
**                  (IE THAT PORTION BELOW THE TOP OF THE CORE)
76  72.23           TOTAL HEAT TRANSFER AREA OF UPPER CORE BARREL
77  0.0033782       CLEARANCE BETWEEN FUEL RODS (ROD PITCH - OUTSIDE DIAMETER
**                  OF FUEL ROD)
************************************************************************
*PRESSURIZER
************************************************************************
01  42.48       PRESSURIZER VOLUME
02  6.138       PRESSURIZER CROSS-SECTIONAL AREA
03  1.4189E+07 PRESSURIZER HEATER PRESSURE SETPOINT
04  1.4217E+07 PRESSURIZER SPRAY PRESSURE SETPOINT
05  2.844       WATER LEVEL BELOW WHICH PZR HEATERS TRIP
06  1.500E+06   PRESSURIZER HEATER TOTAL OUTPUT--IN MAAP THE HEATERS
**              ARE EITHER ALL ON OR ALL OFF
07  18.04       SPRAY SYSTEM FLOW RATE
08  28.98       FLOW RATE OF SAFETY VALVE AT ITS SETPOINT
09  1.724E+07   LOWEST SETPOINT OF A SAFETY VALVE (OPENING PRESSURE)
10  1.779E+07   HIGHEST SETPOINT OF A SAFETY VALVE (OPENING PRESSURE)
11  0.2667      DIAMETER OF THE SURGE LINE
12  7.249       ELEVATION OF SPRAY HEAD ABOVE BOTTOM OF PZR
13  18.58       LENGTH OF THE SURGE LINE
14  3           NUMBER OF SAFETY VALVES
15  2.540E-03   NOMINAL PZR SPRAY DROPLET
16  1.5017+07   LOWEST SET POINT OF PORV (OPENING PRESSURE)
17  1.5320+07   HIGHEST SET POINT OF PORV (OPENING PRESSURE)
18  0           NUMBER OF PORVS
**-REV08-START------------------------------------------------------------
**19  19.28       NOMINAL FLOWRATE OF A PORV AT ITS SETPOINT
19  80.40       NOMINAL FLOWRATE OF A PORV AT ITS SETPOINT
**-REV08-END--------------------------------------------------------------
20  9.163E+04   EMPTY MASS OF PZR STEEL
21  0           ENTER A 1 IF THE SURGE LINE HAS A LOOP SEAL (EG TMI);
**              THIS PREVENTS COUNTER-CURRENT DRAINING OF PRESSURIZER
**              THROUGH SURGE LINE WHEN THE PRIMARY COOLANT LOOP SIDE
**              IS VOIDED (SEE WRITEUP FOR SUBROUTINE DRAIN)
22  6.138       SEDIMENTATION AREA
**PRESSURIZER RELIEFS ARE ASSUMED TO CLOSE AT PRESSURE PSET-PDEAD WHERE
**PSET IS THE OPENING PRESSURE DEFINED ABOVE AND PDEAD IS GIVEN BELOW
23  5.171E+05   DEADBAND ON PRESSURIZER SAFETY VALVES
24  4.623E+05   DEADBAND ON PRESSURIZER PORVS
25  3950.0      SURGE LINE MASS (BE SURE IS CONSISTENT WITH LENGTH GIVEN
**              ABOVE)
26  0.01270     DIAMETER OF HOLES IN THE SCREEN AT THE TOP OF SURGE LINE
27  792         NUMBER OF HOLES IN THE SCREEN AT THE TOP OF SURGE LINE
**
************************************************************************
*ICE CONDENSER("I" COMPARTMENT)
************************************************************************
01  0.0         TOTAL VOLUME INCLUDING THE ICE
**02 EXIT GAS TEMPERATURE--THIS IS THE TEMPERATURE OF GAS LEAVING THE
**   ICE BOX (SEE WRITE-UP FOR SUBROUTINE HTICE IN VOL 2 OF USER'S MAN)
**03 INITIAL TEMPERATURE OF THE ICE
**04 SPECIFIC VOLUME OF ICE--NOTE THE TOTAL VOLUME MINUS THE ICE MASS
**   TIMES THE SPEC VOL SHOULD BE THE FREE VOLUME
**05 FLOOR AREA OF WATER SUMP IN BOTTOM OF ICE CONDENSER
```

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**06 HEIGHT OF SUMP (IE CURB OVER WHICH WATER DRAINS INTO B)
**07 VERTICAL HEIGHT OF ICE BOX
**08 FLOW AREA BETWEEN LOWER COMPARTMENT AND THE ICE CONDENSER
**09 SEDIMENTATION AREA
**
**
**********************************************************************
*CAVITY (CCOMPT)
**********************************************************************
**THE CAVITY INCLUDES ALL THE VOLUME BELOW THE REATOR NOZZLES INSIDE
**THE BIOLOGICAL SHIELD AND ALL THE VOL OUT TO WHERE THE TUNNEL SLOPES UP
**
**NOTE THAT THE CAVITY HAS TWO FLOWPATHS--"TUNNEL" REFERS TO A WATER
**AND PERHAPS CORIUM FLOW PATH THAT ENTERS NEAR THE BASE OF THE CAVITY;
**"BYPASS" REFERS TO A FLOWPATH HIGHER IN THE CAVITY; THIS COULD BE THE
**AREA AROUND THE RV NOZZLES, OR IN THE CASE OF SOME PLANTS, BLOWOUT PANELS
**HIGHER IN THE CAVITY--THE BYPASS AREA IS ASSUMED TO EMPTY INTO B
**
**IN SOME PLANTS WATER CAN FLOW DOWN FROM THE REFUELING POOL TO THE CAVITY
**AND IN SOME, CORIUM CAN BE ENTRAINED UP TO THE UPPER COMPARTMENT AROUND
**THE RV ANNULUS--AT PRESENT GAS IS NOT EXCHANGED BETWEEN C AND A HOWEVER
**
**IN MANY SEQUENCES, NAT. CIRC. IS SET UP WHEREBY COLD GAS ENTERS THE
**CAVITY THROUGH THE TUNNEL, IS HEATED BY PASSING OVER CORIUM, AND LEAVES
**THROUGH THE BYPASS AREA
01  7.458       BYPASS (NON-TUNNEL) FLOW AREA COUPLING CAVITY TO LOWER/UPPER
**              COMPARTMENTS; THIS SHOULD BE THE LIMITING FLOW AREA, EG
**              THE AREA AROUND THE NOZZLES AS THEY PENETRATE THE BIOLOGICAL
**              SHIELD OR THE ANNULAR FLOW AREA BETWEEN THE RV AND THE SHIELD
02  35.32       AREA OF CAVITY POOL--THIS INCLUDES KEYWAY ETC WHERE APPLIC
**03  0.7031      NO LONGER USED.  SEE #20 AND #21 BELOW.
04  0.4032      HEIGHT OF VESSEL ABOVE BOTTOM OF CAVITY
05  1.001       TUNNEL CROSS-SECTNL AREA
06  17.12       LARGEST CHARAC CROSS-SECTNL AREA THAT CORIUM MUST
**              TRAVERSED ON ITS WAY TO THE OPENING WHERE IT MAY BE
**              ENTRAINED OR FLOODED TO COMPTS A OR B--IN PLANTS WITH
**              BOTTOM HEAD PENETRATIONS, THIS WILL TYPICALLY BE THE
**              "KEYWAY" AREA (THIS IS USED TO CALCULATE THE MINIMUM
**              VELOCITY WHICH CAN ENTRAIN THE CORIUM AND WATER)
**-REV10-START---------------------------------------------------------------
**07  170.9       CAVITY FREE VOLUME
** ARTIFICIALLY INCREASE THE CAVITY VOLUME TO PREVENT CAVITY FORM GOING SOLID
** THIS VOLUME IS SUBTRACTED FROM BCOMPT VOLUME TO BE CONSISTENT
07   350.9      CAVITY FREE VOLUME
**-REV10-END-----------------------------------------------------------------
08  9.8552      HEIGHT OF TOP OF TUNNEL ABOVE CAVITY FLOOR (MEASURED AT
**              CAVITY END OF THE TUNNEL IF IT SLOPES)
**              WHEN THE WATER LEVEL IN C EXCEEDS THIS VALUE, GAS TRANSFER
**              BETWEEN B AND C THROUGH THE TUNNEL IS PREVENTED (EXCEPT
**              WHEN THE DELTA-P  EXCEEDS THE STATIC HEAD OF WATER IN THE
**              TUNNEL EG AT VESSEL FAILURE)--THIS PREVENTS NAT CIRC THRU THE
**              CAVITY SINCE ONLY THE BYPASS FLOWPATH IS THEN AVAILABLE
09  157.3       AREA OF CAVITY OUTER WALLS
10  0.00635     LINER THICKNESS
11  0.015207    LINER GAP RESISTANCE
12  2.438       THICKNESS OF WALL (OR DEPTH TO BE MODELLED FOR HEAT
**              TRANSFER IF IT IS VERY DEEP)
13  3.459       THERMAL CONDUCTIVITY OF WALL
14  1076.0      SPECIFIC HEAT OF WALL
15  2440.0      DENSITY OF WALL
16  0           NUMBER OF IGNITION SOURCES IN C
17  0.0         AVG ELEVATION OF IGNITERS FROM THE FLOOR OF C
18  35.32       SEDIMENTATION AREA
19  1.001       MINIMUM FLOW AREA WHICH CONNECTS CAVITY TO LOWER COMPT
**              THROUGH TUNNEL--THIS IS USED TO DEFINE THE FLOW RESISTANCE
20  0.3334      CHARACTERISTIC RADIUS FOR BURN IN C
21  7.9248      CHARACTERISTIC HEIGHT FOR BURN IN C
**
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*ENGINEERED SAFEGUARDS
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**METRIC UNITS:
**FLOWRATES SPECIFIED TO BE VOLUMETRIC SHOULD BE M**3/SEC; OTHER FLOWRATES
**IE ALL THOSE NOT EXPLICITLY STATED TO BE VOLUMETRIC
**SHOULD BE KG/SEC; HEADS SHOULD BE IN M; PRESSURES IN PA
**ENGLISH UNITS:
**RESPECTIVELY GPM,LBM/HR,FT, PSIA--
**NOTE TO MAAP/BWR USERS--GPM IS USED IN MAAP/PWR INSTEAD OF FT**3/HR
**
**IN THE FOLLOWING,"FANS"REFER TO FAN COOLERS--(AIR RETURN FANS IN
**CONDENSER PLANTS)
**
**FOR BETTER ACCURACY, YOU MAY ELECT TO INPUT "SYSTEM" PUMP HEAD CURVES WHICH
**INCLUDE THE EFFECTS OF FRICTION IN THE INLET AND OUTLET PIPING (WHICH IS
**IGNORED IN MAAP); IF YOU DO SO, BE SURE THE ASSUMPTIONS ON STATIC HEAD
**WHICH ARE USED IN THEIR CALCULATION ARE CONSISTENT WITH THE PUMP ELEVATIONS
**ETC. WHICH ARE INPUT BELOW--THIS IS GENERALLY A FACTOR ONLY IN CRITICAL
**APPLICATIONS SUCH AS FEED AND BLEED WHERE THE CHARGING PUMP FLOW IS
**BARELY (OR NOT) ADEQUATE TO MATCH DECAY HEAT
01   0.26670     ACCUMULATOR PIPE DIAMETER
02   1.0983E+07 PRESSURE SETPOINT FOR LPI
03   1.0983E+07 PRESSURE SETPOINT FOR HPI
04   1.4800E+06 INITIAL PRESSURE OF ACCUMULATORS
05   310.9       TEMPERATURE OF REFUELING WATER STORAGE TANK (RWST)--IE
**               THE TANK FROM WHICH THE CHARGING, HPI, LPI, AND SPRAYS
**               DRAW THEIR WATER DURING THE INJECTION PHASE
06   332.1       TEMPERATURE OF ACCUMULATORS
**BAB 11/12/01 '07   1.016E+06(old)INITIAL MASS IN RWST'
07   8.36996E+05 INITIAL MASS IN RWST
08   3.416E+04  INITIAL MASS PER COLD LEG ACCUMULATOR
09   154.4       AREA OF BASE OF RWST
10   61.92       LENGTH OF AN ACCUMULATOR PIPE
11   1.3169E+05 PRESSURE SETPOINT OF BLDG SPRAYS
12   1.3169E+05 PRESSURE SETPOINT OF BLDG FANS
13   3           NUMBER OF OPERATING FAN COOLERS OR FANS
**BAB 12/11/01 '14   17.70(old) VOLUMETRIC FLOW THROUGH ONE FAN COOLER OR FAN
14   14.16       VOLUMETRIC FLOW THROUGH ONE FAN COOLER OR FAN
15   1.000E-03  NOMINAL DIAMETER OF CONTAINMENT SPRAY DROPLETS AS THEY
**               LEAVE THE SPRAY HEADER
16   60.41       VOLUME OF ONE COLD LEG ACCUMULATOR
17   4           NUMBER OF OPERATIONAL COLD LEG ACCUMULATORS
18   2           NUMBER OF OPERATIONAL HPI PUMPS
19   2           NUMBER OF OPERATIONAL LPI PUMPS
20   5           NUMBER OF ENTRIES USED IN HPI PUMP-HD CURVE TABLE(5 MAX)
** BAB 12/11/01 Update the HPSI System Injection Head Curve Based
** on EA-SDW-95-0001 r2 Table 12 Case 1A
**21   882.1       HIGHEST HEAD IN TABLE (UNITS ARE METERS)
**22   848.1       NEXT HIGHEST HEAD IN HPI PUMP-HEAD CURVE TABLE
**23   722.8       NEXT HIGHEST HEAD IN HPI PUMP-HEAD CURVE TABLE
**24   439.6       NEXT HIGHEST HEAD IN HPI PUMP-HEAD CURVE TABLE
**25   10.6        LOWEST HEAD IN HPI PUMP-HEAD CURVE TABLE
**26   0.0         VOLUMETRIC FLOWRATE CORESPONDING TO FIRST ENTRY IN
**                 THE PRESSURE TABLE
**27   1.02E-02  NEXT VOL. FLOWRATE
**28   2.031E-02  NEXT VOL. FLOWRATE
**29   3.003E-02  NEXT VOL. FLOWRATE
**30   4.353E-02  NEXT VOL. FLOWRATE
21   850.1       HIGHEST HEAD IN TABLE (UNITS ARE METERS)
22   842.3       NEXT HIGHEST HEAD IN HPI PUMP-HEAD CURVE TABLE
23   718.4       NEXT HIGHEST HEAD IN HPI PUMP-HEAD CURVE TABLE
24   435.2       NEXT HIGHEST HEAD IN HPI PUMP-HEAD CURVE TABLE
25   10.4        LOWEST HEAD IN HPI PUMP-HEAD CURVE TABLE
26   0.0         VOLUMETRIC FLOWRATE CORESPONDING TO FIRST ENTRY IN
**               THE PRESSURE TABLE
27   3.700E-03  NEXT VOL. FLOWRATE
28   1.666E-02  NEXT VOL. FLOWRATE
29   2.860E-02  NEXT VOL. FLOWRATE
30   3.980E-02  NEXT VOL. FLOWRATE
** BAB 12/11/01 Update the LPSI System Injection Head Curve Based
** on EA-SDW-95-0001 r2 Table 14 Case 2A
**31   5           NUMBER OF ENTRIES USED IN LPI TABLE
**32   125.0       HIGHEST HEAD IN LPI TABLE
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**33   121.9       NEXT HEAD
**34   106.7       NEXT HEAD
**35   77.72       NEXT HEAD
**36   10.6        NEXT HEAD
**37   0.0         FIRST VOLUMETRIC FLOWRATE IN TABLE
**38   1.262E-01   NEXT VOL. FLOWRATE
**39   2.050E-01   NEXT VOL. FLOWRATE
**40   2.934E-01   NEXT VOL. FLOWRATE
**41   2.997E-01   NEXT VOL. FLOWRATE
31   5           NUMBER OF ENTRIES USED IN LPI TABLE
32   130.1       HIGHEST HEAD IN LPI TABLE
33   127.2       NEXT HEAD
34   98.9        NEXT HEAD
35   63.5        NEXT HEAD
36   10.4        NEXT HEAD
37   0.0         FIRST VOLUMETRIC FLOWRATE IN TABLE
38   0.346E-01   NEXT VOL. FLOWRATE
39   1.132E-01   NEXT VOL. FLOWRATE
40   1.615E-01   NEXT VOL. FLOWRATE
41   2.112E-01   NEXT VOL. FLOWRATE
42   1.0983E+07 CHARGING PUMP PRESSURE SETPOINT
43   3           NUMBER OF WORKING CHARGING PUMPS
44   1           NUMBER OF ENTRIES IN CHARGING PUMP HEAD CURVE TABLE
45   2108.5      FIRST HEAD
** HEADS 46-49 ARE NOT USED
50   0.002797    FIRST VOL. FLOWRATE
** VOL. FLOWS 51-54 ARE NOT USED
55   35.32       AREA OF BASE OF CONTMT SUMP
56   1.524       DEPTH OF CONTMT SUMP
** NOTE, IF DESIRED YOU CAN SUPPLY ONE NUMBER--IF DO SO GIVE IT A LARGE
** HEAD, THEN A CONSTANT FLOW MODEL WILL BE USED
57   5           NUMBER OF USED ENTRIES IN SPRAY PUMP HEAD CURVES (5 MAX)
58   146.44      FIRST ENTRY IN SPRAY PUMP HEAD TABLE
59   140.95      NEXT HEAD
60   115.46      NEXT HEAD
61    73.68      NEXT HEAD
62    30.28      NEXT HEAD
63   0.0         FIRST VOLUMETRIC FLOW ENTRY IN SPRAY PUMP TABLE
64   1.577E-02   NEXT VOL. FLOWRATE
65   3.758E-02   NEXT VOL. FLOWRATE
66   6.309E-02   NEXT VOL. FLOWRATE
67   8.201E-02   NEXT VOL. FLOWRATE
** FOR NPSH TABLES, THE SAME FLOWS AS WERE GIVEN FOR HEAD CURVES ARE
** ASSUMED TO CORRESPOND TO THE NPSH HEADS GIVEN
68   2.031        NPSH (UNITS OF LENGTH) REQ'D FOR CHARGING PUMP
**                AT FIRST FLOW IN TABLE
** NPSH 69-72 ARE NOT USED
73   3.048        FIRST NPSH ENTRY FOR LPI
74   3.048        NEXT ENTRY FOR LPI
75   3.429        NEXT ENTRY FOR LPI
76   6.096        NEXT ENTRY FOR LPI
77   7.315        NEXT ENTRY FOR LPI
78   1.524        FIRST NPSH ENTRY FOR HPI
79   2.268        NEXT ENTRY FOR HPI
80   2.743        NEXT ENTRY FOR HPI
81   3.658        NEXT ENTRY FOR HPI
82   6.706        NEXT ENTRY FOR HPI
83   3.048        FIRST NPSH ENTRY FOR SPRAY PUMPS
84   3.277        NEXT ENTRY FOR SPRAY PUMPS
85   4.001        NEXT ENTRY FOR SPRAY PUMPS
86   5.791        NEXT ENTRY FOR SPRAY PUMPS
87   7.239        NEXT ENTRY FOR SPRAY PUMPS
88   3            NUMBER OF OPERATING SPRAY PUMPS FOR UPPER COMPARTMENT
89   0            NUMBER OF OPERATING SPRAY PUMPS FOR LOWER COMPARTMENT
**BAB 11/12/01 '90   22.12(old) HEIGHT OF BOTTOM OF RWST ABOVE THE ENG SAFE PUMPS'
90   22.8         HEIGHT OF BOTTOM OF RWST ABOVE THE ENG SAFE PUMPS
**BAB 11/12/01 '91   3.3274(old)HEIGHT OF BOTTOM OF CONTAIN SUMP ABOVE THE ENG SAFE PUMPS'
91   4.13         HEIGHT OF BOTTOM OF CONTAIN SUMP ABOVE THE ENG SAFE PUMPS
**BAB 11/12/01 '92   13.91(old)ELEVATION OF THE RV INJECTION NOZZLES ABOVE THE SI PUMPS
92   14.25        ELEVATION OF THE RV INJECTION NOZZLES ABOVE THE SI PUMPS
93   1.00         FLOW THROUGH ONE SPRAY PUMP WHEN ITEM 94 IS MEASURED
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94   0.0         DIFFERENTIAL PRESSURE ACROSS THE SPRAY NOZZLES
95   0.0         MASS FLOWRATE OF EXTERNAL RWST REPLACEMENT WATER, IF ANY
96   5.0         TIME DELAY FOR HPI (IE TIME BETWEEN THE ACTUATION AND WHEN
**               ACTUAL OPERATION BEGINS)
97   5.0         TIME DELAY FOR LPI
98   5.0         TIME DELAY FOR CHARGING PUMPS
99   65.0        TIME DELAY FOR UPPER COMPARTMENT SPRAYS
**100  N/A       TIME DELAY FOR LOWER COMPARTMENT SPRAYS
101  0.0         TIME DELAY FOR FAN COOLERS
102  1536        NUMBER OF TUBES IN A FAN COOLER
**-REV11-START--------------------------------------------------------------
** MODIFIY TUBE AREA SO FANCLR MODEL GETS DESIGN HEAT TRANS RATE
**103  116.7       OUTSIDE AREA OF ALL TUBES IN A FAN COOLER
103  190.0       OUTSIDE AREA OF ALL TUBES IN A FAN COOLER
**-REV11-END----------------------------------------------------------------
104  1699.0.     AREA OF ALL FINS IN A FAN COOLER
105  0.78        FAN COOLER FIN EFFICIENCY
106  1.763E-04   FAN COOLER INSIDE FOULING FACTOR
107  0.064552    FAN COOLER FIN DIAMETER
108  0.001245    FAN COOLER TUBE THICKNESS
109  383.9       FAN COOLER TUBE THERMAL CONDUCTIVITY
110  7.432       MINIMUM FLOW AREA THROUGH FAN COOLER
111  0.01339     FAN COOLER TUBE ID
112  5           NUMBER OF NODES USED TO MODEL FAN COOLER (5 MAX)
113  322.1       INLET COOLING WATER TEMP TO FAN COOLER--NOTE THIS IS
**               ALSO USED AS THE COOLING WATER TEMP FOR ALL OTHER
**               SAFEGUADS HEAT EXCHANGERS
114  80.19       INLET COOLING WATER FLOW TO A FAN COOLER
115  0           NUMBER OF LPI PUMPS USED FOR RHR SPRAYS WHEN VALVE OPEN
116  1           ENTER A 1 IF FANS/COOLERS DISCHARGE TO B;0 TO D
**
**ESF HX'S
**CALCULATIONS CONTROLLED BY HEAT EXCHANGER TYPE
**HEAT EXCHANGER TYPE:
**    -1    SET OUTLET TEMP OF HX TO RWST TEMPERATURE
**     0    IS NO HX--OUTLET TEMP IS CONTMT SUMP TEMP
**     1    STRAIGHT TUBE HX
**     2    U-TUBE HX
**
**IMPORTANT NOTE:
**FOR HX TYPES 1 AND 2 EITHER SUPPLY ALL GEOMETRIC PARAMETERS
**OR THE NTU (NUMBER OF TRANSFER UNITS) PER HX--ALL KNOWN USERS DO
**THE LATTER--NTUS ARE AVAILABLE BY CONSULTING NAMEPLATE DATA AND
**USING GRAPHS IN, FOR EXAMPLE, HOLMAN, HEAT TRANSFER
**ALL PARAMETERS ARE ON A PER HX BASIS
**
117  2           TYPE OF HX FOR SPRAY
118  0           NUMBER OF TUBES IN SPRAY HXS
119  0           NUMBER OF SHELL SIDE BAFFLES IN SPRAY HXS
120  0.0         SPRAY HX TUBE ID
121  0.0         SPRAY HX TUBE THICKNESS
122  0.0         TUBE TO TUBE SEPARATION IN SPRAY HX
123  0.0         SHELL LENGTH IN SPRAY HX
124  0.0         THERMAL CONDUCTIVITY OF SPRAY HX TUBES
125  0.0         LARGEST PERP DISTANCE FROM SHELL TO BAFFLE ("BAFFLE CUT")
126  0.0         SHELL TO TUBE CLEARANCE AT OUTSIDE OF SPRAY HX TUBE BDL
127  105.13      SPRAY HX COOLING WATER MASS FLOWRATE
128  1.0E+06     PRESSURIZER LEVEL SETPOINT FOR MAKEUP CONTROL SYSTEM, OR
**               A LARGE NO. IF YOU DON'T WANT TO CONTROL MAKEUP AND/OR
**               CHARGING PUMP FLOW ON PRESSURIZER LEVEL
129  0           TYPE OF HX FOR RHR
130  0           NUMBER OF TUBES IN RHR HXS
131  0           NUMBER OF BAFFLES IN RHR HXS
132  0.0         TUBE ID IN RHR HXS
133  0.0         TUBE THICKNESS IN RHR HXS
134  0.0         TUBE TO TUBE SEPERATION IN RHR HXS
135  0.0         SHELL LENGTH IN RHR HXS
136  0.0         TUBE THERMAL CONDUCTIVITY IN RHR HXS
137  0.0         BAFFLE CUT DISTANCE IN RHR HXS (SEE 125)
138  0.0         SHELL TO TUBE CLEARANCE AT OUTSIDE OF RHR HX TUBE BUNDLE
139  0.0         RHR HX COOLING WATER MASS FLOWRATE
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140  1.380        SPRAY HX NTU
141  0.0          RHR HX NTU
142  0.0          SHELL ID OF SPRAY RECIRC HX
143  0.0          SHELL ID OF RHR RECIRC HX
**ENTER ZERO VOLUME FOR ITEM 148 IF NO UHI SYSTEM
**144               INITIAL MASS IN THE UHI WATER ACCUMULATOR
**145               LENGTH OF THE UHI PIPE TO THE RV
**146               DIAMETER OF THE UHI PIPE
**147               INTIAL PRESSURE OF THE UHI ACCUMULATOR
148  0.0          TOTAL (WATER + GAS) VOLUME IN THE UHI ACCUMULATORS
**149               FAILURE DIFFERENTIAL PRESSURE OF THE UHI PIPE RUPTURE DISK
**THE "CAVITY INJECTION SYSTEM" IS (RARELY) USED TO SIMULATE A
**PROPOSED DEDICATED ESF WHICH MERELY DUMPS WATER INTO THE CAVITY
150  0.0          TOTAL MASS IN THE CAVITY INJECTION SYSTEM TANK
151  0.0          MASS FLOWRATE OF THE CAV INJ SYSTEM WHEN ACTIVATED
**    USER HAS THE OPTION TO THROTTLE ESF SYSTEMS AT LESS THAN
**    THEIR FULL FLOW GIVEN THE CONDITIONS EXISTING--TO DO THIS,
**    ENTER FOR THE APPROPRIATE SYSTEM (AND FOR THE AFW IN THE STM
**    GENERATOR SECTION) A TOTAL FLOWRATE DESIRED; THE CODE WILL USE
**    THE MINIMUM OF THIS FLOW AND THAT CALCULATED FROM THE HEAD CURVES
**    AND THE NO. OF OPERATIONAL PUMPS;IF OPERATOR ISN'T THROTTLING,
**    ENTER A LARGE NO.;IF HE CHANGES THE DEGREE OF THROTTLING, ENTER
**    PARAMETER CHANGES USING INTERVENTION NO. 1000 IN CONTROL CARDS
152  1000.0       THROTTLED FLOW FOR LPI SYSTEM (TOTAL)
153  1000.0       SAME FOR HPI
154  1000.0       SAME FOR CHARGING PUMPS
155  1000.0       SAME FOR UPPER COMPT NORMAL SPRAYS
156  1000.0       SAME FOR UPPER COMPT RHR SPRAYS (WHEN ACTIVATED)
157  0.0          SAME FOR LOWER COMPT SPRAYS
158  5            NO. OF POINTS USED IN AFW PUMP-HEAD CURVE (5 MAX)
159  0.0          FIRST VOL FLOW IN PUMP-HEAD CURVE
160  2.555E-02    NEXT VOL. FLOWRATE
161  4.164E-02    NEXT VOL. FLOWRATE
162  6.389E-02    NEXT VOL. FLOWRATE
163  6.624E-02    NEXT VOL. FLOWRATE
164  882.4        FIRST HEAD IN AFW PUMP-HEAD CURVE
165  830.6        NEXT HEAD
166  662.9        NEXT HEAD
167  259.1        NEXT HEAD
168  10.6         NEXT HEAD
169  1.894E+05    AREA OF BASE OF CST
170  4.966        DISTANCE THAT CST IS ABOVE AFW PUMPS
171  20.21        DISTANCE THAT S/G IS ABOVE AFW PUMPS
**
***********************************************************************
*UPPER COMPARTMENT (OR "A" COMPT)
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01  34040.0     FREE VOLUME
02  111.6       AREA OF REFUELING POOL
03  33.34       HEIGHT OF CONTAINMENT SPRAY HEAD ABOVE BOTTOM OF COMPARTMENT
04  134.7       FLOW AREA FROM UPPER COMPARTMENT INTO ANNULAR COMPT
**05  299.3       NO LONGER USED.  SEE #51 AND #52 BELOW.
**              CALCS--EG THE BURN TIME IS THE SQUARE ROOT OF THIS
**              AREA DIVIDED BY THE BURN VELOCITY
06  0.0         CURB HEIGHT IN REFUELING POOL TO ALLOW OVERFLOW--NORMALLY
**              0 UNLESS YOU ASSUME REFUELING POOL DRAINS ARE BLOCKED (A
**              CLASSICAL ICE CONDENSER SEQUENCE), THEN MAKE IT LARGE
07  4639.0      SURFACE AREA OF OUTER WALLS IN UPPER COMPARTMENT
08  0.006350    LINER THICKNESS ON OUTER WALL
09  0.019369    OUTER WALL LINER GAP RESISTANCE--SEE NOTE IN *LOWER COMPT
**              FOR HOW TO MODEL FREE STANDING STEEL CONTMTS WITH A SHIELD
**              WALL
10  1.015       OUTER WALL TOTAL THICKNESS
11  3.459       THERMAL CONDUCTIVITY OF OUTER WALL (FOR CONCRETE STRUCTURES
**              WITH A LINER, THIS REFERS TO THE CONCRETE PART)
12  1076.0      SPECIFIC HEAT OF OUTER WALL
13  2440.0      DENSITY OF OUTER WALL
14  0           ENTER A 1 IF THE OUTER WALL IS SOLID STEEL (IE A STEEL CONTMT
**              WITH NO SHIELD BUILDING), 0 FOR CONCRETE WITH OR W/O LINER
15  914.9       HALF AREA (WALLS MODELED AS 1-D SLABS) OF INTERNAL WALLS
16  0.004763    LINER THICKNESS ON INTERIOR WALL, IF ANY
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17  0.019369   LINER GAP RESISTANCE IN INTERIOR WALL
18  0.9138     THICKNESS OF INTERNAL WALLS
19  418.9      DECK AREA
20  0.0        LINER THICKNESS ON DECK
21  0.0        LINER GAP RESISTANCE ON DECK
22  0.7620     DECK THICKNESS
23  3.459      THERMAL CONDUCTIVITY OF DECK
24  1076.0     SPECIFIC HEAT OF DECK
25  2440.0     DENSITY OF DECK
26  0          ENTER A 1 IF THE DECK IS SOLID STEEL, 0 FOR CONCRETE
27  4.881E+05  METAL EQPT MASS
28  4797.0     EQPT HEAT TRANSFER AREA
29  0          NUMBER OF IGNITION SOURCES IN UPPER COMPT (A COMPARTMENT)
30  0.0        AVERAGE ELEVATION OF IGNITERS FROM THE FLOOR OF A
**FOLLOWING PARAMETERS ARE USED TO DETERMINE WHICH IGNITERS OR IGNITION
**SOURCES IN THE LOWER, ANNULAR, OR UPPER PLENUM CAN INITIATE BURNS IN
**THEIR RESPECTIVE COMPARTMENTS WHICH CAN THEN PROPAGATE INTO THE UPPER
**COMPARTMENT--IF NO IGNITERS IGNORE 31-33
31  0          NO. OF IGNITERS/IGN SOURCES IN B WHICH CAN BE SEEN FROM A
32  0          NO. OF IGNITERS/IGN SOURCES IN D WHICH CAN BE SEEN FROM A
33  39.62      DISTANCE FROM THE TOP OF A TO THE DECK
34  0.8628     FRACTION OF UPPER COMPT SPRAY WATER THAT RUNS INTO THE
**             REFUELING POOL (VS. CONTINUING ON DIRECTLY INTO LOWER COMPT)
35  0.2189     FRACTION OF WATER DRAINING OUT OF REFUELING POOL THAT
**             GOES INTO LOWER COMPT (REMAINING FRACTION RUNS INTO THE
**             CAVITY)
**INPUTS FOR SIMPLE (FAILURE PRESSURE SUPPLIED) OR DETAILED (CONTMT STRAINS
**CALCULATED) MODELS FOR CONTAIMENT FAILURE--SEE GENERAL NOTES ABOVE
36  1.0756E+06 FAILURE PRESSURE OF CONTAINMENT OR 0 TO USE DETAILED MODEL
37  1          ENTER A 1 IF CONTMT FAILS IN UPPER COMPT;0 FOR
**             FAILURE IN THE ANNULAR COMPT (USED ONLY FOR THE SIMPLE MODEL)
38  18.5166    CONTAINMENT RADIUS FOR STRESS CALCULATIONS
39  2.111E-06  EQUIVALENT AREA TO CALCULATE CONTAINMENT NORMAL LEAKAGE--
**             NORMAL LEAKAGE IS ASSUMED TO COME FROM THE ANNULAR COMPT;
**             GIVEN A DESIGN LEAKAGE, THE AREA SHOULD BE CALCULATED BY
**             USING CHOKED GAS FLOW FORMULA SHOWN IN SUBROUTINE GFLOW
**             WRITEUP
40  0.0        MASS OF WATER IN NEUTRON SHIELD BAGS--WHEN BAGS RUPTURE
**             THEY DROP THEIR CONTENTS INTO REFUELING POOL
41  837.8      SEDIMENTATION AREA FOR FISSION PRODUCT SETTLING
**THE REST OF THESE ARE NEW
42  151        NUMBER OF TENDONS IN HOOP DIRECTION IN THE LENGTH OF WALL
**             GIVEN IN ITEM 43
43  0.01211    VOLUME OF REBAR PER UNIT AREA OF OUTER WALL (EQUIV THICKNESS)
**             RUNNING IN THE HOOP DIRECTION
44  0.01420    VOLUME OF REBAR PER UNIT AREA OF OUTER WALL (EQUIV THICKNESS)
**             RUNNING IN THE Z DIRECTION
45  0.060242   DIAMETER OF HOOP TENDONS
46  27.432     HEIGHT OF THE CYLLINDRICAL PART OF THE CONTAINMENT WALL ABOVE
**             THAT PART OF THE WALL REPRESENTED IN DCOMPT ITEM NO. 5
**             (EG APPROX THAT ABOVE THE OPERATING DECK)
47  6.61       HEIGHT OF INTERNAL WALLS
48  0.35       DISPLACEMENT IN AXIAL DIRECTION WHICH IS SUFFICIENT TO TEAR
**             THE CONTMT WALL (EG AT A PENETRATION)
49  0.15       SAME AS 48 FOR THE RADIAL DIRECTION
50  1.0        AVG VERTICAL HEIGHT OF THE METAL EQPT IN ACOMPT THAT IS
**             REPRESENTED BY THE MASS ENTERED IN ITEM 27
51  18.288     CHARACTERISTIC RADIUS OF UPPER COMPT FOR H2 BURNS
52  21.336     CHARACTERISTIC HEIGHT OF UPPER COMPT FOR H2 BURNS
**             THIS IS FLOOR TO CEILING (NOT IGNITER TO CEILING)
**
***********************************************************************
*LOWER COMPARTMENT (OR "B" COMPT)
***********************************************************************
01  17.98      DISTANCE FROM FLOOR TO TOP OF B COMPARTMENT
02  160.3      AREA OF CORIUM POOL; THIS MUST BE LESS THAN THE AREA OF
**             THE FLOOR (ENTERED BELOW)
03  7.9248     HEIGHT OF CURB ON FLOOR (OVER WHICH WATER OVERFLOWS TO C)
**04  13.90      NO LONGER USED.  SEE #44 AND #45 BELOW.
**-REV10-START--------------------------------------------------------------
** BORROWING A SMALL VOLUME TO PREVENT THE CAVITY FROM GOING SOLID
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**05  6293.0      FREE VOLUME
05  6113.0      FREE VOLUME
**-REV10-END-----------------------------------------------------------------
06  7.912       VERTICAL DISTANCE FROM THE CAVITY BYPASS FLOW AREA
**              (EG AREA AROUND VESSEL NOZZLES BUT SEE DEFINITION
**              IN CAVITY SECTION BELOW) TO THE CENTER OF THE CAVITY END
**              OF THE TUNNEL FLOW AREA
07  2.057       DISTANCE FROM THE FLOOR OF A TO THE OPENING FROM B INTO D
08  0           FOR CASES WHERE THE OUTER BOUNDARY OF CONTMT IS A
**              STEEL SHELL SEPERATED FROM A CONCRETE SHIELD WALL,
**              ENTER DISTANCE BETWEEN THE TWO AND TREAT THE STEEL
**              SHELL AS A LINER (ACOMPT AND DCOMPT OUTER WALLS)--
**              ENTER 0 OTHERWISE
**OUTER WALL OF B DIVIDES IT FROM COMPT D
09  1163.0      AREA OF OUTER WALL
10  0.0         OUTER WALL LINER THICKNESS
11  0.0         GAP RESISTANCE OF OUTER WALL LINER
12  0.8376      THICKNESS OF OUTER WALL
13  3.459       THERMAL CONDUCTIVITY OF OUTER WALL
14  1076.0      SPECIFIC HEAT OF OUTER WALL
15  2440.0      DENSITY OF OUTER WALL
16  0           ENTER 1 IF THE OUTER WALL IS SOLID STEEL, 0 FOR CONCRETE
**NOTE THAT CORIUM IN B IS ASSUMED TO SEE ONLY ONE FACE OF THE INTERIOR
**WALL FOR RADIATION CALCULATIONS
17  421.9       HALF SURFACE AREA OF INTERIOR WALL
18  0.0         INTERIOR WALL LINER THICKNESS
19  0.0         GAP RESISTANCE OF BUILDING INTERIOR WALL LINER
20  1.870       THICKNESS OF INTERIOR WALLS
21  3.459       THERMAL CONDUCTIVITY OF INTERIOR WALLS
22  1076.0      SPECIFIC HEAT OF INTERIOR WALLS
23  2440.0      DENSITY OF INTERIOR WALLS
24  210.13      AREA OF FLOOR (USE WATER POOL AREA IF LESS)
25  0.0         FLOOR LINER THICKNESS
26  0.0         GAP RESISTANCE OF FLOOR LINER
27  1.169       THICKNESS OF FLOOR (TRUE THICKNESS = 3.756 M)
28  3.459       THERMAL CONDUCTIVITY OF FLOOR
29  1076.0      SPECIFIC HEAT OF FLOOR
30  2440.0      DENSITY OF FLOOR
31  5.135E+05   MASS OF EQUIPMENT--THIS REFERS TO EQPT INTERNAL TO THIS
**              REGION;
**              THE PRIMARY SYSTEM MASS SHOULD NOT BE INCLUDED SINCE IT
**              HAS A SPECIFIC TREATMENT ELSEWHERE
32  6538.0      HEAT TRANSFER AREA OF EQPT
**QUANTITY 33 IS USED FOR ALL EXTERNAL WALLS
33  29.5        HEAT TRANSFER COEFFICIENT TO BE USED ON THE OUTER SURFACE
**              OF THE CONTAINMENT OUTER WALLS (EG IN A AND D)
**34 NOT USED
35  0.0         FRACTIONAL AREA AVAILABLE FOR REVERSE FLOW ON B-I FLOWPATH
**              COMPARED TO THE FORWARD DIRECTION(EG DUE TO ICE
**              CONDENSER DOOR(S) SHUTTING)--THIS NO. MUST
**              BE NONZERO AND POSITIVE IN ICE CONDENSER PLANTS--IGNORED IN
**              LARGE, DRY CONTMTS
36  1.0         FRACTIONAL AREA AVAILABLE FOR REVERSE FLOW ON A-D FLOWPATH
**              (EG AIR RETURN FAN FLOW DAMPERS IN ICE CONDENSERS)
**              ENTER 1 IF NO DAMPER
37  211.3       FLOW AREA FROM B INTO D
38  173.0       FLOW AREA FROM B TO A
39  0           NUMBER OF IGNITERS/IGNITION SOURCES IN B
40  0.0         AVG ELEVATION OF IGNITERS FROM THE FLOOR OF B
41  0.0         HEIGHT OF FLOOR OF B ABOVE FLOOR OF C
42  622.8       SEDIMENTATION AREA
43  1.0         AVG VERTICAL HEIGHT OF THE METAL EQPT IN BCOMPT THAT IS
**              REPRESENTED BY THE MASS ENTERED IN ITEM 31
44  14.935      CHARACTERISTIC RADIUS OF LOWER COMPT FOR H2 BURNS
45  17.983      CHARACTERISTIC HEIGHT OF LOWER COMPT FOR H2 BURNS
**
*********************************************************************
*ANNULAR COMPARTMENT ("D" COMPARTMENT)
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**
**IN LARGE DRY CONTAINMENTS:
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**THIS COMPARTMENT REPRESENTS THE VOLUME BETWEEN THE CRANE WALL (IF ANY)
**AND THE CONTMT WALL, AND BETWEEN THE DECK AND THE LOWER COMPT FLOOR--
**IF NO CLEAR DISTINCTION, ARBITRARILY DIVIDE THE SPACE BELOW THE UPPER
**COMPT AND USE LARGE FLOW AREAS TO KEEP THE GAS WELL MIXED--AT PRESENT,
**CORIUM IS ASSUMED NOT TO GET INTO THIS COMPARTMENT
**
**IN ICE CONDENSERS: THIS VOLUME REFLECTS THE "DEAD-END" COMPARTMENTS
01  5936.0     FREE VOLUME
02  292.7      AREA OF WATER POOL
03  0.0        DISTANCE THE FLOOR OF D IS ABOVE THE FLOOR OF B
**04  2.691       NO LONGER USED. SEE #28 AND #29 BELOW.
05  1756.0     AREA OF EXTERIOR WALLS
06  0.006350   WALL LINER THICKNESS
07  0.019369   GAP RESISTANCE OF WALL LINER
08  1.015      THICKNESS OF WALL
09  3.459      THERMAL CONDUCTIVITY OF WALL
10  1076.0     SPECIFIC HEAT OF WALL
11  2440.0     DENSITY OF WALL
12  0          ENTER A 1 IF THE OUTER WALL (CONTMT OUTER BOUNDARY)
**             IS MADE OF STEEL
13  0.0        HEIGHT OF CURB SEPERATING D AND B MEASURED FROM B'S FLOOR
14  0          NUMBER OF IGNITERS OR IGNITION SOURCES IN D
15  0.0        AVG ELEVATION OF IGNITERS FROM THE FLOOR OF D
16  521.9      SEDIMENTATION AREA
**THE NEXT THREE PARAMETERS ARE USED TO DEFINE THE EFFICIENCY OF
**INERTIAL IMPACTION
**IN LARGE, DRY'S THESE PARAMETERS SHOULD CHARACTERIZE
**GRATES WHICH ARE ASSUMED TO BE IN THE ANNULAR COMPARTMENT
**
**IN ICE CONDENSER PLANTS, THESE PARAMETERS (EVEN THOUGH LOCATED
**IN THE ANNULAR COMPARTMENT DATA SECTION) SHOULD REFLECT IMPACTION AND
**FLOW AREAS AND STRAP  WIDTHS IN THE ICE BOX--SEE EG POSTMA
17  33.75      IMPACTION AREA (AREA OF BARS IN GRATES THAT INTERCEPT FLOW)
18  0.00318    WIDTH OF GRATE BARS
19  134.7       TOTAL UPWARD GAS FLOW AREA IN THE COMPT AT THE ELEVATION
**              OF THE GRATING (USED TO CALCULATE THE GAS VELOCITY THROUGH
**              THE GRATING GIVEN MASS FLOWS THROUGH THE COMPT)--IF DIFFERENT
**              ELEVATIONS ON WHICH GRATING IS FOUND HAVE DIFFERENT TOTAL
**              FLOW AREAS, USE THE LARGEST TO GIVE SLOWEST VELOCITY FOR
**              CONSERVATISM
**NOTE: IF MORE THAN ONE LEVEL OF GRATES EXISTS, USE THE TOTAL IMPACTION AREA
**OF ALL THE GRATES, AND THE MAXIMUM FLOW AREA AT ANY OF THE GRATE ELEVATIONS
**AS NOTED ABOVE
**DETAILED CONTAINMENT FAILURE MODEL INPUTS--IGNORE IF SIMPLE MODEL
**USED
20  99         NUMBER OF TENDONS IN HOOP DIRECTION IN THE PART OF THE WALL
**             WHOSE AREA IS GIVEN IN ITEM 5 ABOVE
21  259        NUMBER OF TENDONS WHICH RUN IN THE AXIAL (VERTICAL) DIRECTION
22  0.01211    VOLUME OF REBAR PER UNIT AREA OF OUTER WALL (EQUIV THICKNESS)
**             RUNNING IN THE HOOP DIRECTION
23  0.060242   DIAMETER OF HOOP TENDONS
24  0.060242   DIAMETER OF THE AXIAL TENDONS
25  0.01420    VOLUME OF REBAR PER UNIT AREA OF OUTER WALL (EQUIV THICKNESS)
**             RUNNING IN THE AXIAL DIRECTION
26  0.35       DISPLACEMENT IN AXIAL DIRECTION WHICH IS SUFFICIENT TO TEAR
**             THE CONTMT WALL (EG AT A PENETRATION)
27  0.15       SAME AS 26 FOR THE RADIAL DIRECTION
28  3.3528     CHARACTERISTIC RADIUS OF ANNULAR COMPT FOR H2 BURNS
29  17.983     CHARACTERISTIC HEIGHT OF ANNULAR COMPT FOR H2 BURNS
**
**
*************************************************************************
*INITIAL CONDITIONS
*************************************************************************
**-REV12-START---------------------------------------------------------------
** CORRECTED TAVG FROM 574øF TO 558.3øF
**01  574.3       NOMINAL FULL POWER PRIMARY SYSTEM WATER TEMPERATURE
01  565.56     NOMINAL FULL POWER PRIMARY SYSTEM WATER TEMPERATURE
**-REV12-END-----------------------------------------------------------------
02  1.4203E+07 NOMINAL FULL POWER PRIMARY SYSTEM PRESSURE
03  4.3142     PRESSURIZER WATER LEVEL (ABOVE BOTTOM OF PZR HEAD)
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04  1.034E+05  CONTAINMENT BUILDING PRESSURE
05  323.2      LOWER CONTAINMENT BUILDING COMPARTMENTS (ALL BUT
**             UPPER COMPT AND ICE CONDENSER) TEMPERATURE
06  290.0      ICE CONDENSER GAS TEMPERATURE, WHERE APPLICABLE
07  0.10       LOWER CONTAINMENT BUILDING COMPARTMENTS REL. HUMIDITY (0-
08  0.0        INITIAL ICE MASS
09  6.1475E+04 INITIAL MASS OF WATER ON SECONDARY SIDE OF EACH S/G
10  323.2      INITIAL TEMPERATURE OF CONTAINMENT CONCRETE AND
**             METAL STRUCTURES
11  5.3779E+06 INITIAL PRESSURE ON SEC SIDE OF S/G'S
**UPPER COMPT CONDITIONS COULD BE DIFFERENT IN ICE CONDENSERS
12  0.10       UPPER COMPARTMENT REL HUMIDITY (0-1)
13  332.1      UPPER COMPARTMENT TEMPERATURE
**-REV12-START--------------------------------------------------------------
** CORRECTED TAVG FROM 574øF TO 558.3øF
**14  574.3      INITIAL PRIMARY SYSTEM WATER TEMPERATURE FOR THIS RUN
14  565.56     INITIAL PRIMARY SYSTEM WATER TEMPERATURE FOR THIS RUN
**-REV12-END----------------------------------------------------------------
15  1.4203E+07 INITIAL PRIMARY SYSTEM PRESSURE FOR THIS RUN
16  0.0        AMOUNT OF SUPERHEAT (DEG F OR K) AT EXIT NOZZLE
**             OF AN OTSG; IGNORED FOR U-TUBE STEAM GENERATORS
**
***********************************************************************
*CONTROL CARDS
***********************************************************************
**USE OF THE FAST STEAM TABLES SAVES LITTLE TIME IN CONTMT BUT MAY BE
**USEFUL IN THE PRIMARY SYSTEM
01  1          ENTER A 0 TO USE FAST STEAM TABLES IN PRI SYS WHEN POSSIBLE
02  1          ENTER A 0 TO USE FAST STEAM TABLES IN CONTMT WHEN POSSIBLE
03  1          INTEGRATION METHOD: RUNGE-KUTTA ORDER (1 OR 2);
**             THIS IS CURRENTLY IGNORED SINCE 2ND ORDER RUNGE-KUTTA IS
**             NOT SUPPORTED
04  9          UNIT NUMBER ("TAPE" NO. IN CDC JARGON)
**             TO WRITE RESTART FILES FOR MAIN PROGRAM FROM THIS RUN
**05 NOT USED
06  10         UNIT NUMBER TO WRITE RESTART FILES FOR HEATUP FROM THIS RUN
07  1          IPLMAP =0, USE OLD PLTFIL HARDWIRED PLOT ROUTINES AND APLOT
**                    =1, USE NEW PLTMAP ROUTINES
**             SEE *PLTMAP PARAMETER SECTION FOR DESCRIPTIONS.
**NOTE: CPCO IMPLEMENTATION REQUIRES BOTH #8 AND #9 TO BE SET EQUAL TO 4
08  4          UNIT NUMBER TO PUT PRI SYSTEM OUTPUT ON
09  4          UNIT NUMBER TO PUT CONTAINMENT OUTPUT ON (MOST USERS PUT
**             IN THE SAME NO. WHICH APPENDS THE TWO FILES)
10  12         UNIT NUMBER FOR THE FIRST PLOT FILE (OTHERS SEQUENTIAL)
**             IF NEGATIVE, PLOT FILES WILL BE WRITTEN IN BINARY FORMAT. THIS
**             WILL RESULT IN PLOT FILE SIZE REDUCTION BY 2/3.  THIS PARAMETER
**             IS NOT USED IF PLTMAP IS USED (SEE #7 ABOVE).
11  19         UNIT NUMBER FOR SCENARIO FILE
**NEXT 3 QUANTITIES CONTROL THE PLOT POINT STORAGE FREQUENCY (SEE VOL 1 OF
**USER'S MANUAL)
12  150        NON-SPIKE NUMBER OF POINTS (AVERAGE BEHAVIOR) STORED
13  10         NUMBER OF POINTS STORED DURING A SPIKE (TO RESOLVE FAST
**             TRANSIENTS)
14  500        MAXIMUM NUMBER OF PLOT POINTS ALLOWED PER PLOT FILE
**
**CPCO...CP-MAAP ONLY: A VALUE OF 4 FOR #15 SETS THE PALISADES
**                     SPECIFIC RECIRCULATION ALIGNMENT
**
**SEE ESF LINEUP MENU IN SUBROUTINE ENGSAF WRITE-UP IN
**VOL 2 OF USER'S MANUAL FOR NEXT TWO ENTRIES
**15  3          ESF PUMP LINEUP IN RECIRC (1 FOR ZION, 2 FOR SEQUOYAH)--
**             SEE FIGURES FOR THE DIFFERENT LINEUPS IN THE DESCRIPTION
**             OF SUBROUTINE ENGSAF
**
15  4          ESF PUMP LINEUP IN RECIRC MODE.  PIGGY-BACKS THE HPI PUMPS
**             ON THE CONTAINMENT SPRAY PUMPS IF OPERATOR ACTION CODE 249 IS
**             SET TO TRUE.  ALSO ALLOWS DISABLING CONTAINMENT SPRAY USING
**             OPERATOR ACTION CODE 250, WHILE LEAVING THE SPRAY PUMPS RUNNING
**
16  1          ESF PUMP/ACCUM DISCHARGE SETUP (1 FOR ALL TO COLD LEGS)
17  0          ENTER A 1 FOR B AND W PLANTS, 0 OTHERWISE (NOTE THAT MAAP
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**            WAS WRITTEN FOR B AND W PLANTS WHOSE OTSG LOWER TUBESHEETS
**            LIE BELOW THE LEVEL OF THE PRIMARY SYSTEM NOZZLES--THE
**            OTHER CONFIGURATION IS NOT CURRENTLY ALLOWED)
18  20        FILE NUMBER TO WRITE AUX DATA ON FOR LATER STAND-ALONE
**            AUX RUNS (OR 0 NOT TO WRITE DATA)
19  0         FILE NO. TO READ AUX DATA FROM (IF THIS NUMBER IS NONZERO, ONLY
**            THE AUX BUILDING MODELS ARE RUN, THE INPUT T/H DATA FROM THE
**            CONTAINMENT HAVING BEEN RECORDED FROM A PREVIOUS RUN)
20  9         NUMBER OF NODES IN THE AUX BUILDING (IF 0, THE AUX BLDNG
**            MODELS ARE NOT RUN, BUT A FILE MAY STILL BE CREATED FOR
**            SUBSEQUENT STAND-ALONE AUX BUILDING ANALYSES BY SUPPLYING
**            A NONZERO NO. FOR ITEM 18)--MAXIMUM OF 9 NODES
**            (SEE *AUX SECTION)
**21-26 NOT USED
**REV 16 REQUIRES THAT 12 FISSION PRODUCT GROUPS BE USED
27  12        MAXIMUM NO. OF FISSION PRODUCT GROUP YOU WANT TO MODEL--
**            NORMALLY THE MAXIMUM NO. MODELLED (12) IS USED; USING
**            SMALLER NOS. SPEEDS EXECUTION AT THE EXPENSE OF NOT MODELLING
**            THE MORE OBSCURE FP GROUPS; NOS. LESS THAN 6 SHOULD BE USED
**            WITH CAUTION (SEE GROUPING SCHEME IN FISSION PRODUCT SECTION
**            BELOW); IN PRINCIPLE AS FEW AS 3 GROUPS COULD BE REPRESENTED
28  1         JNTGRT = 1 : USE CONSISTENT TIMESTEPS BETWEEN
**                         DIFFUN (ICALL=3) AND INTGRT
**            JNTGRT = 0 : USE THE SMALLER OF THE DIFFUN (ICALL=3) TIMESTEP
**                         AND THE LIMITING ONE IN INTGRT (AS IN PRE REV 16)
**
29  0         ITDLIM = 1 : UTILIZE USER-INPUT CRITICAL PARAMETERS
**                         IN DETERMINING THE LIMITING TIMESTEP
**            ITDLIM = 0 : UTILIZE ORIGINAL HARDWIRED CRITICAL PARAMETERS
**
30  0         ISORT  = 1 : SORT OUT NEW FIGURES OF MERIT
**                   = 0 : NO SORTING
**
** 31 RESERVED FOR MODEL DEVELOPMENT
**
***********************************************************************
*TIMING DATA
***********************************************************************
**01 NOT USED
**02 NOT USED
03  5.0       MAX TIME STEP (ALWAYS INPUT IN SECONDS)
04  0.005     MINIMUM TIME STEP (ALWAYS INPUT IN SECONDS)
**TIME SELECTION ALGORITHMS ARE EXPLAINED IN THE WRITE-UPS FOR SUBROUTINES
**INTGRT (T/H MODELS) AND INTGFP (FISSION PRODUCT MODELS)
05  0.025     RELATIVE MASS CHANGE USED TO SELECT TIME STEP
06  0.050     MINIMUM INTER-NODE FISSION PROD MASS EXCHANGE (UNITS OF
**            MASS) CONSIDERED WHEN PICKING TIME STEP IN FISSION
**            PRODUCT MODELS
07  0.020     RELATIVE GAS TEMPERATURE CHANGE USED TO SELECT TIME STEP
08  0.025     REL MASS CHANGE FOR FISSION PRODUCTS USED TO SELECT TIME
**            STEP IN FISSION PRODUCT ROUTINES
**
**
***********************************************************************
*STEAM GENERATOR (VALUES REFER TO ONE UNIT)
***********************************************************************
01  260.90    TOTAL SECONDARY SIDE FREE VOLUME, EG OUT TO THE MSIV'S
02  0.9273    DOWNCOMER CROSS-SECTIONAL FLOW AREA
03  6.469     TUBE BUNDLE (SECONDARY SIDE) FLOW AREA
04  0.0       B AND W ONLY--ELEVATION OF AUX FEED SPRAY HEAD ABOVE
**            THE TOP OF THE LOWER TUBESHEET
05  1.000E+10 INITIAL MASS IN CONDENSATE STORAGE TANK--OR A LARGE
**            NO. IF NO LIMIT ON AFW SUPPLY
06  9.10      2-PHASE WATER LEVEL IN TUBE BUNDLE AT THE SEC SIDE
**            INVENTORY SUPPLIED IN THE *INITIAL CONDITIONS SECTION;
**            THIS IS USED TO ADJUST THE VOID FRACTION DISTRIBUTION
**            IN THE TUBE BUNDLE SO AS TO APPROXIMATELY MAKE UP FOR
**            SIMPLIFICATIONS IN THE MAAP MODEL ; THE CORRECTION
**            SHOULD MOST IMPACT LOSS OF FEED SEQUENCES
07  497.1     MAIN FEEDWATER TEMPERATURE
08  6.895E+06 LOWEST SETPOINT OF SECONDARY SAFETY VALVES
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09  7.170E+06  HIGHEST SETPOINT OF SEC SAFETY VALVES
10  12         NUMBER OF SAFETY VALVES PER S/G
11  61.31      NOMINAL FLOWRATE OF A SAFETY VALVE AT THE SETPOINT
12  6.205E+06  SETPOINT OF SEC RELIEF VLV (ASSUMED SAME FOR ALL RELIEFS)
**IF NO "RELIEF VALVES"--SUPPLY A SET POINT PRESSURE HIGHER THAN THE
**SAFETIES AND USE THE RELIEFS AS MANUALLY CONTROLLED STEAM DUMPS
13  2          NUMBER OF RELIEF VALVES PER S/G
14  116.4      NOMINAL FLOWRATE OF A RELIEF VALVE
15  753.1      MAX FEEDWATER FLOWRATE PER S/G
**INCLUDE THAT PORTION OF THE TUBE VOLUME WHICH IS NOT COOLED (IE IS INSIDE
**THE TUBESHEET(S)) IN ITEM 16
16  15.37      TOTAL (BOTH PLENA FOR OTSG'S) PRIMARY HEAD(S) VOLUME--
**MAIN STEAM ISOLATION VALVE (MSIV) CLOSURE, MAIN FEEDWATER SHUTOFF,
**AND AUX FEEDWATER ACTUATION ARE ASSUMED TO OCCUR AT REACTOR SCRAM
**UNLESS DEFEATED WITH APPROPRIATE EVENT CODES
17  200.0      TIME DELAY FOR ACTIVATION OF AUX FEED AFTER SCRAM
18  5.0        TIME REQUIRED FOR MSIVS TO LINEARLY RAMP FROM OPEN
**             TO CLOSED
**-REV12-START-----------------------------------------------------------
** REVISE VOLUME FOR NEW STM GEN'S
**19  35.70      TOTAL PRIMARY SIDE VOLUME OF ONE STEAM GENERATOR
19  41.3259    TOTAL PRIMARY SIDE VOLUME OF ONE STEAM GENERATOR
**-REV12-END-------------------------------------------------------------
20  0.5223     TUBESHEET THICKNESS
21  310.9      AUX FEED TEMPERATURE
22  8219       NUMBER OF TUBES IN A STEAM GENERATOR
23  0.0010668  THICKNESS OF STEAM GENERATOR TUBES
24  0.0169164  ID OF STEAM GENERATOR TUBES
25  19.2       THERMAL CONDUCTIVITY OF STEAM GENERATOR TUBES
26  10.338     THROTTLED AUX FEED FLOW PER S/G IN THE UNBROKEN
**             LOOP(S) OR LARGE NUMBER IF FLOW NOT THROTTLED (SEE
**             DISCUSSION AFTER ENGIN. SAFEGUARDS ITEM 151)
27  1.0        FRACTIONAL AREA USED FOR STEAM DUMPS IN BROKEN LOOP S/G
28  1.0        FRACTIONAL AREA USED FOR STEAM DUMPS IN UNBKN LOOPS S/GS
**STEAM GENERATOR WATER LEVEL CONTROL (SGWLC) SYSTEM PARAMETERS:
29  8.0026    DOWNCOMER PROGRAM WTR LEVEL FOR STEAM GENERATOR WATER
**             LEVEL CONTROL SYSTEM IN BROKEN LOOP S/G
30  8.0026    DOWNCMR PROG WTR LVL FOR SGWLC SYSTEM IN UNBKN LOOP S/GS
31  3.950      STEAM GENERATOR TUBESHEET DIAMETER
**FOR TMI ACCIDENT SIMULATION IT WAS NECESSARY TO INCORPORATE A BANG-BANG
**MODE OF S/G WATER LEVEL CONTROL--IE OPERATOR CONTROLS THE WATER LEVEL
**IN AN OSCILLATORY WAY WITHIN A DEADBAND; MOST USERS WILL NOT WISH
**TO USE THIS MODE AND SHOULD LEAVE THE NEXT THREE ENTRIES EQUAL TO 0
32  0.0          B-LOOP SGWLC DEADBAND
33  0.0          A-LOOP SGWLC DEADBAND (NONZERO VALUE ACTUATES
**               BATCH FEED MODE)
34  0.0          FOR BANG-BANG MODE, THE MINIMUM AFW FLOWRATE PER S/G TO
**               BE USED ON THE DECREASING CYCLE
35  0            MAIN STEAM LINE BREAKS CAN BE SIMULATED:ENTER 0 FOR NO
**               MAIN STEAM LINE BREAK; 1 DIRECTS STEAM FROM BROKEN
**               LOOP S/G TO CONTMT; 2 DIRECTS STEAM FROM ALL S/GS TO
**               CONTMT--SEE ALSO ITEM 44 BELOW
36  14.75        TOTAL HEIGHT OF S/G SHELL ABOVE TUBESHEET
37  2.257E+05    MASS OF S/G SHELL
38  -1           NUMBER OF PLATES IN REFLECTIVE INSULATION ON S/G SHELLS OR
**               CODE INDICATING OTHER INSULATION TYPE (SEE PRIMARY SYSTEM
**               INPUT NO. 71)
39  4            ENTER A 4 FOR BREAK IN HOT SIDE OF S/G OR 5 FOR BREAK
**               IN COLD SIDE--USE 5 FOR B AND W OTSGS
40  0.0          AREA OF PRIMARY SYTEM TO S/G BREAK
41  1.0          ELEVATION OF BREAK (IF ANY) ABOVE TUBESHEET
42  24.50        SEDIMENTATION AREA OF ONE S/G
43  10.338       THROTTLED AUX FEED FLOW TO THE S/G IN THE BROKEN LOOP OR
**               A LARGE NUMBER IF FLOW NOT THROTTLED (SEE DISCUSSION
**               AFTER ENGIN. SAFEGUARDS ITEM 151)
44  0.0          FLOW AREA PER S/G USED TO COMPUTE GAS FLOWS TO CONTMT WHEN
**               A MAIN STEAM LINE BREAK OCCURS
**
*************************************************************************
*CORE
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01  0.01059     FUEL PIN OUTER DIAMETER
02  29330.0     INTIAL ZIRCALLOY MASS
03  42336       NUMBER OF FUEL PINS
04  82710.0     TOTAL UO2 MASS
**ITEM 5 MUST BE ABOVE THE ELEVATION SUPPLIED FOR THE TOP OF THE RV HEAD
**IN THE PRIMARY SYSTEM SECTION
05  2.881       ELEVATION OF BOTTOM OF ACTIVE FUEL ABOVE BOTTOM OF VESSEL
06  6.229       ELEVATION OF TOP OF ACTIVE FUEL ABOVE BOTTOM OF VESSEL
07  7.174E+07   TIME OF IRRADIATION
08  2.530E+09   FULL POWER
**THE CORE NODALIZATION ADMITS UP TO 70 NODES; IN ADDITION, NO MORE THAN
**20 ROWS MAY BE USED AND NO MORE THAN 7 RINGS OR COLUMNS
**WHATEVER NODALIZATION IS USED, INSERT PEAKING FACTORS INTO APPROPRIATE
**ENTRY NUMBERS (EG SECOND RING FROM INSIDE RADIAL PEAKING FACTOR IS
**ALWAYS ITEM 32 NO MATTER HOW MANY AXIAL NODES)
**TOP NODE IS UNFUELED (FISSION GAS PLENUM ETC) AND MUST HAVE ZERO PEAKING
**FACTOR
09  7           NUMBER OF RINGS
10  10          NUMBER OF ROWS
11  0.8715      AXIAL PEAKING FACTOR   BOTTOM
12  1.0425      AXIAL PEAKING FACTOR
13  1.0340      AXIAL PEAKING FACTOR
14  1.0180      AXIAL PEAKING FACTOR
15  1.0120      AXIAL PEAKING FACTOR
16  1.0205      AXIAL PEAKING FACTOR
17  1.0440      AXIAL PEAKING FACTOR
18  1.0795      AXIAL PEAKING FACTOR
19  1.0000      AXIAL PEAKING FACTOR
20  0.0000      AXIAL PEAKING FACTOR   TOP
**ENTRIES 21-30 AXIAL PEAKING FACTORS NOT USED IN THIS NODALIZATION
31  1.0623      RADIAL PEAKING FACTOR    INSIDE
32  1.0848      RADIAL PEAKING FACTOR
33  1.1202      RADIAL PEAKING FACTOR
34  1.1657      RADIAL PEAKING FACTOR
35  1.0934      RADIAL PEAKING FACTOR
36  1.1670      RADIAL PEAKING FACTOR
37  0.6065      RADIAL PEAKING FACTOR    OUTSIDE
38  0.07843     AREA OR VOLUME FRACTIONS   INSIDE
39  0.09804     AREA OR VOLUME FRACTIONS
40  0.11765     AREA OR VOLUME FRACTIONS
41  0.13725     AREA OR VOLUME FRACTIONS
42  0.15686     AREA OR VOLUME FRACTIONS
43  0.17647     AREA OR VOLUME FRACTIONS
44  0.23529     AREA OR VOLUME FRACTIONS   OUTSIDE
**FOLLOWING QUANTITIES CONTROL ANSI DECAY HEAT CALCULATION
45  23000.0     FUEL EXPOSURE AT SCRAM (ALWAYS IN
**              MEGAWATT-DAYS/METRIC TON NO MATTER WHAT UNITS SELECTED)
46  0.3608      FUEL "ALPHA" AT SHUTDOWN (FISSILE ISOTOPE
**              CAPTURES/FISSION) - 1.0
47  0.0325      INITIAL ENRICHMENT OF FUEL IN ATOM FRACTION
48  0.6500      CONVERSION RATIO (PRODUCTION RATE OF U-239/ABSORPTION RAT
**              IN FISSILE ISOTOPES) AT SHUTDOWN
49  0.5610      FRACTION OF FISSION POWER MADE DUE TO FISSIONS IN U-235
**              AND PU-241 AT SHUTDOWN
50  0.3700      SAME AS 43 FOR PU-239
51  0.0690      SAME AS 43 FOR U-238 (FAST FISSIONS)
52  2.45E-04    FRACTIONAL ZRO2 MASS (COMPARED TO ZR MASS) AT TIME 0
53  0.004445    FUEL PELLET RADIUS
54  1.816       CORE FLOW AREA IN THE BYPASS AREA BETWEEN THE CORE BAFFLE
**              AND THE CORE BARREL (ENSURE THIS IS CONSISTENT WITH PRI
**              SYSTEM CORE FLOW AREA PARAMETER NO. 5)
**PARAMETERS 55-60 ARE USED FOR CALCULATING BALLOONING (DATA SHOWN IS
**MOSTLY FROM TMI REPORTS)
55  7.493E-04   CLAD THICKNESS
56  1.446E-05   GAS VOLUME PER FUEL PIN
57  2.213E+06   AS-BUILT ROOM TEMP FUEL PIN FILL GAS PRESSURE
58  1.202E+04   CORE SUPPORT PLATE MASS--THIS PLATE IS MELTED BY THE DEBRIS
**              AS IT LEAVES THE ORIGINAL CORE BOUNDARY
59  0.0         FRACTION OF THE TOTAL FUEL PIN GAS VOLUME WHICH IS
**              CONTAINED IN THE LOWER GAS PLENUM OF THE PIN
60  0.3318      SAME IN THE UPPER GAS PLENUM
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61  2.1938      RADIUS OF CORE BAFFLE (2*PI*THIS ENTRY SHOULD BE THE
**              CIRCUMFERENCE OF THE BAFFLE)
62  0.0         "FLOW AREA PER ROW" IN CORE BAFFLE (IMPORTANT ONLY IF
**              IN-VESSEL NATURAL CIRCULATION RETURN LEG IS IN BAFFLE-CORE
**              BARREL ANNULUS--SEE *MODEL)--THIS REPRESENTS THE APPROXIMATE
**              FLOW AREA AVAILABLE AS THE FLOW TURNS SIDEWAYS AND PENETRATES
**              THE CORE
63  0.00        FOR TMI-TYPE GEOMETRIES THE FLOW AREA THROUGH EACH CORE
**              FORMER PLATE IN AXIAL DIRECTION
64  0           FOR TMI-TYPE CORES,NUMBER OF CORE FORMER PLATES IN THE
**              BAFFLE-CORE ANNULUS
**
**********************************************************************
*QUENCH TANK ("QT" COMPT)
**********************************************************************
01  32.09       TOTAL VOLUME, INCLUDING THAT OF THE INITIAL WATER MASS
02  2.202E+04   INITIAL WATER MASS
03  6.205E+05   FAILURE DIFFERENTIAL PRESSURE OF RUPTURE DISK
04  14.48       HEIGHT OF RUPTURE DISK ABOVE BCOMPT FLOOR
05  11.54       SEDIMENTATION AREA IN QUENCH TANK
**
**
**********************************************************************
*UPLENUM (UPPER PLENUM OF ICE CONDENSER--"U" COMPARTMENT)
**********************************************************************
**IN A LARGE, DRY CONTAINMENT INPUT ZERO ICE CONDENSER VOLUME
** AND IGNORE ALL OTHER INPUTS
01  0.0        FREE VOLUME
**01  47000.    FREE VOLUME
**02            NOT USED. SEE #9 AND #10 BELOW.
**03  16.0      HEIGHT OF UPPER PLENUM
**04  2000.0    FLOW AREA INTO UPPER COMPARTMENT ("A" COMPT)
**              LIMITING FLOW AREA WHICH COUPLES THE ICE CONDENSER TO
**              THE UPPER COMPARTMENT--IE USE THE LESSER OF THE UPPER
**              PLENUM TO UPPER COMPT FLOW AREA OR THAT COUPLING THE
**              UPPER PLEN TO THE ICE CONDENSER
**05  15.0      NUMBER OF IGNITERS IN UPPER PLENUM
**06  8.0       AVERAGE ELEVATION OF IGNITERS FROM THE FLOOR OF U
**07  NOT USED
**08  6000.0    SEDIMENTATION AREA IN U
**09  4.0       CHARACTERISTIC RADIUS FOR BURN IN U
**10  10.0      CHARACTERISTIC HEIGHT FOR BURN IN U
**              THIS IS FLOOR TO CEILING (NOT IGNITER TO CEILING)
**
**********************************************************************
*FISSION PRODUCTS
**********************************************************************
**
**FISSION PRODUCTS ARE ENTERED AS ELEMENTS BELOW, ARE TREATED SEPERATELY
**WHEN IN THE CORE AND DEBRIS, AND THEN LUMPED TO THE FOLLOWING
**12 GROUP SCHEME WHEN RELEASED
**GROUP 1 GAS: NOBLES
**GROUP 1 AEROSOL: ALL INERT AEROSOLS
**GROUP 2: CSI
**GROUP 3: TEO2
**GROUP 4: SRO
**GROUP 5: MOO2
**GROUP 6: CSOH
**GROUP 7: BAO
**GROUP 8: LA2O3+PR2O3+ND2O3+SM2O3+Y2O3
**GROUP 9: CEO2
**GROUP 10: SB
**GROUP 11: TE2
**GROUP 12: UO2+NPO2+PUO2
**STRUCTURAL MATERIAL GROUPING SCHEME
**USED IN CORE NODES (TRACKED IN CONTAINMENT AS LUMPED GROUP 1 AEROSOLS)
**GROUP 1:  CD
**GROUP 2:  IN
**GROUP 3:  AG
**GROUP 4:  SN
**GROUP 5:  MN
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**
**IN THE FOLLOWING, THE DESCRIPTIONS INDICATE THE ASSUMED MOLECULAR WEIGHT
**OF THE ELEMENT; THE TOTAL MASS OF THE ELEMENT (IE INCLUDING ALL OF THE
**ISOTOPES) SHOULD BE ENTERED IN EACH CASE
01  297.6      INITIAL MASS OF XE AS XE-131
02  22.14      INITIAL MASS OF KR AS KR-84
03  13.27      INITIAL MASS OF I  AS I-131
04  20.61      INITIAL MASS OF RB AS RB-86
05  157.9      INITIAL MASS OF CS AS CS-133
06  56.07      INITIAL MASS OF SR AS SR-88
07  79.58      INITIAL MASS OF BA AS BA-138
08  28.99      INITIAL MASS OF Y  AS Y-89
09  70.24      INITIAL MASS OF LA AS LA-139
10  208.8      INITIAL MASS OF ZR AS ZR-91
11  2.969      INITIAL MASS OF NB AS NB-109
12  182.9      INITIAL MASS OF MO AS MO-96
13  44.78      INITIAL MASS OF TC AS TC-99
14  128.8      INITIAL MASS OF RU AS RU-101
15  1.738      INITIAL MASS OF SB AS SB-122
16  26.31      INITIAL MASS OF TE AS TE-128
17  161.3      INITIAL MASS OF CE AS CE-140
18  62.03      INITIAL MASS OF PR AS PR-141
19  207.5      INITIAL MASS OF ND AS ND-144
20  39.40      INITIAL MASS OF SM AS SM-150
21  27.33      INITIAL MASS OF NP AS NP-237
22  575.6.     INITIAL MASS OF PU AS PU-239
**23 RESERVED FOR FUTURE USE
**24 RESERVED FOR FUTURE USE
**25 RESERVED FOR FUTURE USE
26  123.0      INITIAL MASS OF CD IN CORE (STRUC MATERIAL GROUP 1)
27  310.6      INITIAL MASS OF IN IN CORE
28  2389.0     INITIAL MASS OF AG IN CORE
29  380.9      INITIAL MASS OF SN IN CORE
30  55.11      INITIAL MASS OF MN IN CORE (STRUC MATERIAL GROUP 5)
**
**-REV10-START-----------------------------------------------------------------
** FRACTION OF TOTAL DECAY HEAT ASSOCIATED WITH FISSION PRODUCT GROUPS
** SEE MAAP FLAASH NO. 12 (JULY 10, 1992) FOR DISCUSSION AND REVISED VALUES
31  0.03    NOBLE GAS
32  0.17    CSI + RBI
33  0.02    TEO2
34  0.04    SRO
35  0.02    MOO2
36  0.01    CSOH + RBOH
37  0.02    BAO
38  0.27    LA2O3 + PR2O3 + ND2O3 + SM2O3 + Y2O3
39  0.03    CEO2
**-REV15-START-----------------------------------------------------------------
**40  0.00    SB
40  0.006   SB
**-REV15-END-------------------------------------------------------------------
41  0.02    TE2
42  0.16    UO2 + NPO2 + PUO2
**-REV10-END-------------------------------------------------------------------
*************************************************************************
*MODEL PARAMETERS
*************************************************************************
**SEE DISCUSSION IN VOL 1 OF USER'S MANUAL FOR ALLOWABLE LIMITS ON
*MODEL PARAMETER VALUES AND THE DIFFERENT SENSITIVITY ANALYSIS MODES
**
**"SCALE FACTORS" MULTIPLY MODEL PREDICTIONS OF FLOWRATES ETC.--
**THE BEST-ESTIMATE VALUE IS USUALLY 1
01  0.005      CORIUM FRICTION COEFFICIENT FOR VESSEL ABLATION HEAT
**             TRANSFER (REYNOLD'S ANALOGY) CALCS
**-REV10-START-----------------------------------------------------------------
**02  0.00641    LEAK-BEFORE-BREAK CONTMT LEAKAGE AREA. IF THE CONTMT STRAIN
02  0.00929    LEAK-BEFORE-BREAK CONTMT LEAKAGE AREA. IF THE CONTMT STRAIN
**             MODEL (IE., THE DETAILED MODEL), THIS IS THE AREA USED TO
**             CALCULATE THE BREAK FLOW FROM THE CONTAINMENT TO THE
**             ENVIRONMENT.
**-REV10-END-------------------------------------------------------------------
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03  1800.0      TIME TO FAIL VESSEL PEN. WELDS AFTER CONTACT WITH CM
**-REV10-START-------------------------------------------------------------------
**04  0.0488      CONTMT FAILURE AREA USED IF THE CONTMT FAILS DUE TO
04  0.929       CONTMT FAILURE AREA USED IF THE CONTMT FAILS DUE TO
**              CONTAINMENT PRESSURE EXCEEDING THE USER SUPPLIED FAILURE
**              PRESSURE. USED ONLY BY THE SIMPLE CONTAINMENT FAILURE MODEL.
**-REV10-END---------------------------------------------------------------------
05  2.0         MULTIPLIER OF NORMAL CLAD SURFACE AREA USED IN OXIDATION
**              CALCS TO ACCOUNT FOR STEAM INGRESS AFTER
**              CLAD RUPTURE (MUST BE BETWEEN 1 AND 2)
**THE FOLLOWING PARAMETER IS REPLACED IN REV 16 BY #71 BELOW.
**06  983.0       CRITICAL FLAME TEMP AT ZERO STEAM MOLE FRACTION
**              USED IF NO IGNITION SOURCES; THIS IS MULTIPLIED BY THE
**              WESTINGHOUSE FLAME TEMPERATURE MULTIPLIER CORRELATION
**              FOR NONZERO STEAM MOLE FRACTIONS
**@@@REV09 ADDITION , #06
06  0.1E0       TDSTX- TIME DELAY BETWEEN DEBRIS CONTACTING FLOOR
**              AND BEGINNING OF CORE-WATER INTERACTION
07  1.0         SCALE FACTOR FOR FISSION PRODUCT AND INERT AERO RELEASE RATES
**              FROM CORE (SHOULD USE A NO. LESS THAN OR EQUAL TO 1)
08  300.0       NON-RADIATIVE FILM BOIL. HT. TRANS COEFF FROM CM TO POOL
09  850.0       NAT. CIRC. (MCP'S OFF) S/G PRIMARY SIDE FILM RESISTANCE
**              WHEN 2- OR 1- PHASE NATURAL CIRCULATION IS OCCURING
**              IN THE COOLANT LOOPS--NOTE THAT COOLANT VELOCITY AND
**              VOID FRACTION DISTRIBUTION ARE NOT COMPUTED UNDER THESE COND.
10  0.30        FRACTION OF S/G TUBES CARRYING "OUT" FLOWS IN THE HOT LEG
**              NATURAL CIRC MODEL (SEE SUBROUTINE HLNC WRITE-UP); IF YOU
**              WISH TO FORCE THE FLOW OFF, USE 0 (THIS REQUIRES BYPASSING
**              PARAMATER CHECKING BY USING THE SENSITIVITY ANAL OPTION
**              IBATCH=2); PARAMETER DOES NOT AFFECT B AND W GEOMETRY UNLESS
**              0 IS INPUT SINCE OTSG TUBES DON'T PARTICIPATE IN FLOW
11  0.10        B AND W ONLY: FRACTION OF S/G TUBES STRUCK BY AFW
12  1000.0      HT. TRANSFER COEFF BETWEEN MOLTEN CORIUM AND A FROZEN CRUST;
**              USED IN DECOMP AND IN CALCULATIONS WITHIN A MOLTEN POOL IN
**              THE CORE
**
**CPCO...CP-MAAP ONLY: THE VALUE OF #13 REPRESENTS THE FRACTION
**                      OF THE DEBRIS THAT IS ENTRAINED TO A. ONE
**                      MINUS #13 IS ENTRAINED TO B.
**
13  1.00        ENTER A 0 FOR ENTRAINMENT FROM C TO B; 1 FOR C TO A--LATTER
**              GENERALLY USED ONLY IF CAVITY HAS NO INSTRUMENT TUNNEL
**
**CPCO...CP-MAAP ONLY: A NEGATIVE VALUE OF #14 ACTIVATES A
**                      TELLURIUM RELEASE MODEL DURING DCH
**
**SCOPING DIRECT CONTMT HEATING MODEL (SUBROUTINE DCH)
**14  0.25        FRACTION OF THE ENTRAINED CORIUM MASS WHICH IS ASSUMED TO
14 -0.25        FRACTION OF THE ENTRAINED CORIUM MASS WHICH IS ASSUMED TO
**              BE FINELY FRAGMENTED AND TO INTERACT COMPLETELY (SENSIBLE
**              HEAT AND OXIDATION) WITH THE GAS OF THE COMPT TO WHICH IT
**              IS ENTRAINED--CALCS IN IDCOR 85/2 AND IN THE PWR IPE SOURCE
**              TERM REPORT SHOW THAT THIS NO. SHOULD BE LESS THAN ABT .1
**              TYPICALLY
**NEW H2 BURN MODEL IN REV 16 MAKES #15-#19 OBSOLETE
**15  100.0       DRAG COEFFICIENT OF RISING PLUME DURING BURNS IN UPPER
**              COMPT-- LARGER VALUES RESULT IN A SLOWER AND FATTER PLUME
**              AND THUS INCREASE THE EFFICIENCY OF THE IGNITERS
**16  100.0       SAME FOR B COMPT
**17  100.0       SAME FOR C COMPT
**-REV12-START-------------------------------------------------------------------
**18  100.0       SAME FOR D COMPT
**19  100.0       SAME FOR U COMPT
** PARTICLE RADIUS FOR POOL SCRUBBING OF PARTICLES RELEASED FROM
** WATER COVERED DEBRIS BEDS
18  0.01E-06    XRDB
**
** MULTIPLIER FOR VAPOR PRESSURE USED IN REVAPORIZATION CALCULATIONS
19  1.0         FVPREV
**
**-REV12-END---------------------------------------------------------------------
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20  1.53        CHURN-TURBULENT CRITICAL VELOCITY COEFFICIENT
21  3.70        DROPLET FLOW CRITICAL VELOCITY COEFFICIENT
22  1.35        SPARGED POOL VOID FRACTION COEFFICIENT
23  2.0         VOLUMETRIC STEAM GENERATION VOID FRACTION COEFFICIENT
24  0.50        DEBRIS ENTRAINMENT TIME CONSTANT (UNITS OF TIME)
25  0.90        EMISSIVITY OF WATER
26  0.85        EMISSIVITY OF WALLS
27  0.85        EMISSIVITY OF EQUIPMENT
28  0.85        EMISSIVITY OF CORIUM SURFACE
29  0.60        EMISSIVITY OF GAS
30  0.30        CORE HYDRODYNAMIC LIMIT KUTATELADZE NO. FOR REFLOODING HT
**              AND OXIDATION CALCULATIONS
31  0.33        NUMBER TO MULTIPLY KUTATELADZE CRITERION BY TO REPRESENT
**              DIFFICULTY (GT 1.D0) OR EASE (LT 1.D0) FOR DEBRIS TO GET
**              OUT OF CAVITY
32  3.0         FLOODING CRITICAL VELOCITY COEFFICIENT
33  0.080       FLAT PLATE CHF CRITICAL VELOCITY COEFFICIENT
34  1           NUMBER OF VESSEL PENETRATIONS THAT FAIL
35  0.70        DISCHARGE COEFFICIENT FOR PRIMARY SYSTEM BREAK(S)
**"SCALE FACTORS" MULTIPLY MODEL PREDICTIONS--THE BEST-ESTIMATE VALUE
**IS USUALLY 1
36  1.0         SCALE FACTOR FOR BURN VELOCITY CORRELATION
37  1.0         SCALE FACTOR FOR HEAT TRANSFER COEFFICIENTS TO PASSIVE
**              HEAT SINKS
38  2.50        GAMMA SHAPE FACTOR (TO ACCOUNT FOR NON-SPHERICAL SHAPES IN
**              THE COAGULATION EQUATION) USED FOR AEROSOLS
39  1.0         CHI SHAPE FACTOR (TO ACCOUNT FOR NON-SPHERICAL SHAPES IN
**              STOKES LAW) USED FOR AEROSOLS
40  8.0         RATIO OF AIRBORNE AEROSOL MASS TO THE MASS WHICH WOULD LEAVE
**              YOU IN STEADY-STATE WITH THE CURRENT SOURCE STRENGTH;THIS IS
**              USED TO CONTROL THE SELECTION OF DECAY VS STEADY-STATE AEROSOL
**              SETTLING CORRELATIONS
41  3.0         DECONTAMINATION FACTOR ASSOCIATED WITH THE PASSAGE THROUGH 1
**              METER (REFERENCE LENGTH USED FOR EITHER SET OF UNITS) OF WATER;
**              ASSUME DF IS LINEAR FUNCTION OF DEPTH FOR OTHER DEPTHS
42  0.020       CAPTURE EFFICIENCY OF CONTMT SPRAY FOR AEROSOLS--THIS IS
**              THE FRACTION OF THE TOTAL VOLUME SWEPT BY FALLING DROPS WHICH
**              IS CLEANSED OF AEROSOLS
43  1.0         ABSOLUTE VALUE OF THE DESIRED MULTIPLIER OF CSI AND
**              CSOH VAPOR PRESSURE--ENTER A NEGATIVE NUMBER TO SELECT
**              JANAF CSOH FUNCTION; POS FOR SANDIA CORELLATION (BEST-EST)
44  0.125       FRACTION OF CLAD OXIDIZED WHICH CAUSES CORE TO COLLAPSE ON
**              REFLOOD (GIVES SMALLER KU FOR HEAT TRANSFER THAN INTACT
**              MODEL) AND  CAUSES CORE GEOMETRY TO CHANGE
**-REV10-START------------------------------------------------------------------
45  1.0         FCDDC - NEW CONDENSATION MODEL PARAMETER
**45  0.0         FOR B AND W UNITS ONLY, FRACTION OF PERFECT CONDENSATION
****              OF STEAM ENTERING DOWNCOMER THROUGH FLAPPER VALVES
**-REV10-END--------------------------------------------------------------------
46  1200.0      TEMPERATURE AT WHICH CLAD FAILS IF IT HASN'T ALREADY RUPTURED;
**              THIS HALTS FURTHER BALLOONING AND ALLOWS FISS PROD RELEASE
47  2.50E+05    LATENT HEAT OF U-ZR-ZRO2 EUTECTIC
48  0.25        VOID FRACTION OF A COLLAPSED CORE
49  3.00E-07    SEED RADIUS ASSUMED FOR HYGROSCOPIC AEROSOL GROWTH CALC
50  -2          ENTER A 2 FOR FISSION PRODUCT RELEASE TO BE COMPUTED
**              BY THE IDCOR/EPRI STEAM OXIDATION MODEL; 1 FOR
**              NUREG-0772 MODEL; NEGATIVE NOS. ACTIVATE THE SAME MODEL
**              AS POSITIVE NUMBERS BUT ALSO TURN ON A BLOCKAGE MODEL
**              WHICH REDUCES THE RELEASE OF NONVOLATILE FISSION PRODS
**              WHEN THE NODE IS BLOCKED FOR GAS TRANSPORT
51  0           ENTER A 1 IF TELLURIUM IS RELEASED IN-VESSEL; 0 IF IT
**              IS ASSUMED TO BE TOTALLY BOUND UP WITH ZIRCALLOY
**              (0 IS BEST-EST)
52  2500.0      ASSUMED EUTECTIC MELTING TEMP
53  0.1091      FRICTION COEF FOR AXIAL FLOW USED FOR UPPER PLENUM-CORE FLOW
**              CALCS;THIS CAN BE ESTIMATED BY F=2.*DP*RHO/G**2 WHERE (ALL
**              VALUES ARE FOR NORMAL OPERATION WITH MCP'S ON) DP=CORE
**              PRESSURE DROP, RHO=DENSITY OF PRIMARY SYSTEM COOLANT, G=
**              CORE AVERAGE MASS FLOW PER UNIT AREA (IN BRIT UNITS,
**              INCLUDE G0 AND OTHER NECESSARY CONVERSIONS TO MAKE F
**              DIMENSIONLESS)--USE GT 100 TO ARTIFICIALLY STOP FLOW
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**              (REQUIRES USING THE SENSTIVITY OPTION IBATCH=2)
54  0           INSERT 0 IF IN-VESSEL NATURAL CIRCULATION FLOW RETURN LEG
**              IS IN OUTER FUEL ASSEMBLIES (USUAL CASE);INSERT 1 IF RETURN
**              IS DOWN "BYPASS" (IE BAFFLE-CORE BARREL ANNULUS)--THIS WOULD
**              BE EXPECTED ONLY IF THERE WAS A LOT OF FLOW AREA IN THE
**              BYPASS (EG PERHAPS B AND W PLANTS)
**-REV10-START-------------------------------------------------------------
55  2501.0      TCPFAL - CORE PLATE FAILURE TEMPERATURE CRITERION
**55  0.10        A VOID FRACTION, BELOW WHICH A CORE NODE IS ASSUMED BLOCKED
****              FOR GAS FLOW OR OXIDATION
**-REV10-END---------------------------------------------------------------
56  10          NO. OF SAMPLES AVERAGED OVER IN NC MODEL (SEE USER'S MANUAL)
57  -0.450      CROSS-FLOW FRICTION COEF IN CORE NATURAL CIRCULATION
**              MODELS (LITERATURE SAYS .25-.45); USE OF A NEGATIVE NO.
**              DISABLES THE FULL "REMIX" TWO-DIMENSIONAL CORE FLOW MODEL
**              AND REPLACES IT WITH A SIMPLE MODEL THAT SPLITS
**              THE FLOW BASED ONLY ON FLOW AREAS ETC.
**              (IE FRICTION IS CONSIDERED BUT BUOYANCY IS NOT).
**              THIS SIMPLIFIED MODEL IS NOT STRICTLY CORRECT, BUT APPEARS
**              TO GIVE INTEGRAL ANSWERS NOT TOO DIFFERENT FROM THE
**              DETAILED MODEL.
**              IT IS CURRENTLY THE DEFAULT FOR THIS REASON, THE
**              FACT THAT THE DETAILED MODEL HAS POOR CONVERGENCE PROPERTIES,
**              AND THE FACT THAT IT SPEEDS UP CODE EXECUTION.
58  0.070       FRACTION OF XENON INVENTORY IN THE PELLET-CLAD GAP DUE TO
**              LONG-TERM OPERATION (OFTEN CALLED THE "GAP RELEASE", THIS
**              IS USED IN CALCULATING THE PRESSURE INSIDE THE FUEL PIN FOR
**              BALLOONING CALCS--NUREG 0772 SAYS OBSERVED VALUES ARE 0-0.25)
59  0.40        VOID FRACTION IN PRIMARY SYSTEM ABOVE WHICH THE PHASES
**              SEPARATE AND TWO-PHASE NATURAL CIRCULATION STOPS--VALUE
**              SHOWN IS TYPICAL OF FLECHT-SEASET TESTS; AT HIGHER PRESSURES
**              A SMALLER VALUE IS APPROPRIATE; RANGE SEEN IS MAYBE .4 - .6
60  1060.0      TEMPERATURE OF H2 JET ENTERING NON-INERTED COMPARTMENT WHICH
**              IS SUFFICIENT TO CAUSE A LOCAL BURN--FROM HEDL-TME 78-80
61  0.01        ACTIVITY COEFFICIENT FOR SIO2 IN METOXA EQUILIBRIUM
**              CHEMISTRY MODEL
62  0.05        ACTIVITY COEFFICIENT FOR SRO
63  0.05        ACTIVITY COEFFICIENT FOR BAO
64  1.00E-08    ACTIVITY COEFFICIENT FOR K2O
65  0.10        FRACTION OF ORIGINAL CORE MASS BELOW WHICH THE REMAINING
**              CORE IS JUST DUMPED INTO REACTOR CAVITY
**              (ASSUMING VESSEL FAILURE AND DEPRESSURIZATION HAVE OCCURED)
**              THE MAAP CORE MELT PROGRESSION
**              MODELLING TENDS TO RESULT IN A SMALL FRACTION OF THE CORE
**              BEING HELD INDEFINITELY IN THE ORIGINAL CORE BOUNDARIES
**              WITH HEAT BEING REMOVED CONVECTIVELY AND RADIATIVELY TO
**              THE REST OF THE PRIMARY SYSTEM; THIS IS NOT CONSIDERED
**              UNREASONABLE; HOWEVER THE ABILITY OF THE MODEL TO
**              CORRECTLY COMPUTE HEAT AND GAS FLOW AREAS IS CLEARLY
**              LIMITED UNDER THESE CONDITIONS AND MANY USERS WILL
**              FIND IT DESIRABLE TO DUMP THE CORE OUT AT THIS POINT,
**              IF FOR NO OTHER REASON THAN TO SAVE ON CPU TIME
66  0.40        FROUDE NO. USED FOR COUNTER-CURRENT DRAINING OF
**              PRESSURIZERS THROUGH SURGE-LINE WHEN NO LOOP SEAL EXISTS
67  0           ENTER A 1 TO ACTIVATE THE IDCOR BLOCKAGE MODEL IN THE CORE.
**              AT PRESENT, THIS STOPS OXIDATION AND GAS FLOW THROUGH A CORE
**              NODE AT THE ONSET OF MELTING IN THE NODE. THIS IS MEANT TO
**              REPRESENT THE EFFECTS OF PHENOMENA SUCH AS SURF. AREA TO VOLUME
**              REDUCTIONS AFTER MELTING; FLOW CHANNEL BLOCKAGES, HYDRAULIC
**              DIAMETER REDUCTIONS, AND INCREASES IN SURFACE ROUGHNESS; AND
**              MOVEMENT OF UNREACTED ZIRCALLOY TO LOWER PARTS OF THE CORE.
**              CONSIDERABLE CONTROVERSY SURROUNDS THE USE OF THIS MODEL
**              SINCE IT TENDS TO GREATLY REDUCE THE HYDROGEN SOURCE TERM
**              COMPARED TO NRC (SOURCE TERM CODE PACKAGE) RESULTS.
**              AT PRESENT A CONSENSUS ON THE HYDROGEN SOURCE TERM SEEMS
**              FAR OFF.  TO SEE IF A GIVEN ANALYSIS IS SENSITIVE TO THE
**              SOURCE TERM, ENTERING A 0 (WHICH REQUIRES ACTIVATING THE
**              SENSITIVITY OPTION WITH IBATCH=2) WILL OVER-ESTIMATE THE
**              SOURCE TERM (PROBABLY EVEN WHEN COMPARED TO CODES WHICH
**              ATTEMPT A DETAILED MELT PROGRESSION CALCULATION) SINCE THIS
**              STOPS GAS FLOW THROUGH A NODE AND THUS OXIDATION
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**              ONLY IF THE NODE IS COMPLETELY FULL OF MOLTEN MATERIAL.
68  0.330       PRUPACHER-KLETT COLLISION EFFICIENCY (USE .33 FOR P-K MODEL;
**              1 FOR FUCHS)
69  18.00       NUSSELT NO. WHICH GOVERNS HEAT CONDUCTION INTO A SMALL
**              DROPLET (EG FROM CONTAINMENT SPRAYS); AVAILABLE DATA
**              SUGGESTS THAT A CONSTANT VALUE IS FAIRLY ACCURATE
**70             NOT USED
71  983.0       TAUTO AUTOIGNITION TEMPERATURE FOR H2 BURNS
**              A BURN WILL OCCUR IF THE GAS T EXCEEDS THIS VALUE
**              NO MATTER WHAT THE H2 CONCENTRATION IS
72  0.75        STEAM MOLE FRACTION TO INERT A H2-AIR-H2O MIXTURE
**              AT INCIPIENT AUTOIGNITION -- AT TEMPERATURES JUST
**              BELOW AUTOIGNITION, THIS STEAM MOLE FRACTION WILL
**              PREVENT A BURN.
73  0.00        OFFSET H2 MOLE FRACTION FOR DEFINITION OF IGNITION
**              DURING A BLACKOUT SEQUENCE: THIS IS ADDED TO (OR TAKEN
**              FROM, IF NEGATIVE) THE DOWNWARD FLAMMABILITY LIMIT
**              IGNITION (GLOBAL BURNS) WILL OCCUR IF THE H2
**              MOLE FRACTION EXCEEDS THE LIMIT PLUS THE OFFSET
74  2.0         FLAME FLUX MULTIPLIER (BETWEEN 1.0 AND 10.0)
**              BEST-ESTIMATE USED FOR CONTAINMENTS IS 2
**              USE HIGHER VALUES FOR FANS ON
75  0.115       COEFFICIENT IN EQUATION TO CALCULATE THE HOT LEG NATURAL
**              CIRCULATION FLOW RATE.  IT HAS BEEN CHANGED FROM 0.09 TO
**              0.115 AS A RESULT OF BENCHMARKING EXERCISE.
**
*************************************************************************
*AUXILIARY BUILDING
*************************************************************************
**A MAXIMUM OF 9 NODES CAN BE REPRESENTED--THE NO. OF NODES INODRB IS GIVEN
**IN THE *CONTROL SECTION--NOTE THAT NODE INODRB+1 IS THE ENVIRONMENT BUT
**NO INFORMATION NEED BE ENTERED FOR IT
**THE FOLLOWING ARE MODELLED AT PRESENT:
**     1. WATER OVERFLOWS--THE SAME JUNCTIONS ARE USED AS IN THE GAS TRANSFERS
**        AND ARE SPECIFIED IN THE *TOPOLOGY SECTION BELOW; NOTE THAT ENTERING
**        A ONE IN THE APPROPRIATE SPOT MODELS FLOOR DRAINS WHICH INSTANTLY
**        DRAIN ALL ACCUMULATED WATER AWAY
**     2. H2 BURNS
**     3. CO2 FIRE SUPPRESSION SYSTEMS
**     4. SPRAYS
**     5. NATURAL CIRCULATION, BOTH UNIDIRECTIONAL AND COUNTER-CURRENT
**     6. TWO HEAT SINKS/NODE--ONE HEAT SINK REPRESENTS AN "OUTER" WALL WHICH
**        HAS THE NODE IN QUESTION ON ONE SIDE AND A USER-SPECIFIED NODE ON
**        THE OTHER SIDE; THE OTHER HEAT SINK REPRESENTS AN "INNER" WALL WHICH
**        HAS THE NODAL GAS TEMPERATURE ON BOTH SIDES
**
**                 VOLRB(I) FREE VOLUME OF NODE
001   955.9        NODE 1 - W ENG SAFE
002   647.9        NODE 2 - E ENG SAFE
003   1538.4       NODE 3 - CCW (590+625+649)
004   6378.0       NODE 4 - AUX 590
005   603.9        NODE 5 - AUX 602
006   6302.0       NODE 6 - AUX 611 + AUX 625
007   50481.0      NODE 7 - TURBINE BUILDING
008   11140.0      NODE 8 - AUX 649
009   825.4        NODE 9 - STAIR/ELEVATOR/LIFTWAY SHAFTS
**
**                 AREA OF FLOOR IN NODE--USED BOTH FOR WATER DEPTH AND TO
**                 REPRESENT CHARACTERISTIC DIMENSION OF COMPT FOR BURN TIMES
011   193.6        NODE 1
012   136.5        NODE 2
013   152.3        NODE 3
014   1256.0       NODE 4
015   278.7        NODE 5
016   659.5        NODE 6
017   2060.0       NODE 7
018   602.2        NODE 8
019   39.62        NODE 9
**
**CPCO...CP-MAAP ONLY: ANY AUX BUILDING NODE THAT CAN HAVE CORIUM
**                     MUST HAVE A NON-TRIVIAL OUTER WALL AREA
```

```
**
**EITHER A STEEL OR CONCRETE WALL CAN BE MODELED BY INPUTTING THE
**APPROPRIATE MATERIAL PROPERTIES
**                 AHSRB(I) ONE-SIDED OUTER WALL AREA FOR NODE
**-REV07-START-------------------------------------------------------------
** IT IS MORE APPROPRIATE TO MODEL THE WALL BETWEEN THE EAST AND WEST
** SAFEGUARDS ROOMS BY PUTTING HALF OF THE WALL AREA IN EACH NODE
**021   52.68       NODE 1
**022   10.00       NODE 2
021   26.34       NODE 1
022   26.34       NODE 2
**-REV07-END---------------------------------------------------------------
023   227.5       NODE 3
024   929.3       NODE 4
025   314.5       NODE 5
026   1799.0      NODE 6
027   0.01        NODE 7
028   492.4       NODE 8
029   937.4       NODE 9
**
**                XHSRB(I) THICKNESS FOR NODE OUTER WALL
031   0.6096      NODE 1
**-REV07-START-------------------------------------------------------------
** SEE COMMENT ABOVE
**032   0.3048      NODE 2
032   0.6096      NODE 2
**-REV07-END---------------------------------------------------------------
033   0.6096      NODE 3
034   0.7428      NODE 4
035   0.6096      NODE 5
036   0.5723      NODE 6
037   0.3048      NODE 7
038   0.3322      NODE 8
039   0.3167      NODE 9
**
**                KHSRB(I) THERMAL CONDUCTIVITY OF OUTER WALL IN NODE
041   3.459       NODE 1
042   3.459       NODE 2
043   3.459       NODE 3
044   3.459       NODE 4
045   3.459       NODE 5
046   3.459       NODE 6
047   3.459       NODE 7
048   3.459       NODE 8
049   3.459       NODE 9
**
**                CPHSRB(I) SPECIFIC HEAT OF OUTER WALL IN NODE
051   1076.0      NODE 1
052   1076.0      NODE 2
053   1076.0      NODE 3
054   1076.0      NODE 4
055   1076.0      NODE 5
056   1076.0      NODE 6
057   1076.0      NODE 7
058   1076.0      NODE 8
059   1076.0      NODE 9
**
**                ZHSRB(I) HEIGHT OF OUTER WALL FOR NODE
061   5.486       NODE 1
062   5.486       NODE 2
063   4.724       NODE 3
064   5.029       NODE 4
065   2.134       NODE 5
066   4.837       NODE 6
067   1.0         NODE 7
068   4.572       NODE 8
069   6.096       NODE 9
**
**                DHSRB(I) DENSITY OF OUTER WALL IN NODE
071   2440.0      NODE 1
072   2440.0      NODE 2
```

```
073   2440.0      NODE 3
074   2440.0      NODE 4
075   2440.0      NODE 5
076   2440.0      NODE 6
077   2440.0      NODE 7
078   2440.0      NODE 8
079   2440.0      NODE 9
**
**THE VENTILATION (OR "SGTS") SYSTEM IS MODELED BY SUPPLYING
**A FORCED OUT FLOW AND/OR A FORCED IN FLOW--IF AC POWER IS AVAILABLE,
**THIS FLOW IS ON UNTIL THE FIRE DAMPER SETPOINT(SEE BELOW) IS
**REACHED IN A COMPARTMENT--THIS SHUTS FLOW DOWN IN THAT COMPT
**FOR RECIRCULATING FLOWS, ENTER THE APPROPRIATE NODE ON THE SUCTION
**SIDE IN FIELDS 161-169
**                WVORB(I) FORCED VOLUMETRIC VENTILATION FLOW OUT OF NODE
**                (REMEMBER, IN PWR CODE THIS MUST BE M**3/SEC OR GPM)
081   1.336       NODE 1
082   0.906       NODE 2
083   4.719       NODE 3
084   8.022       NODE 4
085   0.844       NODE 5
086   3.996       NODE 6
087   232.4       NODE 7
088   7.551       NODE 8
089   0.0         NODE 9
**
**                WVIRB(I) FORCED VOLUMETRIC VENTILATION FLOW INTO NODE
**                (REMEMBER, IN PWR CODE THIS MUST BE M**3/SEC OR GPM)
091   1.336       NODE 1
092   0.906       NODE 2
093   4.719       NODE 3
094   8.022       NODE 4
095   0.844       NODE 5
096   3.996       NODE 6
097   232.4       NODE 7
098   5.570       NODE 8
099   0.0         NODE 9
**
**                ASEDRB(I) AEROSOL SETTLING AREA FOR NODE
101   387.2       NODE 1
102   313.0       NODE 2
103   823.2       NODE 3
104   2512.0      NODE 4
105   557.4       NODE 5
106   3280.0      NODE 6
107   4120.0      NODE 7
108   1204.0      NODE 8
109   76.68       NODE 9
**
**AEROSOL IMPACTION DATA
**SEE DISCUSSION OF IMPACTION PARAMETERS IN *ANNULAR SECTION ABOVE
**IF IMPACTION IS MODELED IN A NODE, THE IMPACTION AREA, DIAMETER (EG GRATE
**THICKNESS), AND FLOW AREA MUST ALL BE GIVEN
**                AIMPRB(I) IMPACTION AREA FOR NODE
111   0.0         NODE 1
112   0.0         NODE 2
113   0.0         NODE 3
114   0.0         NODE 4
115   0.0         NODE 5
116   0.0         NODE 6
117   0.0         NODE 7
118   0.0         NODE 8
119   8.222       NODE 9
**
**                XDIMRB(I) IMPACTION DIAMETER FOR NODE
121   0.0         NODE 1
122   0.0         NODE 2
123   0.0         NODE 3
124   0.0         NODE 4
125   0.0         NODE 5
126   0.0         NODE 6
```

```
127  0.0       NODE 7
128  0.0       NODE 8
129  0.00318   NODE 9
**
**             AGRARB(I) TOTAL FLOW AREA THROUGH NODE AT THE ELEVATION
**             OF THE GRATING (USED TO CALCULATE THE GAS VELOCITY THROUGH
**             THE GRATING GIVEN MASS FLOWS THROUGH THE NODE)--IF DIFFERENT
**             ELEVATIONS ON WHICH GRATING IS FOUND HAVE DIFFERENT TOTAL
**             FLOW AREAS, USE THE LARGEST TO GIVE SLOWEST VELOCITY FOR
**             CONSERVATISM
131  0.0       NODE 1
132  0.0       NODE 2
133  0.0       NODE 3
134  0.0       NODE 4
135  0.0       NODE 5
136  0.0       NODE 6
137  0.0       NODE 7
138  0.0       NODE 8
139  12.08     NODE 9
**
**SPRAYS (EG FIRE SPRAYS)--THESE ARE TURNED ON AND OFF MANUALLY USING EVENT
**CODE 240
**THEY WILL ALSO COME ON IF THE NODAL TEMPERATURE EXCEEDS THE SETPOINT
**VALUE INPUT BELOW
**             WSPRB(I)  SPRAY MASS FLOW RATE FOR NODE
141  0.0       NODE 1
142  0.0       NODE 2
143  0.0       NODE 3
144  0.0       NODE 4
145  0.0       NODE 5
146  0.0       NODE 6
147  0.0       NODE 7
148  0.0       NODE 8
149  0.0       NODE 9
**
**             XHSPRB(I) SPRAY FALL HEIGHT FOR NODE
151  0.0       NODE 1
152  0.0       NODE 2
153  0.0       NODE 3
154  0.0       NODE 4
155  0.0       NODE 5
156  0.0       NODE 6
157  0.0       NODE 7
158  0.0       NODE 8
159  0.0       NODE 9
**
**             NODE NO. THAT THE VOL IN A NODE RECEIVES ITS INLET VENT.
**             FLOW FROM; USE INODRB+1 FOR ENVIRONMENT WHERE INODRB IS
**             NO. OF NODES IN THE MODEL; USE SMALLER NOS. IF A
**             RECIRCULATING SYSTEM EXISTS (IE TAKES FROM NODE 1 AND PUTS
**             INTO NODE 4)
161  10        NODE 1
162  10        NODE 2
163  10        NODE 3
164  10        NODE 4
165  10        NODE 5
166  10        NODE 6
167  10        NODE 7
168  10        NODE 8
169  4         NODE 9
**
**             ENTER A ONE TO INSTANTLY DRAIN ALL WATER FROM A NODE; THIS
**             IS CONVENIENT IF THE BLDG HAS AN EFFICIENT DRAIN SYSTEM THAT
**             PUTS ALL THE WATER INTO A LARGE SUMP (EG SEQUOYAH)--IF 0 IS
**             ENTERED, THE WATER DRAINS THROUGH THE SAME JUNCTIONS USED FOR
**             GAS TRANSFER
171  0         NODE 1
172  0         NODE 2
173  0         NODE 3
174  0         NODE 4
175  0         NODE 5
```

```
176  0          NODE 6
177  0          NODE 7
178  0          NODE 8
179  0          NODE 9
**
**              ELEVATION OF FLOOR OF NODE WITH RESPECT TO GROUND LEVEL
181  -6.096     NODE 1
182  -6.096     NODE 2
183  0.0        NODE 3
184  0.0        NODE 4
185  3.658      NODE 5
186  6.401      NODE 6
187  0.0        NODE 7
188  17.99      NODE 8
189  -6.096     NODE 9
**
**              CO2 MASS FLOWRATE FROM FIRE SUPPRESSION SYSTEM, IF ANY,
**              FOR NODE
**              THIS SYSTEM IS ACTIVATED IF THE NODAL GAS TEMP EXCEEDS
**              THE SETPOINT SPECIFIED BELOW
191  0.0        NODE 1
192  0.0        NODE 2
193  0.0        NODE 3
194  0.0        NODE 4
195  0.0        NODE 5
196  0.0        NODE 6
197  0.0        NODE 7
198  0.0        NODE 8
199  0.0        NODE 9
**
**              AREA OF INTERNAL WALL(S) IN NODE
201  660.1      NODE 1
202  641.9      NODE 2
203  807.5      NODE 3
204  5295.0     NODE 4
205  132.5      NODE 5
206  2279.0     NODE 6
207  4120.0     NODE 7
208  802.5      NODE 8
209  96.69      NODE 9
**
**              THICKNESS OF INTERNAL WALL(S) IN NODE
211  0.8447     NODE 1
212  0.5983     NODE 2
213  0.7099     NODE 3
214  0.7876     NODE 4
215  1.067      NODE 5
216  0.5093     NODE 6
217  0.4572     NODE 7
218  0.8189     NODE 8
219  0.3286     NODE 9
**
**              THERMAL CONDUCTIVITY OF INTERNAL WALL(S) IN NODE
221  3.459      NODE 1
222  3.459      NODE 2
223  3.459      NODE 3
224  3.459      NODE 4
225  3.459      NODE 5
226  3.459      NODE 6
227  3.459      NODE 7
228  3.459      NODE 8
229  3.459      NODE 9
**
**              SPECIFIC HEAT OF INTERNAL WALL(S) IN NODE
231  1076.0     NODE 1
232  1076.0     NODE 2
233  1076.0     NODE 3
234  1076.0     NODE 4
235  1076.0     NODE 5
236  1076.0     NODE 6
237  1076.0     NODE 7
```

```
238   1076.0     NODE 8
239   1076.0     NODE 9
**
**               HEIGHT OF INTERNAL WALL(S) IN NODE
241   5.486      NODE 1
242   5.486      NODE 2
243   4.724      NODE 3
244   4.572      NODE 4
245   2.743      NODE 5
246   3.832      NODE 6
247   3.000      NODE 7
248   4.574      NODE 8
249   6.096      NODE 9
**
**               DENSITY OF INTERNAL WALL(S) IN NODE
251   2440.0     NODE 1
252   2440.0     NODE 2
253   2440.0     NODE 3
254   2440.0     NODE 4
255   2440.0     NODE 5
256   2440.0     NODE 6
257   2440.0     NODE 7
258   2440.0     NODE 8
259   2440.0     NODE 9
**
**               NODE NO. ON THE OTHER SIDE OF THE WALL DESIGNATED
**               AS THE OUTER WALL OF A NODE;
**               USE INODRB+1 FOR ENVIRONMENT WHERE INODRB IS
**               NO. OF NODES IN THE MODEL; USE SMALLER NOS. IF AN
**               OUTER WALL IN NODE 1 HAS A DIFFERENT NODE ON THE OTHER SIDE;
**
**               FOR DIFFICULT SITUATIONS, IE WHEN A GIVEN NODE'S OUTER WALLS
**               HAVE DIFFERENT NODES ON THEIR OTHER SIDE CONSIDER THE
**               FOLLOWING:
**               FOR CONCRETE WALLS THICKER THAN ROUGHLY 1-2 FEET, THE THERMAL
**               BOUNDARY LAYER DOESN'T PENETRATE THE WALL OVER THE TIME
**               OF TYPICAL TRANSIENTS
**               THUS, ONE CAN TAKE CONCRETE WALL SURFACE AREA
**               (OR FLOORS AND CEILINGS) NOT ACCOUNTED FOR IN THE OUTER WALL
**               ASSIGNMENTS AND LUMP WITH THE TRUE
**               INTERIOR WALLS AS INTERIOR WALLS--THE OTHER SIDE OF SUCH WALLS
**               WOULD THEN BE LUMPED WITH THE INTERIOR WALLS IN THE ADJACENT
**               NODE
**
261   2          NODE 2
262   1          NODE 2
263   7          NODE 3
264   10         NODE 4
265   6          NODE 5
266   10         NODE 6
267   10         NODE 7
268   10         NODE 8
269   4          NODE 9
**
271   6.500      CHARACTERISTIC RADIUS FOR BURN IN NODE 1
272   4.572      CHARACTERISTIC RADIUS FOR BURN IN NODE 2
273   4.572      CHARACTERISTIC RADIUS FOR BURN IN NODE 3
274   24.38      CHARACTERISTIC RADIUS FOR BURN IN NODE 4
275   3.048      CHARACTERISTIC RADIUS FOR BURN IN NODE 5
276   12.19      CHARACTERISTIC RADIUS FOR BURN IN NODE 6
277   15.24      CHARACTERISTIC RADIUS FOR BURN IN NODE 7
278   12.19      CHARACTERISTIC RADIUS FOR BURN IN NODE 8
279   1.829      CHARACTERISTIC RADIUS FOR BURN IN NODE 9
**
281   5.486      CHARACTERISTIC HEIGHT FOR BURN IN NODE 1
282   5.486      CHARACTERISTIC HEIGHT FOR BURN IN NODE 2
283   10.06      CHARACTERISTIC HEIGHT FOR BURN IN NODE 3
284   6.069      CHARACTERISTIC HEIGHT FOR BURN IN NODE 4
285   2.743      CHARACTERISTIC HEIGHT FOR BURN IN NODE 5
286   3.962      CHARACTERISTIC HEIGHT FOR BURN IN NODE 6
287   9.144      CHARACTERISTIC HEIGHT FOR BURN IN NODE 7
```

```
288   7.620       CHARACTERISTIC HEIGHT FOR BURN IN NODE 8
289   30.48       CHARACTERISTIC HEIGHT FOR BURN IN NODE 9
**                THESE ARE FLOOR TO CEILING (NOT IGNITER TO CEILING)
**
**INITAL CONDITION DATA AND OTHER DATA WHICH APPLIES TO ALL NODES
291   0.0       TOTAL INITIAL MASS OF WATER AVAILABLE FOR FIRE SPRAYS
292   0.0       TOTAL INITIAL MASS OF CO2 IN FIRE SUPPRESSION SYSTEM
293   300.0     INITIAL TEMPERATURE OF AUX BUILDING
294   300.0     AUX BLDG SPRAY WATER TEMPERATURE
295   0.001     AUX BLDG SPRAY DROP DIAMETER
296   0.50      INITIAL REL HUMIDITY OF AUX BUILDING COMPTS
297   300.0     ENVIRONMENT TEMP
298   1.03E+05 ENVIRONMENT/AUX BLDG PRESSURE
299   3000.0    FIRE DAMPER ACTIVATION TEMP; PUT IN A VERY HIGH NO.
**              IF NO FIRE DAMPERS)
300   3000.0    FIRE SPRAY ACTIVATION TEMP
301   3000.0    CO2 INJECTION ACTIVATION TEMP
302   0.00E+00 MASS OF AEROSOL WHICH CAUSES SGTS FILTERS TO FAIL
303   1.00E+00 DF USED FOR SGTS FILTERS WHEN THEY ARE INTACT
**
***********************************************************************
*TOPOLOGY
***********************************************************************
**THIS SECTION DEFINES THE WAYS THAT THE VARIOUS AUX NODES ARE CONNECTED
**TOGETHER--THERE ARE THREE FORMATS FOR ENTERING DATA THAT ARE DESCRIBED
**BELOW; THE LAST CARD IN THIS SECTION MUST BE "END"
**    1. "JUNCTION" CARDS--THIS IS DEFINED BY A CARD WITH A "J" IN COLUMN
**        1 FOLLOWED BY A CARD WITH THE FOLLOWING INFORMATION:
**        A. NODE NO. OF THE VOLUME ON THE UPSTREAM SIDE OF JUNCTION;
**        B. NODE NO. OF DOWNSTREAM VOLUME;
**        C. 1 IF JUNCTION IS IN A HORIZONTAL WALL (IE FLOW IS VERTICAL,
**           USE 0 IF JUNCTION IS IN A VERTICAL WALL);
**        D. ELEVATION OF THE BOTTOM OF THE JUNCTION ABOVE THE FLOOR
**           OF THE UPSTREAM NODE;
**        E. FACING THE HOLE, THE WIDTH OF JUNCION;
**        F. FACING THE HOLE, THE HEIGHT OF JUNCTION;
**        G. LENGTH OF JUNCTION;
**        H. AREA OF JUNCTION
**
**        NOTE: IF WIDTH=HEIGHT, THE JUNCTION IS ASSUMED CIRCULAR, OTHERWISE
**        RECTANGULAR (USE WIDTH SLIGHTLY DIFFERENT THAN HEIGHT FOR SQUARE)
**        EVEN IF THE JUNCTION IS RECTANGULAR, THE AREA CAN BE DIFFERENT
**        THAN THE PRODUCT OF LENGTH AND WIDTH IF THE JUNCTION REPRESENTS THE
**        SUM OF SEVERAL HOLES WHICH HAVE THE SAME ELEVATION, ETC.
**    2. "FAILURE" CARDS--THIS IS DEFINED BY A CARD WITH AN "F" IN COLUMN
**        1 FOLLWED BY A CARD WITH THE FOLLOWING INFORMATION:
**        A. NODE NO. OF NODE WHICH CAN FAIL (UPSTREAM NODE);
**        B. NODE NO. THAT THE FAILED VOLUME  BLOWS DOWN INTO;
**        C. 1 IF THE JUNCTION IS HORIZ (0 IF VERTICAL);
**        D. ELEVATION OF THE BOTTOM OF THE OPENING ABOVE THE FLOOR OF
**           THE FAILED NODE;
**        E. FACING THE HOLE, THE WIDTH OF JUNCTION;
**        F. FACING THE HOLE, THE HEIGHT OF JUNCTION;
**        G. LENGTH OF JUNCTION;
**        H. AREA OF JUNCTION;
**        I. DIFFERENTIAL PRESSURE REQUIRED TO FAIL THE NODE IF THE UPSTREAM
**           NODE HAS THE HIGHEST PRESSURE
**        J. DIFFERENTIAL PRESSURE REQUIRED TO FAIL THE NODE IF THE DOWNSTRM
**           NODE HAS THE HIGHEST PRESSURE
**
**
**        NOTE: IF WIDTH=HEIGHT, THE JUNCTION IS ASSUMED CIRCULAR, OTHERWISE
**        RECTANGULAR (USE WIDTH SLIGHTLY DIFFERENT THAN HEIGHT FOR SQUARE)
**        EVEN IF THE JUNCTION IS RECTANGULAR, THE AREA CAN BE DIFFERENT
**        THAN THE PRODUCT OF LENGTH AND WIDTH IF THE JUNCTION REPRESENTS THE
**        SUM OF SEVERAL HOLES WHICH HAVE THE SAME ELEVATION, ETC.
**     3. "CONTAINMENT INTERFACE" CARD--ONE SUCH SET OF TWO CARDS SHOULD BE
**        PROVIDED
**        THE FIRST CARD SHOULD HAVE A "C" IN COLUMN ONE;
**        THE SECOND CARD GIVES:
**        A. THE NODE NO. WHICH RECEIVES FLUID FROM THE CONTAINMENT (OR
```

```
**          PRIMARY SYSTEM FOR V SEQUENCES) AND
**       B. ELEVATION ABOVE THE FLOOR OF THIS NODE OF THE TOP OF THE
**          JUNCTION THROUGH WHICH THE PRI SYS OR CONTMT EFFLUENT IS ISSUING
**
**       ONLY ONE SET OF THESE SHOULD BE INCLUDED
**
**CPCO...CP-MAAP ONLY:
**    4. "SUMP INTERFACE" CARD--ONE SET OF FIVE CARDS SHOULD BE PROVIDED IF
**       MODELING THE SUMP TO AUX BUILDING JUNCTIONS:
**
**       CARD #1: "S" IN COLUMN ONE
**       CARD #2: THE NODE WHICH RECEIVES FLUID FROM THE PRIMARY SYSTEM
**                FOR ISLOCA SEQUENCES AND THE ELEVATION OF THE BREAK ABOVE
**                THE FLOOR OF THE RECEIVING NODE
**       CARD #3: THE NUMBER OF SUMP TO AUX BUILDING JUNCTIONS, AND THE
**                AUX BUILDING NODES RECEIVING THE CORIUM FLOW.  THE NUMBER
**                OF JUNCTIONS IS LIMITED TO TWO.
**       CARD #4: THE AUX BUILDING NODE NUMBERS WHICH CAN CONTAIN CORIUM.
**                THE NUMBER OF NODES IS LIMITED TO THREE.
**       CARD #5: THE AUX BUILDING MODEL JUNCTION NUMBERS WHICH ARE ALLOWED
**                TO HAVE CORIUM FLOW.  THE NUMBER OF JUNCTIONS IS LIMITED
**                TO FIVE.
**
**       ONLY ONE SET OF THESE SHOULD BE INCLUDED
**
**TO MAKE TEMPORARY CHANGES TO THESE QUANTITIES IN THE CONTROL CARDS USE
**THE FOLLOWING FORMAT; ENTER THE CARD BELOW AND THEN A CARD WITH THE REQ'D
**INFORMATION AS SHOWN BELOW)
**
**JUNCTION CARD:   ENTER  20,1,J (WHERE J IS THE JUNCTION NO. YOU WANT TO
**                                 ADD OR CHANGE--NOTE THAT THE JUNCTION NOS.
**                                 ARE ASSIGNED CONSECUTIVELY)
**FAILURE CARD:    ENTER  20,2,J (WHERE J IS THE JUNCTION NO.)
**CONTAINMENT INTERFACE CARD: ENTER 20,3,0
**
**CPCO...CP-MAAP ONLY:
**SUMP INTERFACE CARD: ENTER 20,4,0
**
**
*********************************************************************
**IMPORTANT NOTE:
**THE MODEL WILL NOT RELIABLY FIND A
**SOLUTION FOR THE AUX BLDG FLOWS IN ONE SPECIFIC CIRCUMSTANCE:
**            1. TWO VOLUMES ONE ABOVE THE OTHER
**            2. PARALLEL FLOW PATHS CONNECTING THE TWO VOLUMES THROUGH
**               THE FLOOR OF THE UPPER VOLUME
**
**IT APPEARS THAT SUCH A SITUATION IS NUMERICALLY ILL-POSED
**TO AVOID PROBLEMS, IT IS RECOMMENDED IN SUCH A SITUATION TO
**LUMP THE TWO FLOWPATHS TOGETHER
**
*********************************************************************
**-REV07-START--------------------------------------------------------------
** THE JUNCTIONS WERE SUBSTANTIALLY MODIFIED TO KEEP FROM EXCEEDING
** THE MAAP LIMIT OF 30 ACTIVE JUNCTIONS.  HOPEFULLY, THE DECREASE IN DETAIL
** WILL NOT AFFECT THE RESULTS
** NOTE: JUNCTIONS AFTER 32 HAVE BEEN RENUMBERED.  AUXFLOWS FILE ARROWS.AXF
**         MUST BE UPDATED TO BE COMPATIBLE
FAILURE - WEST/EAST ENG SAFEGUARDS WATER TIGHT DOOR            - J1
1  2  0  0.3048   1.829   4.267  0.6096   7.804   7.754E+04  7.754E+04
FAILURE - WEST/EAST ENG SAFEGUARDS PENETRATIONS                - J2
1  2  0  2.591    0.1576 0.1576 0.6096   0.5657  3.447E+04  3.447E+04
FAILURE - WEST ENG SAFEGUARDS HATCH TO AUX 590                 - J3
1  4  1  5.4864   1.8288 1.8289 0.6096   3.345   1.462E+04  2.000E+07
FAILURE - WEST ENG SAFEGUARDS PENETRATIONS TO CCW 590          - J4
1  3  1  5.4864   0.1644 0.1644 0.6096   0.9313  3.447E+04  3.447E+04
FAILURE - SCUTTLE FROM WEST ENG SAFEGUARDS TO CCW 590          - J5
1  3  1  5.4864   0.7620 0.7620 0.6096   0.4560  7.754E+04  7.754E+04
FAILURE - WEST ENG SAFEGUARDS VENTILATION DUCTS                - J6
1  4  1  5.486    0.8636 0.8636 2.1336   2.343   2.758E+04  2.758E+04
FAILURE - EAST ENG SAFEGUARDS WATERTIGHT DOOR TO STAIR SHAFT   - J7
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2  9  0  0.1254   1.067   2.184   0.3048   2.330   7.754E+04   7.754E+04
FAILURE - EAST ENG SAFEGUARDS WATERTIGHT DOOR TO 602 PIPEWAY    - J8
2  5  0  9.754    1.067   2.184   0.3048   2.330   7.754E+04   7.754E+04
**-REV07-START-----------------------------------------------------------------
** CORRECT REVERSE DIRECTION FAILURE PRESSURE
**2  4  1  5.4864  1.905   2.413   0.6096   4.597   1.458E+04   1.458E+04
FAILURE - EAST ENG SAFEGUARDS HATCH TO AUX 590                  - J9
2  4  1  5.4864   1.905   2.413   0.6096   4.597   1.462E+04   2.000E+07
**-REV07-END-------------------------------------------------------------------
FAILURE - EAST ENG SAFEGUARDS PIPE PENETRATIONS TO 602 PIPEWAY  - J10
2  5  0  10.82    0.2038  0.2038  0.2032   0.0652  3.447E+04   3.447E+04
FAILURE - EAST ENG SAFEGUARDS VENTILATION DUCTS                 - J11
2  4  1  5.486    0.8636  0.8636  2.1336   2.343   2.758E+04   2.758E+04
FAILURE - CCW 590 TO AUX 590                                    - J12
3  4  0  0.1524   1.943   2.038   0.6096   3.961   7.745E+04   7.754E+04
JUNCTION - CCW 625 TO ENVIRONMENT - DOORS                       - J13
3  10 0  10.82    1.905   2.032   0.4572   5.702
JUNCTION - CCW 625 TO ENVIRONMENT - S/G CODE SAFETY PENETRATIONS - J14
3  10 1  14.33    2.072   2.072   0.6096   3.372
JUNCTION - CCW 590 TO TURBINE BUILDING                          - J15
3  7  0  1.499    1.600   1.254   0.6096   1.991
JUNCTION - AUX 590 TO 602 PIPEWAY - OPEN DOORS                  - J16
4  5  0  3.8100   0.9144  1.829   0.3048   3.530
FAILURE - AUX 590 DOORS TO STAIR SHAFT                          - J17
4  9  0  0.0      0.9144  2.134   0.3048   3.902   1.379E+04   2.758E+04
JUNCTION - AUX 590 VENTILATION DUCTS                            - J18
4  10 1  6.401    1.765   1.765   52.12    2.447
FAILURE - C-40 ROOM TO BORONOMETER ROOM DOOR                    - J19
4  5  0  3.9624   0.9114  2.134   2.438    1.951   1.379E+04   2.758E+04
JUNCTION - LADDER WAY FROM 602 PIPEWAY TO AUX 611               - J20
5  6  1  2.134    0.8763  0.8764  0.6096   0.7679
FAILURE - AUX 611 DOORS TO STAIR SHAFT                          - J21
6  9  0  0.0      0.9144  2.134   0.3048   4.078   1.379E+04   2.758E+04
FAILURE - AUX 611 DOOR TO SERVICE BUILDING                      - J22
6  10 0  0.0      0.9144  2.134   0.3048   1.951   1.379E+04   2.758E+04
JUNCTION - AUX 611 VENTILATION DUCTS                            - J23
6  10 1  4.267    1.765   1.765   10.00    2.447
FAILURE - AUX 625 DOORS TO ENVIRONMENT                          - J24
6  10 0  4.267    1.524   2.134   0.3048   46.03   689.5       689.5
JUNCTION - AUX 625 DOORS - LEAKAGE TO ENVIRONMEMT               - J25
6  10 0  4.267    1.524   0.0254  0.3048   4.603
JUNCTION - TURB BLDG WALL PENETRATIONS TO ENVIRONMENT - HIGH    - J26
7  10 0  15.21    1.207   1.208   0.1524   25.63
JUNCTION - TURB BLDG WALL PENETRATIONS TO ENVIRONMENT - LOW     - J27
7  10 0  5.745    1.207   1.208   0.1524   23.30
JUNCTION - TURBINE BUILDING ROOF EXHAUSTERS                     - J28
7  10 1  30.10    1.232   1.232   0.3048   14.30
FAILURE - TURBINE BUILDING DOOR TO AUX 625                      - J29
7  6  0  10.668   1.905   2.032   0.1524   3.871   1.379E+04   2.758E+04
JUNCTION - NORMALLY OPEN TURB BLDG DOORS TO THE ENVIRONMENT     - J30
7  10 0  0.0      1.829   2.134   0.1524   3.902
FAILURE - NORMALLY CLOSED TURB BLDG DOORS TO THE ENVIRONMENT    - J31
7  10 0  0.0      1.905   2.032   0.1524   47.38   1.379E+04   2.758E+04
FAILURE - AUX 649 DOORS TO STAIR SHAFT                          - J32
8  9  0  0.0      0.9144  2.134   0.3048   7.370   1.379E+04   2.758E+04
** SEE COMMENT FOR JUNCTIONS 38 THROUGH 40
**JUNCTION - AUX 649 TO STAIR SHAFT NORMAL LEAKAGE                - J33
**8  9  0  0.0      0.9144  0.0286  0.3048   0.1703
FAILURE - AUX 649 HATCH TO TRACK ALLEY                          - J33
8  10 1  0.1524   4.572   9.144   9.144    41.88   2.758E+04   2.758E+04
JUNCTION - AUX 649 TO ENVIRONMENT - NEW FUEL PIT FLOOR          - J34
8  10 1  0.1524   1.524   7.315   9.144    11.15
JUNCTION - AUX 649 TO ENVIRONMENT - LOUVERS                     - J35
8  10 0  0.9144   1.524   2.483   0.3048   7.618
FAILURE - STAIR SHAFT TO ENVIRONMENT                            - J36
9  10 0  19.81    0.9144  2.134   19.81    1.951   1.379E+04   2.758E+04
** JUNCTIONS 33 AND 38 THROUGH 40 MODELED THE FLOW AREA AROUND A CLOSED DOOR.
** IT IS BELIEVED THAT DELETING THESE AREAS WILL NOT AFFECT MOST SEQUENCES.
** (THE DOORS THEMSELVES BLOW OPEN ANYWAY).
**JUNCTION - STAIR SHAFT TO ENVIRONMENT                           - J38
**9  10 0  16.76    0.9144  0.0254  19.81    0.03968
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**JUNCTION - AUX 611/625 TO STAIR SHAFT NORMAL LEAKAGE           - J39
**6   9   0   0.0      0.9144  0.0286  0.3048   0.3406
**JUNCTION - AUX 590 TO STAIR SHAFT NORMAL LEAKAGE               - J40
**4   9   0   0.0      0.9144  0.0286  0.3048   0.1703
**-REV07-END-------------------------------------------------------------------
CONTAINMENT INTERFACE - PENETRATION LEAKAGE TO 602 PIPEWAY
5   1.524
**CPCO...CP-MAAP ONLY:
SUMP INTERFACE - ESF RECIRCULATION LINES
5   1.524
2   1   2
1   2   0
1   2   0   0   0
END
**
*********************************************************************
**PLTMAP
*********************************************************************
**
**@@@REV 15, THIS PLTMAP SECTION IS NEW
**
** YOU CAN HAVE UP TO 25 PLOT FILES AND UP TO 99 VARIABLES.
** BEGAN EACH PLOT FILE SECTION WITH THE WORD "PLOTFIL" FOLLOWED BY
** THE UNIT NUMBER YOU WANT THE FILE WRITTEN TO.  A NEGATIVE UNIT
** NUMBER WILL FORCE BINARY OUTPUT.  (USE FORM=UNFORMATTED IN OPEN
** STATEMENTS)
**
** NEXT, SELECT THE VARIABLES YOU WANT TO BE PLOTTED BY SIMPLY
** SPECIFYING THE VARIABLE NAMES.  PLOT FILES 31 THRU 37 DEFINED BELOW
** ARE IDENTICAL TO THE "OLD" HARDWIRED MAAP PLOT FILES.
**
** FOR THE CASE OF A VARIABLE NOT PRESENT IN THE MAAP COMMON BLOCK BUT
** YOU WANT TO PLOT IT OUT (OR USE IT IN USER DEFINED EVENTS CODES),
** A COMMON/XPLTX/ PLT(500) WAS PROVIDED EXPRESSLY FOR THAT PURPOSE.
** INSERT THE LINE  "COMMON/XPLTX/ PLT(500)"  INTO THE ROUTINE THAT
** HAS THE LOCAL VARIABLE YOU WANT TO SAVE, AND ASSIGN THE VALUE OF
** THE VARAIBLE TO ONE OF THE ARRAY PLT INDICES.  THEN SELECT THAT
** ARRAY INDICE TO BE PLOTTED IN THE PLOTFIL SECTION.
**
** BE SURE TO END THIS SECTION WITH THE KEYWORD "END", AND **
**  COMMENTING IS ALLOWED.
**
**@@@REV 16, PLOT FREQUECNY OPTION ADDED
** A NEW ADDITION TO THE OLD PLTFIL SCHEME IS THE CONSTRAINTS TO
** THE MINIMUM/MAXIMUM PLOT DT AS DETERMINED BY THE AUTODT PLOT SCALER.
** PREVIOUSLY UNDER THE OLD AUTODT SCHEME, THE PLOT SPACING BETWEEN THE
** PLOTTED DATA POINTS CAN BE AS SMALL AS MAAP TIMESTEP OR AS LARGE AS
** THE MAAP RUN TIME.  THIS ADDITION WILL PROVIDE REASONABLE CONTROL OF
** THE WAY PLOTTTING DATA POINTS MAY TURN OUT, EG., ELIMINATION OF
** VERY NOISY (IE., MANY DATA POINTS OVER SMALL TIME INTERVAL) AND
** VERY COARSE (IE., FEW DATA POINTS SPREAD OVER LARGER TIME INTERVAL)
** PLOTS.  PRESENTLY, THE PLOT FREQUENCY IS SET TO A MINMUM OF 1 SEC,
** AND MAXIMUM OF 5 MINUTE AS SPECIFIED BELOW.  SOME MAY FIND THIS
** UNSUITABLE AND MAY WANT TO ALLOW LARGER OR SMALLER FREQUENCY.  THE
** FORMAT TO SPECIFY THE PLOT FREQUENCY CONSTRAINTS IS
**
**         FREQ  <MINIMUM PLOT DT>  <MAXIMUM PLOT DT>
**
** WHERE THE MAX/MIN PLOT DT IS SUPPLIED IN SECONDS.  NOTE THAT PLOT
** FREQUENCY CONSTRAINTS APPLIES TO ALL PLOT FILES.
**
**@@@REV 16, LOCAL PARAMETER CHANGE TO ADD PLOTFIL ADDED
** PLOT FILES CAN ALSO BE SETUP VIA INPUT DECK THROUGH LOCAL PARAMETER
** CHANGE.  SIMPLY SPECIFY 25,0,0 FOLLOWED BY THE SYNTAX EXPLAINED,
** (PRATICALLY IDENTICAL TO THE SETUP BELOW BUT WITHOUT THE *PLTMAP
** LINE) AND BE SURE TO END PLTMAP INPUT WITH THE KEYWORD END.  NOTE
** THAT IF YOU SPECIFY THE SAME UNIT NUMBER, THE CURRENT PLOTFIL WILL
** SUPERSEDE THE PREVIOUS ONE.
**
**@@@REV 16, TIME OFFSET OPTION ADDED
** FOR CERTAIN APPLICATIONS, IT IS ADVANTANEOUS TO OFFSET THE PLOT
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** FILE TIME BY SOME DELTA TIME.  FOR EXAMPLE, LATE INTO A MAAP RUN
** THE RESOLUTION OF TIME INTERVAL IS LOST DUE TO THE LARGE NUMBER IN
** SECONDS EXPRESSED IN E FORMAT.  THIS REOLUTION CAN BE REGAINED BY
** UTILIZING THE TIME OFFSET.  FOR EXAMPLE, IF THE TIME OFFSET IS 10,000.
** SECONDS, THEN THE TIME STORED TO THE PLOT FILE WILL BE MAAP RUN TIME
** MINUS 10,000 SECONDS.  THE FORMAT TO SPECIFY THE TIME OFFSET IS
**
**       TIMOFF  <TIME IN SECONDS TO OFFSET>
**
** AND WILL ONLY APPLY TO THE PLOTFIL IN WHERE TIMOFF IS SPECIFIED.
** THUS, EACH PLOTFIL CAN HAVE ITS OWN TIME OFFSET.
**
**
*PLTMAP
**
FREQ 1.0 300.0
**
*********************************************************************
**                     MAAP PWR PLOT FILES
*********************************************************************
**
PLOTFIL 31  /  PRIMARY SYSTEM
MCR,MH2CR1,MWCR1,QWCR,TWCR,ZWV,WGUPCR
MH2CB1,PPS,TCMPS,TWUI,TGPS,ZWCPS,WWUL,MWPS,MH2PS1,MDWTOT
MCMTPS,ZWBC,ZWUC,TWBI,TCRHOT,WHLBL,WSGBL,TSGBHP
TGPZ,TWPZ,PPZ,ZWPZ,MH2PZ1,TSR1,WWBB,WGBB,ZWBH,ZWUH,WHLUL,WSGUL,TGUP
**-REV08-START-----------------------------------------------------------
**TIMRAT
**-REV10-START-----------------------------------------------------------
**PALXO(6),PALXO(7)
**-REV10-END-------------------------------------------------------------
**-REV08-END-------------------------------------------------------------
*********************************************************************
**
PLOTFIL 32  /  STEAM GENERATOR AND ESF
ZWBS,PBS,TGBS,ZWUS,PUS,TGUS,TWBS,TWUS,QSGTOT
WCDHBS,WCDHUS,WCDCBS,WCDCUS
PACUM,ZWRWST,WESFDC,WESFCL,WSPTA,PQT,TWQT,MH2QT1,TD,NCRTEQ
*********************************************************************
**
PLOTFIL 33  /  CONTAINMENT
TGC,PC,TWC,TCMC,ZWC,MWC1,MH2C1,MCMTC,XCNC1,TFMC
TGB,PB,TWB,TCMB,ZWB,MH2B1,MCMTB,XCNB1,TFMB,WCMTN,WWTN
TGA,PA,TCMA,MH2A1,MCMTA,XCNA1,TFMA,WCMAC,WWAC
TGD,PD,ZWD,MH2D1,TFMD
MSWA,MSWB,MSWC,MSWD,MAWA,MAWB,MAWC,MAWD
XCLWDA,XCLWDB,XCLWDC,XCLWDD
*********************************************************************
**
PLOTFIL 34  /  DETAILED PRI. SYSTEM THERMAL HYDRAULIC INFO.
TGCR,TGUP,TGBH,TGBHT,TGBCT,TGBIL,TGBC,TGDC,TGUH,TGUHT
TGUCT,TGUIL,TGUC,TGDM,TPHSF(1),TPHSF(2),TPHSF(3),TPHSF(4),TBH(2,1)
TPHSF(6),TPHSF(7),TPHSF(8),TPHSF(9),TPHSF(10),TPHSF(11),TPHSF(12)
TUH(2,1),TPHSF(14),TPHSF(15),TPHSF(16),TPHSF(17),TPHSF(18),TPHSF(19)
WVUL,WVBL,FLOSS
*********************************************************************
**
PLOTFIL 35  /  FISSION PRODUCT INFO.
FREL(1),FREL(2),FREL(3),FREL(4),FREL(5),FREL(6),FREL(7),FREL(8)
FREL(9),FREL(10),FREL(11),FREL(12),MAIRPS,MAIRC,MFCSIP,MFCSIC
QFPHSF(1),QFPHSF(2),QFPHSF(3),QFPHSF(4),QFPHSF(5),QFPHSF(6),QFPHSF(7)
QFPHSF(8),QFPHSF(9),QFPHSF(10),QFPHSF(11),QFPHSF(12),QFPHSF(13)
QFPHSF(14),QFPHSF(15),QFPHSF(16),QFPHSF(17),QFPHSF(18),QFPHSF(19)
QGFPPS(1),QGFPPS(2),QGFPPS(3),QGFPPS(4),QGFPPS(5),QGFPPS(6),QGFPPS(7)
QGFPPS(8),QGFPPS(9),QGFPPS(10),QGFPPS(11),QGFPPS(12),QGFPPS(13)
QGFPPS(14),LAMSA,LAMSD
*********************************************************************
**
** NOTE: IF YOU ARE NOT MODELING THE AUXILARY/REACTOR BUILDING MODEL
**  THAT IS INODRB=0 IN *CONTROL SECTION, COMMENT THIS SECTION OUT.
**
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PLOTFIL 36  /  AUXILARY BUILDING
ZWRB(1),ZWRB(2),ZWRB(3),ZWRB(4),ZWRB(5),ZWRB(9)
TGRB(1),TGRB(2),TGRB(3),TGRB(4),TGRB(5),TGRB(6),TGRB(7),TGRB(8),TGRB(9)
PRB(1),PRB(2),PRB(3),PRB(4),PRB(5),PRB(6),PRB(7),PRB(8),PRB(9)
FMENVP(1),FMENVP(2),FMENVP(3),FMENVP(4),FMENVP(5),FMENVP(6)
FMENVP(7),FMENVP(8),FMENVP(9),FMENVP(10),FMENVP(11),FMENVP(12)
**
********************************************************************************
**
PLOTFIL 37 /AUX BLDG FLOWS FOR AUXFLOWS
WRB(1),WRB(2),WRB(3),WRB(4),WRB(5),WRB(6),WRB(7),WRB(8),WRB(9),WRB(10)
WRB(11),WRB(12),WRB(13),WRB(14),WRB(15),WRB(16),WRB(17),WRB(18),WRB(19),WRB(20)
WRB(21),WRB(22),WRB(23),WRB(24),WRB(25),WRB(26),WRB(27),WRB(28),WRB(29),WRB(30)
WRB(31),WRB(32),WRB(33),WRB(34),WRB(35),WRB(36)
WGCFC(1),WGCFC(2)
**
**********************************************************************
**CPCO...CP-MAAP ONLY:
**
PLOTFIL 38  /  PALISADES SPECIFIC
WGCFC(1),WGCFC(2),WWCFRB(1),WWCFRB(2)
MCMTRB(1),MCMTRB(2),MCMTRB(3),FQCMRB(1),FQCMRB(2),FQCMRB(3)
XCNRB(1),XCNRB(2),XCNRB(3),TCMRB(1),TCMRB(2),TCMRB(3)
ZCMRB(1),ZCMRB(2),ZCMRB(3)
INBSRV,INBSSV(1),INPORV(1),INPZSV(1),INUSRV,INUSSV(1)
TDAUX,TD
**********************************************************************
END
**
**********************************************************************
**EVTMESS
**********************************************************************
**
**@@@REV 15, THIS EVTMESS SECTION IS NEW
**
** THIS EVTMES SECTION DEFINES THE MAAP EVENT MESSAGES FOR EVENT CODES
**  1 THRU 250 IN THE PWR CODE, AND 1 THRU 300 IN THE BWR CODE.
**
** EXPECTED FORMAT OF THIS SECTION IS;
**
**  <NUMBER>  <FLAG>  <MESSAGE>
**
**  WHERE  <NUMBER> IS THE EVENT CODE NUMBER
**           <FLAG> IS THE EVENT FLAG
**        <MESSAGE> IS THE EVENT CODE MESSAGE
**
** EVENT FLAG TOKENS "0", "1", "T", "F", "TRUE", AND "FALSE" ARE
** ACCEPTABLE.  BE SURE TO END THIS SECTION WITH THE KEYWORD "END".
** ** COMMENTING IS ALLOWED, AND THE FOLLOWING EVENT MESSAGES ARE
** DEFAULT MAAP EVENT CODE MESSAGES, AS PRESENT IN MAAP BLOCK DATA.
** HENCE, THIS SECTION IS NOT NECCESSARY IF YOU LEAVE EVENT MESSAGES
** UNMODIFIED.
**
**********************************************************************
*EVTMESS
  1  T  BROKEN LEG BREAK UNCOVERED
  1  F  BROKEN LEG BREAK COVERED
  2  T  SUPPORT PLATE FAILED
  2  F  SUPPORT PLATE INTACT
  3  T  REACTOR VESSEL FAILED
  3  F  REACTOR VESSEL INTACT
  4  T  PRIMARY COOLANT PUMPS OFF
  4  F  PRIMARY COOLANT PUMPS ON
  5  T  HPSI ON
  5  F  HPSI OFF
  6  T  LPSI ON
  6  F  LPSI OFF
  7  T  SIT'S NOT FUNCTIONAL
  7  F  SIT'S FUNCTIONAL
  8  T  ALL CORIUM DISCHARGED IN INITIAL BLOWDOWN
  9  T  ALL WATER DISCHARGED IN INITIAL BLOWDOWN
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10  T  BROKEN LEG BREAK WATER FLOW EQUIL WITH INJ
10  F  NORMAL BROKEN LEG BREAK FLOW CALCULATION
11  T  CHARGING PUMPS ON
11  F  CHARGING PUMPS OFF
12  T  CORIUM OR CORE CAN STEAM
12  F  CORE POOL SUBCOOLED
13  T  REACTOR SCRAM
13  F  REACTOR AT FULL POWER
14  T  FISSION PRODUCT MODELS ON
14  F  FISSION PRODUCT MODELS OFF
15  T  UNBROKEN LOOP HOMOGENEOUS
15  F  UNBROKEN LOOP PHASES SEPERATED
16  T  REACTOR HEAD VENT LINE UNCOVERED
16  F  REACTOR HEAD VENT LINE COVERED
17  T  CORIUM IN LOWER HEAD POOL
17  F  NO CORIUM IN LOWER HEAD POOL
18  T  H2 PRODUCTION IN REACTOR VESSEL POOL OVER
19  T  CORIUM QUENCHED IN VESSEL
19  F  REACTOR VESSEL CORIUM NOT QUENCHED
20  T  PRIMARY SYSTEM SATURATED ENERGY AVAILABLE
20  F  PRIMARY SYSTEM AS A WHOLE SUBCOOLED
21  T  PRIMARY SYSTEM PRESSURE CALCULATED
21  F  PRIMARY SYSTEM PRESSURE DETERMINED BY PRESSURIZER
22  T  PRIMARY SYSTEM SURGE LINE NOZZLE UNCOVERED
22  F  PRIMARY SYSTEM SURGE LINE NOZZLE COVERED
23  T  DOWNCOMER NODE HAS NO WATER
23  F  DOWNCOMER NODE HAS WATER
24  T  MAKEUP FLOW OFF
24  F  MAKEUP FLOW ON
25  T  PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS
25  F  PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS
26  T  PRIMARY POOLS ISOLATED
26  F  PRIMARY POOLS WELL-MIXED
27  T  UNBROKEN LOOP NOT BLOCKED AT LOOP SEAL
27  F  UNBROKEN LOOP BLOCKED AT LOOP SEAL
28  T  DOWNCOMER NOT BLOCKED FOR GAS TRANSPORT
28  F  DOWNCOMER BLOCKED FOR GAS TRANSPORT
29  T  REACTOR HEAD VENT OPEN
29  F  REACTOR HEAD VENT CLOSED
30  T  PRESSURIZER HEATERS ON
30  F  PRESSURIZER HEATERS OFF
**-REV08-START---------------------------------------------------------------
31  T  NORMAL PRESSURIZER SPRAYS ON
31  F  NORMAL PRESSURIZER SPRAYS OFF
**-REV08-END-----------------------------------------------------------------
32  T  PRESSURIZER EMPTY
32  F  PRESSURIZER NOT EMPTY
36  T  PRESSURIZER POOL SATURATED
36  F  PRESSURIZER POOL SUBCOOLED
38  T  PRESSURIZER INSUFFIENT ENERGY FOR SATURATION
38  F  PRESSURIZER SYSTEM SAT ENERGY AVAILZBLE
39  T  PRESSURIZER EQUILIBRIUM THERMODYNAMICS
39  F  PRESSURIZER NONEQILIBRIUM THERMODYNAMICS
40  T  PRESSURIZER SOLID
40  F  PRESSURIZER HAS STEAM
41  T  PRESSURIZER PRESSURE DETERMINED BY PRISYS
41  F  PRESSURIZER PRESSURE CALCULATED
42  T  PRESSURIZER CODE SAFETY VALVE(S) OPEN
42  F  PRESSURIZER CODE SAFETY VALVES CLOSED
43  T  RV,BK FLOW/SI ACCUM EQUIL;SYSTEM SOLID
43  F  NORMAL RV,BK FLOW CALC
44  T  PRESSURIZER PORV(S) OPEN
44  F  PRESSURIZER PORV(S) CLOSED
45  T  BROKEN LOOP NOT BLOCKED AT LOOP SEAL
45  F  BROKEN LOOP BLOCKED AT LOOP SEAL
46  T  LETDOWN FLOW OFF
46  F  LETDOWN FLOW ON
47  T  UHI RUPTURE DISK BROKEN
47  F  UHI RUPTURE DISK INTACT
48  T  UHI ACCUMULATOR NOT FUNCTIONAL
48  F  UHI ACCUMULATOR FUNCTIONAL
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 49  T  CORE HAS UNCOVERED
 49  F  CORE NEVER UNCOVERED
 51  T  CAVITY CORIUM CAN STEAM
 51  F  CAVITY POOL SUBCOOLED
 52  T  CAVITY WALLS TAKEN TO BE SUBMERGED
 52  F  CAVITY WALLS NOT SUBMERGED
 53  T  CORIUM ENTRAINED FROM CAVITY TO UPPER CONT
 53  F  CORIUM NOT ENTRAINED FROM CAV TO UPPER CONT
 54  T  H2 PRODUCTION COMPLETED IN CAVITY POOL
 55  T  BURN IN PROGRESS IN CAVITY
 55  F  NO BURN IN PROGRESS IN CAVITY
 56  T  WATER ENTRAINED FROM CAVITY TO UPPER CONT
 56  F  WATER NOT ENTRAINED FROM CAVITY TO UPPER CONT
 57  T  WATER IN CAVITY
 57  F  CAVITY DRY
 58  T  CORIUM FLOODING FROM CAVITY TO LOWER CONT
 58  F  CORIUM NOT FLOODING FROM CAVITY TO LOWER CONT
 59  T  WATER FLOODING FROM CAVITY TO LOWER CONT
 59  F  WATER NOT FLOODING FROM CAVITY TO LOWER
 60  T  GAS TRANSFER FROM CAVITY TO VESSEL BLOCKED
 60  F  NORMAL CAVITY-REACTOR VESSEL GAS TRANSFER
 61  T  CORIUM IN CAVITY
 61  F  NO CORIUM IN CAVITY
 62  T  CORIUM FROZEN IN CAVITY
 62  F  CORIUM MOLTEN IN CAVITY
 65  T  CAVITY COUPLED MODEL USED
 65  F  CAVITY UNCOUPLED MODEL USED
 66  T  STEAMING IN CAVITY LIMITED BY FLOODING
 66  F  STEAMING IN CAVITY NOT FLOODING-LIMITED
 67  T  TUNNEL COVERED/NO CAV NATURAL CIRCULATION
 67  F  TUNNEL NOT COVERED
 68  T  CAVITY SOLID
 68  F  CAVITY NOT FULL
 69  T  STEAM EXPLOSION HAS OCCURED IN CAVITY
 69  F  NO STEAM EXPLOSION HAS YET OCCURED IN CAVITY
 70  T  CORIUM IN CONTACT WITH CAVITY FLOOR
 70  F  CORIUM NOT YET IN CONTACT WITH CAVITY FLOOR
 71  T  LOWER CONTAINMENT CORIUM CAN STEAM
 71  F  LOWER CONTAINMENT POOL SUBCOOLED
**CPCO...CP-MAAP ONLY: EVENT CODES 72 AND 73 ARE FOR CP-MAAP/3.0B ONLY
 72  T  CAVITY FLOOR FAILED
 72  F  CAVITY FLOOR INTACT
 73  T  ESF RECIRCULATION PIPING FAILED BY CORIUM
 73  F  ESF RECIRCULATION PIPING INTACT
 74  T  POOL H2 PRODUCTION COMPLETED IN LOWER CONT
 75  T  BURN IN PROGRESS IN LOWER CONTAINEMNT
 75  F  NO BURN IN LOWER CONTAINMENT
 79  T  CONTAINMENT AIR COOLERS ON
 79  F  CONTAINMENT AIR COOLERS OFF
 81  T  WATER ON LOWER CONTAINMENT FLOOR
 81  F  LOWER CONTAINMENT FLOOR DRY
 82  T  CORIUM IN LOWER CONTAINMENT
 82  F  NO CORIUM IN LOWER CONTAINMENT
 83  T  CORIUM FROZEN IN LOWER CONTAINMENT
 83  F  CORIUM MOLTEN IN LOWER CONTAINMENT
 86  T  LOWER CONTAINMENT SPRAYS ON
 86  F  LOWER CONTAINMENT SPRAYS OFF
 92  T  QUENCH TANK RUPTURE DISK FAILED
 92  F  QUENCH TANK RUPTURE DISK INTACT
 93  T  QUENCH TANK RUPTURE DISK COVERED
 93  F  QUENCH TANK RUPTURE DISK NOT COVERED
 94  T  QUENCH TANK RUPTURE DISK OVERFLOWING
 94  F  QUENCH TANK RUPTURE DISK NOT OVERFLOWING
 95  T  QUENCH TANK CONTAINS WATER
 95  F  QUENCH TANK EMPTY
 96  T  QUENCH TANK WATER CAN STEAM
 96  F  QUENCH TANK WATER SUBCOOLED
101  T  UPPER CONTAINMENT WATER CAN STEAM
101  F  UPPER CONTAINMENT WATER SUBCOOLED
102  T  BURN IN PROGRESS IN UPPER CONTAINMENT
102  F  NO BURN IN UPPER CONTAINMENT
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103  T  CONTAINMENT SPRAYS ON
103  F  CONTAINMENT SPRAYS OFF
104  T  CONTAINMEMT FAILED
104  F  CONTAINMENT INTACT
105  T  WATER IN REFUELING POOL
105  F  NO WATER IN REFUELING POOL
106  T  NEUTRON SHIELD BAGS RUPTURED
106  F  NEUTRON SHIELD BAGS INTACT
107  T  CORIUM IN UPPER CONTAINMENT
107  F  NO CORIUM IN UPPER CONTAINMENT
108  T  CORIUM FROZEN IN UPPER CONTAINMENT
108  F  CORIUM NOT FROZEN IN UPPER CONTAINMENT
119  T  CONTMT FAILED IN UPPER CONT ON PRESSURE
120  T  CONTMT FAILED IN UPPER CONT ON STRAIN
121  T  WATER IN ANNULAR COMPARTMENT
121  F  NO WATER IN ANNULAR COMPARTMENT
122  T  BURN IN PROGRESS IN ANNULAR COMPARTMENT
122  F  NO BURN IN ANNULAR COMPARTMENT
123  T  ANNULAR COMPARTMENT WATER CAN STEAM
123  F  ANNULAR COMPARTMENT WATER SUBCOOLED
129  T  CONTAINMENT FAILED IN ANNULAR COMPT ON PRESSURE
130  T  CONTAINMENTT FAILED IN ANNULAR COMPT ON STRAIN
131  T  I/C SUMP HAS WATER
131  F  I/C SUMP EMPTY
132  T  ICE DEPLETED
132  F  ICE AVAILABLE
133  T  I/C SUMP WATER CAN STEAM
133  F  I/C SUMP WATER SUBCOOLED
141  T  BURN IN PROGRESS IN I/C UPPER PLENUM
141  F  NO BURN IN I/C UPPER PLENUM
**-REV13-START-------------------------------------------------------------
150  T  TURBINE BYPASS VALVE OPEN
150  F  TURBINE BYPASS VLAVE CLOSED
**-REV13-END---------------------------------------------------------------
151  T  BROKEN STEAM GENERATOR DRY
151  F  BROKEN STEAM GENERATOR NOT DRY
152  T  ADV(S) OPEN ON BROKEN STEAM GENERATOR
152  F  ADV(S) NOT OPEN ON BROKEN STEAM GENERATOR
153  T  CODE SAFETY(S) OPEN ON BROKEN STEAM GENERATOR
153  F  CODE SAFETY(S) NOT OPEN ON BROKEN STEAM GENERATOR
154  T  AUXILARY FEEDWATER ON
154  F  AUXILARY FEEDWATER OFF
155  T  BROKEN LOOP STAGNANT
155  F  BROKEN LOOP CIRCULATING
156  T  MSIV CLOSED
156  F  MSIV OPEN
157  T  MAIN FEED WATER OFF
157  F  MAIN FEED WATER ON
158  T  BROKEN STEAM GENERATOR EQUILIBRIUM THERMO
158  F  BROKEN STEAM GENERATOR NONEQUILIBRIUM THERMO
159  T  BROKEN LOOP STEAM GENERATOR SOLID
159  F  BROKEN LOOP STEAM GENERATOR VOIDED
160  T  S/G TUBE RUPTURE UNCOVERED PRIMARY SIDE
160  F  S/G TUBE RUPTURE COVERED PRIMARY SIDE
161  T  UNBROKEN STEAM GENERATOR DRY
161  F  UNBROKEN STEAM GENERATOR NOT DRY
162  T  ADV(S) OPEN ON UNBROKEN STEAM GENERATOR
162  F  ADV(S) NOT OPEN ON UNBROKEN STEAM GENERATOR
163  T  CODE SAFETY(S) OPEN ON UNBROKEN STEAM GENERATOR
163  F  CODE SAFETY(S) NOT OPEN ON UNBROKEN STEAM GENERATOR
164  T  UNBROKEN LOOP STAGNANT
164  F  UNBROKEN LOOP CIRCULATING
165  T  BUMP UNBROKEN LOOP
166  T  BUMP BROKEN LOOP
167  T  UNBKN STEAM GENERATOR EQUIL THERMO
167  F  UNBROKEN STEAM GENERATOR NONEQ THERMO
168  T  UNBROKEN LOOP STEAM GENERATOR SOLID
168  F  UNBROKEN LOOP STEAM GENERATOR VOIDED
169  T  STEAM GENERATOR BREAK UNCOVERED SECONDARY SIDE
169  F  STEAM GENERATOR BREAK COVERED SECONDARY SIDE
170  T  IGNITERS POWER ON
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170  F  IGNITERS POWER OFF
171  T  BROKEN LOOP HOMOGENEOUS
171  F  BROKEN LOOP PHASES SEPERATED
172  T  BROKEN STEAM GENERATOR POOL SATURATED
172  F  BROKEN STEAM GENERATOR POOL SUBCOOL
176  T  BURN IN AUXILARY BUILDING
176  F  NO BURN IN AUXILARY BUILDING
177  T  AUXILARY BUILDING SPRAY WATER GONE
178  T  AUXILARY BUILDING CO2 SUPLY DEPLETD
179  T  AUX BUILDING VENTILATION FILTERS FAILED
179  F  AUX BUILDING VENTILATION FILTERS OK
181  T  ESF RECIRCULATION MODE IN OPERATION
181  F  SAFETY INJECTION PUMPS USING SIRWT
182  T  CONT SPRAY PUMPS INSUFFICIENT NPSH
182  F  CONT SPRAY PUMPS NPSH OK
183  T  CHARGING PUMPS INSUFFICIENT NPSH
183  F  CHARGING PUMPS NPSH OK
184  T  LPSI PUMPS INSUFFIENT NPSH
184  F  LPSI PUMPS NPSH OK
185  T  HPSI PUMPS INSUFFICIENT NPSH
185  F  HPSI PUMPS NPSH OK
186  T  CONT SUMP WATER AVAILABLE
186  F  CONT SUMP EMPTY
187  T  SIRWT WATER DEPLETED
187  F  SIRWT WATER AVAILABLE
188  T  SIT WATER DEPLETED
188  F  SIT WATER AVAILABLE
189  T  LOWER CONT SPRAY PUMPS INSUFFICIENT NPSH
189  F  LOWER CONT SPRAY PUMPS NPSH OK
190  T  UHI ACCUM EMPTY
190  F  UHI ACCUM NOT EMP
191  T  CST WATER DEPLETED
191  F  CST WATER AVAILABLE
192  T  CAV INJ TANK DEPLETED
192  F  CAV INJ WATER AVAILABLE
193  T  LPSI SPRAYS INSUFFICIENT NPSH
193  F  LPSI SPRAYS NPSH OK
194  T  UNBROKEN BREAK WATER FLOW EQUIL WITH INJ
194  F  NORMAL UNBROKEN BREAKK FLOW CALCULATION
196  T  FAST STM PROPS IN PRI SYS USED
196  F  FULLBLOWN STM PROPS IN PRI SYS
197  T  UNBROKEN LOOP BREAK UNCOVERED
197  F  UNBROKEN LOOP BREAK COVERED
198  T  CORE COLLAPSED
198  F  CORE GEOMETRY NORMAL
199  T  PRIMARY SYSTEM DEPRESSURIZED
199  F  PRIMARY SYSTEM AT PRESSURE
200  T  DC CD H2 BLOCK OFF
200  F  DC H2 BLOCK NORML
201  T  UHI DIVERTED TO CORE POOL
201  F  UHI MODEL NORMAL
202  T  CORE SUBMERGED BLOCK MODEL OFF
202  F  BLOCKAGE MODEL NORMAL
203  T  HEAT EXCHANGER COOLING WATER OFF
203  F  HEAT EXCHANGER COOLING WATER AVAILABLE
204  T  LOOP SEALS CANNOT CLEAR DURING BLOWDOWN
204  F  LOOP SEALS CAN CLEAR DURING BLOWDOWN
205  T  POWER NOT AVAILABLE
205  F  POWER AVAILABLE
**CPCO...CP-MAAP ONLY: EVENT CODE 206 IS FOP CP-MAAP/3.0B ONLY
206  T  CONTAINMENT SPRAY HEADER VALVE CLOSED
206  F  CONTAINMENT SPRAY HEADER VALVE OPEN
207  T  IGNITERS FORCED ON
207  F  IGNITERS NORMAL
208  T  CLEAR LOOP SEALS
208  F  LOOP SEAL MODELS NORMAL
209  T  PRIMARY SYSTEM BREAK(S) FAILED
209  F  PRIMARY SYSTEM BREAK(S) NOT ACTIVE
210  T  PRESSURIZER PORV STUCK OPEN
210  F  PRESSURIZER PORV NOT STUCK OPEN
211  T  PRESSURIZER PORV: MANUALLY OPEN
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```
211  F  PRESSURIZER PORV: NOT MANUALLY OPEN
212  T  HPSI: MANUALLY ON
212  F  HPSI: NOT MANUALLY ON
213  T  LPSI: MANUALLY ON
213  F  LPSI: NOT MANUALLY ON
214  T  SIT BLOCK VALVES: CLOSED
214  F  SIT BLOCK VALVES: OPEN
215  T  PCP SWITCH OFF OR HI-VIBRATION TRIP
215  F  PCP SWITCH: ON/NO TRIP
216  T  HPSI: FORCED OFF
216  F  HPSI: NOT FORCED OFF
217  T  LPSI: FORCED OFF
217  F  LPSI: NOT FORCED OFF
218  T  CONTAINMENT AIR COOLERS: MANUALLY ON
218  F  CONTAINMENT AIR COOLERS: NOT MANUALLY ON
219  T  CONTAINMENT SPRAYS: MANUALLY ON
219  F  CONTAINMENT SPRAYS: NOT MANUALLY ON
220  T  RECIRCULATION MODE: MANUALLY ON
220  F  RECIRCULATION MODE: OFF
221  T  CONTAINMENT AIR COOLERS: FORCED OFF
221  F  CONTAINMENT AIR COOLERS: NOT FORCED OFF
222  T  CONTAINMENT SPRAYS: FORCED OFF
222  F  CONTAINMENT SPRAYS: NOT FORCED OFF
223  T  PRESSURIZER SPRAYS FORCED OFF
223  F  PRESSURIZER SPRAYS NOT FORCED OFF
224  T  AUXILARY FEED WATER: FORCED OFF
224  F  AUXILARY FEED WATER: AUTO
225  T  PRESSURIZER PORV: BLOCKED
225  F  PRESSURIZER PORV: AUTO
226  T  PRESSURIZER HEATERS: FORCED OFF
226  F  PRESSURIZER HEATERS: AUTO
227  T  MANUAL SCRAM
227  F  REACTOR PROTECTIVE SYSTEM: AUTO
228  T  MAIN FEED WATER: FORCED OFF
228  F  MAIN FEED WATER: AUTO
229  T  REACTOR HEAD VENT: MANUALLY OPEN
229  F  REACTOR HEAD VENT: CLOSED
**-REV13-START---------------------------------------------------------------
**230  T  UHI ACCUM BLOCKED
**230  F  UHI ACCUM NOT BLOCKED
230  T  TURBINE BYPASS VALVE: MANUALLY OPEN
230  F  TURBINE BYPASS VALVE: AUTO
**-REV13-END-----------------------------------------------------------------
231  T  CHARGING PUMPS: MANUALLY ON
231  F  CHARGING PUMPS: AUTO
232  T  CHARGING PUMPS: FORCED OFF
232  F  CHARGING PUMPS: AUTO
233  T  STEAM GENERATOR ADV: MANUALLY OPEN
233  F  STEAM GENERATOR ADV: AUTO
234  T  RHR SPRAY VALVE: MANUALLY OPEN
234  F  RHR SPRAY VALVE: MANUALLY CLOSED
235  T  STEAM GENERATOR MSIV: FORCED CLOSED
235  F  STEAM GENERATOR MSIV: AUTO
236  T  STEAM GENERATOR MSIV: FORCED OPEN
236  F  STEAM GENERATOR MSIV: AUTO
237  T  EXTERNAL SIRWT REFILL SOURCE ON
237  F  NO EXTERNAL SIRWT SOURCE
238  T  INTER-FACING SYSTEM LOCA SEQUENCE
238  F  BREAK FLOW TO LOWER CONTAINMENT
**-REV07-START---------------------------------------------------------------
**239  T  MODEL DEVELOPMENT USE
239  T  STUCK OPEN BROKEN STEAM GENERATOR SAFETY VALVE
**-REV07-END-----------------------------------------------------------------
240  T  AUXILARY BUILDING SPRAYS: ON
240  F  AUXILARY BUILDING SPRAYS: OFF
241  T  CAV INJ PUMP ON
241  F  CAV INJ OFF
242  T  PRIMARY SYSTEM MAKEUP: OFF
242  F  PRIMARY SYSTEM MAKEUP: ON
243  T  LETDOWN SWITCH: OFF
243  F  LETDOWN SWITCH: ON
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244  T  BROKEN LOOP PCP'S IDLED
244  F  BROKEN LOOP PCP'S NORMAL
245  T  MAIN FEED WATER NOT OFF AT SCRAM
245  F  MAIN FEED WATER OFF AT SCRAM
246  T  PRESSURIZER SPRAY: MANUALLY ON
246  F  PRESSURIZER SPRAY: AUTO
247  T  BUMP BROKEN LOOP PCP(TMI)
247  F  BROKEN LOOP PCP NORMAL
248  T  FORCE EXECUTION STOP
**CPCO...CP-MAAP ONLY: EVENT CODE 249 IS FOR CP-MAAP/3.0B ONLY
249  T  CONT SPRAY SYSTEM DICHARGE ALIGNED TO HPSI SUCTION
249  F  CONT SPRAY SYSTEM NORMAL DISCHARGE ALIGNMENT
250  T  ZERO OUT FRACTIONAL CHANGES IN INTGRT
END
**
**********************************************************************
*INTEGRATION
**********************************************************************
**
**@@@REV 15, THIS INTEGRATION TIMESTEP CONTROL SECTION IS NEW
**
**
** SI units only allowed
**
** ALLOWED SYNTAXES:
**
** 1. Fractional change limitation:
** INDEX  R  X-NAME F-NAME F-CHANGE  X-MIN  X-MAX  TRUE  #1  FALSE  #2
** where:
** INDEX = index of limiting variable
** R = a fractional change (ie, a rate) limitation
** X-NAME = state or aux variable name
** F-NAME = rate of change variable name
** F-CHANGE = fractional change
** X-MIN = minimum x value for limitation
** X-MAX = maximum x value for limitation
** The "TRUE  #1" & "FALSE  #2" are optional:
** TRUE  #1 = used when event #1 true
** FALSE  #2 = used when event #2 false
** when code #1 is true the control is on
** when code #2 is false the control is on
** either "TRUE" or "FALSE" , or both "TRUE" & "FALSE" conditions can be used
** Example:
** 1   R  MSTPS  FMSTPS  0.05  1.E1  1.E10  TRUE  25
** timestep limiting variable 1 is MSTPS, rate of change FMSTPS
** its fractional change is 5% maximum during a timestep
** if MSTPS < 10 kg it is not used to limit the timestep
** if MSTPS > 1.e10 kg it is not used to limit the timestep
** it is used when event code 25 is true, ie PS nonequilibrium thermo model
**
** 2. Threshold specified explicitly:
** INDEX  T   X-NAME  F-NAME  THRESH
** INDEX  T+  X-NAME  F-NAME  THRESH
** INDEX  T-  X-NAME  F-NAME  THRESH
** where:
** T = a threshold limitation both ascending and descending
** T+ =  an ascending threshold limitation
** T- =  a descending threshold limitation
** THRESH = the threshold value
** Example:
** 2   T+  PPS  FPPS  17.5E6
** timestep limiting variable 2 is PPS, rate of change is FPPS
** the timestep will be limited if PPS attempts to cross 17.5 MPa
**  in an ascending manner (ie, as if a relief valve were to open)
**
**
** 3. Threshold specified by reference to parameter input:
** INDEX  T  X-NAME  F-NAME  T-NAME
** where:
** T-NAME = the variable name for the threshold
** Example:
```

```
** 3   T+  PPS  FPPS  PPZSVL
** timestep limiting variable 3 is PPS, rate of change is FPPS
** the timestep will be limited if PPS attempts to cross PPZSVL
**  in an ascending manner (ie, as if a safety valve were to open)
**  and PPZSVL is input in the parameter file already as the
**  safety valve setpoint
**
************************************************************************
**
** ORIGINAL CRITICAL QUANTITIES FOR TIME LOST INFORMATION
**
** CATEGORY 1 -- GAS MASSES
1   R  MSTPS  FMSTPS  0.05  1.E1  1.E10  TRUE  25
2   R  MH2PS  FMH2PS  0.05  1.E1  1.E10
3   R  MSTPZ  FMSTPZ  0.05  1.E1  1.E10  FALSE  39
4   R  MH2PZ  FMH2PZ  0.05  1.E1  1.E10
5   R  MSTB   FMSTB   0.05  1.E1  1.E10
6   R  MH2B   FMH2B   0.05  1.E1  1.E10
**7   R  MSTC   FMSTC   0.05  1.E1  1.E10  FALSE  65
**8   R  MH2C   FMH2C   0.05  1.E1  1.E10
**9   R  MC2C   FMC2C   0.05  1.E1  1.E10
**10  R  MN2C   FMN2C   0.05  1.E1  1.E10
11  R  MSTA   FMSTA   0.05  1.E1  1.E10
12  R  MH2A   FMH2A   0.05  1.E1  1.E10
13  R  MSTD   FMSTD   0.05  1.E1  1.E10
14  R  MH2D   FMH2D   0.05  1.E1  1.E10
15  R  MSTI   FMSTI   0.05  1.E1  1.E10
16  R  MH2I   FMH2I   0.05  1.E1  1.E10
17  R  MSTBS  FMSTBS  0.05  1.E1  1.E10  FALSE  158
18  R  MSTUS  FMSTUS  0.05  1.E1  1.E10  FALSE  167
**19  R  MSTU   FMSTU   0.05  1.E1  1.E10
20  R  MH2U   FMH2U   0.05  1.E1  1.E10
**
** CATEGORY 2 -- WATER & SOLIDS MASSES
21  R  MWBI   FMWBI   0.05  1.E2  1.E10  FALSE  10
22  R  MWUI   FMWUI   0.05  1.E2  1.E10  FALSE  10
23  R  MWPZ   FMWPZ   0.05  1.E2  1.E10
24  R  MWC    FMWC    0.05  1.E2  1.E10
**25  MU2C = UO2 mass in compartment C (variable dummied out as DUM31)
26  R  MACUM  FMACUM  0.05  1.E2  1.E10
27  R  MWCR   FMWCR   0.05  1.E2  1.E10
28  R  MWDC   FMWDC   0.05  1.E2  1.E10
29  R  MUHI   FMUHI   0.05  1.E2  1.E10
**30  MU2B = UO2 mass in compartment B (variable dummied out as DUM30)
31  R  MWBS   FMWBS   0.05  1.E2  1.E10  FALSE  158
32  R  MWUS   FMWUS   0.05  1.E2  1.E10  FALSE  167
**
** CATEGORY 3
**33  LIMIT PRESSURE CHANGES ("EXCESS VOLUME") IN PRIMARY SYSTEM & BROKEN S/G
** -- (HARDWIRED AS IN ORIGINAL INTGRT)
**34  UCMB = corium internal energy in compartment B (not used)
**35  UCMC = corium internal energy in compartment C (not used)
**
** CATEGORY 4 -- CONTAINMENT GAS TEMPERATURES
36  R  TGC    FTGC    0.02  1.E2  1.E4  FALSE  65
37  R  TGB    FTGB    0.02  1.E2  1.E4
38  R  TGA    FTGA    0.02  1.E2  1.E4
39  R  TGD    FTGD    0.02  1.E2  1.E4
40  R  TGI    FTGI    0.02  1.E2  1.E4
41  R  TGU    FTGU    0.02  1.E2  1.E4
**
** CATEGORY 5 -- HEATUP PROCESSES(OXIDATION,NODAL TEMPERATURE RATES OF CHANGE)
**42  SUBROUTINE HEATUP REQUIRED TIME STEP (HARDWIRED AS IN ORIGINAL INTGRT)
**
** CATEGORY 6 -- CRUST THICKNESS FOR DEBRIS BED CALCULATIONS
43  R  XCRDC  FXCRDC  0.05  1.E-3  1.0
**
** CATEGORY 7 -- PRIMARY SYS & PZR GAS TEMPERATURES
44  R  TGPS   FTGPS   0.02  1.E2   1.E4  TRUE  25
45  R  TGPZ   FTGPZ   0.02  1.E2   1.E4  FALSE  39
**
```

```
** CATEGORY 8 -- CONTROL FOR IMPLICIT PRIMARY SYS FLOW ALGORITHM
**46  CIRC SUBROUTINES REQUIRED TIME STEP (HARDWIRED AS IN ORIGINAL INTGRT)
**47  AUX BLBG REQUIRED TIME STEP (HARDWIRED AS IN ORIGINAL INTGRT)
**
** CATEGORY 6 CONTINUED HERE FOR INDEXING
48  R  XCRUC  FXCRUC  0.05  1.E-3  1.0
49  R  XCRDB  FXCRDB  0.05  1.E-3  1.0
50  R  XCRUB  FXCRUB  0.05  1.E-3  1.0
51  R  XCRDA  FXCRDA  0.05  1.E-3  1.0
52  R  XCRUA  FXCRUA  0.05  1.E-3  1.0
**
** NEW ONES: THRESHOLDS
**
** S/G SAFETY VALVE SET POINTS
**
**53  T+  PBS    FPBS1  PSGSVH
**54  T-  PBS    FPBS1  PSGSVL
**55  T+  PUS    FPUS1  PSGSVH
**56  T-  PUS    FPUS1  PSGSVL
**
** S/G RELIEF VALVE SET POINTS
**
**57  T   PBS    FPBS1  PSGRV
**58  T   PUS    FPUS1  PSGRV
**
** PZR RELIEF VALVE SET POINTS
**
**59  T+  PPZ    FPPZ1  PPORVH
**60  T-  PPZ    FPPZ1  PPORVL
**
** NEW ONES: RATES OF CHANGE
**
**61  R  PPS    FPPS1   0.05  1.E5   1.E10  TRUE   25
**62  R  PPZ    FPPZ1   0.05  1.E5   1.E10  FALSE  39
**63  R  PBS    FPBS1   0.05  1.E5   1.E10  FALSE  158
**64  R  TWCR1  FTWCR1  0.05  1.E2   1.E4   TRUE   25
**65  R  UGPZ   FUGPZ   0.05  1.E2   1.E4   FALSE  39
**66  R  UWDC   FUWDC   0.05  1.E2   1.E4   TRUE   25
**67  R  UWC    FUWC    0.05  1.E2   1.E4   FALSE  65
**68  R  UWD    FUWD    0.05  1.E2   1.E4
**69  R  UWBT   FUWBT   0.05  1.E2   1.E4   FALSE  158
**70  R  UWUT   FUWUT   0.05  1.E2   1.E4   FALSE  167
**71  R  MWBT   FMWBT   0.05  1.E2   1.E10  FALSE  158
**72  R  MWD    FMWD    0.05  1.E2   1.E10
END
**
*************************************************************************
*USEREVT
*************************************************************************
**
**@@@REV 16, THIS USEREVT SECTION IS NEW
**
** THIS DEFINES THE USER DEFINED EVENT CODES.  THE FOLLOWING SYNTAX
**  SHOWN BELOW ARE WHAT IS NORMALLY EXPECTED IN THE *USEREVT PARAMETER
**  SECTION.  ANYTHING ELSE IS IGNORED AND THE USER IS WARNED.
**
**  1) **        / COMMENTING
**  2) END       / END OF SECTION KEYWORD
**  3) <NUMBER> <EXPRESSION> / USER DEFINED EVENT CODE
**  4) <TRUE>   <MESSAGE>    / USER SUPPLIED TRUE MESSAGE
**     <FALSE>  <MESSAGE>    / USER SUPPLIED FALSE MESSAGE
**  5) SELECT <NUMBER1> <NUMBER2> ... ETC.
**     SELECT ALL
**
**
**  OPTIONAL USER DEFINED EVENT MESSAGE DISCRIPTION MESSAGE CAN FOLLOW
**   THE EVENT CODE EXPRESSION.  THE ONLY RESTRICTION IS THAT SUCH
**   MESSAGE NEED TO CONFORM TO THE FOLLOWING FORMAT AND MUST COME AFTER
**   THE EVENT CODES THE MESSAGES ARE DEFINED FOR.
**
**      <"TRUE"/"FALSE">  <USER DEFINED MESSAGE>
```

```
**
**  AND BOTH TRUE AND FALSE MESSAGE OR JUST ONE OR NONE COULD BE SUPPLIED.
**   TOKENS "TRUE", "T", "FALSE", AND "F" ARE ACCEPTABLE.  NOTE THAT THE
**   CODE WILL GENERATE THE EVENT MESSAGE FROM THE USER DEFINED EVENT CODE
**   EXPRESSION, AND SUPERSEDE IT WITH USER'S IF SUPPLIED.
**
**
**  THE SELECT KEYWORD IS USED TO "SELECT" THE USER DEFINED EVENT CODE
**   NUMBERS TO BE WRITTEN TO THE SUMMRY FILE AND LOG FILE IF NEGATIVE
**   WHEN THE CORRESPONDING EVENT CODE NUMBER STATUS HAS CHANGED.  IF
**   YOU WANT ALL, SIMPLY SAY SELECT ALL, AND THEY WILL ALL BE WRITTEN TO
**   THE SUMMRY FILE.  NOTE THAT NO MESSAGE IS WRITTEN TO THE LOG FILE
**   UNLESS YOU SELECTED A NUMBER WITH A NEGATIVE SIGN.  NOTE THAT WHEN
**   AN MAAP OPERATOR EVENT CODE STATUS CHANGED DUE TO USER DEFINED EVENT
**   CODE STATUS CHANGE, IT IS REPORTED TO THE LOG FILE ALWAYS.
**
**
**  AN VALID USER DEFINED EVENT CODE EXPRESSION FORMAT CONSISTS OF AN
**   EVENT CODE NUMBER AND CORRESPONDING EVENT CODE EXPRESSION, EG.,
**
**      <EVENT CODE NUMBER> <DEFINING EVENT CODE EXPRESSION>
**
**  EVENT CODE NUMBERS 300-399 ARE ALLOCATED FOR USER DEFINED EVENT CODE
**   DEFINITIONS.  ALSO ALLOWED ARE MAAP DEFINED OPERATOR EVENT FLAGS SO
**   THAT THE USER CAN HAVE THE FLEXIBILTY TO CONTROL HARDWIRED MAAP
**   FUNCTIONS, EG., MANUAL SCRAM, TURN CONTAINMENT SPRAYS ON, ETC.
**   THE MAAP OPERATOR EVENT FLAG CODES ARE 200-299 FOR THE BWR CODE
**   AND 200-250 FOR THE PWR CODE.  CONSULT THE MAAP USER MANUAL OR THE
**   *EVTMESS PARAMETER SECTION FOR DEFINITION OF MAAP OPERATOR CODES.
**
**  AN VAILD EVENT EXPRESSION FORMAT IS EXPECTED TO CONFORM TO ONE OF THE
**   FOLLOWING FORMATS:
**
**  1) "EVENT"  <NUMBER>  <"TRUE"/"FALSE"> <"LOCKOUT">
**
**  2) <VARIABLE1/REAL1>  <REAL_OPERATOR>  <VARIABLE2/REAL2>  <"LOCKOUT">
**
**  3) <FORMAT1/FORMAT2> <LOGICAL_OPERATOR> <FORMAT1/FORMAT2> <"LOCKOUT">
**
**   WHERE    "EVENT"  = THE KEYWORD "EVENT"
**          <NUMBER>   = THE CORRESPONDING EVENT CODE NUMBER
**   <"TRUE"/"FALSE">  = THE KEYWORD "TRUE" OR "FALSE"
**
**       <VARIABLE1>   = THE MAAP COMMON BLOCK VARIABLE NAME
**           <REAL1>   = THE NUMBERIC REAL VALUE
**    <REAL_OPERATOR>  = SELF EXPLANATORY (SEE BELOW)
**       <VARIABLE2>   = THE MAAP COMMON BLOCK VARIABLE NAME
**           <REAL2>   = THE NUMBERIC REAL VALUE
**
**         <FORMAT1>   = IS THE FORMAT DEFINED ABOVE
**         <FORMAT2>   = IS THE FORMAT DEFINED ABOVE
** <LOGICAL_OPERATOR>  = SELF EXPLANATORY (SEE BELOW)
**
**       <"LOCKOUT">   = OPTIONAL "LOCKOUT" KEYWORD
**
**  THE FIRST FORMAT TYPE IS DEFINED AS A LOGICAL EXPRESSION, THE
**   SECOND FORMAT TYPE IS DEFINED AS A REAL EXPRESSION, AND THE THIRD
**   FORMAT TYPE IS DEFINED AS AN MULTIPLE EXPRESSION CONSISTING OF A
**   COMBINATIONS OF FORMAT1 AND/OR FORMAT2.
**
**  NOTE THAT "/" USED ABOVE IN DEFINING THE FORMATS IS EXPRESSED AS
**   "EITHER".  THUS THERE ARE TWO LOGICAL EXPRESSION, FOUR REAL
**   EXPRESSION, AND FOUR MULTIPLE EXPRESSION POSSIBLE COMBINATIONS.
**
**  OPTIONAL KEYWORD "LOCKOUT" TOKEN COULD BE ADDED AT END OF LINE.
**   THIS WILL PERMANETLY LOCK THE EVENT CODE TO TRUE ALWAYS ONCE THE
**   DEFINING EXPRESSION IS SATISFIED. TOKENS "L", "LKO", & "LO" ARE
**   ACCEPTABLE.
**
**  ALLOWABLE <REAL_OPERATOR> TOKENS ARE
**
```

```
**      >  or GT          (GREATER THAN)
**      <  or LT          (LESS THAN)
**      >= or GE or =>    (GREATER THAN OR EQUAL TO)
**      <= or LE or =<    (LESS THAN OR EQUAL TO)
**      =  or EQ          (EQUAL TO)
**      <> or NE          (NOT EQUAL TO)
**
**  AND ALLOWABLE <LOGICAL_OPERATOR> TOKENS ARE
**
**      AND or A
**      OR  or O
**
**
**  WE WILL NOW SHOW SOME EXAMPLES OF USER DEFINED EVENT CODES, AND
**   WE'LL START WITH A SIMPLE EXPRESSION AND END WITH A MULTIPLE
**   EXPRESSION EXAMPLE.
**
**  LET'S SAY WE HAVE THE FOLLOWING SIMPLE EXPRESSION;
**
**     301 PPS > 1.E6
**
**  EVENT CODE 301 IS TRUE WHEN PPS, THE REACTOR VESSEL PRESSURE, IS
**   GREATER THAN 1.E6 PASCALS, OTHERWISE IT IS FALSE.
**
**
**  THE SECOND EXAMPLE INVOLVING MULTIPLE EXPRESSION, AS SHOWN IS;
**
**     302 TGPS > 450 AND EVENT 301 TRUE LOCKOUT
**
**  EVENT CODE 303 IS SET PERMANETLY TRUE WHEN TGPS, THE REACTOR GAS
**   TEMPERATURE, IS GREATER THAN 450 KELVINS AND WHEN EVENT CODE 301
**   IS TRUE.
**
**
**  TWO IMPORTANT NOTES MUST BE MADE.  THE FIRST IS THAT ALL NUMBERS
**   ARE EXPECTED TO BE IN SI UNITS.  THIS IS DONE TO PREVENT CONFUSION
**   AS TO WHAT MAAP COMMON BLOCK VARIABLES HAVE DEFINING UNITS NUMBERS
**   ASSIGNED.  THOSE THAT DO, CAN BE EASILY CONVERETED TO/FROM SI AND
**   BRITISH UNITS.  THOSE THAT DO NOT ARE ALWAYS IN SI UNITS.  SINCE NOT
**   ALL MAAP COMMON BLOCK VARIABLES HAVE DEFINING UNIT NUMBERS, THE
**   POTENIAL TO CONFUSE WHAT TYPE OF NUMBERS TO INPUT IS GREAT AND WE
**   WANT TO AVOID THIS SITUATION.  HOPEFULLY THIS WOULD BE RECIFIED IN
**   THE NEAR FUTURE.
**
**  THE SECOND NOTE IS THAT USER DEFINED EVENT CODES ARE EVALUATED
**   IMMEDIATELY AFTER MAAP EVENT CODES ARE EVALUATED.  USER DEFINED
**   EVENT CODES ARE EVALUATED SEQUENTIALLY FROM 300 TO 399 FIRST, AND
**   THEN USER DEFINED EVENT CODES 200-299 (WHICH HAVE A ONE TO ONE
**   CORRESPONDENCE WITH MAAP OPERATOR EVENT CODES) ARE EVALUATED NEXT.
**   THIS IS IMPORTANT TO NOTE SINCE IF THE EVALUATION OF AN EVENT CODE
**   DEPENDS ON THE STATUS OF ANOTHER EVENT CODE, YOU'LL WANT TO BE
**   SURE THAT THE "OTHER" EVENT CODE HAS ALREADY BEEN EVALUTED FIRST.
**
**  USER DEFINED EVENT CODES CAN ALSO BE DEFINED IN THE INPUT DECK VIA
**   LOCAL PARAMETER CHANGE.  SPECIFY 28,0,0 FOLLOWED BY THE SYNTAX
**   EXPLAINED ABOVE.  BE SURE TO END WITH THE KEYWORD END.
**
**  IT IS HOPED THAT THE ABOVE DESCRIPTIONS SHOULD BE MORE THAN ADQUATE
**   IN EXPLAINING THE PURPOSE OF USER DEFINED EVENTS.
**
END
**
**CPCO...CP-MAAP ONLY
************************************************************************
*PALISADES SPECIFIC PARAMETERS
************************************************************************
01  1          ENTER A 1 IF FAN COOLERS DISCHARGE TO ACOMPT
02  0.12065    ELEVATION OF SUMP TO AUX BUILDING JUNCTION ABOVE SUMP FLOOR
03  0.88834    AREA OF BCOMPT TO SUMP FLOOR DRAINS
04  0.05080    ELEVATION OF BCOMPT TO SUMP DRAINS ABOVE BCOMPT FLOOR
05  0.51435    ELEVATION OF BCOMPT TO SUMP DRAINS ABOVE SUMP FLOOR
```

```
06 -4.572       ELEVATION OF AUX BUILDING FLOOR REFERENCED TO SUMP FLOOR
07  300.0       TIME REQUIRED TO FAIL CAVITY FLOOR AFTER CORIUM IN CAVITY
08  4.118       ELEVATION OF FIRST SUMP TO AUX BUILDING JUNCTION
**              REFERENCED TO AUX BUILDING NODE FLOOR
09  4.118       ELEVATION OF SECOND SUMP TO AUX BUILDING JUNCTION
**              REFERENCED TO AUX BUILDING NODE FLOOR
10  1.915       WETTED PERIMETER OF FIRST SUMP TO AUX BUILDING JUNCTION
11  1.915       WETTED PERIMETER OF SECOND SUMP TO AUX BUILDING JUNCTION
12  0.2918      AREA OF FIRST SUMP TO AUX BUILDING JUNCTION
13  0.2918      AREA OF SECOND SUMP TO AUX BUILDING JUNCTION
**VALUES FOR #14 - #16 MUST BE CONSISTENT WITH *AUX AND *TOPOLOGY SECTIONS
14  193.6       AREA OF CORIUM POOL IN FIRST AUX BUILDING NODE WHICH
**              CAN HAVE CORIUM (AUX NODE #1 - W. ENG SAFEGUARDS ROOM)
15  136.5       AREA OF CORIUM POOL IN SECOND AUX BUILDING NODE WHICH
**              CAN HAVE CORIUM (AUX NODE #2 - E. ENG SAFEGUARDS ROOM)
16   0.0        AREA OF CORIUM POOL IN THIRD AUX BUILDING NODE WHICH
**              CAN HAVE CORIUM
17   1          ENTER 1 TO USE BROKEN LOOP FOR DEFAULT FLOW IF ALL LOOPS
**              BLOCKED, 0 TO USE MAAP DEFAULT (UNBROKEN LOOPS)
18   930.0      REFLECTIVE INSULATION PLATE MELTING TEMPERATURE (ALUMINUM)
**-REV10-START------------------------------------------------------------------
** MUST ADJUST TOP OF CAVITY TO ACCOUNT FOR BORROWED VOLUME THAT KEEPS
** THE CAVITY FROM GOING SOLID
**19   7.9248     ELEVATION OF TOP OF CAVITY
19  17.675      ZCAVT      ELEVATION OF TOP OF CAVITY
**-REV10-END--------------------------------------------------------------------
20   0.0        EFFECTIVE FLOW AREA TO COMPUTE TURBINE-DRIVEN AFW STEAM FLOW
**              USE NEGATIVE NUMBER IF FROM BROKEN UNIT
21   0.005      CONVERGENCE CRITERION FOR EQUIL--NOTE: IF POSITIVE NUMBERS ARE
**              USED, EQUIL IS ALLOWED TO USE THE CONTAINMENT BULK PRESSURE
**              AND THE AMBIENT PRESSURE IN PLACE OF THE CAVITY PRESSURE AND
**              THE RECEPTOR AUX BUILDING NODE PRESSURES, RESPECTIVELY, WHEN
**              COMPUTING THE CAVITY/AUX. BUILDING FLOWS, PROVIDED THAT IN
**              EACH CASE THE PRESSURES ARE WITHIN A FRACTION PTOL (0.1) OF
**              EACH OTHER; THIS SMOOTHES INSTABILITIES AND REPRESENTS LITTLE
**              LOSS OF REALISM GIVEN THAT NO NAT. CIRCULATION IS ALLOWED
**              BETWEEN THE CAVITY AND AUX. BUILDING; ENTERING A NEGATIVE
**              CONVERGENCE CRITERION DEFEATS THIS
**-REV08-START------------------------------------------------------------------
** LARSON-MILLER CREEP RUPTURE CALCULATIONS USING MINER'S RULE FOR FIVE
** PCS COMPONENTS
22   0.0        XXBH       Ro T FOR CREEP RUPTURE CALC: BROKEN HOT LEG
23   0.0        XXUH       Ro T FOR CREEP RUPTURE CALC: UNBROKEN HOT LEG
24   0.0        XXBHT      Ro T FOR CREEP RUPTURE CALC: BROKEN HOT TUBES
25   0.0        XXUHT      Ro T FOR CREEP RUPTURE CALC: UNBROKEN HOT TUBES
26   0.0        XXSR       Ro T FOR CREEP RUPTURE CALC: PRESSURIZER SURGE LINE
**
27   0.0        WWAUXO     PRESSURIZER AUXILIARY SPRAY FLOW RATE.
**                         PZ AUX SPRAY IS INITIATED WHEN EVENT CODE 246
**                         IS SET TO TRUE, THE CHARGING PUMPS ARE ON,
**                         THE PCP'S ARE OFF AND THIS VALUE IS GREATER > 0.0
**-REV08-END--------------------------------------------------------------------
**-REV09-START------------------------------------------------------------------
** SIMPLISTIC HYDROGEN/CARBON MONOXIDE ADDITION/REMOVAL CAPABILITY
** CAN BE USED TO MODEL ADDITIONAL SOURCES OF FLAMMABLE GAS
** (IE, ALUMINUM CORROSION) OR THE EFFECTS OF RECOMBINERS
28   0.0       WH2EXB     HYDROGEN ADDITION/REMOVAL RATE
29   0.0       WCOEXB     CARBON MONOXIDE ADDITION/REMOVAL RATE
**
30   8.6E4     CPUMAX     MAXIMUM CPU TIME ALLOWED (SECONDS)
**
31   0.78      MFFESS     MASS FRACTION OF IRON IN STAINLESS STEEL
32   0.06      MFNISS     MASS FRACTION OF NICKEL IN STAINLESS STEEL
33   0.16      MFCRSS     MASS FRACTION OF CHROMIUM IN STAINLESS STEEL
**-REV09-END--------------------------------------------------------------------
**-REV10-START------------------------------------------------------------------
** CPMAAP IMPLEMENTATION OF STM GEN LEVEL LOOKUP TABLE
34   7         NZPTS      NUMBER OF POINTS IN SG LEVEL LOOKUP TABLE
**
35   0.E0      VOFZSG(1)  VOLUME FOR CORRESPONDING LEVEL
36  45.845E0   VOFZSG(2)
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37  76.060E0  VOFZSG(3)
38  79.961E0  VOFZSG(4)
39  177.671E0 VOFZSG(5)
40  221.211E0 VOFZSG(6)
41  260.900E0 VOFZSG(7)
**
42  0.E0      ZOFSG(1)   LEVEL FOR CORRESPONDING VOLUME
43  6.0182E0  ZOFSG(2)
44  7.8216E0  ZOFSG(3)
45  8.0026E0  ZOFSG(4)
46 11.7800E0  ZOFSG(5)
47 14.3158E0  ZOFSG(6)
48 16.2314E0  ZOFSG(7)
**
49 0.E0       ZOFFCL     DIFFERENCE IN ELEVATION BETWEEN THE BOTTOM OF THE
**                       COLD LEG AT THE PCP DISCHARGE AND AT THE RPV NOZZLE
50 0.35E0     ZSINOZ     ELEVATION OF THE SI NOZZLES ABOVE THE BOTTOM OF
**                       THE LOOP PIPING
**
51 30.E0      ZHDACC     ELEVATION HEAD FOR SIT'S
52 1.E0       FCPSCR     WHEN SET TO 1, RX SCRAM IS PREVENTED WHEN
**                       CHARGING PUMPS ARE TURNED ON
**-REV10-END------------------------------------------------------------------
**-REV12-START----------------------------------------------------------------
53 1.0        FQMIN      MINIMUM PLOT POINT FREQUENCY
54 300.0      FQMAX      MAXIMUM PLOT POINT FREQUENCY
**-REV12-END------------------------------------------------------------------
**-REV13-START----------------------------------------------------------------
55 0          NTBV       NUMBER OF TURBINE BYPASS VALVES
56 6.2052E6   PTBV0      PRESSURE AT WHICH TBV RATED FLOW RATE IS GIVEN
57 54.431     WTBV0      TBV RATED FLOW RATE
58 0.0        FATBVX     TBV FRACTION OPEN
59 6.2052E6   PTBV       TBV SETPOINT PRESSURE
60 20.0       KSEC0      STM GEN SECONDARY SIDE HEAT TRANS COEFF AFTER SCRAM
61 1.7177     ZWSGDP     DURING NORMAL OPERATION, INDICATED STM GEN LEVEL
**                       INCREASE DUE PRESSURE DROP IN TUBE BUNDLE
**-REV13-END------------------------------------------------------------------
**-REV14-START----------------------------------------------------------------
62 -22.0      TIFRV      TIME TO COMPLETELY CLOSE MFW REG VALVES FOLLOWING
**                       MSIS SIGNAL, SEC. A NEGATIVE VALUE DISABLES THE
**                       THE CPCO MFW ALGORITHM
63 100.0      FAFRV0     MFW REG VALVES INITIAL PERCENT (%, NOT FRACTION) OPEN
64 4365.0     NMFWP0     INITIAL MFW PUMP SPEED, RPM
65 0.0        FPPSCR     FLAG TO CONTROL WHETHER A REACTOR TRIP IS ASSUMED TO
**                       OCCUR WHEN THE PRIMARY COOLANT PUMPS TRIP. WHEN SET
**                       TO 1, REACTOR TRIP IS PREVENTED WHEN THE PCP'S ARE
**                       TRIPPED.
66 0.0        AMSLBU     AREA OF STEAM LINE BREAK FOR UNBROKEN STEAM GENERATOR.
**                       WHEN FMSLB IS SET TO 2, THIS AREA IS USED FOR THE
**                       BREAK AREA IN THE UNBROKEN STEAM GENERATOR, RATHER
**                       THAN AMSLB WHICH IS ENTERED IN THE *STEAM GENERATOR
**                       SECTION.
67 15000.0    MWMFWP     MASS OF WATER IN MFW SYSTEM PIPING BETWEEN THE
**                       STEAM GENERATOR(S) AND THE MFW REG VALVE(S).
**                       THIS WATER IS ASSUMED TO BE ADDED TO THE STEAM
**                       GENERATOR(S) AT A RATE DETERMINED BY TIPPNG.
68 60.0       TIPPNG     TIME PERIOD OVER WHICH THE MASS OF WATER IN THE
**                       MFW PIPING (MWMFWP) IS ADDED TO THE STEAM GENERATOR(S)
**-REV14-END------------------------------------------------------------------
**-REV15-START----------------------------------------------------------------
**INPUT DATA FOR POINT KINETIC NEUTRONICS MODEL
******************************************************************************
*KINETICS
******************************************************************************
01 -1.00         SET FIRST ENTRY TO -1 TO DISABLE KINETICS MODEL
**01  0.53000E-02 BETA     TOTAL DELAYED NEUTRON FRACTION
02  0.26100E-04  LBAR     EFFECTIVE NEUTRON GENERATION TIME, SEC
03  0.00000E+00  NEUSRC   EXTERNAL NEUTRON SOURCE RATE (NEUTRONS/SEC)
04 -0.44810E-01  RCRO     TOTAL CONTROL ROD WORTH (DELTA RHO)
05 -0.63000E-03  ALPMT    MODERATOR TEMPERATURE COEFFICIENT (DELTA RHO/K)
06  0.10150E-08  ALPMP    MODERATOR PRESSURE COEFFICIENT (DELTA RHO/PA)
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07 -0.33840E-04  ALPF      FUEL TEMPERATURE (DOPPLER) COEFFICIENT (DELTA RHO/K)
08 -0.11360E-03  ALPBOR    BORON CONCENTRATION COEFFICIENT (DELTA RHO/PPM)
09  1780.0       FBRACO    BORON CONCENTRATION IN ACCUMULATORS (PPM BORON/WATER)
10  1780.0       FBRSIO    BORON CONCENTRATION IN SIRWT TANKS (PPM BORON/WATER)
11  0.0          FBRPSO    INITIAL PCS BORON CONCENTRATION (PPM BORON/WATER)
12  0.0          FBRPZO    INITIAL PZR BORON CONCENTRATION (PPM BORON/WATER)
13  10           NCRPTS    NUMBER OF POINTS IN THE FRACTIONAL CONTROL
**                         ROD WORTH VS NORMALIZED TIME AFTER SCRAM
**                         SIGNAL TABLE
14  0.0000       FTICR0(1)    NORMALIZED TIME SINCE SHUTDOWN
15  0.2083       FTICR0(2)
16  0.4167       FTICR0(3)
17  0.5000       FTICR0(4)
18  0.5833       FTICR0(5)
19  0.6250       FTICR0(6)
20  0.7500       FTICR0(7)
21  0.7917       FTICR0(8)
22  0.8750       FTICR0(9)
23  1.0000       FTICR0(10)
24  0.0000        FRCR0(1)    TABLE OF FRACTIONAL CONTROL ROD WORTH
**                            CORRESPONDING TO NORMALIZED TIMES IN FTICR
25  0.0000        FRCR0(2)
26  0.0375        FRCR0(3)
27  0.0840        FRCR0(4)
28  0.1590        FRCR0(5)
29  0.2520        FRCR0(6)
30  0.8320        FRCR0(7)
31  0.8880        FRCR0(8)
32  0.9720        FRCR0(9)
33  1.0000        FRCR0(10)
**-REV15-END--------------------------------------------------------------
**
```

EMERGENCY OPERATING PROCEDURE VALIDATION FORM

1. **EOP IDENTIFICATION**

   a. Number EOP-9.0 (Loss of Offsite Power) Revision 16

   b. Title Functional Recovery Procedure

2. **VALIDATION METHOD** (Check one)

   TABLE-TOP ☐ WALK-THROUGH ☐ SIMULATOR ■

NOTE: Steps 3 through 5 apply only to Simulator Validations.

3. **EVENT INITIATOR**

   a. Major Failure Loss of Offsite Power

   b. Additional Failures Failure of Both Emergency Diesel Generators and P-8B, Steam Driven Auxiliary Feedwater Pump

4. **INITIAL CONDITIONS**

   a. Power Level, % 100%

   b. Time At Power, Hrs Any Time

   c. Pressurizer Pressure, psia Nominal

   d. Pressurizer Level, % Nominal

   e. Steam Generator Level, % Nominal

   f. Steam Generator Pressure, psia Nominal

   g. Boron Concentration, ppm No specific PPM required.

   h. Core Life, MWD/MT EOL

   i. Electric Lineup Normal Other ______

[redacted]

EA-PSA-LOSOC-003-11
ATTACHMENT 4

EMERGENCY OPERATING PROCEDURE VALIDATION FORM

5. **CONTROL SYSTEM STATUS**

a. CVCS

Makeup Mode Normal

Pressurizer Level Control — Auto ✓ Manual ____

Number of Charging Pumps Available — 1 2 3 ✓

Charging Pump Control Status Normal

Letdown — Auto ✓ Manual ____

b. Pressurizer Pressure Control — Auto ✓ Manual ____

c. Steam Generator Level Control

Number of Feedpumps 2

Feedpump Speed Control — Auto ✓ Manual ____

Feed Regulating Valve Control — Auto ✓ Manual ____

d. Steam Bypass Control — Auto ✓ Manual ____

e. Atmospheric Dump Valves — Auto ✓ Manual ____

6. **SCENARIO DESCRIPTION**

Loss of Offsite Power caused by digging. Both Diesel Generators Fail to Start and P-8B trips on overspeed. The following relays will be actuated in the Switchyard: 486B-P/F, 486 S-X1, 486SG-P and the 487-SG. The following Relays will be actuated In the Control Room: 386-P, 386TT. EDGs and P-8B will be unrecoverable, the crew will be informed of this no sooner than 10 minutes after investigating the equipment. There will be a minimum crew of AOs to work with (4).

[redacted]

EA-PSA-LOSOC-03-11 XO
ATTACHMENT Y

EMERGENCY OPERATING PROCEDURE VALIDATION FORM

7. EXPECTED OPERATOR ACTIONS

It is expected that the operators will work through the EOPs, restore 2400V busses via Backfeed and then initiate Once-Through-Cooling once power is restored. Other actions consistent with a loss of offsite power are also expected. Operator Actions outside the Control Room have been validated for certain actions. Other actions will be validated at the time by an AO in the plant.

8. TERMINATION CRITERIA

When Once-Through-Cooling is initiated.

The times for the following actions will be recorded: EOP-1 complete, Completion of EOP Supplement 22, Entering EOP Supplement 21, Starting Backfeed alignment, Completion of Backfeed alignment, Opening of PORV to initiate OTC

9. DESIGNATED OBSERVER/REVIEWER(S)

Robert A. White, George W. Sleeper

Preparation Completed By George W. Sleeper GWS Date 9/17/03

[redacted]

EA-PSA-LOSOC-03-11 R0
Attachment V

EMERGENCY OPERATING PROCEDURE VALIDATION FORM

10. **OPERATOR PARTICIPANTS** / **QUALIFICATION (SRO, RO, OTHER)**

Bernie Benson (SS), SRO	Ron Hudzik (NCO), RO
Todd Mulford (CRS), SRO	
Chad Main (SE), SRO	
Steve Cogswell (NCO), RO	

11. **DISCREPANCIES/COMMENTS DURING EVALUATION**

The cues given on the failure of the Diesel Generators were not as complete as they could have been causing the crew to spend more time on recovery of the Diesel Generators than they otherwise would have. This is felt to have resulted in a longer time to get to Backfeed and thus a longer time to get to Once-Through-Cooling. See the attached time line of actions taken during the scenario.

Evaluator George W. Sleeper *[signature]* Date 9/21/03

12. **RESOLUTION OF DISCREPANCIES/COMMENTS**

If this scenario is used again, better cues will be given on the failure of the Diesel Generators. The scenario provided a conservative time to get to Once-Through-Cooling because with the cues given, the crew elected to pursue the D.G. as the success path instead of Backfeed. 45 minutes into the event the crew asked for another NCO to pursue Backfeed but were denied. In addition, we simulated MOD-389 taking 10 minutes longer to open than actual. The simulator response at the end also Delayed the crew response since they were not seeing degrading plant parameters.

Resolved By George W. Sleeper *[signature]* Date 9/21/03

Validation Approved/Acceptable: YES ☑ NO ☐ (Check one)

Operations Technical Supervisor ______________ Date ______________

[redacted]

FA-PSA-LOSOC-03-11 xb
Attachment 4

EMERGENCY OPERATING PROCEDURE VALIDATION FORM

EOP Validation Times if needed for scenario	
Task	Times
Performance of EOP Supplement 22	30 minutes [1]
Backfeed using EOP Supp. 29(Use 20 minutes for time to open the MOD)	45 minutes [1]
Supplement 28 section 1 except purging with C02 IAW SOP-8	5 minutes [1]
Supplement 28 section 2	10 minutes [1]
Supplement 28 section 3	10 minutes
Troubleshoot Emergency Diesel Generators	>10 minutes
Troubleshoot P-8B, Steam Driven Auxiliary Feedwater Pump	>10 minutes
EOP Supp. 24 Preliminary Actions (Remove Fuses)	15 minutes
EOP Supp. 24 Subsequent Actions (CCW and SW)	5 minutes each
[1] Previously Validated	

Operator Cues	
Action	Cue
EDG Trouble	Low Jacket Water Pressure Alarm #15 and Low Lube Oil Pressure #3 and Engine Trouble. Investigating. After more than 10 minutes explain that there appears to be a loss of Jacket water pressure and Lube Oil Pressure believe the pumps are bad.
P-8B Trip Investigation	Pump tripped on Overspeed and cannot be reset. Will continue to try and reset. Mechanism is loose.
Loss of 'F' and 'R' Busses	If asked as power control what the status of switchyard, respond that there are no problems on the grid and Power Control would like to investigate before resetting switchyard relays.

[redacted]

EA-PSA-1050C-03-11 XO
Attachment 4

EMERGENCY OPERATING PROCEDURE VALIDATION FORM

Scenario Observed Time Line	
Time	Action
1451	Scenario Starts
1453	Loss of Offsite Power, Turbine and Reactor Trip
1454	Report that D.G.s did not start. Attempted to manually start D.G.s
1455	Vital Area Door Keys obtained to distribute to the AOs
1456	CRS Briefs AO about troubleshooting D.G.s
1458	Report of no AFW. S/G levels ~40% and lowering
1458	EOP-1 Verbal Verifications Start
1458	ENS Called to report to the Switchyard
1505	SEP Announcement and Siren
1506	EOP-1 Verbal Verifications Done and AO Reports back on initial D.G. Troubleshooting
1507	SROs hold discussion on going to EOP-9.0
1508	AO Briefed on making initial SEP notifications
1509	Crew Brief
1510	Crew notes Cook Line #1 Available for use in Backfeeding
1511	End of Brief
1518	AO Reports status of P-8B, Steam Driven Auxiliary Feedwater Pump
1520	S/G Blowdowns Isolated
1523	SS Relieved of SED duties
1525	AO Briefed on performing EOP Supplement 19 for P-8B
1531	Crew Brief
1533	End of Brief
1536	EOP Supplement 24 Thermal Hydraulic Actions started
1538	Control Room Requests additional WCC NCO support for Backfeed. Request Denied.
1550	Additional D.G. 1-1 Start Attempt made
1552	D.G. 1-1 reported not available
1554	Starting to set up for Backfeed
1555	Briefed AO on additional 1-2 D.G. Start Attempt
1559	1-2 D.G. Start Attempt failed
1603	1-2 D.G. reported not available
1607	AO Told to make preparations for opening MOD-389
1610	ENS Reports relays that are actuated in the Switchyard
1611	AO Asked to check Transformers per EOP Supplement 29
1614	AO sent to open MOD-389
1634	MOD-389 open
1638	'D' Bus energized off of Backfeed
1641	Started P-7A Service Water Pump
1642	Started P-52B CCW Pump
1642	Started P-66A, HPSI Pump
1644	Opening Valve for Right Train HPSI
1645	AO Sent to place Battery Chargers 2 and 3 in-service per SOP-30.
1647	First PORV Open
1647	Started 2 Charging Pumps (P-55A and P-55B)
1649	Battery Chargers 2 and 3 place in service
1658	'C' Bus Reenergized
1700	Start Left Channel HPSI Pump P-66B
1701	Started Third Charging Pump (P-55C)
1702	Second PORV opened

EA-PSA-10500-03-11 R0
Attachment 4

EMERGENCY OPERATING PROCEDURE VALIDATION FORM

1. **EOP IDENTIFICATION**

   a. Number EOP Supplement 22 Revision 7

   b. Title Switchyard Relay/Target List

2. **VALIDATION METHOD** (Check one)

   TABLE-TOP ☐ WALK-THROUGH ☑ SIMULATOR ☐

NOTE: Steps 3 through 5 apply only to Simulator Validations.

3. **EVENT INITIATOR**

   a. Major Failure Loss of Offsite Power

   b. Additional Failures Failure of Both Emergency Diesel Generators and P-8B, Steam Driven Auxiliary Feedwater Pump

4. **INITIAL CONDITIONS**

   a. Power Level, % 100%

   b. Time At Power, Hrs Any Time

   c. Pressurizer Pressure, psia Nominal

   d. Pressurizer Level, % Nominal

   e. Steam Generator Level, % Nominal

   f. Steam Generator Pressure, psia Nominal

   g. Boron Concentration, ppm No specific PPM required

   h. Core Life, MWD/MT End of Life (EOL)

   i. Electric Lineup Normal ✓ Other

EA-PSA-LOSOC-03-11 RO
ATTACHMENT 5

EMERGENCY OPERATING PROCEDURE VALIDATION FORM

5. **CONTROL SYSTEM STATUS**

a. CVCS

Makeup Mode Normal

Pressurizer Level Control Auto ✓ Manual ____

Number of Charging Pumps Available 1 ____ 2 ____ 3 ✓

Charging Pump Control Status ________

Letdown Auto ✓ Manual ____

b. Pressurizer Pressure Control Auto ✓ Manual ____

c. Steam Generator Level Control

Number of Feedpumps 2

Feedpump Speed Control Auto ✓ Manual ____

Feed Regulating Valve Control Auto ✓ Manual ____

d. Steam Bypass Control Auto ✓ Manual ____

e. Atmospheric Dump Valves Auto ✓ Manual ____

6. **SCENARIO DESCRIPTION**

Loss of Offsite Power caused by digging. Both Diesel Generators fail to start and P-8B, Steam Driven Auxiliary Feed Pump trips on Overspeed. An Auxiliary Operator is sent to the Switchyard to determine the status of Switchyard Relays per EOP Supplement 22.

EA-PSA-LOSOC-03-11 R0
ATTACHMENT 5

EMERGENCY OPERATING PROCEDURE VALIDATION FORM

7. EXPECTED OPERATOR ACTIONS

The operator is expected to travel to the Switchyard, check the status of all Relays in EOP Supplement 22, travel back to the plant to report the relay status.

8. TERMINATION CRITERIA

Once the AO has returned to the Control Room area.

9. DESIGNATED OBSERVER/REVIEWER(S)

George Sleeper

Preparation Completed By George W. Sleeper GWS Date 7/15/03

EA-PSA-2050C-03-11 r0
Attachment 5

EMERGENCY OPERATING PROCEDURE VALIDATION FORM

10. **OPERATOR PARTICIPANTS** | **QUALIFICATION (SRO, RO, OTHER)**

OPERATOR PARTICIPANTS	QUALIFICATION (SRO, RO, OTHER)
Dale Timmer (AO)	

11. **DISCREPANCIES/COMMENTS DURING EVALUATION**

1227-Start, 1236-In the relay house, 1244-Supplement Complete, 1248-Wait at checkpoint, 1249-clear checkpoint, 1256-Back in WCC. Total time to perform the supplement 29 min. Human Factors of the Supplement could be improved.

Evaluator George W. Sleeper [signature] Date 9/22/03

12. **RESOLUTION OF DISCREPANCIES/COMMENTS**

Procedure Change Request PCR003364 initiated to improve the Human Factors of EOP Supplement 22. No other discrepancies noted.

Resolved By George W. Sleeper [signature] Date 9/22/03

Validation Approved/Acceptable: YES ☑ NO ☐ (Check one)

Operations Technical Supervisor ____________________ Date ______

EA-PSA-LOSDC-03-11 R0
Attachment 5

TITLE: Switchyard Relay/Target List

1.0 DETERMINE SWITCHYARD RELAY STATUS

1. **WALKDOWN** the panels in the switchyard using this Supplement and mark items that have actuated.

#	✓	Relay	Function	Indications
Control Panel C-70				
1		'R' Bus Primary (3)	'R' Bus Primary Voltage Differential (PVD) Relays	Targets Only
2		'R' Bus Backup	'R' Bus Backup PVD Relays	An LED light other than "EN" and/or LCD other than "EN"
3		486 B-P/R	'R' Bus Primary Relays LOR	Amber Light, Trip Position & Target on the Reset Handle
4		486 B-B/R	'R' Bus Backup Relays LOR	Amber Light, Trip Position & Target on the Reset Handle
5		'F' Bus Primary (3)	'F' Bus Primary Voltage Differential (PVD) Relays	Targets Only
6		'F' Bus Backup (3)	'F' Bus Backup PVD Relays	Targets Only
7		486 B-P/F	'F' Bus Primary Relays LOR	Amber Light, Trip Position & Target on the Reset Handle
8		486 B-B/F	'F' Bus Backup Relays LOR	Amber Light, Trip Position & Target on the Reset Handle
9		486 S-X	S/U Transformer LOR	Amber Light, Trip Position & Target on the Reset Handle
10		486 S-X1	S/U Transformer LOR	Amber Light, Trip Position & Target on the Reset Handle
Control Panel C-71				
11		25F7 486BF	25F7 Fail to Trip Aux Relay	Amber Light, Trip Position & Target on the Reset Handle
12		25H9 486BF	25H9 Fail to Trip Aux Relay	Amber Light, Trip Position & Target on the Reset Handle
Control Panel C-72				
13		25R8 486BF	25R8 Fail to Trip Aux Relay	Amber Light, Trip Position & Target on the Reset Handle

EA-PSA-1050C-03-11 XCO
Attachment 5

TITLE: Switchyard Relay/Target List

#	✓	Relay	Function	Indications
			Control Panel C-73	
14		27F7 486BF	27F7 Fail to Trip Aux Relay	Amber Light, Trip Position & Target on the Reset Handle
15		27H9 486BF	27H9 Fail to Trip Aux Relay	Amber Light, Trip Position & Target on the Reset Handle
			Control Panel C-74	
16		486 TT/L3	L3 Trip Signal Rcvd	Trip Position on the Reset Handle
17		27R8 486BF	27R8 Fail to Trip Aux Relay	Amber Light, Trip Position & Target on the Reset Handle
			Control Panel C-75	
18		486 TT/L4	L4 Trip Signal Rcvd	Trip Position on the Reset Handle
19		29F7 486BF	29F7 Fail to Trip Aux Relay	Amber Light, Trip Position & Target on the Reset Handle
20		29H9 486BF	29H9 Fail to Trip Aux Relay	Amber Light, Trip Position & Target on the Reset Handle
			Control Panel C-76	
21		486 TT/L5	L5 Trip Signal Rcvd	Trip Position & Target on the Reset Handle
22		29R8 486BF	29R8 Fail to Trip Aux Relay	Amber Light, Trip Position & Target on the Reset Handle
			Control Panel C-77	
23		31F7 486BF	31F7 Fail to Trip Aux Relay	Amber Light, Trip Position & Target on the Reset Handle
24		31H9 486BF	31H9 Fail to Trip Aux Relay	Amber Light, Trip Position & Target on the Reset Handle
			Panel C-41	
25		31R8 486BF	31R8 Fail to Trip Aux Relay	Amber Light, Trip Position & Target on the Reset Handle
			Control Panel C-90	
30		86FX	Generator Breakers Flashover	Amber Light, Trip Position & Target on the Reset Handle

LOCATION: C-90 is located just outside of the battery room in the switchyard house.

EA-PSA-LOSDC-03-11 R0
Attachment 5

PALISADES NUCLEAR PLANT EMERGENCY OPERATING PROCEDURE	Proc No EOP Supplement
	Supplement 22
	Revision 7
	Page 7 of 7 ~~3 of 3~~

TITLE: Switchyard Relay/Target List

#	✓	Relay	Function	Indications
Control Panel C-79				
31		486SG-P	Safeguards XFMR 1-1 Primary Lockout	Amber Light, Trip Position & Target on the Reset Handle
32		486SG-B	Safeguards XFMR 1-1 Backup Lockout	Amber Light, Trip Position & Target on the Reset Handle
33		487-SG (3)	Safeguards XFMR 1-1 Differential	Targets Only
34		450/451-SG (3)	Safeguards XFMR 1-1 Overcurrent	Targets Only
35		451 N-SG	Safeguards XFMR 1-1 ground Overcurrent	Targets Only

LOCATION: C-79 is located just outside of the battery room in the switchyard house.

Completed By: ____________________

Date/Time: ______/______

Reviewed By: ____________________ (SS)

EA-PSA-LOSOC-03-11 XO
Attachment S

EMERGENCY OPERATING PROCEDURE VALIDATION FORM

1. **EOP IDENTIFICATION**

   a. Number EOP Supplement 29 Section 4.0 Revision 6

   b. Title Restore Buses 1C, 1D, 1E Power From Offsite Source - Backfeed

2. **VALIDATION METHOD** (Check one)

   TABLE-TOP ☐ WALK-THROUGH ☑ SIMULATOR ☐

NOTE: Steps 3 through 5 apply only to Simulator Validations.

3. **EVENT INITIATOR**

   a. Major Failure Loss of Offsite Power

   b. Additional Failures Failure of Both Emergency Diesel Generators and P-8B, Steam Driven Auxiliary Feedwater Pump

4. **INITIAL CONDITIONS**

   a. Power Level, % 100%

   b. Time At Power, Hrs Any Time

   c. Pressurizer Pressure, psia Nominal

   d. Pressurizer Level, % Nominal

   e. Steam Generator Level, % Nominal

   f. Steam Generator Pressure, psia Nominal

   g. Boron Concentration, ppm No Specific PPM Required

   h. Core Life, MWD/MT End of Life (EOL)

   i. Electric Lineup Normal ✓ Other

[redacted]

EA-PSA-LOSOC-03-11 R0
Attachment 6

EMERGENCY OPERATING PROCEDURE VALIDATION FORM

5. CONTROL SYSTEM STATUS

a. CVCS

Makeup Mode Normal

Pressurizer Level Control — Auto ✓ Manual ___

Number of Charging Pumps Available — 1 ___ 2 ___ 3 ✓

Charging Pump Control Status Normal

Letdown — Auto ✓ Manual ___

b. Pressurizer Pressure Control — Auto ✓ Manual ___

c. Steam Generator Level Control

Number of Feedpumps 2

Feedpump Speed Control — Auto ✓ Manual ___

Feed Regulating Valve Control — Auto ✓ Manual ___

d. Steam Bypass Control — Auto ✓ Manual ___

e. Atmospheric Dump Valves — Auto ✓ Manual ___

6. SCENARIO DESCRIPTION

Loss of Offsite Power caused by digging. Both Diesel Generators Fail to Start and P-8B trips on Overspeed. An Auxiliary Operator has been dispatched to perform the actions in the plant for establishing Backfeed in accordance with EOP Supplement 29.

[redacted]

EA-PSA-LOSOC-03-11 R0

Attachment 6

EMERGENCY OPERATING PROCEDURE VALIDATION FORM

7. **EXPECTED OPERATOR ACTIONS**

The operator will walk through the actions in the plant for establishing Backfeed. The time to manually open the MOD will be 10 minutes based on PPAC TGS015 which periodically tests the MOD.

8. **TERMINATION CRITERIA**

When the 2400V Busses are reenergized.

9. **DESIGNATED OBSERVER/REVIEWER(S)**

George Sleeper

Preparation Completed By George Sleeper GWS Date 9/15/03

EA-PSA-LOSDC-03-11 RD
ATTACHMENT 6

EMERGENCY OPERATING PROCEDURE VALIDATION FORM

10. OPERATOR PARTICIPANTS	QUALIFICATION (SRO, RO, OTHER)
Dale Timmer (AO)	

11. **DISCREPANCIES/COMMENTS DURING EVALUATION**

1316-Start, 1318 to 1321-Checking Transformers, 1322 to 1327-Checking Breakers Locally (would most likely be done by the Control Room), 1328-Starting the MOD section, 1330-Getting the Drill/Key, 1332-Checking Breaker, 1334 to 1344-Opening MOD. Total time from the start to the MOD being open is 28 minutes. The remaining actions take place in the Control Room and involve closing 25H9 then the 2400V incoming breaker to the bus.

Evaluator George W. Sleeper Date 9/22/03

12. **RESOLUTION OF DISCREPANCIES/COMMENTS**

No resolutions needed. Actions were performed as expected.

Resolved By George W. Sleeper Date 9/22/03

Validation Approved/Acceptable: YES ☑ NO ☐ (Check one)

Operations Technical Supervisor ____________________ Date _______

[redacted]

EA-PSA-LOSDC-03-11 XC
Attachment 6

TITLE: Restore Buses 1C, 1D, 1E Power From Offsite Source

4.0 BACKFEED

1. IF 'F' Bus or Cook 1 line is ENERGIZED
AND the following equipment is available:

- Power lines between switchyard and plant
- Main Transformer
- Station Power Transformers

THEN **ENERGIZE** available 2400V buses via backfeeding the Main Transformer by performing ALL of the following:

a. **COORDINATE** ALL switchyard actions with Area Power Control.

b. **ENSURE** the following conditions are established:

1) **ENSURE OPEN** ALL phases of the following breakers:

- 25F7
- 25H9

2) **VERIFY** the following parameters are within acceptable limits:

Parameter	Main XFMR	Station Power XFMR 1-1	Station Power XFMR 1-2
Nitrogen Pressure	N/A	0.5 to 7 psig	0.5 to 7 psig
Oil Level (*)	> Low	> Low	> Low
Liquid Temp	< 85°C	< 80°C	< 80°C
Winding Temp	< 90°C	< 70°C	< 70°C
HV Bushing Oil Level	> Low	N/A	N/A
Gas Detector Gauge	< 50 cc	N/A	N/A
Vacuum Gauge (*)	+2 to -2 psig	N/A	N/A

(*) Located on Constant O[redacted]

FA-PSA-1030C-03-11 XCO
Attachment 6

TITLE: Restore Buses 1C, 1D, 1E Power From Offsite Source

___ c. **ENSURE** Safeguards/Station Power incoming breakers are RACKED IN and OPEN:

Bus	Breaker
1A	252-101
1B	252-201
1C	152-105
1D	152-203
1E	152-302
1F	252-301
1G	252-401

CAUTION

MOD 389 is NOT designed to operate with the isophase bus energized.

___ d. **ENSURE OPEN** Main Generator Field Breaker. CR

e. **OPEN** Main Generator Disconnect MOD 389 as follows:

1) IF power is available AND operating Main Generator MOD 389 electrically is desired, THEN **OPEN** MOD 389 as follows:

___ a) **UNLOCK AND CLOSE** Breaker 52-383, Main Generator MOD 389 power supply.

KEY: Company Standard

___ b) **OPEN** Main Generator MOD 389 at Panel C-389.

KEY: 378

EA-PSA-1030C-03-11 RCO
Attachment 6

TITLE: Restore Buses 1C, 1D, 1E Power From Offsite Source

2) IF power is NOT available
OR operating Main Generator MOD 389 manually is desired,
THEN **OPEN** MOD 389 as follows:

___ a) **CHECK** OPEN Breaker 52-383, Main Generator MOD 389 power supply.

___ b) **OPEN** Panel C-389.

KEY: 378

NOTE: When using a battery-operated drill, hand cranking the MOD may be necessary near the end of travel due to battery depletion.

___ c) **MANUALLY OPEN** Main Generator MOD 389 using hand crank (located inside Panel C-389) or battery-operated drill (located in M&TE cabinet).

___ d) **CLOSE AND LOCK** Panel C-389.

___ 3) **VERIFY** three red CLOSED lamps extinguish and three green OPEN lamps illuminate (on Panel C-389).

4) **VISUALLY VERIFY** each of the three phases FULLY OPEN by observing position of switch through the viewing window at bottom of each isophase bus section.

___ 5) **OPEN AND LOCK** Breaker 52-383.

KEY: Company Standard

___ 6) **RETURN** unneeded keys to Shift Supervisor.

[redacted]

EA-PSA-2050C-03-11 R0
ATTACHMENT 6

TITLE: Restore Buses 1C, 1D, 1E Power From Offsite Source

f. IF MOD 26H5 is OPEN,
THEN **CLOSE** MOD 26H5 by performing the following:

___ 1) **VISUALLY CHECK** all phases of the following Generator ABBs are OPEN:

Already closed

- 25F7
- 25H9

2) **PERFORM** the following at MOD 26H5:

___ a) **UNLOCK** the connector latch from the MOD housing.

___ b) **MANUALLY ALIGN** AND **LATCH** the MOD flanges.

___ c) **CLOSE** MOD 26H5 from the Control Room or Relay House.

___ d) **VISUALLY CHECK** the MOD is CLOSED.

___ e) **DISENGAGE** the connector latch from the MOD housing.

___ f) **LOCK** the connector latch to the MOD housing.

___ g. **ENSURE CUT-IN:**

- TPS-386
(386P, 386B, 386C, 25F7, and 25H9 Direct Trip Cutout) CI2

LOCATION: Rear of C-04

- TPS-386TT
(386P, 386B, 386C, 25F7, and 25H9 Backup XFR Trip Cutout). CI2

OCATION: Rear of C-04

EA-PSA-20SDC-03-11 R0
Attachment 6

TITLE: Restore Buses 1C, 1D, 1E Power From Offsite Source

___ h. **ENSURE RESET:**

- 386P
(Back of panel C-04)
- 386B
(Back of panel C-04) CR
- 386C
(Back of panel C-04)

i. WHEN directed by Area Power Control,
THEN **ENERGIZE** Main/Station Power XFMRs as follows:

___ 1) IF "F" Bus is ENERGIZED,
THEN **SCOPE** AND **CLOSE** 25F7.

___ 2) IF Cook Line 1 is ENERGIZED, CR
THEN **SCOPE** AND **CLOSE** 25H9.

___ j. **ENSURE OPEN** Safeguards Supply Breaker, 152-401. CR

___ k. **CLOSE** Station Power Supply Breaker, 152-402. CR

___ l. **SCOPE** AND **CLOSE** only the following DEENERGIZED and available Safeguards/Station Power Incoming breakers one at a time:

- 152-105 (Bus 1C) CR
- 152-203 (Bus 1D)
- 152-302 (Bus 1E)

TITLE: Restore Buses 1C, 1D, 1E Power From Offsite Source

NOTE: The Main XFMR cooling fans are supplied by either MCC-4 or MCC-5. The Isophase Bus Cooling Fans are supplied by either MCC-5 or MCC-6.

___ m. **ENSURE** the following MCCs are ENERGIZED to support available Main XFMR and Isophase Bus cooling:

- MCC 4
- MCC 5
- MCC 6

___ n. **PLACE** Main XFMR cooling in service. Refer to SOP-8, "Main Turbine And Generating Systems."

___ o. **PLACE** an Isophase Bus Cooling Fan in service. Refer to SOP-8, "Main Turbine And Generating Systems."

- C-8A
- C-8B

___ 2. IF either of the following buses is being supplied from its associated Diesel Generator,
AND restoring offsite power to that bus is required,

- Bus 1C
- Bus 1D

THEN, as time permits, **RESTORE** offsite power to the selected bus
AND **STOP** the running D/G. Refer to Section 5.0, "Transfer Bus 1C or 1D From D/G to Offsite Power."

FA-ASA-405DC-003-11 X20
Attachment 6

Introduction

In this Attachment the "K:\Eng_prgm\Rel_Eng\PSA\CPMAAP\02-24-1994\Cp3b1615.exe" and the "K:\Eng_prgm\Rel_Eng\PSA\CPMAAP\CPMAAP v7-30-02\CPMAAP_Final.exe" code versions were compared.

The following input file was used to evaluate both executable versions of CPMAAP.

Input File

```
VERBOSE

SENSITIVITY RUN

TITLE
CASE 923 CASE- Station Blackout with Failure of all AFW.
Credit only 1 PORV and 1 HPSI Pump.  Employ limiting HPSI system
head curve from EA-SDW-95-001.
END TITLE

SYMBOL TABLES
       INPUT  SYMBOLS ARE IN ISFILE15.PAL
       OUTPUT SYMBOLS ARE IN OSFILE15.PAL
END

ATTACH USERFUNC.PAL

PARAMETER FILE pal15r2.par NOLIST

PLOT FILE
       WGRV
       WWRV
       TCRHOT
       PPS
       WHPSI
       ZWCPS
END OF PLOT FILE SPECIFICATION

PARAMETER CHANGES
C MODEL TWO PRESSURIZER PORV'S
       NPORV 1
C TIME DELAY FOR HPSI Pps (Nominal)
       TDHPI 40 S
C SIRWT INITIAL MASS NOMINAL
       MRWST0 9.76275E5 KG
C SIRWT INITIAL TEMPERATURE NOMINAL (87.9F)
       TRWST 304.2 K
C # HPSI PUMPs
       NHPI 1

END OF PARAMETER CHANGES AND NOLIST

NOT A RESTART

PRINT TIME  1.0 HOUR

FINAL TIME 5.0 HRS

PARALLEL

C INTERVENTION #1

WHEN BEGIN
C INITIATORS
C WHEN POWER IS TURNED OFF, MAAP TURNS OFF BOTH AC AND DC POWER
C SINCE THE PZR PORVS REQUIRE POWER, THIS PREVENT THEM FROM OPENING
C IF "POWER OFF" IS USED AS THE INITIATOR
C THEREFORE MUST TURN OFF EVERY THING SEPERATELY
        CCW/SWS OFF
        HPSI PUMPS OFF
        LPSI PUMPS OFF
        PCP'S OFF
```

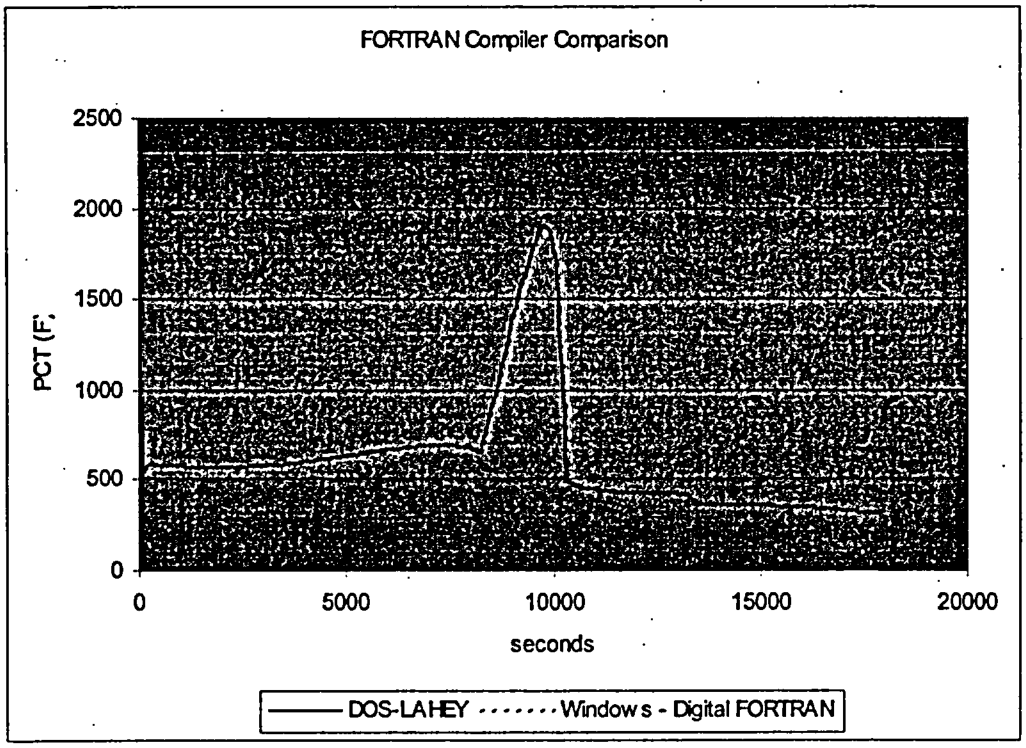
```
        CONT AIR COOLERS OFF
        CONT SPRAY OFF
        AUX FEED OFF
        PZR HEATERS OFF
        MANUAL SCRAM TRIP
        MAIN FEED OFF
        CHARGING PUMPS OFF
        MSIV'S CLOSE
        PCS MAKE UP OFF
        PCS LETDOWN OFF
        PZR PORV CLOSE
END

WHEN SCRAM IS TRUE
     SET STOPWATCH 1
END
WHEN STOPWATCH 1 > 8000.0 S
       PZR PORV OPEN
       HPSI PUMPS ON
END
```

<u>Results</u>

The results of both analyses are presented in Figure 1. The Peak Clad Temperature (PCT) was compared for both cases. From the Figure it is difficult to distinguish the two cases.

Figure 1



As a further comparison the summary file event codes were compared. The results are shown in Table 1 below.

Table 1

Event Code Timing (sec)		DOS Version	Event Code Timing (sec)		Windows Version
0	4	PRIMARY COOLANT PUMPS OFF	0	4	PRIMARY COOLANT PUMPS OFF
0	13	REACTOR SCRAM	0	13	REACTOR SCRAM
0	24	MAKEUP FLOW OFF	0	24	MAKEUP FLOW OFF
0	46	LETDOWN FLOW OFF	0	46	LETDOWN FLOW OFF
0	156	MSIV CLOSED	0	156	MSIV CLOSED
0	157	MAIN FEED WATER OFF	0	157	MAIN FEED WATER OFF
0	177	AUXILARY BUILDING SPRAY WATER GONE	0	177	AUXILARY BUILDING SPRAY WATER GONE
0	178	AUXILARY BUILDING CO2 SUPLY DEPLETD	0	178	AUXILARY BUILDING CO2 SUPLY DEPLETD
0	203	HEAT EXCHANGER COOLING WATER OFF	0	203	HEAT EXCHANGER COOLING WATER OFF
0	215	PCP SWITCH OFF OR HI-VIBRATION TRIP	0	215	PCP SWITCH OFF OR HI-VIBRATION TRIP
0	216	HPSI: FORCED OFF	0	216	HPSI: FORCED OFF
0	217	LPSI: FORCED OFF	0	217	LPSI: FORCED OFF
0	221	CONTAINMENT AIR COOLERS: FORCED OFF	0	221	CONTAINMENT AIR COOLERS: FORCED OFF
0	222	CONTAINMENT SPRAYS: FORCED OFF	0	222	CONTAINMENT SPRAYS: FORCED OFF
0	224	AUXILARY FEED WATER: FORCED OFF	0	224	AUXILARY FEED WATER: FORCED OFF
0	225	PRESSURIZER PORV: BLOCKED	0	225	PRESSURIZER PORV: BLOCKED
0	226	PRESSURIZER HEATERS: FORCED OFF	0	226	PRESSURIZER HEATERS: FORCED OFF
0	227	MANUAL SCRAM	0	227	MANUAL SCRAM
0	228	MAIN FEED WATER: FORCED OFF	0	228	MAIN FEED WATER: FORCED OFF
0	232	CHARGING PUMPS: FORCED OFF	0	232	CHARGING PUMPS: FORCED OFF
0	235	STEAM GENERATOR MSIV: FORCED CLOSED	0	235	STEAM GENERATOR MSIV: FORCED CLOSED
0	242	PRIMARY SYSTEM MAKEUP: OFF	0	242	PRIMARY SYSTEM MAKEUP: OFF
0	243	LETDOWN SWITCH: OFF	0	243	LETDOWN SWITCH: OFF
4970.7	161	UNBROKEN STEAM GENERATOR DRY	4973.9	151	BROKEN STEAM GENERATOR DRY
4980.7	151	BROKEN STEAM GENERATOR DRY	4973.9	161	UNBROKEN STEAM GENERATOR DRY
5027.7	39	PRESSURIZER EQUILIBRIUM THERMODYNAMICS	4988.9	39	PRESSURIZER EQUILIBRIUM THERMODYNAMICS
5027.7	40	PRESSURIZER SOLID	4988.9	40	PRESSURIZER SOLID
5256.9	92	QUENCH TANK RUPTURE DISK FAILED	5246.5	92	QUENCH TANK RUPTURE DISK FAILED
6228.2	57	WATER IN CAVITY	6227.9	57	WATER IN CAVITY
6474.7	14	FISSION PRODUCT MODELS ON	6458.6	14	FISSION PRODUCT MODELS ON
7302.6	40	PRESSURIZER HAS STEAM	7306.4	40	PRESSURIZER HAS STEAM
7334.8	40	PRESSURIZER SOLID	7338.5	40	PRESSURIZER SOLID
7374.8	40	PRESSURIZER HAS STEAM	7378.5	40	PRESSURIZER HAS STEAM
7378.8	16	REACTOR HEAD VENT LINE UNCOVERED	7383.8	16	REACTOR HEAD VENT LINE UNCOVERED
7400.1	40	PRESSURIZER SOLID	7404.1	40	PRESSURIZER SOLID
7417.9	81	WATER ON LOWER CONTAINMENT FLOOR	7424.1	81	WATER ON LOWER CONTAINMENT FLOOR
7434.8	40	PRESSURIZER HAS STEAM	7442.9	40	PRESSURIZER HAS STEAM
8003	5	HPSI ON	8001.5	5	HPSI ON
8003	211	PRESSURIZER PORV: MANUALLY OPEN	8001.5	211	PRESSURIZER PORV: MANUALLY OPEN
8003	212	HPSI: MANUALLY ON	8001.5	212	HPSI: MANUALLY ON
8003	216	HPSI: NOT FORCED OFF	8001.5	216	HPSI: NOT FORCED OFF
8003	225	PRESSURIZER PORV: AUTO	8001.5	225	PRESSURIZER PORV: AUTO
8233	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS	8225.5	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS
8233	49	CORE HAS UNCOVERED	8236.9	49	CORE HAS UNCOVERED
8239.6	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS	8238.1	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS
8239.6	25	PRIMARY SYSTEM NONEQUILIBRIUM	8238.1	25	PRIMARY SYSTEM NONEQUILIBRIUM

Table 1

Event Code Timing (sec)		DOS Version	Event Code Timing (sec)		Windows Version
		THERMODYNAMICS			THERMODYNAMICS
8239.7	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS	8238.1	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS
8239.7	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS	8238.1	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS
8239.7	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS	8238.1	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS
8239.7	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS	8238.2	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS
8239.7	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS	8238.2	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS
8239.7	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS	8238.2	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS
8239.8	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS	8238.2	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS
8239.8	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS	8238.2	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS
8239.8	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS	8238.2	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS
8239.8	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS	8238.2	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS
8239.8	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS	8238.3	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS
8239.8	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS	8238.3	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS
8239.8	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS	8238.3	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS
8239.8	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS	8238.3	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS
8239.9	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS	8238.3	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS
8239.9	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS	8238.3	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS
8239.9	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS	8238.3	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS
8239.9	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS	8238.3	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS
8239.9	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS	8238.4	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS
8239.9	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS	8238.4	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS
8239.9	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS	8238.4	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS
8240	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS	8238.4	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS
8240	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS	8238.4	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS
8240	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS	8238.4	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS
8240	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS	8238.4	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS
8240	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS	8238.4	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS
8240	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS	8238.5	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS
8240	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS	8238.5	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS
8240	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS	8238.5	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS
8240.1	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS	8238.5	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS
8240.1	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS	8238.5	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS

Table 1

Event Code Timing (sec)		DOS Version	Event Code Timing (sec)		Windows Version
8240.1	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS	8238.5	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS
8240.1	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS	8238.5	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS
8240.1	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS	8238.5	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS
9222.8	39	PRESSURIZER NONEQILIBRIUM THERMODYNAMICS	8238.6	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS
9887.2	32	PRESSURIZER EMPTY	8238.6	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS
13033.9	32	PRESSURIZER NOT EMPTY	8238.6	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS
13350.7	39	PRESSURIZER EQUILIBRIUM THERMODYNAMICS	8238.6	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS
13386.7	40	PRESSURIZER SOLID	8238.6	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS
13390.1	40	PRESSURIZER HAS STEAM	8238.6	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS
13393.7	40	PRESSURIZER SOLID	8238.6	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS
17578.5	188	SIT WATER DEPLETED	8238.6	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS
17739	40	PRESSURIZER HAS STEAM	8238.7	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS
			8238.7	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS
			8238.7	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS
			8238.7	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS
			8238.7	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS
			8238.7	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS
			8238.7	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS
			8238.7	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS
			8238.8	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS
			8238.8	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS
			8238.8	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS
			8238.8	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS
			8238.8	25	PRIMARY SYSTEM EQUILIBRIUM THERMODYNAMICS
			8238.8	25	PRIMARY SYSTEM NONEQUILIBRIUM THERMODYNAMICS
			9207.6	39	PRESSURIZER NONEQILIBRIUM THERMODYNAMICS
			9873.1	32	PRESSURIZER EMPTY
			13022.7	32	PRESSURIZER NOT EMPTY
			13351.2	39	PRESSURIZER EQUILIBRIUM THERMODYNAMICS
			13392.9	40	PRESSURIZER SOLID
			13394.7	40	PRESSURIZER HAS STEAM
			13396.9	40	PRESSURIZER SOLID
			17594	188	SIT WATER DEPLETED
			17697.1	40	PRESSURIZER HAS STEAM

Conclusions

As can be seen in Figure 1, the PCT's are nearly identical as well as the summary files. The event code occurrence in the summary files differs by about 3 seconds until the steam generators boil dry. At later times, differences of 30 to 40 seconds were observed in the occurrence of the event codes. Even with differences of 30 to 40 seconds, the two different compiled codes operating on different PC platforms compared very well.

Engineering Analysis Placekeeping Tool

Ref: Admin Proc 9.11, "Engineering Analysis" - **EA-PSA-LOSDC-03-11**

Section	Y or N/A	Task
Need Identified for Engineering Analysis		
6.1.1	Y	Reason identified for engineering analysis
Assign Engineering Analysis Initiator		
6.1.2	Y	Initiating engineer assigned
6.1.2	Y	Supervisor initials "Initiator Approved By" box on analysis cover sheet
4.4	Y	Responsible engineer assigned
	Y	Pre-job brief performed
Access Record Management System		
4.2	Y	Identify existing design information relative to the Engineering Analysis
4.2	Y	Identify analysis inputs
4.2	Y	Verify that analysis inputs are consistent with the Design Basis
4.2	N/A	Identify document(s) affected by the engineering analysis
4.2	N/A	Notify the sponsor of the affected document(s)
6.1.3	N/A	Search RECTRAK for existing analyses relevant to the subject of the analysis to be prepared
6.1.3	N/A	Search CalcXRef to identify any other documents which may provide input to the analysis to be prepared or use the results of the analysis
Revise Existing Engineering Analysis		
6.1.5	N/A	Identify if revision to an existing analysis is necessary
6.1.5.a		Identify method of revision
		Yes | No
		(1) Revision to a microfilmed analysis
		(2) Revision to an original analysis
		(3) Revision to an electronic file
6.1.5.b	N/A	Identify and describe changes in the revised engineering analysis
6.1.5.d	N/A	Determine whether the revision impacts a stress/serial package. If so, refer to EM-18-03.
6.1.5.c	N/A	If an existing analysis bounds the situation in question and does not require revision, prepare a disposition and link to the existing calculation
Prepare New Engineering Analysis		
6.1.4.c	Y	Engineering analysis number selected
6.1.4.d	Y	Engineering analysis title selected
6.2.3	Y	Prepare EA Checklist
6.2.4	N/A	Perform Walkdown
6.1.4.d.1	Y	Each sheet of engineering analysis uniquely numbered
6.1.4.d.1	Y	Total number of sheets indicated on cover sheet
6.1.4.d.2(a)	Y	Prepare objective statement
6.1.4.d.2(b)	Y	Identify analysis inputs
6.1.4.d.2(c)	Y	State assumptions and reference them where they are used in the analysis
6.1.4.d.2(c) (1)	Y	Identify major assumptions and their bases
6.1.4.d.2(c) (2)	Y	Identify minor assumptions and their bases
6.1.4.d.2(d)	Y	Prepare analysis section
6.1.4.d.2(d) (1)	N/A	Document result of reference searches and their applicability to the analysis
6.1.4.d.2(d) (2)	Y	Describe the methodology used
6.1.4.d.2(d) (3)	Y	Discuss each aspect of the problem
6.1.4.d.2(d) (4)	N/A	Identify impact of analysis on test requirements
6.1.4.d.2(d) (5)	N/A	Consider the effects of system degradation over time on design margins
6.1.4.d.2(d) (6)	N/A	Ensure that computer codes used for design are controlled by Admin 9.14

Engineering Analysis Placekeeping Tool

6.1.4.d.2(d) (7)	✓	Identify the Basis of any engineering judgment
6.1.4.d.2(d) (8)	✓	Verify that calculated values are within allowable ranges
6.1.4.d.2(d) (9)	✓	Identify as a reference the source of equations used in the analysis
6.1.4.d.2(d)(10)	✓	Describe formulas used in analysis and provide units for calculated values.
6.1.4.d.2(d)	✓	Prepare a conclusion
6.1.4.d.2(d)	✓	Verify that the conclusion supports the stated objective
6.1.4.d.2(d)	NA	Consider writing a condition report if the conclusion does not support the stated objective
4.4	NA	If the Engineering Analysis is generated by a vendor, ensure that it conforms to Administrative Procedure 9.11 requirements
4.4	NA	If there are any changes to piping systems, coordinate with the Piping and Stress Package Custodian
Technical Requirements		
6.2.1	NA	Prepare 50.59 Review
6.2.2	NA	Prepare EEQ Review
6.1.4.d.2(f)(1)	✓	Attach EA Checklist
6.1.4.d.2(f)(5)	NA	Attach Preliminary EA item list (Section 6.2.5)
6.1.4.d.2(f)(6)	NA	Attach 50.59 Review (Section 6.2.1)
6.1.4.d.2(f)(7)	NA	Attach EEQ Review (Section 6.2.2)
Perform Required Reviews		
4.1		Supervisory review performed
4.1, 6.3.1	NA	Technical reviewer assigned by Safety/Design Review Supervisor
6.3.2	✓	Technical Reviewer performs technical review
4.3		Technical Reviewer verifies that the affected documents are properly identified
6.3.3	✓	Technical Reviewer documents review comments
6.3.4	NA	Technical Reviewer prepares technical review checklist
6.3.6		Safety Design/Review approval required if reviewed by vendor
Resolve Review Comments		
6.3.3	✓	Resolve comments
6.1.4.d.2(f)(2)	✓	Attach Technical Review Checklist and EA Checklist
6.1.4.d.2(f)(3)	✓	Attach EA Review Sheets
6.1.4.d.2(f)(4)	✓	Attach technical review standard design evaluation or alternate calculations (Section 6.3.2a)
Calculation Approved		
6.3.5	✓	Obtain all necessary approvals
Complete Record Indexing Form & Submit to ERC		
6.4	✓	Prepare Record Indexing Form and attach to front of calculation
6.4	✓	Forward analysis to ERC or PSPC

PALISADES - NUCLEAR GENERATING PLANT		
TITLE:	ENGINEERING PRE-JOB BRIEFING	Revision Draft
		Page 1 of 2

Type of Task: Prepare Engineering Analysis EA-PSA-LOSDC-03-11 r0 in accordance with Admin Procedure 9.11.	Date:	9-15-03
	Time:	1500
	Assigned To:	BBrogan

Task Description:
Prepare an engineering analysis is to examine the validity of the 1 and 4 hour screening criterion employed in the NRC SDP Phase 2 analysis.

Objectives/ Expectations:
Evaluate the limiting time that the operator has to recover PCS makeup given a station blackout (with and without secondary side cooling).

CHECKLIST

☒ Scope/expectations understood
☒ Documentation format reqmts clear
☒ Validation reqmts for data clear
☒ Communication reqmts clear
☒ Reqd completion date/time clear
☒ Approp time included for checking
☒ Knowledge/Skills/Training approp
☐ Time pressure minimized
☐ Distractions minimized

☒ Reqd Information in Hand
☒ Applicable directives reviewed
☐ Contingency Plans discussed
☒ Approp Engineering tools used
☒ Approp groups involved
☐ Lateral Communications occurring
☐ Task sched to minimize fatigue
☒ Questioning attitude emphasized
☐ Operating Experience Considered (list above)

KEY STRATEGIES TO PREVENT GROUP THINK
1. Open Climate
2. Avoid Isolation of Group
3. Assign member Role of critical evaluator
4. Avoid being too directive

EIGHT SYMPTOMS OF GROUP THINK
1. Illusion of Invulnerability
2. Belief in inherent morality
3. Stereotypes of out Groups
4. Illusion of Unanimity
5. Rationalization
6. Mind Guards
7. Self Censorship
8. Direct Pressure

Estimated Time to Complete: few days	Due Date/Time: ASAP

TWIN ANALYSIS

Task Demands
☒ Time/Schedule pressure
☒ High Workload
☒ Multiple simultaneous tasks
☐ Repetitive Actions / monotony
☐ Unrecoverable/Irreversible actions
☐ Interpretation requirements
☐ Unclear goals, roles, responsibilities
☐ Lack of /or unclear Standards

Work Environment
☒ Distractions / Interruptions
☐ Changes from routine
☐ Confusing displays / Controls
☐ Work arounds / OOS equipt
☐ Hidden system responses
☐ Unexpected equip conditions
☐ Lack of alternative indication
☐ Adverse physical conditions
☐ Vague or incorrect guidance
☐ Identical and adjacent controls

Individual Capabilities
☐ Unfamiliarity with task / First time
☐ Lack of Knowledge
☐ New techniques not used before
☐ Imprecise communications habits
☐ Lack of Proficiency / Inexperience
☐ Unsystematic problem solving skills
☐ "Unsafe" attitude for critical tasks
☐ Illness / Fatigue / General Health

Human Nature
☒ Stress - Work/Home
☐ Habit patterns
☐ Assumptions
☐ Complacence
☐ Overconfidence
☐ Mind Set
☐ Inaccurate risk perceptions
☐ Mental shortcuts
☐ Limited short term memory
☐ Apparent emotional health
☐ Backshift/recent shift change
☐ First day back from days off

Describe the Risk Basis: (1. Factors that increase the likelihood of making a mistake and 2. Worsen the consequences of an error).

Schedule pressure of competing issues.

PALISADES - NUCLEAR GENERATING PLANT		
TITLE:	**ENGINEERING PRE-JOB BRIEFING**	Revision Draft

What are the Critical Steps? Determine the limiting time that PCS makeup is required for SBO events. Operability Concerns? If makeup cannot be recovered core damage could occur. When and who to call for help? ERIN Engineering. Contingency Plans? None Important Error Reduction Tools for this Task? External subject matter experts will perform tech review.		1. Critical Safety Issues 2. Operability Concerns 3. When and who to call for help. 4. Contingency Plans 5. Important Error Reduction Tools for this Task	
Activity Performer:	Brian Brogan	Date:	9-15-2003
Supervisor:	Jeb B Kingseed	Date:	9-15-2003

PALISADES NUCLEAR PLANT
ENGINEERING ANALYSIS CHECKLIST

EA-PSA-LOSDC-03-11 REV 0

SECTION I Identification of Items Affected By This EA	Affected Yes	Affected No	Revision Required	Identify*	Closeout
1.0 Other EAs	☐	☑			
2.0 Design Documents Electrical E-38 through E-49	☐	☑			
3.0 Design Documents Mechanical M240-M246, M257-M261, M664-M666, M1600	☐	☑			
4.0 LICENSING DOCUMENTS					
4.1 Final Safety Analysis Report (FSAR)	☐	☑			
4.2 Technical Specifications	☐	☑			
4.3 Operating Requirements Manual	☐	☑			
5.0 PROCEDURES					
5.1 Administrative Procedures	☐	☑			
5.2 Operating Procedures (SOP, EOP, ONP, etc)	☐	☑			
5.3 Working Procedures	☐	☑			
5.4 Tech Spec Surveillance Test Procedures	☐	☑			
6.0 OTHER DOCUMENTS					
6.1 Q-List	☐	☑			
6.2 Plant Drawings	☐	☑			
6.3 Equipment Data Base	☐	☑			
6.4 Spare Parts (Stock/MMS)	☐	☑			
6.5 Fire Protection Program Report (FPPR)	☐	☑			
6.6 Design Basis Documents	☐	☑			
6.7 Operating Checklists	☐	☑			
6.8 SPCC/PIPP Oil and Hazardous Material Spill Prevention Plan	☐	☑			
6.9 EEQ Documents	☐	☑			
6.10 MOV/AOV Program Documents (Voltage, thrust, weak link, etc)	☐	☑			
6.11 Engineering Programs, Component Engineering Documents	☐	☑			
6.12 Work Instructions	☐	☑			
6.13 Other ______					

*Identify Section No., Drawing, Document, etc

SECTION II

Do any of the following documents need to be generated?

	Yes	No	
1. Corrective Action Document?	☐	☑	Reference ______
2. 50.59 Review?	☐	☑	Reference: EA's that are not used in the FSAR Analyses, and do not involve the design basis of a system, structure or component do not require a 50.59 Review. Admin 9.11 r14 page 21.
3. Verification Test Procedure (for changes to the Design Basis)?	☐	☑	Reference ______

Completed By *Brian Brogan* Date *9-23-03*

Technical Reviewed By *[signature] for J Gabor* Date *9-23-03*

ENGINEERING ANALYSIS REVIEW SHEET

Title CPMAAP Analysis of the 3/25/2003 Loss of Shutdown Cooling Event	EA Number EA-PSA-LOSDC-03-11	Revision Number 0	Page 1 of 1

Item Number	Page, Line, or Section Number	Comments	Response or Resolution
1	Section 4.3	Assumption 4.3 of EA should read "core damage success criterion" or you could say "core damage criterion...defined...temperature greater than ..."	Corrected.
2	SBO-003.inp	The only other comment is that I see the parameter file is using .002797 m3/s as the default flow for a single HPI pump. You appear to be using .002933 m3/s in the input file when you change flow. I am sure it doesn't matter, but the numbers are slightly different.	Corrected. This comment applies to the charging pumps which are referred to as high pressure injection pumps in MAAP.

Technical Reviewer	Organization	Date	Initiator	Date	Technical Reviewer or Supervisor	Date
Jeff Gabor	ERIN Engineering	9-23-2003	BABrogan	9-23-2003	RSW [illegible] for J Gabor	9-23-03

TECHNICAL REVIEW CHECKLIST

EA-PSA-LOSDC-03-11 REV 0

This checklist provides guidance for the review of engineering analyses. Answer questions Yes or No, or N/A if they do not apply. Document all comments on an EA Review Sheet. Satisfactory resolution of comments and completion of this checklist is noted by the Technical Review signature at the bottom of this sheet.

		(Y, N, N/A)
1.	Have the proper input codes, standards and design principles been specified?	Y
2.	Have the input codes, standards and design principles been properly applied?	Y
3.	Are all inputs and assumptions valid and the basis for their use documented?	Y
4.	Is Vendor information used as input addressed correctly in the analysis?	Y
5.	If the analysis argument departs from Vendor Information/ Recommendations, is the departure justification documented?	Y
6.	Are assumptions accurately described and reasonable?	Y
7.	Are the design basis changes permitted by this EA bounded by the applicable 50.59 Review?	N/A
8.	Are all constants, variables and formulas correct and properly applied?	Y
9.	Have all comments been documented on an EA Review Sheet and resolved, or have any minor (insignificant) errors been identified and their insignificance justified? (Indicate "No Comments," if none were made.)	Y
10.	If the analysis involves welding, is the following information accurately represented on the analysis drawing (Output document)? • Type of Weld • Size of Weld • Material Being Joined • Thickness of Material Being Joined • Location of Weld(s) • Appropriate Weld Symbology	N/A
11.	Has the objective of the analysis been met?	Y
12.	Have administrative requirements such as numbering, format, and indexing been satisfied?	Y

Technical Reviewer RAW RAWhite for JGabor Date 9-24-03

Jeff Gabor answered the 12 questions via tele-conference call with J. Kingsbeko & B. Brown.

EA-PSA-LOSDC-03-11 R0
Attachment 9

ERIN® ENGINEERING AND RESEARCH, INC.

MEMORANDUM

TO:	Brian Brogan, Palisades	*DATE:*	September 23, 2003
FROM:	Jeff Gabor, ERIN Engineering	*Doc. No.:*	P0495-03-0008-2276

SUBJECT: Technical Review of EA-PSA-LOSDC-03-11 r0

I have performed an independent review of the subject engineering analysis. Included in this review:

- Review of overall methodology and results
- Independent verification of MAAP analyses

General Observations and Conclusions

Calculation EA-PSA-LOSDC-03-11 r0 has been reviewed and found to contain no major errors. The results of the independent analysis have confirmed the selected assumptions and results from the EA. A minor correction to the text and a slight change to the charging pump flow was identified and corrected prior to finalization of this EA. The attached Form 3110 documents these minor corrections.

Background and Review of Overall Methodology

The objective of this EA is to compute the potential of core damage for selected SBO scenarios with assumed recovery actions. Three scenarios were analyzed to investigate if recovery of AC power at selected times in the event would result in maintaining adequate core cooling and preventing core damage.

The following three (3) accident scenarios were analyzed:

1. SBO-001:
   - Station Blackout with failure of all injection and loss of AFW.
   - One (1) HPSI pump available at 6512 sec.
   - Two (2) charging pumps recovered at 6794 sec.
   - One (1) Pressurizer PORV opened at 6845 sec.
   - Additional HPCI pump available at 7584 sec.
   - Additional Charging pump available at 7669 sec.
   - Second PORV opened at 7727 sec.

2. SBO-002:
   - Station Blackout with failure of all injection and loss of AFW.
   - One (1) HPSI pump available at 8500 sec.
   - Two (2) charging pumps recovered at 8782 sec.
   - One (1) Pressurizer PORV opened at 8833 sec.
   - Additional HPCI pump available at 9572 sec.
   - Additional Charging pump available at 9657 sec.
   - Second PORV opened at 9715 sec.

3. SBO-003:
   - Station Blackout with failure of all injection, AFW is available
   - AFW assumed unavailable at 14400 sec
   - One (1) HPSI pump available at 30500 sec.
   - One (1) charging pump recovered at 30782 sec.
   - One (1) Pressurizer PORV opened at 30833 sec.

Independent Analyses and Verification

Verification of CPMAAP Cases

All three CPMAAP cases were run independently by the technical reviewer. Table 1 shows a comparison between the peak core temperatures for each scenario.

Table 1 – Peak Core Temperature Comparison

Case	NMC Result	Independent Assessment
SBO-001	800 °F	800 °F (700 K)
SBO-002	1700 °F	1700 °F (1200 K)
SBO-003	1400 °F	1400 °F (1000 K)

Plots of the independent assessment are included in Attachment 1 of this review. Note that the plots indicate temperatures in units of K. The peak core temperatures are confirmed by the reviewer.

Verification of CPMAAP input Files

The MAAP input files were reviewed to confirm that they were accurately representing the three scenarios described in the EA.

ERIN® ENGINEERING AND RESEARCH, INC.

Review of Attachment 7

Attachment 7 summarizes the results of a similar scenario executed using the DOS executable of CPMAAP and the Windows version of the same code. Similar comparisons performed by the MAAP Users Group have shown slight variations in the accident timing. This is primarily due to differences between the compiler options for DOS and Windows and is an expected result. Attachment 7 shows excellent agreement between the DOS and Windows versions of the code and further supports the quality of the code.

Review of CPMAAP Results

The peak core temperatures were reviewed for the three scenarios and found to agree with expected trends from other similar analyses.

Findings and Conclusions

The overall methodology described in this EA is judged to adequately estimate the time available for AC Power recovery for the SBO scenarios investigated. The input files developed accurately reflect the desired actions detailed in the EA and did not contain errors. The calculated peak core temperatures are consistent with expected results from other plant analyses and were independently confirmed by the technical reviewer.

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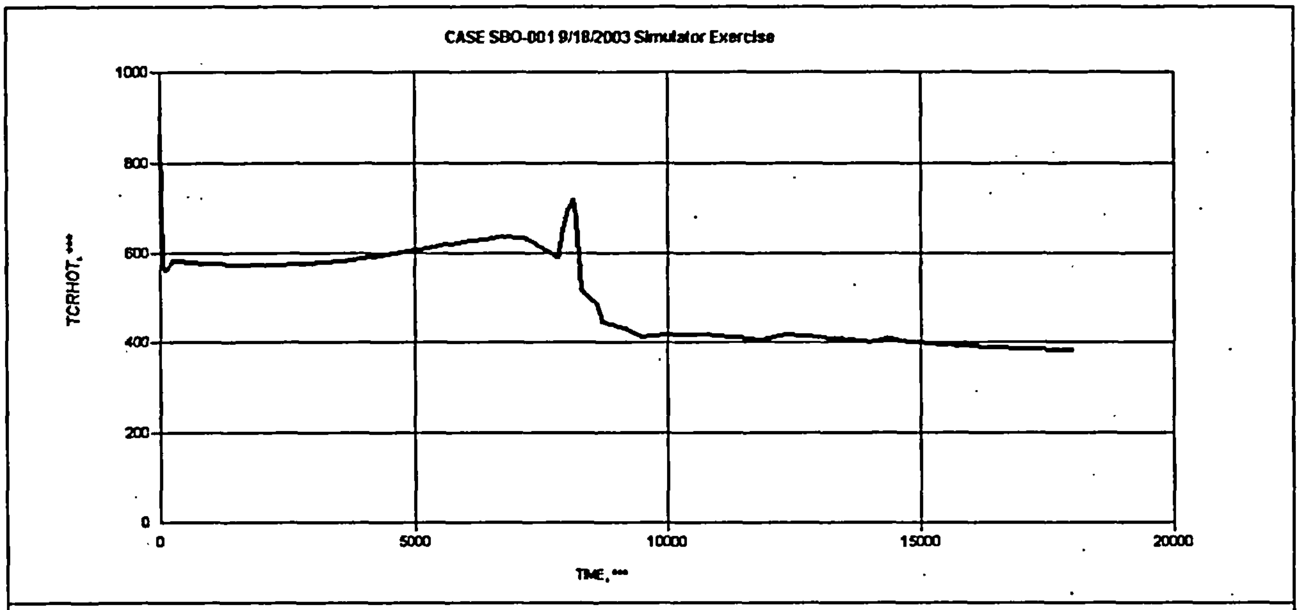
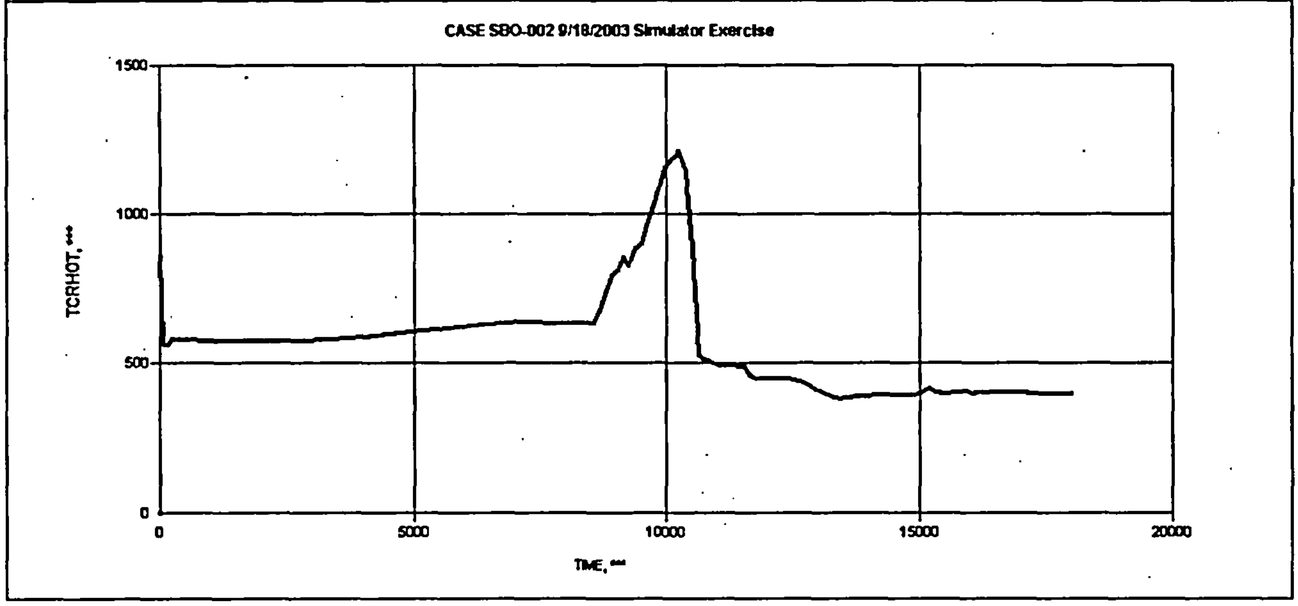
Attachment 1
Plots from Independent Assessment
Peak Core Temperatures (K)



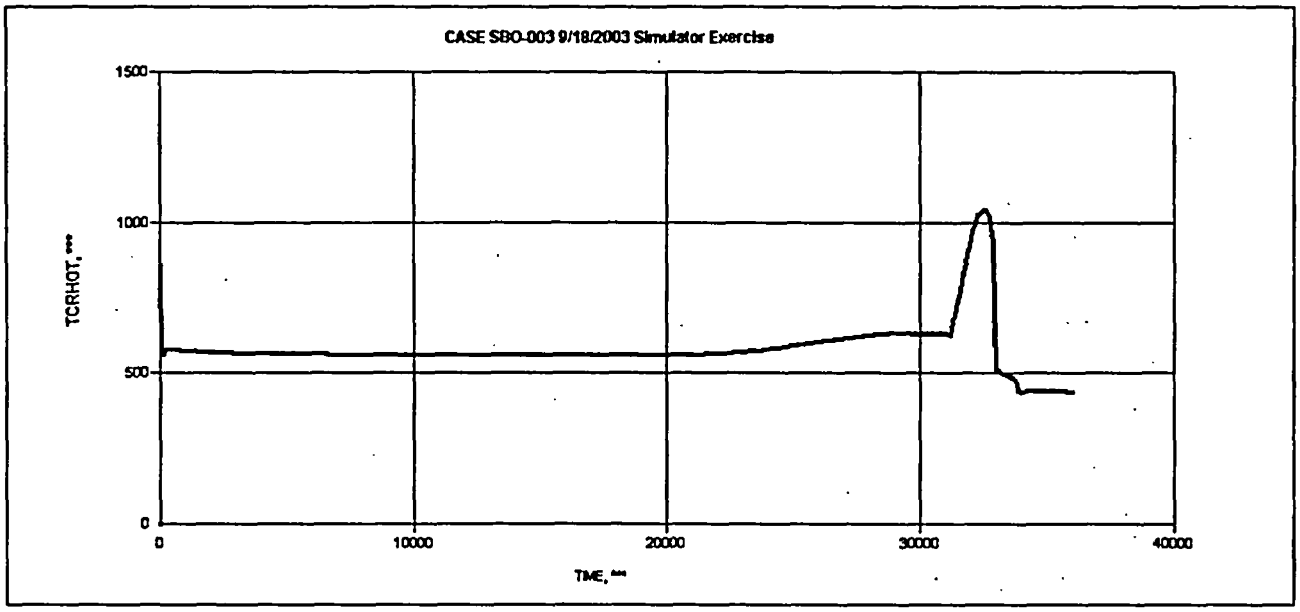


[redacted]

FA-PSA-LOSOC-03-11 R0

Attachment 9

ERIN® ENGINEERING AND RESEARCH, INC.



ATTACHMENT 3

NUCLEAR MANAGEMENT COMPANY, LLC
PALISADES NUCLEAR PLANT
DOCKET 50-255

October 28, 2003

PROBABILITY OF FAILING TO RECOVER AN OFFSITE POWER SOURCE FOLLOWING A LOOP EVENT CAUSING BY DIGGING/EXCAVATING
EA-PSA-SWY-REC-03-10

33 Pages Follow

NMC
Committed to Nuclear Excellence

PALISADES NUCLEAR PLANT
ANALYSIS COVER SHEET

EA-PSA-SWY-REC-03-10 Rev 0
Total Number of Sheets 33

Title	Probability of Failing to Recover an Off-Site Power Source Following a LOOP Event Caused by Digging/Excavating
INITIATION AND REVIEW	
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ATTACHMENTS

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1.0 OBJECTIVE

This Engineering Analysis (EA) calculates the probability of failing to recover an off-site power source following a digging/excavating event between the plant and the switchyard that may lead to a disconnection of the plant from the switchyard and is classified as a loss of off-site power (LOOP) event. This EA estimates the failure probability for reconnecting the switchyard to the plant following a digging/excavating event causing a LOOP. This EA evaluates recovery of off-site power for two station blackout (SBO) sequences with the plant initially at-power: with and without auxiliary feedwater (AFW) available. The results of this EA may be used in the NRCs Significance Determination Process (SDP) to determine the safety significance of the inadequate digging/excavating policy deficiency identified following the March 25, 2003, LOOP/loss of shutdown cooling event at Palisades.

2.0 ANALYSIS INPUT/REFERENCES

2.1 NUREG/CR-4772, "Accident Sequence Evaluation Program Human Reliability Analysis Procedure", February, 1987 (R0914)
2.2 EA-PSA-LOSDC-03-11, CPMAAP Analysis of 3/25/2003 LOSDC Event
2.3 EOP Supplement 29, Restore Buses 1C, 1D, 1E Power From Offsite Source, revision 6
2.4 NUREG/CR-1278, "Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Applications", August 1983
2.5 PPAC TGS015, PM on 389 MOD Linear Actuator

3.0 DEFINITIONS

3.1 *accident sequence evaluation program (ASEP)* - human reliability analysis methodology (ref 2.1)
3.2 *error factor* - statistical term identifying the ratio of the upper bound estimate to the median estimate or the median estimate to the lower bound estimate
3.3 *HEP - human error probability* - the probability that an operator will fail to correctly perform a given task or activity within the required time frame
3.4 *HRA - human reliability analysis* - evaluation of operator actions in the PSA model, including identification of actions, consequences of failing to perform actions, HEP calculations
3.5 *LOOP - loss of off-site power* - for this evaluation, LOOP is disconnection of the switchyard to the plant
3.6 *LOSDC - loss of shutdown cooling* - event
3.7 *PSA/PRA - probabilistic safety assessment/probabilistic risk assessment* - probabilistic model of plant systems, structures and components and their response to plant events
3.8 *recovery of off-site power* - for the evaluation, recovery of off-site power is defined as reconnection of the switchyard to the plant
3.9 *SBO - station blackout* - an accident sequence initiated by LOOP with failure of onsite emergency AC power (diesel generators)
3.10 *SDP - Significance Determination Process* - NRC process to assess the safety significance of a finding or observation

4.0 ASSUMPTIONS

4.1 Major Assumptions

4.1.1 Two simulator exercises were performed for a SBO without AFW scenario. These exercises simulated a scenario for digging/excavating (as identified in Attachment A) between the plant and the switchyard. This scenario had ~2 ½ hours to complete the required actions (ref 2.2). The critical times for recovering off-site power through backfeed and initiating once through cooling (OTC) are assumed to be representative for both time frames evaluated in this EA (~2 ½ hours and 4 hours). Since there would be more time and, therefore, less stress in the 4 hours scenario, using the ~2 ½ hour scenario time frames is assumed to bound the 4 hour scenario. Page 6 of Attachments B and C, EOP Validation for each simulator exercise, provide the observed time for various actions. Attachments B and C times are rounded to the nearest minute. The following simulator critical times were recorded to the nearest second:

Simulator Exercises
Critical Time Summary

(9-17-03) Time (min)	(9-26-03) Time (min)	Action
0	0	Start of the scenario
60.40	34.57	Start backfeed (EOP Supplement 29)
104.55	80.43	Energize bus 1D
*108.53	*86.53	Manually start right channel HPSI (P-66A)
*113.23	*86.53	Manually start 2 charging pumps (P-55A, P-55B)
*114.08	*90.92	Open PORV (PRV-1043A)
124.40	84.72	Energize bus 1C
*126.42	*86.53	Manually start left channel HPSI (P-66B)
*127.82	*86.53	Manually start 3rd charging pump (P-55C)
*128.78	*90.92	Open PORV (PRV-1042A)

* Under realistic scenario conditions, manually initiating SIS would have started the charging and HPSI pumps. However, the simulator conditions did not reflect that the PCS pressure increased above the SIS block setpoint and, therefore, would have allowed manual or automatic SIS. Since manual initiation of SIS could not be performed on the simulator, the crew continued to manually start these pumps and open their discharge valves, which was required prior to opening the PORVs. Specific times for pump starts were recorded in the first exercise, but only the time for manually initiating SIS was recorded for the second exercise.

The critical times used in this EA are the longest time frame from either simulator scenario. Since the actions are a result of following procedures and both simulator exercises had similar results, the critical times are assumed to apply to any crew for the given circumstances. Conservatisms in the times are discussed in Section 5.4. The critical times for this EA are summarized in the following table. The critical times are: time to complete backfeed (from start of backfeed to energizing first bus); time to open the first PORV from the start of the scenario; and time to open the first PORV after recovery of an AC power source.

Critical Times Used in this EA

Action	(9-17-03) time (min)	(9-26-03) time (min)	This EA time (min)
complete backfeed actions	44.15	45.86	46
open first PORV (from start of scenario)	114.08	90.92	115
open first PORV (since recovery of AC power)	9.53	10.49	11

4.2 Minor Assumptions

4.2.1 One critical backfeed alignment action required during the simulator exercise was simulated: EOP Supplement 29, Section 4.0, step 1.e.2. EOP Supplement 29 (ref 2.1), Section 4.0, Backfeed, contains the step-by-step actions to align backfeed. Step 1.e.2 to manually open the main generator disconnect MOD 389 could not be performed on the simulator. The time required to perform this step was estimated. During the simulator exercise, the operations crew could not proceed to the next step until completion of this step while the scenario continued to progress. Therefore, use of this walkthrough information did not alter the control room response to the scenario.

Manually opening MOD-389 was simulated to take 20 minutes in the first simulator exercise. This time was later validated per PPAC TGS-015 (ref 2.5), which specifies that this action is required to be performed within 10 minutes. The second simulator exercise used 10 minutes for this action. Since the second simulator exercise took longer to complete the backfeed actions and used the correct MOD opening time, using 20 minutes in the first simulator exercise did not affect the results.

4.2.2 The PSA currently assumes that failing to recover an AC power source within the battery depletion time of 4 hours is a core damage sequence because of lack of instrumentation. However, there is additional time available beyond the 4 hours to recover off-site power (DGs may not start due to depleted batteries) since the steam generators would have water in them and the decay heat load is relatively low (compared to decay at reactor trip). MAAP results (ref 2.2), assuming no AFW after 4 hours, indicate that there would be an additional 4 hours to recover off-site power and initiate OTC to prevent core damage. If AFW injection continued after the initial 4 hours, even more time would be available. Using 4 hours for the maximum off-site power recovery time versus 8 hours (or more) during a SBO with AFW available is conservative.

4.2.3 The actions to align backfeed are part of a step-by-step procedure (EOP Supplement 29). To complete these actions within 4 hours, the crew is considered to be under moderate to low stress, since there is more than 3 hours and Technical Support Center is fully functional. There is no match in Table 8-5 (ref 2.1) that applies to the human error probability (HEP) for this type of action. This evaluation will assume one half of the median HEP for the action in Item 3 of Table 8-5 for moderately high stress step-by-step actions. The recovery HEPs for these actions will also assume one half of the median HEP for Item 6 in Table 8-5 for the same reasons. The same error factor as Items 3 and 6 in Table 8-5 will be used for these HEPs.

5.0 ANALYSIS

5.1 METHODOLOGY

The post-accident HEP for failure to recover an off-site power source is dependent on the scenario evaluated. To support the NRC SDP, two specific scenarios are evaluated for recovering from a SBO: recovery of an off-site power source within ~2 ½ hours (identified as REC2, occurs when no AFW is available); and recovery of an off-site power source within 4 hours (identified as REC4, AFW available, but batteries deplete). Each recovery term contains operator actions for which the HEP can be estimated using the Accident Sequence Evaluation Program (ASEP) Human Reliability Analysis Procedure (ref 2.1). Nominal HEPs per Chapter 8 are calculated.

5.2 Recovery of Off-site Power Within ~2 ½ Hours

ASEP (ref 2.1) Chapter 8, Table 8-1, Procedure for Nominal HRA of Post-Accident Tasks, provides a 12 step methodology for estimating post-accident HEPs. Each step of the procedure and its result are discussed in this section.

5.2.1 Step 1 - Review of Definitions

This step is a review of definitions and concepts in Table 2-1, Table 6-1 and Figure 6-1 for the use of ASEP. No data is identified or calculated in this step.

5.2.2 Step 2 - Identification of When no HRA/HEP is Required

This step identifies instances when the HEP = 1 (failure to perform the task) and no further evaluation is required. There are two instances provided where this happens:

1) critical skill-based or rule-based post-diagnosis actions are not described in written procedures
2) required instrumentation fails to support diagnosis or post-diagnosis actions

Neither of these conditions apply to the recovery of an off-site power source for the scenarios to be evaluated, therefore, step 2 does not apply to this calculation.

5.2.3 Step 3 - Maximum Allowable Time to Recover an Off-Site Power Source

From CPMAAP calculations (ref 2.2), Table 6.2, indicates that a SBO without AFW scenario with recovery an AC power source and initiation of OTC within 147.2 minutes (8833 seconds) results in a peak clad temperature <1600F. Since LOOP is the initiating event and corresponds to time T=0, 147 minutes is the maximum time available to complete all of the operator actions. From the simulator exercise (assumption 4.1.1), completing the OTC actions takes about eleven minutes after recovery of an AC power source. Therefore, the maximum time available to recover an off-site power source (Tmax) is:

$$T_{max} = 147 \text{ min} - 11 \text{ min} = 136 \text{ minutes}$$

5.2.4 Step 4 - Post-Diagnosis Actions

This step identifies the post-diagnosis actions required for successful backfeed alignment. Once backfeed is identified as the success path, EOP Supplement 29 (ref 2.3) provides the guidance to align backfeed. The following two sets of critical operator actions are part of the process:

1) step 1.e.2, manually open MOD-389 (performed in the turbine building)
2) step 1.h, reset lockout relays; step 1.i.2, close breaker 25H9; restore power to at least one of the safeguards buses via step 1.k, close breaker 152-402; and step 1.l, close breaker 152-105 (1C) or 152-203 (1D) or 152-302 (1E) (all performed in the control room by the same person in close proximity and time)

Completion of these two steps restores off-site power to one of the 2400VAC buses via backfeeding through the main transformer to the safeguards bus.

5.2.5 Step 5 - Time Estimates for Control Room Actions

This step estimates the time to complete control room actions, including travel and manipulation time. Simulator exercises were performed that provide the total time to align backfeed (steps 5 and 6). Backfeed was completed within 46 minutes after starting to align backfeed (assumption 4.1.1).

5.2.6 Step 6 - Time Estimates for Outside Control Room Actions

This step estimates the time to complete actions outside the control room, including travel and manipulation time. Simulator exercises were performed that provide the total time to align backfeed (steps 5 and 6). Backfeed was completed within 46 minutes after starting to align backfeed (assumption 4.1.1).

5.2.7 Step 7 - Time Estimates to Complete Post-Diagnosis Actions

Summing the time estimates from steps 5 and 6 provides the total time to complete the post-diagnosis actions. Simulator exercises were performed that provide the total time to align backfeed. The time to complete the backfeed post-diagnosis actions (Tact) is (assumption 4.1.1):

Tact = 46 minutes

5.2.8 Step 8 - Calculate Allowable Diagnosis Time

This step calculates the allowable diagnosis time (Tdiag) by subtracting the time to complete post-diagnosis actions (Tact) from the maximum allowable time (Tmax):

Tdiag = Tmax - Tact = 136 min - 46 min = 90 minutes

5.2.9 Step 9 - Diagnosis HEP

This step estimates the appropriate diagnosis HEP. Figure 8-1, Nominal Diagnosis Model (labeled as Figure 7-1 in the NUREG) identifies that the HEP for 90 minutes is 7.5E-5 (error factor = 30) for the median joint HEP. Table 8-3, Guidelines for Adjusting Nominal Diagnosis HEPs from Table 8-2, is used to determine potential adjustments to make to the median HEP. Backfeed is covered during training, is periodically discussed prior to refueling outages and several licensed operators were surveyed with all indicating they know there is a procedure with general steps to align backfeed. Therefore, the upper bound HEP is not applicable. Aligning backfeed is not a classic event, therefore, the lower bound HEP is not applicable either. The median HEP for diagnosis (HEPdiag) is:

HEPdiag = 7.5E-5, error factor 30

5.2.10 Step 10 - Post-Diagnosis HEP

This step assigns HEPs for each independent post-diagnosis task. There are two critical independent tasks (see step 4). Each task is associated with a HEP. Both of these tasks are critical actions as part of a step-by-step procedure under moderately high stress, therefore, Item 3 from Table 8-5 (ref 2.1) applies. The median HEP for the action to complete each task (HEPact) is:

HEPact = .02, error factor 5

In addition, each action will be verified by one of several methods (control room indications, equipment performance, three way communication/observation, etc.). Each action will have an associated recovery factor. Similar to the actions themselves, the verification is a step-by-step verification under moderately high stress, therefore, Item 6 from Table 8-5 (ref 2.1) applies. The median HEP for recovery of each action (HEPrec) is:

HEPrec = .2, error factor 5

The overall HEP for the task (HEPtask) is the product of the action and recovery probabilities:

HEPtask = HEPact * HEPrec

5.2.11 Step 11 - Total HEP

This step estimates the total HEP from the HEPs calculated in steps 9 and 10. The total HEP for aligning backfeed within ~2 ½ hours (HEPbackfeed-2) is equal to the sum of the diagnosis and task (including recovery) HEPs:

HEPbackfeed-2 = HEPdiag + HEPtask1 + HEPtask2

The HEPs calculated in steps 9 and 10 are median HEPs. Before the final HEP is calculated, these HEPs need to be converted into means, since the PSA uses mean probabilities. NUREG/CR-1278 (ref 2.4), Appendix A, provides a six step method for converting a median to a mean probability and propagating the uncertainties. This EA uses the first four steps to calculate the mean and standard deviation for the HEPbackfeed-2.

5.2.11.1 Step 1 - Identify the HEPbackfeed-2 Components

This step identifies the HEPbackfeed-2 components and how they are combined into the overall HEP. The equation above identifies the HEP components and their combinations. Components are added together (HEPdiag, HEPtask1, HEPtask2) with subcomponents multiplied together (HEPact1, HEPrec1, HEPact2, HEPrec2), as defined below:

HEPdiag
HEPtask1 = HEPact1 * HEPrec1
HEPtask2 = HEPact2 * HEPrec2

5.2.11.2 Step 2 - Calculate the Mean (ln) and Standard Deviation (ln) for each Component

This step calculates the Mean ln(P) and Standard Deviation ln(P) for each component according to the following equations (ref 2.4, page A-8):

Mean ln(Pdiag) = ln (HEPdiag)
Mean ln(Ptask1) = ln (HEPact1) + ln (HEPrec1)
Mean ln(Ptask2) = ln (HEPact2) + ln (HEPrec2)

SD ln(Pdiag) = ((1/3.29)^2)*(ln(U/L for HEPdiag))^2
SD ln(Ptask1) = ((1/3.29)^2)*[(ln(U/L for HEPact1))^2 + (ln(U/L for HEPrec1))^2]
SD ln(Ptask2) = ((1/3.29)^2)*[(ln(U/L for HEPact2))^2 + (ln(U/L for HEPrec2))^2]

where U/L = upper bound/lower bound = (error factor)^2

Substituting using the median HEPs and error factors from steps 9 and 10 results in:

Mean ln(Pdiag) = -9.5
Mean ln(Ptask1) = -5.5
Mean ln(Ptask2) = -5.5

SD ln(Pdiag) = 4.3
SD ln(Ptask1) = 1.9
SD ln(Ptask2) = 1.9

5.2.11.3 Step 3 - Calculate the Mean and Standard Deviation for each Component

This step calculates the Mean and Standard Deviation for each component according to the following equations (ref 2.4, page A-9):

Mean (Pdiag) = exp(Mean ln(Pdiag) + (SD ln(Pdiag))/2)
Mean (Ptask1) = exp(Mean ln(Ptask1) + (SD ln(Ptask1))/2)
Mean (Ptask2) = exp(Mean ln(Ptask2) + (SD ln(Ptask2))/2)

SD (Pdiag) = exp(SD ln(Pdiag) + 2*Mean ln(Pdiag)) * (exp(SD ln(Pdiag)) - 1)
SD (Ptask1) = exp(SD ln(Ptask1) + 2*Mean ln(Ptask1)) * (exp(SD ln(Ptask1)) - 1)
SD (Ptask2) = exp(SD ln(Ptask2) + 2*Mean ln(Ptask2)) * (exp(SD ln(Ptask2)) - 1)

Substituting using the results of step 2 (Section 5.2.11.2) results in:

Mean (Pdiag) = 6.4E-4
Mean (Ptask1) = 1.1E-2
Mean (Ptask2) = 1.1E-2

SD (Pdiag) = 3.0E-5
SD (Ptask1) = 6.3E-4
SD (Ptask2) = 6.3E-4

5.2.11.4 Step 4 - Calculate the Mean and Standard Deviation for the final HEP

This step calculates the Mean and Standard Deviation for overall HEPbackfeed-2 according to the following equations (ref 2.4, page A-9):

Mean HEPbackfeed-2 = Mean (Pdiag) + Mean (Ptask1) + Mean (Ptask2)

SD HEPbackfeed-2 = SD (Pdiag) + SD (Ptask1) + SD (Ptask2)

Substituting using the results of step 3 (Section 5.2.11.3) results in:

Mean HEPbackfeed-2 = 2.3E-2

SD HEPbackfeed-2 = 1.3E-3

5.2.12 Step 12 - Add HEP to PSA Model

This step adds HEPbackfeed-2 to the PSA model. This step is not performed in this EA.

5.3 Recovery of Off-site Power Within 4 Hours

ASEP (ref 2.1) Chapter 8, Table 8-1, Procedure for Nominal HRA of Post-Accident Tasks, provides a 12 step methodology for estimating post-accident HEPs. Each step of the procedure and its result are discussed in this section.

5.3.1 Step 1 - Review of Definitions

This step is a review of definitions and concepts in Table 2-1, Table 6-1 and Figure 6-1 for the use of ASEP. No data is identified or calculated in this step.

5.3.2 Step 2 - Identification of When no HRA/HEP is Required

This step identifies instances when the HEP = 1 (failure to perform the task) and no further evaluation is required. There are two instances provided where this happens:

1) critical skill-based or rule-based post-diagnosis actions are not described in written procedures
2) required instrumentation fails to support diagnosis or post-diagnosis actions

Neither of these conditions apply to the recovery of an off-site power source for the scenarios to be evaluated, therefore, step 2 does not apply to this calculation.

5.3.3 Step 3 - Maximum Allowable Time to Recover an Off-Site Power Source

The PSA currently assumes that when the batteries are depleted after 4 hours of operation, core damage will occur due to the lack of instrumentation. This situation occurs during a SBO with the turbine driven AFW pump operating. This is conservative since recovery of an off-site power source beyond the 4 hours can prevent core damage (assumption 4.2.2). This analysis will use the current 4 hour time in the PSA to recover an off-site power source and initiate AFW suction makeup or OTC. Since secondary cooling using the AFW pump has been successful for this scenario, initiating AFW suction makeup or OTC is not required within the 4 hour time period and, therefore, the entire 4 hour time period is for recovering an off-site power source. The LOOP is the initiating event and corresponds to time T=0, therefore, 240 minutes (4 hours) is the maximum time available to complete all of the operator actions to recover an off-site power source. The maximum time available to recover an off-site power source (Tmax) is:

Tmax = 240 minutes

5.3.4 Step 4 - Post-Diagnosis Actions

Section 5.2.4 identifies the two sets of critical operator actions to restore off-site power to one of the 2400VAC buses via backfeeding through the main transformer to the safeguards bus.

5.3.5 Step 5 - Time Estimates for Control Room Actions

This step estimates the time to complete control room actions, including travel and manipulation time. Simulator exercises were performed that provide the total time to align backfeed. Backfeed was completed within 46 minutes after starting to align backfeed (assumption 4.1.1).

5.3.6 Step 6 - Time Estimates for Outside Control Room Actions

This step estimates the time to complete actions outside the control room, including travel and manipulation time. Simulator exercises were performed that provide the total time to align backfeed. Backfeed was completed within 46 minutes after starting to align backfeed (assumption 4.1.1).

5.3.7 Step 7 - Time Estimates to Complete Post-Diagnosis Actions

Summing the time estimates from steps 5 and 6 provides the total time to complete the post-diagnosis actions. Simulator exercises were performed that provide the total time to align backfeed. The time to complete the backfeed post-diagnosis actions (Tact) is (assumption 4.1.1):

Tact = 46 minutes

5.3.8 Step 8 - Calculate Allowable Diagnosis Time

This step calculates the allowable diagnosis time (Tdiag) by subtracting the time to complete post-diagnosis actions (Tact) from the maximum allowable time (Tmax):

Tdiag = Tmax - Tact = 240 min - 46 min = 194 minutes

5.3.9 Step 9 - Diagnosis HEP

This step estimates the appropriate diagnosis HEP. Figure 8-1, Nominal Diagnosis Model (labeled as Figure 7-1 in the NUREG) identifies that the HEP for 194 minutes is 4.3E-5 (error factor = 30) for the median joint HEP. Table 8-3, Guidelines for Adjusting Nominal Diagnosis HEPs from Table 8-2, is used to determine potential adjustments to make to the median HEP. Backfeed is covered during training, is periodically discussed prior to refueling outages and several licensed operators were surveyed with all indicating they know there is a procedure with general steps to align backfeed. Therefore, the upper bound HEP is not applicable. Aligning backfeed is not a classic event, therefore, the lower bound HEP is not applicable. The resultant median HEP for diagnosis (HEPdiag) is:

HEPdiag = 4.3E-5, error factor 30

5.3.10 Step 10 - Post-Diagnosis HEP

This step assigns HEPs for each independent post-diagnosis task. There are two critical independent tasks (see step 4). Each task is associated with a HEP. Both tasks are critical actions as part of a step-by-step procedure under moderate to low stress (more than 3 hours, with support from TSC). There is no specific Item from Table 8-5 (ref 2.1) that applies. One half of the median HEP for the action In Item 3 (Item 3 used for the 2 hour recovery in Section 5.2.10) is used for this evaluation (assumption 4.2.3). The HEP to complete each task (HEPact) is:

HEPact = .01, error factor 5

In addition, each action will be verified by one of several methods (control room indications, equipment performance, three way communication/observation, etc.). Each action will have an associated recovery factor. Similar to the actions themselves, the verification is a step-by-step verification under moderately high stress, therefore, Item 6 from Table 8-5 (ref 2.1) applies. The median HEP for recovery of each action (HEPrec) is:

HEPrec = .1, error factor 5

The overall HEP for the task (HEPtask) is the product of the action and recovery probabilities:

HEPtask = HEPact * HEPrec

5.3.11 Step 11 - Total HEP

This step estimates the total HEP from the HEPs calculated in steps 9 and 10. The total HEP for aligning backfeed within 4 hours (HEPbackfeed-4) is equal to the sum of the diagnosis and task (including recovery) HEPs:

HEPbackfeed-4 = HEPdiag + HEPtask1 + HEPtask2

The HEPs calculated in steps 9 and 10 are median HEPs. Before the final HEP is calculated, these HEPs need to be converted into means, since the PSA uses mean probabilities. The same methodology as described in Section 5.2.11 is used in this section, refer to Section 5.2.11 for the specific equations.

5.3.11.1 Step 1 - Identify the HEPbackfeed-4 Components

The HEPbackfeed-4 components for 4 hours are the same as identified for 2 hours in Section 5.2.11.1:

HEPdiag
HEPtask1 = HEPact1 * HEPrec1
HEPtask2 = HEPact2 * HEPrec2

5.3.11.2 Step 2 - Calculate the Mean (ln) and Standard Deviation (ln) for each Component

This step calculates the Mean ln(P) and Standard Deviation ln(P) for each component according to the following equations (same as Section 5.2.11.2):

Mean ln(Pdiag) = -10
Mean ln(Ptask1) = -6.9
Mean ln(Ptask2) = -6.9

SD ln(Pdiag) = 4.3
SD ln(Ptask1) = 1.9
SD ln(Ptask2) = 1.9

5.3.11.3 Step 3 - Calculate the Mean and Standard Deviation for each Component

This step calculates the Mean and Standard Deviation for each component according to the following equations (same as Section 5.2.11.3):

Mean (Pdiag) = 3.9E-4
Mean (Ptask1) = 2.6E-3
Mean (Ptask2) = 2.6E-3

SD (Pdiag) = 1.1E-5
SD (Ptask1) = 3.9E-5
SD (Ptask2) = 3.9E-5

5.3.11.4 Step 4 - Calculate the Mean and Standard Deviation for the final HEP

This step calculates the Mean and Standard Deviation for overall HEPbackfeed-4 according to the following equations (same as Section 5.2.11.4):

Mean HEPbackfeed-4 = 5.6E-3

SD HEPbackfeed-4 = 8.9E-5

5.3.12 Step 12 - Add HEP to PSA Model

This step adds HEPbackfeed-4 to the PSA model. This step is not performed in this EA.

5.4 Conservatisms in the HEP Calculations

These HEP and recovery factor results calculated in this EA are conservative for the following reasons:

1) In the first simulator exercise, the crew spent more time than expected trying to recover a DG and AFW pump during the simulator exercise. Most non-recoverable failure modes for the DG or AFW pump are expected to be recognized within 10-20 minutes. The crew spent more than one hour to troubleshoot and determine the DGs and AFW pump to be non-recoverable. This was due to the failure mode identified and lack of proper control room alarms that led the crew to believe that there was a minor, recoverable failure of the DGs and AFW pump. This diverted crew resources away from the available success path of backfeed and OTC. Even though backfeed was identified early in the scenario to be available (Cook Line 1 available), resource priority was placed on recovery of the DG and AFW pump. Backfeed alignment did not start until after DG and AFW pump recovery was determined to be outside the control of the control room. In the second simulator exercise, non-recovery of the DGs occurred earlier, but still about 30 minutes into the event. Again, recognition of the unlikely recovery of the DG under realistic non-recoverable DG failure modes would be expected to occur earlier. Even with this resource distraction, the control room crew aligned backfeed and OTC within the required time frame. Therefore, under realistic scenarios, the control room performance would be expected to align backfeed and initiate OTC sooner than the simulator exercises.

2) As identified in assumption 4.2.2, the PSA currently assumes that if an AC power source is not recovered within the battery depletion time of 4 hours, core damage will occur because of lack of instrumentation. However, there is time available beyond the 4 hours to recover an AC power source and prevent core damage since SG dryout and core damage are not expected to occur immediately after loss of instrumentation. MAAP (ref 2.2) indicates that there is an additional 4 hours beyond battery depletion to recover an AC power source and initiate OTC to prevent core damage. Having more time than the assumed 4 hours results in less stress and more time for the diagnosis. More diagnosis time would result in a lower HEP for diagnosis and, therefore, a lower off-site power recovery factor.

3) The HEP calculations do not credit Technical Support Center support to align backfeed if the control room staff failed to diagnose the need for or experienced difficulty in aligning backfeed. Especially in the 4 hour scenario, the TSC would be fully staffed and able to identify the need for backfeed and provide technical support for any issues during backfeed alignment. Crediting additional recovery factors during the HEP development would reduce the HEP and, therefore, lower the off-site power recovery factor.

4) The simulator primary conditions did not reflect the actual conditions expected following SG dryout. Following SG dryout, the simulator indicated that the PCS pressure and temperature stabilized. In reality, the PCS pressure and temperature would increase until the safety relief valves control the PCS pressure. This would have reset the SIS block and allowed manual or automatic initiation of SIS. During both simulator exercises, the operators attempted to manually initiate SIS following recovery of 1D bus, which would have started the charging and HPSI pumps. However, the simulator conditions did not reset the SIS block and, therefore, manual initiation of SIS was unsuccessful. The crew continued to manually start these pumps and open their discharge valves, which was required prior to opening the PORVs. Therefore, under realistic conditions, the charging and HPSI pumps and their valves would not have needed to be manually opened and the PORVs would have been opened earlier. Opening the PORVs earlier would allow more time for backfeed diagnosis, resulting in a lower diagnosis HEP.

5) The MAAP analyses in reference 2.2 employed conservative assumptions (i.e., degraded HPSI flow). In addition, the MAAP analyses had resulted in peak clad temperatures below 1600F, well below the FSAR accident analysis temperature limit of 2200F. Removing the conservative assumptions and allowing peak clad temperatures to approach the limits would result in a longer time to recover an AC power source. More time to recover an AC power allows more diagnosis time resulting in a lower HEP for diagnosis and, therefore, a lower off-site power recovery factor.

6.0 CONCLUSIONS

This EA conservatively estimated the probability of failing to recover an off-site power source following a digging/excavating event between the plant and the switchyard, which may lead to a LOOP event. The specific scenarios evaluated include SBO without AFW (~2 ½ hours to recover an off-site power source) and a SBO with successful AFW injection/cooling (4 hours to recover an off-site power source). The PSA terms for recovery of an off-site power source within ~2 ½ hours is REC2 and recovery of an off-site power source within 4 hours is REC4. From Section 5.2.11.4, the failure probability for REC2 = 2.3E-2. From Section 5.3.11.4, the failure probability for REC4 = 5.6E-3.

These results are specific to the digging/excavating event causing a LOOP as identified in Attachment A. Even though these results are conservative (Section 5.4), these results should be used in the NRCs Significance Determination Process (SDP) to determine the safety significance of the inadequate digging/excavating policy deficiency identified in the NRC inspection report following the March 25, 2003, LOOP/loss of shutdown cooling event at Palisades.

Attachment A
Scenario for Digging/Excavating

The following table provides a summary of the potential consequences for circuits that were within the conduit that was damaged on March 25, 2003. These consequences are similar to that experienced on March 25, 2003, except that two of three (the third cable does not affect offsite power availability) were conservatively assumed to have damage due to digging/excavating (versus only one damaged cable during the actual event).

Potential Digging/Excavating Consequences
Cables MISC-1/C56-J49A/1, MISC-2/C56-J49A/1 and F01-18/J49-J50/1

Circuit	Description of Consequence
486S-X1	486S-X1 energizes and trips R bus breakers (lockout relay which requires reset prior to closing R bus breakers)
486TT	486TT energizes and energizes primary generator breaker lockout relay 386P and trips the generator breakers (25F7 and 25H9, lockout relay which requires reset prior to closing generator breakers)
386TT	386TT energizes and trips generator breakers (no lockout relay)
486B-X/F	486B-X/F energizes and trips safeguards bus feeder breaker 152-401 (no lockout relay) and initiates fast transfer relays 383-11, 383-11A, 383-12, 383-12A
62C	No manual safeguards transformer load tap changer control capability, automatic function not affected
487/SG	487/SG energizes (due to differential current signal) which energizes 486/SG-P and 486B-P/F resulting in a trip signal to F bus breakers (lockout realty which requires reset prior to closing F bus breakers)
pilot wire	None, relay circuit in series with relay circuit in another, unaffected cable/conduit

Based on the consequences in the table, the following scenario was developed:

1) reactor trips on loss of load because generator breakers 25F7 and 25H9 open due to generator breaker transfer trip relay 386TT and generator breaker backup transfer trip relay 486TT (486TT also energizes primary generator breaker lockout relay 386P)

2) R bus breakers open due to startup transformer differential current lockout relay 486S-X1

3) F bus breakers open due to F bus differential current relay 487/SG (487/SG also energizes safeguards transformer primary lockout relay 486/SG-P and F bus primary lockout relay 486B-P/F)

4) safeguards bus supply breaker 152-401 opens due to safeguards transformer protection auxiliary relay 486B-X/F (486B-X/F also initiates fast transfer relays 383-11, 383-11A, 383-12, 383-12A)

The simulator exercises also included both diesel generators failing to start and the turbine driven auxiliary feedwater pump failing to start. The resulting scenario was a station blackout with no AFW.

EA-PSA-SWY-REC-03-10
Attachment B
EOP Validation of 9-17-03 Simulator Exercise

1. **EOP IDENTIFICATION**

   a. Number EOP-9.0 (Loss of Offsite Power) Revision 16

   b. Title Functional Recovery Procedure

2. **VALIDATION METHOD** (Check one)

   TABLE-TOP ▯ WALK-THROUGH ▯ SIMULATOR ▯

NOTE: Steps 3 through 5 apply only to Simulator Validations.

3. **EVENT INITIATOR**

   a. Major Failure Loss of Offsite Power

   b. Additional Failures Failure of Both Emergency Diesel Generators and P-8B, Steam Driven Auxiliary Feedwater Pump

4. **INITIAL CONDITIONS**

   a. Power Level, % 100%

   b. Time At Power, Hrs Any Time

   c. Pressurizer Pressure, psia Nominal

   d. Pressurizer Level, % Nominal

   e. Steam Generator Level, % Nominal

   f. Steam Generator Pressure, psia Nominal

   g. Boron Concentration, ppm No specific PPM required.

   h. Core Life, MWD/MT EOL

   i. Electric Lineup Normal Other ______

5. **CONTROL SYSTEM STATUS**

a. CVCS

Makeup Mode Normal

Pressurizer Level Control	Auto	✓			Manual	
Number of Charging Pumps Available	1		2		3	✓

Charging Pump Control Status Normal

Letdown	Auto	✓	Manual	
b. Pressurizer Pressure Control	Auto	✓	Manual	

c. Steam Generator Level Control

Number of Feedpumps 2

Feedpump Speed Control	Auto	✓	Manual	
Feed Regulating Valve Control	Auto	✓	Manual	
d. Steam Bypass Control	Auto	✓	Manual	
e. Atmospheric Dump Valves	Auto	✓	Manual	

6. **SCENARIO DESCRIPTION**

Loss of Offsite Power caused by digging. Both Diesel Generators Fail to Start and P-8B trips on overspeed. The following relays will be actuated in the Switchyard: 486B-P/F, 486 S-X1, 486SG-P and the 487-SG. The following Relays will be actuated In the Control Room: 386-P, 386TT. EDGs and P-8B will be unrecoverable, the crew will be informed of this no sooner than 10 minutes after investigating the equipment. There will be a minimum crew of AOs to work with (4).

7. **EXPECTED OPERATOR ACTIONS**

It is expected that the operators will work through the EOPs, restore 2400V busses via Backfeed and then initiate Once-Through-Cooling once power is restored. Other actions consistent with a loss of offsite power are also expected. Operator Actions outside the Control Room have been validated for certain actions. Other actions will be validated at the time by an AO in the plant.

8. **TERMINATION CRITERIA**

When Once-Through-Cooling is initiated.

The times for the following actions will be recorded: EOP-1 complete, Completion of EOP Supplement 22, Entering EOP Supplement 21, Starting Backfeed alignment, Completion of Backfeed alignment, Opening of PORV to initiate OTC

9. **DESIGNATED OBSERVER/REVIEWER(S)**

Robert A. White, George W. Sleeper

Preparation Completed By George W. Sleeper

Date 9/17/03

10.

OPERATOR PARTICIPANTS	QUALIFICATION (SRO, RO, OTHER)
Bernie Benson (SS), SRO	Ron Hudzik (NCO), RO
Todd Mulford (CRS), SRO	
Chad Main (SE), SRO	
Steve Cogswell (NCO), RO	

11. DISCREPANCIES/COMMENTS DURING EVALUATION

The cues given on the failure of the Diesel Generators were not as complete as they could have been causing the crew to spend more time on recovery of the Diesel Generators than they otherwise would have. This is felt to have resulted in a longer time to get to Backfeed and thus a longer time to get to Once-Through-Cooling. See the attached time line of actions taken during the scenario.

Evaluator George W. Sleeper

Date 9/21/03

12. **RESOLUTION OF DISCREPANCIES/COMMENTS**

If this scenario is used again, better cues will be given on the failure of the Diesel Generators.

Resolved By George W. Sleeper Date 9/21/03

Validation Approved/Acceptable: YES ☑ NO ☐ (Check one)

Operations Technical Supervisor ________________ Date ________

EOP Validation Times	
Task	**Times**
Performance of EOP Supplement 22	30 minutes [1]
Backfeed using EOP Supp. 29(Use 20 minutes for time to open the MOD)	45 minutes [1]
Supplement 28 section 1 except purging with C02 IAW SOP-8	5 minutes [1]
Supplement 28 section 2	10 minutes [1]
Supplement 28 section 3	10 minutes
Troubleshoot Emergency Diesel Generators	>10 minutes
Troubleshoot P-8B, Steam Driven Auxiliary Feedwater Pump	>10 minutes
EOP Supp. 24 Preliminary Actions (Remove Fuses)	15 minutes
EOP Supp. 24 Subsequent Actions (CCW and SW)	5 minutes each
[1] Previously Validated	

Operator Cues	
Action	**Cue**
EDG Trouble	Low Jacket Water Pressure Alarm #15 and Low Lube Oil Pressure #3 and Engine Trouble. Investigating. After more than 10 minutes explain that there appears to be a loss of Jacket water pressure and Lube Oil Pressure believe the pumps are bad.
P-8B Trip Investigation	Pump tripped on Overspeed and cannot be reset. Will continue to try and reset. Mechanism is loose.
Loss of 'F' and 'R' Busses	If asked as power control what the status of switchyard, respond that there are no problems on the grid and Power Control would like to investigate before resetting switchyard relays.

Scenario Time Line	
Time	Action
1451	Scenario Starts
1453*	Loss of Offsite Power, Turbine and Reactor Trip
1454	Report that D.G.s did not start. Attempted to manually start D.G.s
1455	Vital Area Door Keys obtained to distribute to the AOs
1456	CRS Briefs AO about troubleshooting D.G.s
1458	Report of no AFW. S/G levels –40% and lowering
1458	EOP-1 Verbal Verifications Start
1458	ENS Called to report to the Switchyard
1505	SEP Announcement and Siren
1506	EOP-1 Verbal Verifications Done
1506	AO Reports back on initial D.G. Troubleshooting
1507	SROs hold discussion on going to EOP-9.0
1508	AO Briefed on making initial SEP notifications
1509	Crew Brief
1510	Crew notes Cook Line #1 Available for use in Backfeeding
1511	End of Brief
1518	AO Reports status of P-8B, Steam Driven Auxiliary Feedwater Pump
1520	S/G Blowdowns Isolated
1523	SS Relieved of SED duties
1525	AO Briefed on performing EOP Supplement 19 for P-8B
1531	Crew Brief
1533	End of Brief
1536	EOP Supplement 24 Thermal Hydraulic Actions started
1550	Additional D.G. 1-1 Start Attempt made
1552	D.G. 1-1 reported not available
1554*	Starting to set up for Backfeed
1555	Briefed AO on additional 1-2 D.G. Start Attempt
1559	1-2 D.G. Start Attempt failed
1603	1-2 D.G. reported not available
1607	AO Told to make preparations for opening MOD-389
1610	ENS Reports relays that are actuated in the Switchyard
1611	AO Asked to check Transformers per EOP Supplement 29
1614	AO sent to open MOD-389
1634	MOD-389 open
1638*	'D' Bus energized off of Backfeed
1641	Started P-7A Service Water Pump
1642	Started P-52B CCW Pump
1642*	Started P-66A, HPSI Pump
1644	Opening Valve for Right Train HPSI
1645	AO Sent to place Battery Chargers 2 and 3 in-service per SOP-30.
1647*	Start two charging pumps (P-55A&B)
1647*	First PORV Open
1649	Battery Chargers 2 and 3 place in service
1658*	'C' Bus Reenergized
1700*	Started P-66B, HPSI Pump
1701*	Start third charging pump (P-55C)
1702*	Second PORV opened

* Critical times used in the HEP calculation. The exact times for these tasks are: 14:53:36; 15:54:00; 16:38:09; 16:42:08; 16:46:50; 16:47:41; 16:58:00; 17:00:00; 17:01:25; 17:02:23

EOP Validation of 9-26-03 Simulator Exercise

1. **EOP IDENTIFICATION**

   a. Number EOP-9.0 (Loss of Offsite Power) Revision 16

   b. Title Functional Recovery Procedure

2. **VALIDATION METHOD** (Check one)

   TABLE-TOP ☐ WALK-THROUGH ☐ SIMULATOR ☐

NOTE: Steps 3 through 5 apply only to Simulator Validations.

3. **EVENT INITIATOR**

   a. Major Failure Loss of Offsite Power

   b. Additional Failures Failure of Both Emergency Diesel Generators and P-8B, Steam Driven Auxiliary Feedwater Pump

4. **INITIAL CONDITIONS**

   a. Power Level, % 100%

   b. Time At Power, Hrs Any Time

   c. Pressurizer Pressure, psia Nominal

   d. Pressurizer Level, % Nominal

   e. Steam Generator Level, % Nominal

   f. Steam Generator Pressure, psia Nominal

   g. Boron Concentration, ppm No specific PPM required.

   h. Core Life, MWD/MT EOL

   i. Electric Lineup Normal Other

5. **CONTROL SYSTEM STATUS**

a. CVCS

Makeup Mode Normal

Pressurizer Level Control	Auto ✓		Manual ___	
Number of Charging Pumps Available	1 ___	2 ___	3 ✓	

Charging Pump Control Status Normal

Letdown	Auto ✓	Manual ___
b. Pressurizer Pressure Control	Auto ✓	Manual ___

c. Steam Generator Level Control

Number of Feedpumps 2

Feedpump Speed Control	Auto ✓	Manual ___
Feed Regulating Valve Control	Auto ✓	Manual ___
d. Steam Bypass Control	Auto ✓	Manual ___
e. Atmospheric Dump Valves	Auto ✓	Manual ___

6. **SCENARIO DESCRIPTION**

Loss of Offsite Power caused by digging.. Both Diesel Generators Fail to Start and P-8B trips on overspeed. The following relays will be actuated in the Switchyard: 486B-P/F, 486 S-X1, 486SG-P and the 487-SG. The following Relays will be actuated In the Control Room: 386-P, 386TT. EDGs and P-8B will be unrecoverable, the crew will be informed of this no sooner than 10 minutes after investigating the equipment. There will be a minimum crew of AOs to work with (4).

7. **EXPECTED OPERATOR ACTIONS**

It is expected that the operators will work through the EOPs, restore 2400V busses via Backfeed and then initiate Once-Through-Cooling once power is restored. Other actions consistent with a loss of offsite power are also expected. Operator Actions outside the Control Room have been validated for certain actions. Other actions will be validated at the time by an AO in the plant.

8. **TERMINATION CRITERIA**

When Once-Through-Cooling is initiated.

The times for the following actions will be recorded: EOP-1 complete, Completion of EOP Supplement 22, Entering EOP Supplement 21, Starting Backfeed alignment, Completion of Backfeed alignment, Opening of PORV to initiate OTC

9. **DESIGNATED OBSERVER/REVIEWER(S)**

Robert A. White, George W. Sleeper

Preparation Completed By George W. Sleeper Date 9/26/03

10. **OPERATOR PARTICIPANTS** | **QUALIFICATION (SRO, RO, OTHER)**

OPERATOR PARTICIPANTS	QUALIFICATION (SRO, RO, OTHER)
Bruce Bauer (SS), SRO	Randy Dopp (NCO), RO
Paul Adams (CRS), SRO	
Mike Lee (SE), SRO	
George Stieber (NCO), RO	

11. **DISCREPANCIES/COMMENTS DURING EVALUATION**

No major discrepancies noted. The simulator still does not model this event once the Steam Generators are dry. The crew had to manually operate each piece of equipment for Safety Injection instead of pushing the manual initiate pushbuttons.

Evaluator George W. Sleeper Date 9/26/03

12. **RESOLUTION OF DISCREPANCIES/COMMENTS**

The Simulator Support Group is aware of the modeling problem.

EOP-1.0 was complete 17 minutes after the trip. Relays from EOP Supplement 22 were reported to the Control Room via phone at 54 minutes. EOP Supplement 21 was referred to 57 minutes after the trip. EOP Supplement 29 (Backfeed) was started at 35 minutes post trip. Bus 1D was re-energized 80 min. post trip. Once-Through-Cooling was established on both trains 91 minutes after the trip.

Resolved By George W. Sleeper Date 9/26/03

Validation Approved/Acceptable: YES ☑ NO ☐ (Check one)

Operations Technical Supervisor ____________________ Date ________

EOP Validation Times if needed for scenario	
Task	**Times**
Performance of EOP Supplement 22	30 minutes [1]
Backfeed using EOP Supp. 29(Use 10 minutes for time to open the MOD)	25 minutes [1]
Supplement 28 section 1 except purging with C02 IAW SOP-8	5 minutes [1]
Supplement 28 section 2	10 minutes [1]
Supplement 28 section 3	10 minutes
Troubleshoot Emergency Diesel Generators	>10 minutes
Troubleshoot P-8B, Steam Driven Auxiliary Feedwater Pump	>10 minutes
EOP Supp. 24 Preliminary Actions (Remove Fuses)	15 minutes
EOP Supp. 24 Subsequent Actions (CCW and SW)	5 minutes each
[1] Previously Validated	

Operator Cues	
Action	**Cue**
EDG Trouble	Low Jacket Water Pressure Alarm #15 and Low Lube Oil Pressure #3 and Engine Trouble. Investigating. After more than 10 minutes explain that there appears to be a loss of Jacket water pressure and Lube Oil Pressure believe the pumps are bad.
P-8B Trip Investigation	Pump tripped on Overspeed and cannot be reset. Will continue to try and reset. Mechanism is loose.
Loss of 'F' and 'R' Busses	If asked as power control what the status of switchyard, respond that there are no problems on the grid and Power Control would like to investigate before resetting switchyard relays.

Scenario Observed Time Line	
Time	**Action**
0810	Scenario Starts
0817*	Loss of Offsite Power, Turbine and Reactor Trip
0817	P.A. announcement for Reactor Trip and all AOs to the Control Room
0818	Both Diesel Generators Trip. 'C' and 'D' Busses de-energize
0819	CRS Briefs AO about troubleshooting D.G.s
0820	AO returns to get vital area door keys
0821	Manual Control of the ADVs taken and MSIVs closed
0822	P.A. announcement on Alert
0822	AO Calls back on Diesel Generator Alarms
0823	Siren Sounded
0824	AO directed to trip Overspeed mechanism on both Emergency Diesel Generators
0825	Report of no Aux Feed. P-8B running but no flow
0825	EOP-1 Verbal Verifications start
0826	Both Diesel Generator Overspeed Mechanisms reported tripped
0827	2nd P.A. announcement for the Alert
0830	Simulated first notifications for the Alert
0834	EOP-1 Verbal Verifications complete
0835	S/G levels reported at –56%
0836	Crew Brief for EOP-9.0. Priorities are AFW and Electrical
0838	End of Crew Brief
0838	AO Briefed on investigation of P-8B problem.
0839	Handswitches for CV-1064 and CV-1065 closed
0841	P.A. announcement for Site Area Emergency
0842	AO reports status of P-8B
0843	AO Briefed on communications for Site Area Emergency
0844	Report that Cook #1 is available. SROs discuss going right to Backfeed
0847	AO briefed for performance of EOP Supplements 7 and 8 and Supplement 22
0848	SED Turnover started
0848	Crew Brief
0852	SED Completes turnover
0852*	AO Briefed on Backfeed
0858	AO reports P-8B Overspeed won't reset
0859	Battery discharge limits reported OK
0905	AO briefed on Supplement 28
0907	Supplement 34 complete
0911	Relays from EOP Supplement 22 reported back by phone
0914	NCO reports per EOP Supplement 21 and relays actuated Front and Rear Bus are not available
0918	AO sent to check relay 186-1
0923	AO directed to start opening MOD-389
0933	MOD-389 Open
0935	Relay 386-P Reset
0937*	Bus 1D Re-energized
0941	P-7C Service Water Pump Started
0942*	'C' Bus Re-energized
0943*	Tried to manually initiate SIS it did not work because PCS pressure was already below 1605 psia
0947	Both PORV Block Valves Open
0948*	Both PORVs opened

* Critical times used in the HEP calculation. The exact times for these tasks are: 08:17:14; 08:51:48; 08:37:40; 08:41:57; 08:43:46; 08:43:09

PALISADES - NUCLEAR GENERATING PLANT		
TITLE:	ENGINEERING PRE-JOB BRIEFING	Revision Draft
		Page 1 of 2

Type of Task: Prepare Engineering Analysis EA-PSA-SWY-REC-03-10, Probability of Failing to Recover an AC Power Source Following a LOOP Event Caused by Digging/Excavating, in accordance with Admin Procedure 9.11, Engineering Analysis.	Date:	9-15-03
	Time:	1530
	Assigned To:	RAW

Task Description:
Calculate the probability of failing to recover an AC power source following a digging/excavating event between the plant and the switchyard which may lead to a loss of off-site power (LOOP) event.

Objectives/ Expectations:
Calculate fail to recover an AC power source probabilities for station blackout (SBO) events with and without auxiliary feedwater (AFW) available. Use the time frames from EA-PSA-LOSDC-03-11 for these scenarios. The results of this EA will be used in the NRCs Significance Determination Process (SDP) to determine the safety significance of the inadequate digging/excavating policy deficiency resulting from the March 25, 2003, LOOP/loss of shutdown cooling event at Palisades.

CHECKLIST

X Scope/expectations understood	X Reqd Information in Hand	KEY STRATEGIES TO PREVENT GROUP THINK
X Documentation format reqmts clear	☐Applicable directives reviewed	1. Open Climate
X Validation reqmts for data clear	☐Contingency Plans discussed	2. Avoid Isolation of Group
X Communication reqmts clear	X Approp Engineering tools used	3. Assign member Role of critical evaluator
X Reqd completion date/time clear	X Approp groups involved	4. Avoid being too directive
X Approp time included for checking	X Lateral Communications occurring	EIGHT SYMPTOMS OF GROUP THINK
X Knowledge/Skills/Training approp	X Task sched to minimize fatigue	1. Illusion of invulnerability 5. Rationalization
X Time pressure minimized	X Questioning attitude emphasized	2. Belief in inherent morality 6. Mind Guards
X Distractions minimized	☐Operating Experience Considered (list above)	3. Stereotypes of out Groups 7. Self Censorship
		4. Illusion of Unanimity 8. Direct Pressure

Estimated Time to Complete: 2 weeks	Due Date/Time: 9-26-03/1200 hrs

TWIN ANALYSIS

Task Demands	Work Environment	Individual Capabilities	Human Nature
X Time/Schedule pressure	X Distractions / Interruptions	X Unfamiliarity with task / First time	☐Stress - Work/Home
X High Workload	☐Changes from routine	☐Lack of Knowledge	☐Habit patterns
X Multiple simultaneous tasks	☐Confusing displays / Controls	X New techniques not used before	X Assumptions
☐Repetitive Actions / monotony	☐Work arounds / OOS equipt	☐Imprecise communications habits	☐Complacence
☐Unrecoverable/Irreversible actions	☐Hidden system responses	☐Lack of Proficiency / Inexperience	X Overconfidence
☐Interpretation requirements	☐Unexpected equip conditions	☐Unsystematic problem solving skills	X Mind Set
☐Unclear goals, roles, responsibilities	☐Lack of alternative indication	☐"Unsafe" attitude for critical tasks	X Inaccurate risk perceptions
☐Lack of /or unclear Standards	☐Adverse physical conditions	☐Illness / Fatigue / General Health	X Mental shortcuts
	☐Vague or incorrect guidance		☐Limited short term memory
	☐Identical and adjacent controls		☐Apparent emotional health
			☐Backshift/recent shift change
			☐First day back from days off

Describe the Risk Basis: (1. Factors that increase the likelihood of making a mistake and 2. Worsen the consequences of an error). Schedule/time pressure Infrequently performed tasks Calculating HEPs can be subjective			
What are the Critical Steps? Identifying the correct references/methodology Clearly stating assumptions with justification and/or impact on conclusions Use Applied Reliability Engineering to discuss critical interpretations of the HEP methodology Provide clear documentation for possible NRC review Discuss conservatisms in the analysis		1. Critical Safety Issues 2. Operability Concerns 3. When and who to call for help. 4. Contingency Plans 5. Important Error Reduction Tools for this Task	
Activity Performer:	RAWhite RAW	Date:	9-15-03
Supervisor:	JBKingseed JBK	Date:	9-15-03

PALISADES NUCLEAR PLANT
ENGINEERING ANALYSIS CHECKLIST

EA-PSA-SWY-REC-03-10 REV 0

SECTION I Identification of Items Affected By This EA		Affected Yes	Affected No	Revision Required	Identify*	Closeout
1.0	Other EAs	☐	■			
2.0	Design Documents Electrical E-38 through E-49	☐	■			
3.0	Design Documents Mechanical M240 - M246, M257 - M261, M664 - M666, M1600	☐	■			
4.0	LICENSING DOCUMENTS					
4.1	Final Safety Analysis Report (FSAR)	☐	■			
4.2	Technical Specifications	☐	■			
4.3	Operating Requirements Manual	☐	■			
5.0	PROCEDURES					
5.1	Administrative Procedures	☐	■			
5.2	Operating Procedures (SOP, EOP, ONP, etc)	☐	■			
5.3	Working Procedures	☐	■			
5.4	Tech Spec Surveillance Test Procedures	☐	■			
6.0	OTHER DOCUMENTS					
6.1	Q-List	☐	■			
6.2	Plant Drawings	☐	■			
6.3	Equipment Data Base	☐	■			
6.4	Spare Parts (Stock/MMS)	☐	■			
6.5	Fire Protection Program Report (FPPR)	☐	■			
6.6	Design Basis Documents	☐	■			
6.7	Operating Checklists	☐	■			
6.8	SPCC/PIPP Oil and Hazardous Material Spill Prevention Plan	☐	■			
6.9	EEQ Documents	☐	■			
6.10	MOV/AOV Program Documents (Voltage, thrust, weak link, etc)	☐	■			
6.11	Engineering Programs, Component Engineering Documents	☐	■			
6.12	Work Instructions	☐	■			
6.13	Other	☐	■			

* Identify Section No., Drawing, Document, etc

SECTION II

Do any of the following documents need to be generated?

		Yes	No		
1.	Corrective Action Document?	☐	■	Reference	
2.	50.59 Review?	☐	■	Reference	EA's that are not used in the FSAR Analysis and do not involve the designbasis of a system, structure or component do not require a 50.59 Review per Admin 9.11, r14, pg 21
3.	Verification Test Procedure (for changes to the Design Basis)?	☐	■	Reference	

Completed by RAWhite *[signature]* Date 9-24-03

Technical Reviewed by BABrogan *[signature]* Date 9-29-03

TECHNICAL REVIEW CHECKLIST

EA-PSA-SWY-REC-03-10 REV 0

This checklist provides guidance for the review of engineering analyses. Answer questions Yes or No, or N/A if they do not apply. Document all comments on an EA Review Sheet. Satisfactory resolution of comments and completion of this checklist is noted by the Technical Review signature at the bottom of this sheet.

		(Y, N, N/A)
1.	Have the proper input codes, standards and design principles been specified?	Y
2.	Have the input codes, standards and design principles been properly applied?	Y
3.	Are all inputs and assumptions valid and the basis for their use documented?	Y
4.	Is Vendor information used as input addressed correctly in the analysis?	N/A
5.	If the analysis argument departs from Vendor Information/ Recommendations, is the departure justification documented?	N/A
6.	Are assumptions accurately described and reasonable?	Y
7.	Are the design basis changes permitted by this EA bounded by the applicable 50.59 Review?	N/A
8.	Are all constants, variables and formulas correct and properly applied?	Y
9.	Have all comments been documented on an EA Review Sheet and resolved, or have any minor (insignificant) errors been identified and their insignificance justified? (Indicate "No Comments," if none were made.)	Y
10.	If the analysis involves welding, is the following information accurately represented on the analysis drawing (Output document)? • Type of Weld • Size of Weld • Material Being Joined • Thickness of Material Being Joined • Location of Weld(s) • Appropriate Weld Symbology	N/A
11.	Has the objective of the analysis been met?	Y
12.	Have administrative requirements such as numbering, format, and indexing been satisfied?	Y

Technical Reviewer BABrogan [signature] Date 9-29-03

ENGINEERING ANALYSIS REVIEW SHEET

Title Probability of Failing to Recover an AC Power Source Following a LOOP Event Caused by Digging/Excavating	EA Number EA-PSA-SWY-REC-03-10	Revision Number 0	Page 1 of 1

Item Number	Page,Line,or Section Number	Comments	Response or Resolution
1	General	Clarify that the specific scenario is a disconnection between the plant and the switchyard, off-site power to the switchyard was not and is not expected to be lost.	Clarified the LOOP and recovery terms in the definitions section.
2	5.3.3	Use the latest results from EA-PSA-LOSDC-03-11.	Incorporated the latest results.
3	5.8	Discuss the conservatisms in the MAAP analyses (HPSI pump degraded flow, results ~1600F, etc.).	Added discussion of MAAP conservatisms.

Technical Reviewer	Organization	Date	Initiator	Date	Technical Reviewer or Supervisor	Date
BABrogan	Eng Programs	9-24-03	RAWhite [signature]	9-26-03	BABrogan [signature]	9-29-03

Engineering Analysis Placekeeping Tool

1/10/03

Ref: Admin Proc 9.11, "Engineering Analysis" - EA-PSA-RI-ISI-03-01

Section	Y or N/A	Task
Need Identified for Engineering Analysis		
6.1.1	Y	Reason identified for engineering analysis
Assign Engineering Analysis Initiator		
6.1.2	Y	Initiating engineer assigned
6.1.2	Y	Supervisor initials "Initiator Approved By" box on analysis cover sheet
4.4	Y	Responsible engineer assigned
	Y	Pre-job brief performed
Access Record Management System		
4.2	Y	Identify existing design information relative to the Engineering Analysis
4.2	Y	Identify analysis inputs
4.2	N/A	Verify that analysis inputs are consistent with the Design Basis
4.2	Y	Identify document(s) affected by the engineering analysis
4.2	N/A	Notify the sponsor of the affected document(s)
6.1.3	N/A	Search RECTRAK for existing analyses relevant to the subject of the analysis to be prepared
6.1.3	N/A	Search CalcXRef to identify any other documents which may provide input to the analysis to be prepared or use the results of the analysis
Revise Existing Engineering Analysis		
6.1.5	N/A	Identify if revision to an existing analysis is necessary
6.1.5.a	N/A	Identify method of revision
		Yes / No
		(1) Revision to a microfilmed analysis
		(2) Revision to an original analysis
		(3) Revision to an electronic file
6.1.5.b	N/A	Identify and describe changes in the revised engineering analysis
6.1.5.d	Y	Determine whether the revision impacts a stress/serial package. If so, refer to EM-18-03.
6.1.5.c	N/A	If an existing analysis bounds the situation in question and does not require revision, prepare a disposition and link to the existing calculation
Prepare New Engineering Analysis		
6.1.4.c	Y	Engineering analysis number selected
6.1.4.d	Y	Engineering analysis title selected
6.2.3	Y	Prepare EA Checklist
6.2.4	N/A	Perform Walkdown
6.1.4.d.1	Y	Each sheet of engineering analysis uniquely numbered
6.1.4.d.1	Y	Total number of sheets indicated on cover sheet
6.1.4.d.2(a)	Y	Prepare objective statement
6.1.4.d.2(b)	Y	Identify analysis inputs
6.1.4.d.2(c)	Y	State assumptions and reference them where they are used in the analysis
6.1.4.d.2(c) (1)	Y	Identify major assumptions and their bases
6.1.4.d.2(c) (2)	Y	Identify minor assumptions and their bases
6.1.4.d.2(d)	Y	Prepare analysis section
6.1.4.d.2(d) (1)	Y	Document result of reference searches and their applicability to the analysis
6.1.4.d.2(d) (2)	Y	Describe the methodology used
6.1.4.d.2(d) (3)	Y	Discuss each aspect of the problem
6.1.4.d.2(d) (4)	N/A	Identify impact of analysis on test requirements
6.1.4.d.2(d) (5)	N/A	Consider the effects of system degradation over time on design margins
6.1.4.d.2(d) (6)	N/A	Ensure that computer codes used for design are controlled by Admin 9.14
6.1.4.d.2(d) (7)	Y	Identify the Basis of any engineering judgment

Engineering Analysis Placekeeping Tool

1/10/03

6.1.4.d.2(d) (8)	Y	Verify that calculated values are within allowable ranges
6.1.4.d.2(d) (9)	Y	Identify as a reference the source of equations used in the analysis
6.1.4.d.2(d)(10)	Y	Describe formulas used in analysis and provide units for calculated values.
6.1.4.d.2(d)	Y	Prepare a conclusion
6.1.4.d.2(d)	Y	Verify that the conclusion supports the stated objective
6.1.4.d.2(d)	N/A	Consider writing a condition report if the conclusion does not support the stated objective
4.4	N/A	If the Engineering Analysis is generated by a vendor, ensure that it conforms to Administrative Procedure 9.11 requirements
4.4	N/A	If there are any changes to piping systems, coordinate with the Piping and Stress Package Custodian
Technical Requirements		
6.2.1	N/A	Prepare 50.59 Review
6.2.2	N/A	Prepare EEQ Review
6.1.4.d.2(f)(1)	Y	Attach EA Checklist
6.1.4.d.2(f)(5)	N/A	Attach Preliminary EA item list (Section 6.2.5)
6.1.4.d.2(f)(6)	N/A	Attach 50.59 Review (Section 6.2.1)
6.1.4.d.2(f)(7)	N/A	Attach EEQ Review (Section 6.2.2)
Perform Required Reviews		
4.1	Y	Supervisory review performed
4.1, 6.3.1	Y	Technical reviewer assigned by Safety/Design Review Supervisor
6.3.2	Y	Technical Reviewer performs technical review
4.3	Y	Technical Reviewer verifies that the affected documents are properly identified
6.3.3	Y	Technical Reviewer documents review comments
6.3.4	Y	Technical Reviewer prepares technical review checklist
6.3.6	N/A	Safety Design/Review approval required if reviewed by vendor
Resolve Review Comments		
6.3.3	Y	Resolve comments
6.1.4.d.2(f)(2)	Y	Attach Technical Review Checklist and EA Checklist
6.1.4.d.2(f)(3)	Y	Attach EA Review Sheets
6.1.4.d.2(f)(4)	N/A	Attach technical review standard design evaluation or alternate calculations (Section 6.3.2a)
Calculation Approved		
6.3.5	Y	Obtain all necessary approvals
Complete Record Indexing Form & Submit to ERC		
6.4	Y	Prepare Record Indexing Form and attach to front of calculation
6.4	Y	Forward analysis to ERC or PSPC

ATTACHMENT 4

NUCLEAR MANAGEMENT COMPANY, LLC
PALISADES NUCLEAR PLANT
DOCKET 50-255

October 28, 2003

INDEPENDENT REVIEW AND REANALYSIS OF LOSS OF OFFSITE POWER INITIATING EVENT FREQUENCY FOR PALISADES NUCLEAR PLANT

41 Pages Follow

INDEPENDENT REVIEW AND REANALYSIS OF LOSS OF OFFSITE POWER INITIATING EVENT FREQUENCY FOR PALISADES NUCLEAR PLANT

FINAL REPORT
REVISION 1

Prepared for:

NUCLEAR MANAGEMENT COMPANY LLC
PALISADES NUCLEAR PLANT
PALISADES, MICHIGAN

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October 20, 2003

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5. ....REFERENCES 5-1

1. INTRODUCTION

The purpose of this report is to document the results of a study that was performed for the Palisades Nuclear Power plant. The purpose of the study is to evaluate the frequency of maintenance induced loss of offsite power (LOOP) initiating events in light of a recent event that occurred at the plant that resulted in an offsite power interrupt to key safety and non-safety related buses.

1.1 OBJECTIVES

The objectives of this project are to:

- Perform an independent review of a calculation performed by the Palisades PRA team [1] to evaluate the frequency of loss of offsite power (LOOP) initiating events in light of a recent event that occurred on March 25, 2003
- Perform additional calculations to resolve any technical issues resulting from this review in order to develop an appropriate prior distribution for use in Bayes' updating for maintenance induced LOOP initiating event frequency and in order to preserve the plant to plant variability in the industry data

1.2 SCOPE OF WORK

The scope of work for this study includes technical review of an existing calculation [1], [2] on the Bayes' uncertainty analysis of loss of offsite power initiating event frequency for Palisades in light of a recent occurrence in which power interruption to both safety and non safety related buses occurred. Technical comments from this review are documented in Section 2.

Using data provided by NMC Co. which has been screened for applicability to Palisades, a calculation was performed to construct an appropriate prior distribution for use in a Bayes' update for a plant specific uncertainty distribution for loss of offsite power initiating events. The methodology that was used is referred to as the "Two Stage Bayes" Update Procedure which is well documented as an acceptable process for this application. This calculation starts with a non-informative generic prior distribution and will include a series of separate Bayes' updates for each site in the generic database [3] excluding the Palisades data. Then, a posterior weighting technique is used to synthesize a single plant to plant variability distribution which includes input from each of the separate site distributions in a manner that preserves the plant to plant variability.

The calculations will be done using Excel and @RISK and are documented in a manner that permits future applications and updates at Palisades. These calculations include the second stage Bayes' update using plant specific evidence from Palisades which serve as an independent check on the analysis performed by the Palisades PRA team. These calculations are documented in Section 3. A justification for this approach is also provided in Section 3 for use in deliberations with the NRC staff to determine the appropriate risk significance determination for this event. Conclusions from this evaluation are provided in Section 4.

1.3 STATEMENT OF INDEPENDENCE AND QUALIFICATIONS

This report was prepared by Karl N. Fleming who is qualified to perform this work. Mr. Fleming was invited to perform this work after the calculation in question was prepared and had absolutely no involvement in that work or calculations. Mr. Fleming has no conflict of interest in the performance of this work. Hence this can be regarded as an independent review and reanalysis of technical issues associated with the estimation of LOOP initiating event frequencies at Palisades in light of the recent event on March 25, 2003.

1.4 REPORT VERSION

This version of the report, Revision 1 incorporates comments from an independent review an earlier version of this report provided in Reference [10] and documents the fact that this author is in full agreement with the comments made and conclusions drawn in that review.

2. REVIEW OF CALCULATION DOCUMENTED IN REFERENCE [1]

The following comments arise from an independent review of Reference [1] as well as some of the supporting documents.

Comment 1 - Data Screening

The process of screening the individual LOOP events in the generic data base for applicability to Palisades is both necessary and reasonable and corresponds with standard PRA practice. This reviewer lacks the detailed knowledge on the specifics of the Palisades plant to be able to judge whether any event that was screened out or left in is correct, but the level of screening appears to be reasonable. The reviewer cautions that when screening each event, consideration be given to whether any screened out event belongs to a general category of events that could occur at Palisades, in which case it should be not screened. Any event may have specific details that appear not to be applicable so one must not be too myopic in performing this step.

Comment 2 - Choice of Distribution

In constructing the generic prior the selection of the gamma distribution is a reasonable choice. The lognormal distribution would also be a reasonable choice. It is well known in Bayes' updating that when selecting the prior the three most important factors are the selection of an appropriate shape (unimodal vs. bimodal, symmetric vs. skewed, etc), and selection of the first two moments: the mean and the variance or standard deviation. This principle also carries through when uncertainty distributions are propagated through the model to quantify uncertainties in CDF or LERF.

Comment 3 - Omission of Plant To Plant Variability

An issue which is explored more fully in Section 3 is that the plant to plant variability in the generic data has not been taken into account. The fitting of the gamma distribution appears to be with respect to the industry mean frequency of LOOP and the plant to plant variability about this mean is not really addressed. This has resulted in an extremely narrow prior distribution. The range of the gamma distribution that was developed for the Bayes prior defined by that between the 5th percentile and the 95th percentile is [.013 to .028] and this range does not capture the point estimate of the plant specific evidence (1/32 = .031)! Whenever the point estimate of the plant specific evidence falls outside this range the selection of the prior should be scrutinized. This in turn places undue weight on the generic evidence in the Bayes update calculations in comparison with the case in which a broader distribution is selected. The reason for this is that, according to the procedure for generic data analysis in Reference [2], the data that was fit to the gamma distribution was the year to year variability in the industry average LOOP data. The plant to plant variability in this data was not taken into account and in effect was "averaged out of the process". In the calculation, some comparisons are made with the year to year variability in the data but again the metric that is varied is the average frequency across the industry in each year of the data. The industry LOOP data includes data from 72 sites and about 100 reactor units. Some of these units and sites have experienced multiple LOOP events, others have experienced a single LOOP event, and a sizable fraction have never experienced a LOOP event. Hence on the surface there appears to be some plant to plant variability in the LOOP frequency. Although the calculation followed the process described in the data analysis procedure [2] correctly, the procedure is deficient in that plant to plant variability is ignored. This appears to be a systematic deficiency in the procedure that will predictably result in prior distributions that are too narrow.

The inclusion of plant to plant variability is known to yield a broader prior distribution when statistically significant variations in plant performance are evident in the industry data. Such variability has been ignored and hence has been effectively averaged out of the process described in the procedure. A broader prior distribution reduces the influence of the prior in the Bayes' updating process as will be shown in Section 3. This makes the plant specific experience more important so that conclusions reached in Reference [1] as to the small change in LOOP frequency brought about by the evidence added by the March 25, 2003 event are suspect. A final conclusion on this issue is reached in Section 4 which benefits from the results of Section 3.

Comment 4 - Use of Data from Multiunit Sites.

In analyzing the data from specific plants, the industry data should not be analyzed as though they come from a set of independent reactor units. The 100 or so reactor units cover 72 sites. For most of the sites the multiple reactor units would be expected to have a highly correlated LOOP frequency across the units within a given site for three reasons. One is that there are common cause LOOP events, i.e. two or more units have a LOOP on the same site at the same time due to a dependent cause. The second is that in many cases (except for example Indian Point, Millstone, Nine Mile Point and ANO) the multiple units are identical units, run by the same utility company and integrated operating staff, or both. The third and the one that explains the reason for the first is that many multiunit sites have an interconnected switchyard and electric distribution system. Hence it is better to analyze the generic data in terms of sites rather than independent reactor units. For example, there were two screened in events involving maintenance induced LOOP at Beaver Valley that constituted a dual unit loss of offsite power event and this should be counted as a single event because if the cause had occurred at Palisades, only one LOOP event would have resulted.

Comment 5 Data Screening Inconsistency

There is an inconsistency in the arguments to, on the one hand, screen out the pre-1980 data in the generic database because it is no longer relevant, and on the other hand, retain the pre-1980 Palisades operating experience as being relevant to the Bayes' update. This inconsistency may bias the results in favor of lower LOOP frequency at Palisades depending on the nature the pre-1980 LOOP data which was excluded. This inconsistency is amplified by the further arguments in Reference [1] that are used to exclude the LOOP events at Palisades experienced before 1980 because of the corrective actions and design changes. While the argument to exclude the failures due to design changes is reasonable, this argument raises equally valid reasons to exclude the corresponding experience data period. Hence neither the failures nor the operating experience prior to 1980 should be used in the Bayes' update for Palisades.

Comment 6 Use of Bayes Estimates In Risk Signficance Determination

The author concurs with the use of a Bayes approach to address the risk significance determination of the March 25, 2003 event. A discussion of this and alternative frequentist based approaches is provided at the end of Section 3.

Comment 7 Frequency Basis of Initiating Event Frequencies

The reactor year exposure data developed from the EPRI Report [3] is on a reactor calendar year basis. However, LOOP events that occurred during non-full power operating modes were screened out of the initiating event frequency calculations. Hence the plant availability in the generic evidence was implicitly taken into account as LOOP events during non full power modes was screened out. Hence when applying this data to development of priors for future LOOP frequencies at Palisades, differences between future Palisades availability and historical industry availabilities are not taken into account. However this discrepancy is expected to be small in relation to the magnitude of the plant to plant variability in LOOP frequency and hence is not of concern. The LOOP frequencies calculated in Reference [1] and in this study appropriately account for plant availability and hence will support PRA estimates of CDF and LERF that will be on a reactor calendar year basis and consistent with this authors interpretation of the ASME PRA Standard (IE-C2).

3. DERIVATION OF PRIORS WITH PLANT TO PLANT VARIABILITY

3.1 TWO STAGE BAYES UPDATE PROCEDURE

The methodology used to develop priors with plant to plant variability is the first part of what is referred to as Two Stage Bayes' Updating [4]. The first stage starts with an assumed prior distribution on the parameter in question which is normally selected to be a non-informative prior. The industry data for the parameter is then organized by plant or site. For initiating event frequency calculations the relevant data is the number of events and operating time for each site. Next a Bayes' update is performed for each of the individual sites starting with the same prior and updating it with each plant's specific evidence, producing a set of posterior distributions one for each site. To complete the first stage of the update procedure, these separate Bayes' updated distributions are combined into a single generic distribution that covers the whole industry and in a manner that preserves the plant to plant variability. This is accomplished most simply by the use of a single discrete probability distribution of the form $\{<k, p_k>, k=1,2,...,N\}$ where k is an index to denote a specific site, N is the number of sites, and p_k is the probability weight to be applied to each site. Since the generic data has already been screened on an event by event basis each site should have an equal weight and thus:

$$p_k = 1/N$$

So at this step, we now have N+1 distributions, N for the individual site Bayes' posterior distributions that start with a common generic prior, and 1 for the distribution of sites. The process for combining these into one is known as "Bayes Posterior Weighting" and is described in the following. A set of Monte Carlo Simulations is performed by sampling from each of the N site specific distributions and the site selection distribution to see which site sample to keep for this trial. The result is stored and the process repeated many times. Once each trial, a site is randomly selected and the random sample from that plant's distribution is stored to provide independent samples from the plant to plant variability distribution. At the end of the Monte Carlo process the output distribution is created out of the saved results and the plant to plant variability distribution is created. The Monte Carlo code @RISK was used to perform this step as explained below.

The second stage of the Two Stage Bayes process is simply to perform a second stage application of Bayes theorem using the plant to plant variability distribution as the prior and the Palisades plant specific evidence to quantify the likelihood function as has been done in Reference [1] except that in this case a different prior is being used, namely that from the first stage of Bayes' updates.

To summarize the Two Stage Bayes Procedure for evaluating LOOP frequency:

1. Select a generic prior distribution that is very broad and represents the state of knowledge about the event frequency prior to the knowledge of any industry or plant specific data. A non-informative prior is normally used unless a more informative one can be justified.
2. Separate out the industry data into different sites so that the number of events and number of reactor years for each site is known. If there were any dependent events involving multiple units at the same site due to a single cause at the same time, count as only a single event. Do not include Palisades data at this stage.
3. Perform a separate Bayes update for each of N (=72 not including Palisades) sites creating N posterior distributions, 1 for each site. Number the sites 1 to N so that the site identity can be preserved in the Monte Carlo process. If the available Bayes' update tool requires the use of parametric prior distributions, fit the updated distributions to an appropriate distribution type such as gamma or lognormal preserving the mean and variance or range factor.
4. Construct a site selection distribution with values 1 through N and discrete probabilities of 1/N for each site.
5. Perform a posterior weighting merge operation via Monte Carlo in which an output variable is defined as the plant to plant variability distribution. Samples for this

distribution are created by randomly sampling from the site selection distribution and using a random sample from the selected site taken from the appropriate Bayes updated distribution created in Step 3. The resulting output distribution is the final plant to plant variability distribution for Stage 1 of the Two Stage Bayes update process. If the Bayes update tool requires the use of a parametric prior distribution, perform a distribution fit by matching the first two moments as in Step 3.

6. Perform the second stage Bayes update by applying the plant specific evidence using the results of the first stage as the prior distribution. In future PRA updates the previously developed posterior distribution becomes the prior for the next update which only accounts for the incremental evidence for that update.

3.2 SITE DATA FOR MAINTENANCE INDUCED LOOP FREQUENCY

The site data used for this evaluation was provided by the Palisades PRA team and is shown in Table 3-1. The only differences between this data and the data originally provided by Palisades is the counting of the events at multiunit sites that involved two or more reactor units on the same day as a single event. This counting is made because if the same cause had occurred at Palisades it would only produce a single LOOP event and because such events are not independent events. Only independent events should be separately counted as this assumption is made repeatedly in the statistical analysis of this data. This data has been screened by the Palisades PRA team to exclude industry events that could not occur at Palisades due to design differences. As a sensitivity study, a separate data analysis was performed without screening out events from the generic database due to design differences. This sensitivity study is discussed in Section 3.10.

3.3 SELECTION OF THE GENERIC INDUSTRY PRIOR DISTRIBUTION FOR THE FIRST STAGE BAYES UPDATE

The generic industry prior distribution was selected by the author based on engineering judgment and is characterized as a lognormal distribution with a lower bound (5%tile) of

1E-3 per reactor year and an upper bound (95%tile) of 1 per year. In the knowledge of the author there has never been any credible evidence that the frequency of loss of offsite power is as low as 1E-3 per year, most estimates are in the range of 1E-2 to 1E-3. If a plant experienced a frequency of this event as high as 1 per year, the risk informed oversight process would be expected to force corrective action due to the risk significance of these events.

This is a very broad distribution and has a range factor of over 30. Since it is very broad it will not have an appreciable influence on the Bayes updates that will be performed to establish the plant to plant variability and uncertainty that is inherent in the industry data. A sensitivity study was performed by lowering the lower bound to 1E-4 keeping the upper bound fixed and the resulting bayes updates were not appreciably affected. Hence this generic prior is judged to be sufficiently broad for this application.

3.4 FIRST STAGE BAYES UPDATING

A Bayes update was performed starting from the generic prior distribution described in the previous section for each of the data sets in Table 3-1 for both maintenance induced LOOP and LOOP due to any cause. The Bayes updates were performed via Excel spreadsheet by discretizing the frequency scale very finely and applying Bayes theorem in its discrete form. 100 bins per decade were used to apply the theorem from 1E-9 per year to 1E+7 per year to ensure that both the prior distribution and likelihood functions were included over the full ranges in which these functions exhibit significant probabilities. The Bayes' methodology that was applied is the same as was used in Reference [5] which was subjected to extensive benchmarking and independent reviews sponsored by EPRI [6] and the NRC [7].

The results of this process produced 63 Bayes update distributions whose parameters are listed in Table 3-2 (note that the distributions are numbered 1 through 67, but 4 were subsequently not used). These 63 cases cover the data sets in Table 3-1 and additional data sets defined in Section 3-10 for a sensitivity study in which no screening of generic industry events due to design differences is assumed. Details of each distribution are documented in the Excel files that were used to develop these results. Of the 67 Bayes update calculations that were performed in this step, Bayes-43 involved the strongest evidence of a low frequency of loss of offsite power (0 events in 56.6 reactor years) and Bayes-63 involved the strongest evidence of a relatively high LOOP frequency (6 events in 46.6 reactor years). The results of these updates are plotted together with the generic industry prior in Figure 1 to provide a visual example of two of the 67 Bayes updates. These and the other 65 updates, whose key parameters are in Table 3-2

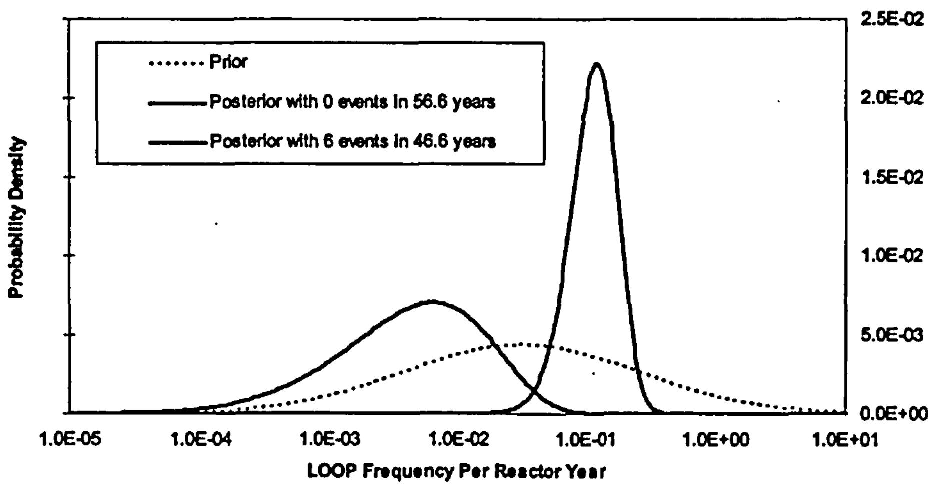

Figure 3- 1 Examples of Bayes Updated Distributions:Bayes-43 (0/56.6) and Bayes-63 (6/46.6)

provide an important input for developing a single plant to plant variability distribution that is performed in the next step.

For convenience in support of the subsequent calculations, these Bayes updated distributions were fitted to a lognormal distribution by matching the means and by matching the range factor, RF, of the Bayes' updated distribution that was calculated using:

$$RF = \sqrt{\frac{95\%tile}{5\%tile}} \tag{3.1}$$

Where the arguments of the square root are the 95%tile and 5%tile of the Bayes updated distribution, respectively. This fitting has a very small effect on the final calculations because the first two moments of the distribution are preserved and the next steps are not significantly influenced by higher moments of the distributions.

Table 3-1 Industry Loss of Offsite Power Events Screened for Applicability to Palisades [9]

Site	Maintenance Induced LOOP			All Causes of LOOP		
	No. Events	Reactor Calendar years	Bayes Update Distribution ID	No. Events	Reactor Calendar years	Bayes Update Distribution ID
Arkansas Nuclear One 1&2	0	46.6	Bayes-42	0	46.6	Bayes-42
Arnold	0	23.3	Bayes-29	0	23.3	Bayes-29
Beaver Valley 1&2	1	39.2	Bayes-9	1	39.2	Bayes-9
Big Rock Point	0	17.7	Bayes-23	0	17.7	Bayes-23
Braidwood 1&2	0	31.2	Bayes-31	1	31.2	Bayes-55
Browns Ferry 2&3	0	35.1	Bayes-36	0	35.1	Bayes-36
Brunswick 1&2	0	46.6	Bayes-42	0	46.6	Bayes-42
Byron 1&2	0	34.9	Bayes-33	1	34.9	Bayes-56
Calaway	0	18.8	Bayes-26	0	18.8	Bayes-26
Calvert Cliffs 1&2	0	46.6	Bayes-42	1	46.6	Bayes-12
Catawba 1&2	0	35.4	Bayes-34	1	35.4	Bayes-57
Clinton	0	16.6	Bayes-21	1	16.6	Bayes-65
Comanche Peak 1&2	0	23.2	Bayes-29	0	23.2	Bayes-29
Cook 1&2	0	46.6	Bayes-42	0	46.6	Bayes-42
Cooper	0	23.3	Bayes-29	0	23.3	Bayes-29
Crystal River	0	23.3	Bayes-29	0	23.3	Bayes-29
Davis Besse	0	23.3	Bayes-29	1	23.3	Bayes-6
Diablo Canyon 1&2	1	37.0	Bayes-8	2	37.0	Bayes-66
Dresden 2&3	0	46.6	Bayes-42	1	46.6	Bayes-12
Farley 1&2	0	45.8	Bayes-40	1	45.8	Bayes-60
Fermi 2	0	18.1	Bayes-24	0	18.1	Bayes-24
Fitzpatrick	0	23.3	Bayes-29	0	23.3	Bayes-29
Fort Calhoun	0	23.3	Bayes-29	0	23.3	Bayes-29
Fort St. Vrain	0	10.0	Bayes-17	1	10.0	Bayes-52
Ginna	0	23.3	Bayes-29	0	23.3	Bayes-29
Grand Gulf	0	20.8	Bayes-28	0	20.8	Bayes-28

Table 3-1 Industry Loss of Offsite Power Events Screened for Applicability to Palisades [9]

Site	Maintenance Induced LOOP			All Causes of LOOP		
	No. Events	Reactor Calendar years	Bayes Update Distribution ID	No. Events	Reactor Calendar years	Bayes Update Distribution ID
Haddam Neck	0	17.0	Bayes-22	0	17.0	Bayes-22
Harris	0	16.5	Bayes-21	0	16.5	Bayes-21
Hatch 1&2	0	46.6	Bayes-42	0	46.6	Bayes-42
Hope Creek	0	17.0	Bayes-22	0	17.0	Bayes-22
Indian Point 2&3	0	46.6	Bayes-42	2	46.6	Bayes-3
Kewaunee	0	23.3	Bayes-29	0	23.3	Bayes-29
LaSalle 1&2	1	40.3	Bayes-11	1	40.3	Bayes-11
Limerick 1&2	0	32.2	Bayes-32	0	32.2	Bayes-32
Maine Yankee	0	17.7	Bayes-23	0	17.7	Bayes-23
McGuire 1&2	2	42.3	Bayes-2	2	42.3	Bayes-2
Millstone 1-2-3	0	56.6	Bayes-43	0	56.6	Bayes-43
Monticello	0	23.3	Bayes-29	0	23.3	Bayes-29
Nine Mile Point 1&2	1	39.8	Bayes-10	2	39.8	Bayes-67
North Anna 1&2	0	46.3	Bayes-41	0	46.3	Bayes-41
Oconee 1-2-3	1	69.9	Bayes-15	1	69.9	Bayes-15
Oyster Creek	0	23.3	Bayes-29	1	23.3	Bayes-6
Palisades	1	23.3	Bayes-6	1	23.3	Bayes-6
Palo Verde 1-2-3	1	51.7	Bayes-13	3	51.7	Bayes-50
Peach Bottom 2&3	0	46.6	Bayes-42	0	46.6	Bayes-42
Perry	0	17.1	Bayes-22	0	17.1	Bayes-22
Pilgrim	0	23.3	Bayes-29	2	23.3	Bayes-1
Point Beach 1&2	0	46.6	Bayes-42	0	46.6	Bayes-42
Prairie Island 1&2	0	46.6	Bayes-42	2	46.6	Bayes-3
Quad Cities 1&2	0	46.6	Bayes-42	1	46.6	Bayes-12
Rancho Seco	0	10.0	Bayes-17	0	10.0	Bayes-17
River Bend	0	17.6	Bayes-23	1	17.6	Bayes-54
Robinson	0	23.3	Bayes-29	0	23.3	Bayes-29

Table 3-1 Industry Loss of Offsite Power Events Screened for Applicability to Palisades [9]

Site	Maintenance Induced LOOP			All Causes of LOOP		
	No. Events	Reactor Calendar years	Bayes Update Distribution ID	No. Events	Reactor Calendar years	Bayes Update Distribution ID
Salem 1&2	0	46.3	Bayes-41	0	46.3	Bayes-41
San Onofre 1-2-3	2	54.5	Bayes-51	2	54.5	Bayes-51
Seabrook	0	13.9	Bayes-20	0	13.9	Bayes-20
Sequoyah 1&2	0	44.9	Bayes-39	0	44.9	Bayes-39
South Texas 1&2	0	29.9	Bayes-30	0	29.9	Bayes-30
St Lucie 1&2	0	43.3	Bayes-38	0	43.3	Bayes-38
Summer	1	20.6	Bayes-5	1	20.6	Bayes-5
Surry 1&2	0	46.6	Bayes-42	0	46.6	Bayes-42
Susquehanna 1&2	0	39.8	Bayes-37	0	39.8	Bayes-37
Three Mile Island 1	0	23.3	Bayes-29	1	23.3	Bayes-6
Trojan	0	12.0	Bayes-18	0	12.0	Bayes-18
Turkey Point 3&4	0	46.6	Bayes-42	1	46.6	Bayes-12
Vermont Yankee	1	23.3	Bayes-6	1	23.3	Bayes-6
Vogtle 1&2	1	30.3	Bayes-7	1	30.3	Bayes-7
Waterford	0	18.3	Bayes-25	0	18.3	Bayes-25
Watts Bar	0	7.4	Bayes-16	0	7.4	Bayes-16
WNP-2	0	19.3	Bayes-27	0	19.3	Bayes-27
Wolf Creek	0	18.1	Bayes-24	0	18.1	Bayes-24
Yankee Rowe	0	12.2	Bayes-19	1	12.2	Bayes-53
Zion 1&2	0	36.2	Bayes-35	0	36.2	Bayes-35
Total	**14**	**2278.1**		**39**	**2278.1**	

Table 3-2 Results of Bayes Updates of Generic Prior Distribution For Each Plant Data Set

Distribution Name	Plant Evidence		Bayes Updated Posterior Distributions					Lognormal Distribution with Same Mean and Range Factor (RF)				
	No. Events	R-yrs	5%tile	median	mean	95%tile	RF	5%tile	median	mean	95%tile	RF
Bayes-1	2	23.3	1.56E-02	6.58E-02	7.93E-02	1.84E-01	3.43	1.74E-02	5.99E-02	7.93E-02	2.06E-01	3.43
Bayes-2	2	42.3	9.69E-03	3.90E-02	4.65E-02	1.06E-01	3.31	1.08E-02	3.57E-02	4.65E-02	1.18E-01	3.31
Bayes-3	2	46.6	8.96E-03	3.58E-02	4.26E-02	9.70E-02	3.29	9.96E-03	3.28E-02	4.26E-02	1.08E-01	3.29
Bayes-4	1	17	5.66E-03	4.09E-02	5.68E-02	1.59E-01	5.29	6.42E-03	3.40E-02	5.68E-02	1.80E-01	5.29
Bayes-5	1	20.6	5.03E-03	3.52E-02	4.85E-02	1.34E-01	5.17	5.70E-03	2.94E-02	4.85E-02	1.52E-01	5.17
Bayes-6	1	23.3	4.65E-03	3.20E-02	4.38E-02	1.20E-01	5.09	5.27E-03	2.68E-02	4.38E-02	1.37E-01	5.09
Bayes-7	1	30.3	3.93E-03	2.60E-02	3.52E-02	9.56E-02	4.93	4.46E-03	2.20E-02	3.52E-02	1.08E-01	4.93
Bayes-8	1	37	3.46E-03	2.23E-02	2.99E-02	8.06E-02	4.82	3.92E-03	1.89E-02	2.99E-02	9.13E-02	4.82
Bayes-9	1	39.2	3.32E-03	2.12E-02	2.84E-02	7.62E-02	4.79	3.76E-03	1.80E-02	2.84E-02	8.64E-02	4.79
Bayes-10	1	39.8	3.29E-03	2.09E-02	2.80E-02	7.52E-02	4.78	3.73E-03	1.78E-02	2.80E-02	8.52E-02	4.78
Bayes-11	1	40.3	3.25E-03	2.07E-02	2.77E-02	7.42E-02	4.77	3.69E-03	1.76E-02	2.77E-02	8.41E-02	4.77
Bayes-12	1	46.6	2.96E-03	1.85E-02	2.45E-02	6.53E-02	4.70	3.35E-03	1.58E-02	2.45E-02	7.41E-02	4.70
Bayes-13	1	51.7	2.75E-03	1.69E-02	2.24E-02	5.94E-02	4.64	3.12E-03	1.45E-02	2.24E-02	6.73E-02	4.64
Bayes-14	Not used											
Bayes-15	1	69.9	2.25E-03	1.33E-02	1.74E-02	4.56E-02	4.50	2.55E-03	1.15E-02	1.74E-02	5.16E-02	4.50
Bayes-16	0	7.4	6.50E-04	1.29E-02	3.13E-02	1.23E-01	13.77	6.39E-04	8.79E-03	3.13E-02	1.21E-01	13.77
Bayes-17	0	10	6.07E-04	1.13E-02	2.61E-02	1.00E-01	12.87	6.07E-04	7.82E-03	2.61E-02	1.01E-01	12.87
Bayes-18	0	12	5.80E-04	1.05E-02	2.33E-02	8.86E-02	12.36	5.87E-04	7.25E-03	2.33E-02	8.96E-02	12.36

Table 3-2 Results of Bayes Updates of Generic Prior Distribution For Each Plant Data Set

Distribution Name	Plant Evidence		Bayes Updated Posterior Distributions					Lognormal Distribution with Same Mean and Range Factor (RF)				
	No. Events	R-yrs	5%tile	median	mean	95%tile	RF	5%tile	median	mean	95%tile	RF
Bayes-19	0	12.2	5.77E-04	1.04E-02	2.31E-02	8.76E-02	12.31	5.85E-04	7.20E-03	2.31E-02	8.87E-02	12.31
Bayes-20	0	13.9	5.58E-04	9.78E-03	2.13E-02	7.99E-02	11.96	5.69E-04	6.81E-03	2.13E-02	8.15E-02	11.96
Bayes-21	0	16.5	5.31E-04	8.99E-03	1.90E-02	7.04E-02	11.51	5.47E-04	6.30E-03	1.90E-02	7.25E-02	11.51
Bayes-22	0	17	5.27E-04	8.86E-03	1.86E-02	6.89E-02	11.43	5.44E-04	6.22E-03	1.86E-02	7.11E-02	11.43
Bayes-23	0	17.7	5.22E-04	8.71E-03	1.82E-02	6.72E-02	11.35	5.39E-04	6.12E-03	1.82E-02	6.94E-02	11.35
Bayes-24	0	18.1	5.19E-04	8.64E-03	1.80E-02	6.64E-02	11.31	5.37E-04	6.07E-03	1.80E-02	6.87E-02	11.31
Bayes-25	0	18.3	5.16E-04	8.54E-03	1.78E-02	6.53E-02	11.25	5.34E-04	6.01E-03	1.78E-02	6.77E-02	11.25
Bayes-26	0	18.8	5.13E-04	8.45E-03	1.75E-02	6.43E-02	11.20	5.32E-04	5.95E-03	1.75E-02	6.67E-02	11.20
Bayes-27	0	19.3	5.08E-04	8.32E-03	1.72E-02	6.29E-02	11.12	5.28E-04	5.87E-03	1.71E-02	6.53E-02	11.12
Bayes-28	0	20.8	4.98E-04	8.03E-03	1.64E-02	5.97E-02	10.96	5.19E-04	5.68E-03	1.64E-02	6.22E-02	10.96
Bayes-29	0	23.3	4.81E-04	7.58E-03	1.52E-02	5.50E-02	10.69	5.03E-04	5.38E-03	1.52E-02	5.76E-02	10.69
Bayes-30	0	29.9	4.43E-04	6.63E-03	1.28E-02	4.55E-02	10.13	4.69E-04	4.76E-03	1.28E-02	4.82E-02	10.13
Bayes-31	0	31.2	4.37E-04	6.48E-03	1.25E-02	4.41E-02	10.04	4.64E-04	4.66E-03	1.25E-02	4.68E-02	10.04
Bayes-32	0	32.2	4.33E-04	6.38E-03	1.22E-02	4.31E-02	9.98	4.60E-04	4.59E-03	1.22E-02	4.58E-02	9.98
Bayes-33	0	34.9	4.21E-04	6.10E-03	1.16E-02	4.06E-02	9.82	4.49E-04	4.41E-03	1.16E-02	4.33E-02	9.82
Bayes-34	0	35.4	4.19E-04	6.04E-03	1.14E-02	4.01E-02	9.78	4.46E-04	4.37E-03	1.14E-02	4.27E-02	9.78
Bayes-35	0	36.2	4.16E-04	5.98E-03	1.13E-02	3.95E-02	9.74	4.44E-04	4.32E-03	1.13E-02	4.21E-02	9.74
Bayes-36	0	35.1	4.20E-04	6.08E-03	1.15E-02	4.04E-02	9.81	4.48E-04	4.39E-03	1.15E-02	4.31E-02	9.81

Table 3-2 Results of Bayes Updates of Generic Prior Distribution For Each Plant Data Set

Distribution Name	Plant Evidence		Bayes Updated Posterior Distributions					Lognormal Distribution with Same Mean and Range Factor (RF)				
	No. Events	R-yrs	5%tile	median	mean	95%tile	RF	5%tile	median	mean	95%tile	RF
Bayes-37	0	39.8	4.02E-04	5.66E-03	1.06E-02	3.67E-02	9.56	4.31E-04	4.12E-03	1.06E-02	3.93E-02	9.56
Bayes-38	0	43.3	3.90E-04	5.40E-03	9.95E-03	3.44E-02	9.39	4.19E-04	3.94E-03	9.95E-03	3.70E-02	9.39
Bayes-39	0	44.9	3.85E-04	5.29E-03	9.70E-03	3.35E-02	9.32	4.14E-04	3.86E-03	9.70E-03	3.60E-02	9.32
Bayes-40	0	45.8	3.82E-04	5.22E-03	9.55E-03	3.29E-02	9.28	4.11E-04	3.82E-03	9.55E-03	3.54E-02	9.28
Bayes-41	0	46.3	3.81E-04	5.20E-03	9.51E-03	3.27E-02	9.27	4.10E-04	3.80E-03	9.51E-03	3.53E-02	9.27
Bayes-42	0	46.6	3.80E-04	5.17E-03	9.45E-03	3.25E-02	9.25	4.09E-04	3.79E-03	9.45E-03	3.50E-02	9.25
Bayes-43	0	56.6	3.53E-04	4.62E-03	8.24E-03	2.80E-02	8.90	3.83E-04	3.41E-03	8.24E-03	3.03E-02	8.90
Bayes-44	3	23.3	3.23E-02	1.03E-01	1.18E-01	2.45E-01	2.76	3.53E-02	9.73E-02	1.18E-01	2.68E-01	2.76
Bayes-45	3	42.3	1.97E-02	6.14E-02	6.97E-02	1.44E-01	2.70	2.15E-02	5.81E-02	6.97E-02	1.57E-01	2.70
Bayes-46	Not used											
Bayes-47	3	37	2.17E-02	6.79E-02	7.71E-02	1.59E-01	2.71	2.37E-02	6.41E-02	7.71E-02	1.74E-01	2.71
Bayes-48	3	39.8	2.03E-02	6.31E-02	7.17E-02	1.48E-01	2.70	2.21E-02	5.97E-02	7.17E-02	1.61E-01	2.70
Bayes-49	Not used											
Bayes-50	3	51.7	1.61E-02	4.95E-02	5.60E-02	1.15E-01	2.68	1.75E-02	4.68E-02	5.60E-02	1.25E-01	2.68
Bayes-51	2	54.5	7.88E-03	3.11E-02	3.69E-02	8.38E-02	3.26	8.75E-03	2.85E-02	3.69E-02	9.31E-02	3.26
Bayes-52	1	10	7.79E-03	6.12E-02	8.75E-02	2.51E-01	5.68	8.82E-03	5.01E-02	8.75E-02	2.85E-01	5.68
Bayes-53	1	12.2	6.93E-03	5.27E-02	7.45E-02	2.12E-01	5.53	7.85E-03	4.34E-02	7.45E-02	2.40E-01	5.53
Bayes-54	1	17.6	5.54E-03	3.98E-02	5.52E-02	1.54E-01	5.27	6.28E-03	3.31E-02	5.52E-02	1.75E-01	5.27

Table 3-2 Results of Bayes Updates of Generic Prior Distribution For Each Plant Data Set

Distribution Name	Plant Evidence		Bayes Updated Posterior Distributions					Lognormal Distribution with Same Mean and Range Factor (RF)				
	No. Events	R-yrs	5%tile	median	mean	95%tile	RF	5%tile	median	mean	95%tile	RF
Bayes-55	1	31.2	3.85E-03	2.53E-02	3.43E-02	9.29E-02	4.91	4.36E-03	2.14E-02	3.43E-02	1.05E-01	4.91
Bayes-56	1	34.9	3.58E-03	2.32E-02	3.13E-02	8.44E-02	4.85	4.06E-03	1.97E-02	3.13E-02	9.57E-02	4.85
Bayes-57	1	35.4	3.54E-03	2.29E-02	3.08E-02	8.32E-02	4.84	4.02E-03	1.95E-02	3.08E-02	9.43E-02	4.84
Bayes-58	1	36.2	3.50E-03	2.26E-02	3.03E-02	8.17E-02	4.83	3.97E-03	1.92E-02	3.03E-02	9.27E-02	4.83
Bayes-59	Not used											
Bayes-60	1	45.8	2.99E-03	1.87E-02	2.48E-02	6.62E-02	4.71	3.39E-03	1.59E-02	2.48E-02	7.51E-02	4.71
Bayes-61	1	56.6	2.60E-03	1.58E-02	2.08E-02	5.50E-02	4.60	2.94E-03	1.35E-02	2.08E-02	6.23E-02	4.60
Bayes-62	3	54.5	1.54E-02	4.73E-02	5.35E-02	1.10E-01	2.67	1.68E-02	4.48E-02	5.35E-02	1.20E-01	2.67
Bayes-63	6	46.6	5.27E-02	1.14E-01	1.23E-01	2.13E-01	2.01	5.57E-02	1.12E-01	1.23E-01	2.25E-01	2.01
Bayes-64	4	46.6	2.82E-02	7.42E-02	8.18E-02	1.57E-01	2.36	3.03E-02	7.14E-02	8.18E-02	1.68E-01	2.36
Bayes-65	1	16.6	5.75E-03	4.16E-02	5.79E-02	1.62E-01	5.31	6.51E-03	3.46E-02	5.79E-02	1.84E-01	5.31
Bayes-66	2	37	1.08E-02	4.38E-02	5.24E-02	1.20E-01	3.34	1.20E-02	4.01E-02	5.24E-02	1.34E-01	3.34
Bayes-67	2	39.8	1.02E-02	4.11E-02	4.91E-02	1.12E-01	3.32	1.13E-02	3.76E-02	4.91E-02	1.25E-01	3.32

3.5 PLANT SELECTION DISTRIBUTION

The plant selection distribution is a discrete distribution that is used to randomly select a plant site for each Monte Carlo trial in the posterior weighting process. Once that site is selected the randomly selected LOOP frequency is selected from that site's Bayes update according to the parameters in Table 3-2. There are 72 sites in the industry data shown on Table 3-1 excluding Palisades, whose experience is not included in the plant to plant variability distribution to meet the requirement that the 2nd stage Bayes update be performed with independent priors and likelihood functions. The Palisades experience is factored into the 2nd Stage Bayes update to be described later in this section. The site selection distribution is shown in Table 3-3.

3.6 POSTERIOR WEIGHTING VIA MONTE CARLO

The posterior weighting step was performed using @RISK 4.5 which is a commercial Monte Carlo uncertainty analysis tool that is used as an "Add-in" to Microsoft Excel. The algorithm that was used in the spreadsheet is based on the following equation:

$$Z = \sum_{j=1}^{72} X_j Y_j \qquad (3.2)$$

Where X_j = Randomly selected LOOP frequency for Site j

Y_j = 1 for the site that is randomly selected from the Site Selection Distribution, otherwise = 0

Z = Output data collected for the plant to plant variability distribution

The effect of this equation is to collect a single value of LOOP frequency from a single randomly selected site on each Monte Carlo Trial. The evaluation was performed for two case: The total frequency of LOOP due to any cause and the frequency of maintenance induced plant centered LOOP events of the type that occurred at Palisades on March 25, 2003.

Table 3-3 Site Selection Distribution

Site No.	Plant	Site Selection Probability
1	Arkansas Nuclear One 1&2	1/72 = 0.01389
2	Arnold	0.01389
3	Beaver Valley 1&2	0.01389
4	Big Rock Point	0.01389
5	Braidwood 1&2	0.01389
6	Browns Ferry 2&3	0.01389
7	Brunswick 1&2	0.01389
8	Byron 1&2	0.01389
9	Calaway	0.01389
10	Calvert Cliffs 1&2	0.01389
11	Catawba 1&2	0.01389
12	Clinton	0.01389
13	Comanche Peak 1&2	0.01389
14	Cook 1&2	0.01389
15	Cooper	0.01389
16	Crystal River	0.01389
17	Davis Besse	0.01389
18	Diablo Canyon 1&2	0.01389
19	Dresden 2&3	0.01389
20	Farley 1&2	0.01389
21	Fermi 2	0.01389
22	Fitzpatrick	0.01389
23	Fort Calhoun	0.01389
24	Fort St. Vrain	0.01389
25	Ginna	0.01389
26	Grand Gulf	0.01389
27	Haddam Neck	0.01389
28	Harris	0.01389
29	Hatch 1&2	0.01389
30	Hope Creek	0.01389
31	Indian Point 2&3	0.01389
32	Kewaunee	0.01389
33	LaSalle 1&2	0.01389
34	Limerick 1&2	0.01389

Table 3-3 Site Selection Distribution

Site No.	Plant	Site Selection Probability
35	Maine Yankee	0.01389
36	McGuire 1&2	0.01389
37	Millstone 1-2-3	0.01389
38	Monticello	0.01389
39	Nine Mile Point 1&2	0.01389
40	North Anna 1&2	0.01389
41	Oconee 1-2-3	0.01389
42	Oyster Creek	0.01389
43	Palo Verde 1-2-3	0.01389
44	Peach Bottom 2&3	0.01389
45	Perry	0.01389
46	Pilgrim	0.01389
47	Point Beach 1&2	0.01389
48	Prairie Island 1&2	0.01389
49	Quad Cities 1&2	0.01389
50	Rancho Seco	0.01389
51	River Bend	0.01389
52	Robinson	0.01389
53	Salem 1&2	0.01389
54	San Onofre 1-2-3	0.01389
55	Seabrook	0.01389
56	Sequoyah 1&2	0.01389
57	South Texas 1&2	0.01389
58	St Lucie 1&2	0.01389
59	Summer	0.01389
60	Surry 1&2	0.01389
61	Susquehanna 1&2	0.01389
62	Three Mile Island 1	0.01389
63	Trojan	0.01389
64	Turkey Point 3&4	0.01389
65	Vermont Yankee	0.01389
66	Vogtle 1&2	0.01389
67	Waterford	0.01389
68	Watts Bar	0.01389
69	WNP-2	0.01389

Table 3-3 Site Selection Distribution

Site No.	Plant	Site Selection Probability
70	Wolf Creek	0.01389
71	Yankee Rowe	0.01389
72	Zion 1&2	0.01389

The details of the @RISK evaluations are documented in Table 3-4 and Reference [8]. The Latin Hypercube sampling method was used and 100,000 iterations were made.

Table 3-4 @RISK Simulation Details

Workbook Name	Model-Total LOOP Screened.xls	Model-Maint LOOP Screened.xls
Number of Simulations	1	1
Number of Iterations	100000	100000
Number of Inputs	73	73
Number of Outputs	1	1
Sampling Type	Latin Hypercube	Latin Hypercube
Simulation Start Time	9/23/03 14:39:24	9/23/03 8:43:24
Simulation Stop Time	9/23/03 14:44:09	9/23/03 8:51:08
Simulation Duration	0:04:45	0:07:44
Random Seed	83434258	928432852

This is a very simple @RISK model that has 73 input distributions including the 72 individual site LOOP frequency uncertainty distributions described in Table 3-2 and the single site selection distribution in Table 3-3.

3.7 PLANT TO PLANT VARIABILITY DISTRIBUTIONS

The results obtained using @RISK for the plant to plant variability distributions for the two cases that were analyzed are shown in Table 3-5 and in Figure 3-2 and 3-3. Figure 3-2 covers the case of total LOOP frequency due to all types of causes and includes the prior that was developed in Reference [1] based on industry data but without consideration of plant to plant variability. There is a large difference when plant to plant variability is taken into account; there is a significant difference in uncertainty and a sizable difference in mean values. In Figure 3-3 the results for maintenance induced LOOP frequency are compared but there was no comparable case in Reference [1] that included only maintenance induced events. When comparing each of the plant to plant variability distributions to the original Stage 1 prior the plant to plant variability distributions are seen to be somewhat wider and shifted to the left reflecting the number of plants that did not experience any LOOP events.

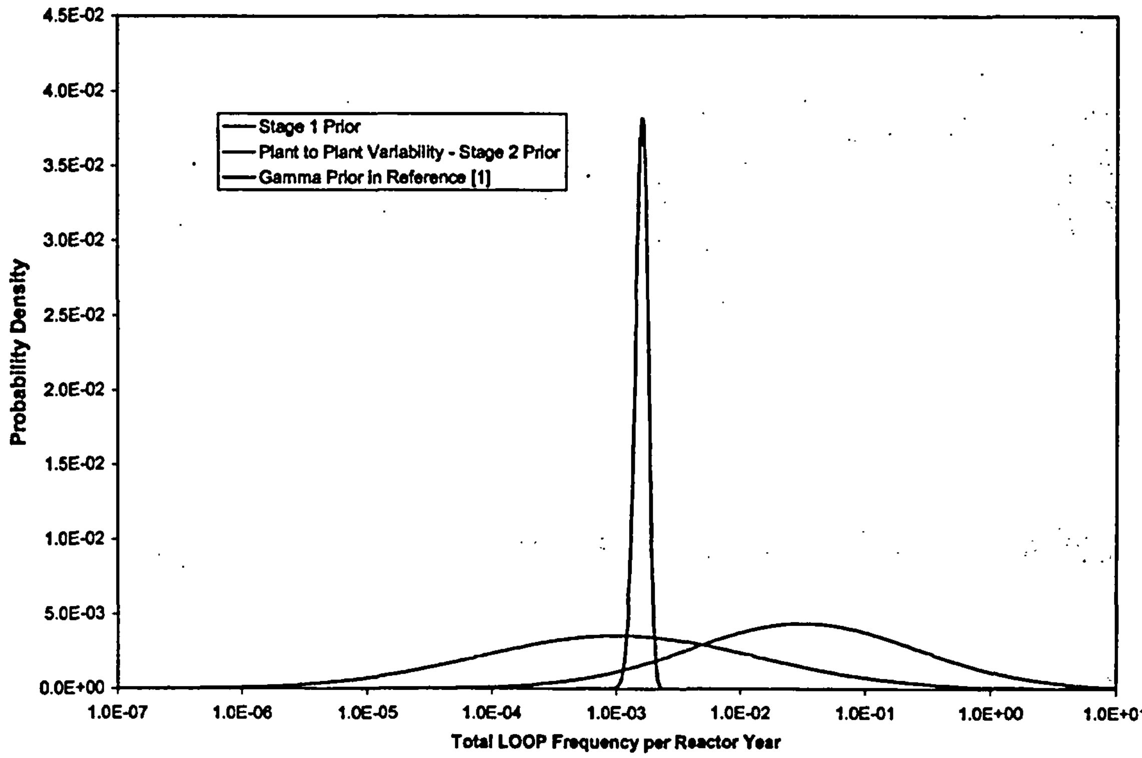

Figure 3-2 Comparison of Total LOOP Plant to Plant Variability Distribution with Stage 1 Prior and Gamma Distribution of Reference [1]

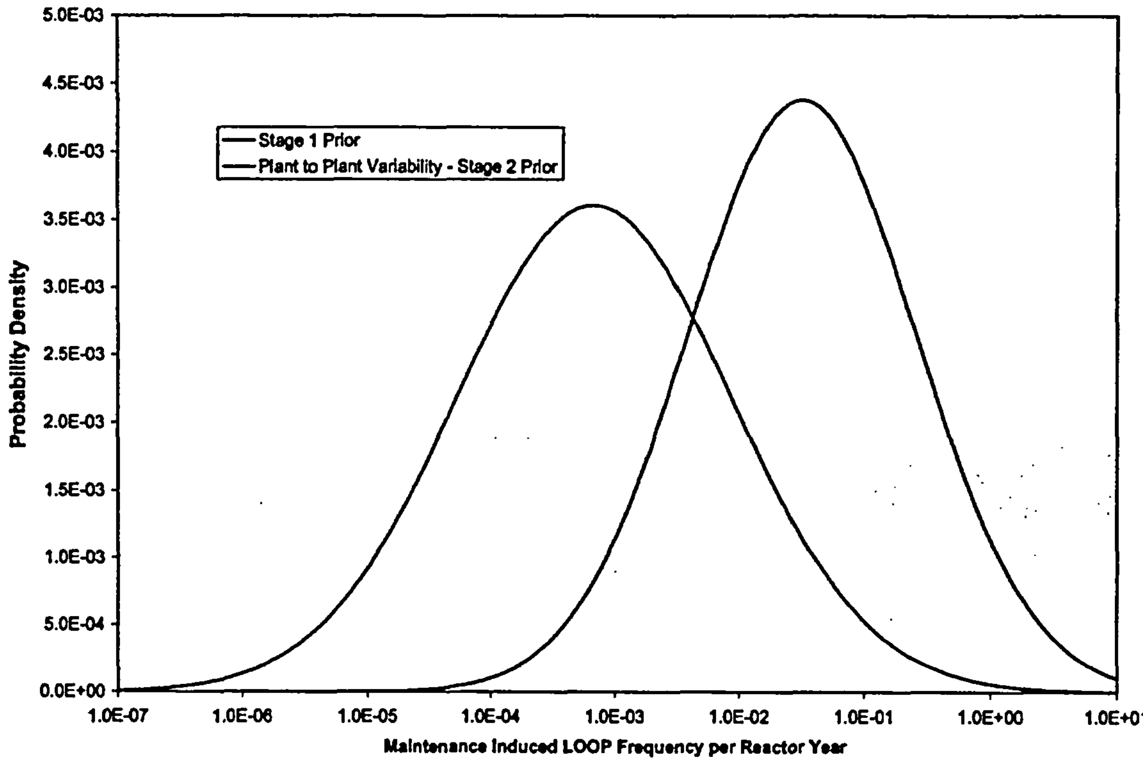

Figure 3-3 Comparison of Maintenance Induced LOOP Plant to Plant Variability Distribution with Stage 1 Prior Distribution

Table 3-5 @RISK Results for Plant to Plant Variability Distributions

Parameter	Total LOOP Frequency	Maintenance Induced LOOP Frequency
Minimum	1.54E-08	3.02E-08
Maximum	1.77E+02	3.52E+01
Mean	2.73E-02	1.74E-02
Standard Deviation	6.13E-01	2.22E-01
Variance	3.75E-01	4.92E-02
Skewness	2.50E+02	8.41E+01
Kurtosis	7.02E+04	1.01E+04
Number of Errors	0	0
Mode	6.66E-05	1.74E-05
5%tile	2.01E-05	1.21E-05
10%tile	5.41E-05	3.09E-05
15%tile	1.07E-04	5.90E-05
20%tile	1.84E-04	9.81E-05
25%tile	2.97E-04	1.53E-04
30% tile	4.52E-04	2.27E-04
35% tile	6.69E-04	3.24E-04
40% tile	9.65E-04	4.58E-04
45% tile	1.38E-03	6.41E-04
50% tile	1.92E-03	8.86E-04
55% tile	2.68E-03	1.23E-03
60% tile	3.74E-03	1.71E-03
65% tile	5.24E-03	2.39E-03
70% tile	7.40E-03	3.42E-03
75% tile	1.07E-02	4.99E-03
80% tile	1.58E-02	7.64E-03
85% tile	2.46E-02	1.24E-02
90% tile	4.22E-02	2.23E-02
95% tile	9.30E-02	5.27E-02

3.8 SECOND STAGE BAYES UPDATE

In this step of the calculations, the Palisades specific data is used to perform a second stage of Bayes updating. This time the plant to plant variability distributions are used as the prior and the Palisades specific evidence is used to perform the update. Since the Bayes' update spreadsheet that was prepared was set up to handle lognormal distributions as prior distributions, the plant to plant variability Distributions were fit to lognormal distributions using the same assumptions as used in Stage 1 updating. The lognormal distributions were defined by linking the means and the range factors defined by Equation (3.1).

A total of 8 cases were defined for this part of the evaluation. These cases are defined by two LOOP types (Total LOOP frequency and Maintenance Induced LOOP frequency), two versions of the number of Palisades LOOP events (0 and 1), and two versions of the Palisades operating experience (32 to account for the entire plant history and 23.3 to account for the period since 1980). The results are presented in Table 3-6 and selected cases are plotted Figures 3-4 and 3-5. Also included in Table 3-6 are results from Reference [1] which did not account for plant to plant variability in the prior and which used 32 reactor years for the Palisades operating experience.

Table 3-6 Stage 2 Bayes Update with Palisades Specific Evidence

Case	No. Events	Reactor Years	Distribution Parameters			
			5%tile	Mean	50%tile	95%tile
Total LOOP This Study	Prior Distribution		1.49E-05	2.73E-02	1.01E-03	6.98E-02
	0	23.3	1.24E-05	3.62E-03	6.62E-04	1.69E-02
	1	23.3	1.12E-03	2.62E-02	1.56E-02	8.55E-02
	0	32	1.20E-05	3.05E-03	6.13E-04	1.42E-02
	1	32	9.40E-04	2.02E-02	1.23E-02	6.48E-02
Total LOOP Per Reference [1]	Prior Distribution		1.28E-02	1.90E-02	1.96E-02	2.82E-02
	0	32	1.23E-02	1.84E-02	1.89E-02	2.73E-02
	1	32	1.33E-02	1.95E-02	2.00E-02	2.86E-02
Maintenance Induced LOOP This Study	Prior Distribution		1.02E-05	1.74E-02	6.75E-04	4.52E-02
	0	23.3	8.26E-06	2.90E-03	4.63E-04	1.36E-02
	1	23.3	9.18E-04	2.41E-02	1.39E-02	8.05E-02
	0	32	8.67E-06	2.52E-03	4.54E-04	1.18E-02
	1	32	7.78E-04	1.86E-02	1.10E-02	6.12E-02

As noted in Section 2, the cases with 23.3 reactor years should be used as the reference cases for two reasons: 1) this covers the same time period from 1980 to present as used to collect the industry data; and 2) there were LOOP events at Palisades prior to 1980 that were screened out as being no longer relevant due to design changes, but the relevance of the operating experience before 1980 is also of questionable relevance. The cases with 32 reactor years are included only for comparison with the calculations in Reference [1].

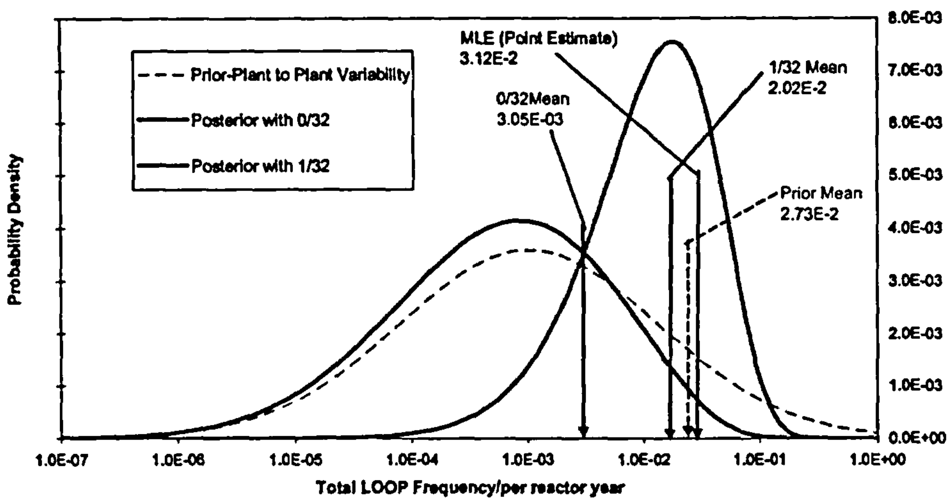

Figure 3-4 Comparison of Stage 2 Update Total LOOP Frequency Cases: 0/32 vs. 1/32

As seen when comparing the results of this study for 32 reactor years with comparable results from Reference [1], all the distributions in Reference [1] are much narrower and the updated distributions are much closer to the assumed prior. This directly stems from a well known property in Bayes updating that the strength of the evidence reflected in the prior is primarily determined by the narrowness of the distribution. Each point in the posterior distribution is proportional to the product of the corresponding point along the prior distribution and the value of the likelihood function for that frequency value. The former value drops towards zero for any point in the distribution far removed from the central tendency when the distribution is extremely narrow. By contrast, for the cases developed in this study, the prior distributions are much broader reflecting the plant to plant variability in the data and hence each Bayes' update case creates a new distribution that is significantly different than the prior.

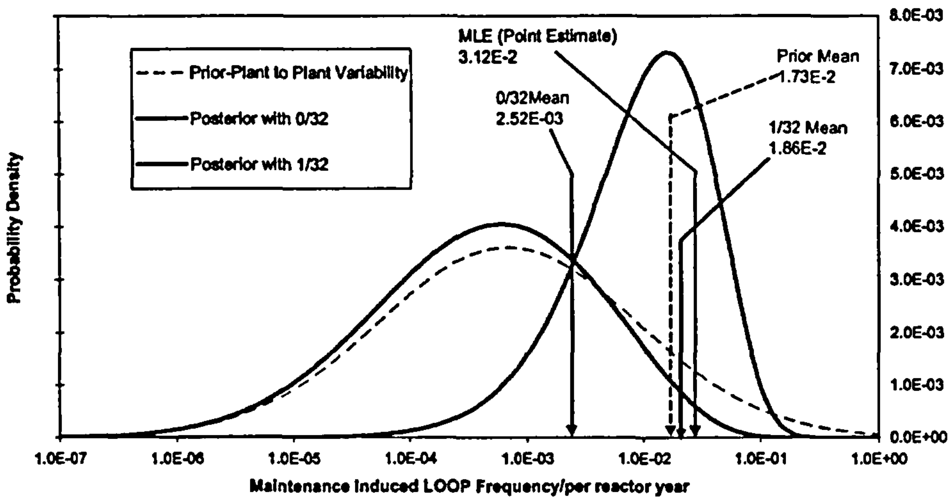

Figure 3-5 Comparison of Stage Update Maintenance LOOP Frequency Cases 0/32 vs. 1/32

3.9 CHANGE IN LOOP FREQUENCY

A key question that is being addressed in the Significance Determination Process for the March 25, 2003 event is the following: What does the occurrence of the event mean in the context of the risk of a severe core damage event at Palisades due to this new evidence about the occurrence of the LOOP event? The change in risk question can be framed in terms of the following equation:

$$\Delta CDF = \Delta F\{LOOP\} * CCDP\{LOOP\} \qquad (3.3)$$

Where:

ΔCDF = Change in core damage frequency due to change in LOOP frequency

$\Delta F\{LOOP\}$ =Change in the frequency of LOOP initiating events

CCDP{LOOP} =Conditional probability of core damage given occurrence of LOOP

There are two ways to look at this question. One is a frequentist approach in which only the observable data is taken into account. The other is a Bayes approach in which all the available generic industry and plant specific evidence that bears on the question is taken into account. In the frequentist approach the increase in LOOP frequency brought about by the March 25, 2003 event is simply (1/32)-(0/32)=1/32=.031 events per reactor year. If we use this approach and ignore other non statistical evidence, we also must note that there was no core damage event on March 25, 2003 and hence, *CCDP{LOOP}*=0 and *ΔCDF*=0. Unfortunately using such a frequentist approach does not lend itself to gaining any insights about risk from the March 25, 2003 event. Another observation that can be made is that the frequentist estimate of the change in LOOP frequency is overstated because it assumes that the frequency of LOOP in absence of knowledge of the March 25, 2003 event is zero. No competent PRA would assign a zero frequency to LOOP just because one might not have happened, but that is the essence of the frequentist model for this question.

The second way to look at the question is the Bayes' approach in which we admit into evidence the operating experience and events that have occurred at other plants that have been determined by the Palisades PRA team to be relevant and have been judged to have the capability to lead to a loss of offsite power if the same causes were to occur at Palisades. In this approach we also admit into evidence information from the Palisades PRA on *CCDP{LOOP}* and are able to calculate a non zero value for *ΔCDF*. In this approach we address the risk significance determination process by asking the following form of the question: In the future operation of Palisades, without considering any design changes that were made to prevent reoccurrence of the March 25, 2003 event, how does the future risk of a core damage accident change in light of the knowledge of the occurrence of the event. When using the Bayes' viewpoint in answering this question we are able to account for the following information that is not accounted for in the frequentist approach:

- A future LOOP event might occur by reoccurrence of the March 25, 2003 event or by another type of LOOP event that has occurred at other plants judged to be relevant and applicable to Palisades
- The response of the plant might be different than what occurred in the March 25, 2003 following the loss of electrical power to the emergency busses.

A summary of the different approaches to estimating the change in LOOP frequency for evaluating Equation (3.3) is presented in Table 3-7. The most relevant estimates from this table is based on the plant experience since 1980 for consistency with the analysis of generic data in the prior providing an increase in total LOOP frequency of .0225 and an increase in the maintenance induced LOOP frequency of .0212. Note that these results are presented to three significant figures only to show the magnitude of the change based on the mean values. As seen in Table 3-6 the range of uncertainty in the LOOP frequency estimates are quantified and are very large.

The Bayes' Estimates are seen to be roughly a factor of 2 lower than the corresponding frequentist or point estimates. In the opinion of the author, the Bayes' estimates are the most appropriate estimates to be used to address the risk significance of the March 25, 2003 event. The reasons for this already addressed in this report are summarized as follows:

1. A purely frequentist approach to addressing risk significance ignores relevant information about LOOP frequency from other plants. Hence the assumption that the frequency of LOOP events before March 25, 2003 was zero understates the frequency in light of events that have occurred at other plants that could occur at Palisades.
2. A purely frequentist approach would include an estimate of CCDP=0 as no core damage event occurred on March 25, 2003. A combination of a frequentist based change in LOOP frequency and a Bayesian estimate of CCDP from the PRA would just produce meaningless statistical fruit salad. PRA based estimates of CDF and CCDP are inherently Bayes estimates.

3. The Bayes methodology provides an appropriate accounting of the statistical uncertainty in the change in LOOP frequency due to the sparcity of the data. Hence 1/23 type of data would be treated differently than 10/230 type of data; yet both would have the same point estimate in the frequentist method.

4. While the actual event that occurred at Palisades on March 25, 2003 might be regarded as unique to Palisades, any event at any plant if looked at finely enough can also be regarded as unique. The approach to data analysis is to define data event categories that are generally applicable to a range of plants even though each event can be described in such fine detail as to be viewed as unique. The event at Palisades on March 25, 2003 belongs to a general category of maintenance induced loss of offsite power events and the events that were included in the plant to plant variability analysis and reflected in the Bayes prior distribution also belong to this category.

Table 3-7 Comparison of Frequentist and Bayesian Estimates of Change in LOOP Frequency

LOOP Type	Time Period	Number of Events	Reactor Years	Change in LOOP Frequency	
				Bayes Estimate	Point Estimate
Total LOOP	Since 1980	1	23.3	2.25E-02	4.29E-02
	Plant Lifetime	1	32	1.71E-02	3.13E-02
Maintenance Induced LOOP	Since 1980	1	23.3	2.12E-02	4.29E-02
	Plant Lifetime	1	32	1.61E-02	3.13E-02

3.10 SENSITIVITY STUDY TO INVESTIGATE SCREENING

The results of the previous section were based on a screening of the industry data to account for important design differences that would preclude the occurrence of LOOP if similar causes were to occur at Palisades. In addition, a LOOP event on July 14, 1987 at Palisades that occurred since 1980 was screened out due to design differences that were made following the event. A sensitivity study was performed to see how much of an effect this screening has on the development of the plant to plant variability distribution and on the Bayes update of Palisades specific data. A tabulation of unscreened LOOP events that occurred since 1980 provided by the Palisades PRA team [9] is provided in Table 3-8 which parallels Table 3-1. The results of the sensitivity study are shown in Table 3-9 which compares the total frequency of LOOP due to all causes for screened and unscreened data. The screening of the data is seen to be significant with respect to the plant to plant variability distribution developed for the prior by shifting up the mean by about 25%. The Bayes updated distributions are slightly more than a factor of 2 higher for the 2 events data cases mostly reflecting a factor of two increase in the Palisades specific LOOP events that were included in the Bayes' update. For decision making it is recommended that the screened cases be used as long as convincing cases can be made for why the screened out events are no longer relevant for future operation of Palisades.

Table 3-8 Unscreened Industry Loss of Offsite Power Events [9]

Site	Maintenance Induced LOOP			All Causes of LOOP		
	No. Events	Reactor Calendar years	Bayes Update Distribution ID	No. Events	Reactor Calendar Years	Bayes Update Distribution ID
Arkansas Nuclear One 1&2	0	46.6	Bayes-42	0	46.6	Bayes-42
Arnold	0	23.3	Bayes-29	0	23.3	Bayes-29
Beaver Valley 1&2	1	39.2	Bayes-9	1	39.2	Bayes-9
Big Rock Point	0	17.7	Bayes-23	0	17.7	Bayes-23
Braidwood 1&2	0	31.2	Bayes-31	1	31.2	Bayes-55
Browns Ferry 2&3	0	35.1	Bayes-36	0	35.1	Bayes-36
Brunswick 1&2	0	46.6	Bayes-42	2	46.6	Bayes-3
Byron 1&2	0	34.9	Bayes-33	1	34.9	Bayes-56
Calaway	0	18.8	Bayes-26	0	18.8	Bayes-26
Calvert Cliffs 1&2	0	46.6	Bayes-42	1	46.6	Bayes-12
Catawba 1&2	0	35.4	Bayes-34	1	35.4	Bayes-57
Clinton	0	16.6	Bayes-21	1	16.6	Bayes-65
Comanche Peak 1&2	0	23.2	Bayes-29	0	23.2	Bayes-29
Cook 1&2	0	46.6	Bayes-42	0	46.6	Bayes-42
Cooper	0	23.3	Bayes-29	0	23.3	Bayes-29
Crystal River	2	23.3	Bayes-1	3	23.3	Bayes-44
Davis Besse	0	23.3	Bayes-29	1	23.3	Bayes-6
Diablo Canyon 1&2	1	37.0	Bayes-8	3	37.0	Bayes-47
Dresden 2&3	0	46.6	Bayes-42	1	46.6	Bayes-12
Farley 1&2	0	45.8	Bayes-40	1	45.8	Bayes-60
Fermi 2	0	18.1	Bayes-24	0	18.1	Bayes-24
Fitzpatrick	0	23.3	Bayes-29	0	23.3	Bayes-29
Fort Calhoun	0	23.3	Bayes-29	1	23.3	Bayes-6
Fort St. Vrain	0	10.0	Bayes-17	1	10.0	Bayes-52
Ginna	0	23.3	Bayes-29	0	23.3	Bayes-29
Grand Gulf	0	20.8	Bayes-28	0	20.8	Bayes-28

Table 3-8 Unscreened Industry Loss of Offsite Power Events [9]

Site	Maintenance Induced LOOP			All Causes of LOOP		
	No. Events	Reactor Calendar years	Bayes Update Distribution ID	No. Events	Reactor Calendar Years	Bayes Update Distribution ID
Haddam Neck	1	17.0	Bayes-4	1	17.0	Bayes-4
Harris	0	16.5	Bayes-21	0	16.5	Bayes-21
Hatch 1&2	0	46.6	Bayes-42	0	46.6	Bayes-42
Hope Creek	0	17.0	Bayes-22	0	17.0	Bayes-22
Indian Point 2&3	2	46.6	Bayes-3	6	46.6	Bayes-63
Kewaunee	0	23.3	Bayes-29	0	23.3	Bayes-29
LaSalle 1&2	1	40.3	Bayes-11	1	40.3	Bayes-11
Limerick 1&2	0	32.2	Bayes-32	0	32.2	Bayes-32
Maine Yankee	0	17.7	Bayes-23	0	17.7	Bayes-23
McGuire 1&2	2	42.3	Bayes-2	3	42.3	Bayes-45
Millstone 1-2-3	0	56.6	Bayes-43	1	56.6	Bayes-61
Monticello	1	23.3	Bayes-6	1	23.3	Bayes-6
Nine Mile Point 1&2	1	39.8	Bayes-10	3	39.8	Bayes-48
North Anna 1&2	0	46.3	Bayes-41	0	46.3	Bayes-41
Oconee 1-2-3	1	69.9	Bayes-15	1	69.9	Bayes-15
Oyster Creek	1	23.3	Bayes-6	2	23.3	Bayes-1
Palisades	1	23.3	Bayes-6	2	23.3	Bayes-1
Palo Verde 1-2-3	1	51.7	Bayes-13	3	51.7	Bayes-50
Peach Bottom 2&3	0	46.6	Bayes-42	0	46.6	Bayes-42
Perry	0	17.1	Bayes-22	0	17.1	Bayes-22
Pilgrim	0	23.3	Bayes-29	3	23.3	Bayes-44
Point Beach 1&2	0	46.6	Bayes-42	0	46.6	Bayes-42
Prairie Island 1&2	0	46.6	Bayes-42	2	46.6	Bayes-3
Quad Cities 1&2	0	46.6	Bayes-42	2	46.6	Bayes-3
Rancho Seco	0	10.0	Bayes-17	0	10.0	Bayes-17
River Bend	0	17.6	Bayes-23	1	17.6	Bayes-54
Robinson	0	23.3	Bayes-29	2	23.3	Bayes-1

Table 3-8 Unscreened Industry Loss of Offsite Power Events [9]

Site	Maintenance Induced LOOP			All Causes of LOOP		
	No. Events	Reactor Calendar years	Bayes Update Distribution ID	No. Events	Reactor Calendar Years	Bayes Update Distribution ID
Salem 1&2	0	46.3	Bayes-41	0	46.3	Bayes-41
San Onofre 1-2-3	2	54.5	Bayes-51	3	54.5	Bayes-62
Seabrook	0	13.9	Bayes-20	0	13.9	Bayes-20
Sequoyah 1&2	0	44.9	Bayes-39	0	44.9	Bayes-39
South Texas 1&2	0	29.9	Bayes-30	0	29.9	Bayes-30
St Lucie 1&2	0	43.3	Bayes-38	0	43.3	Bayes-38
Summer	1	20.6	Bayes-5	1	20.6	Bayes-5
Surry 1&2	0	46.6	Bayes-42	0	46.6	Bayes-42
Susquehanna 1&2	1	39.8	Bayes-10	1	39.8	Bayes-10
Three Mile Island 1	0	23.3	Bayes-29	1	23.3	Bayes-6
Trojan	0	12.0	Bayes-18	0	12.0	Bayes-18
Turkey Point 3&4	1	46.6	Bayes-12	4	46.6	Bayes-64
Vermont Yankee	1	23.3	Bayes-6	1	23.3	Bayes-6
Vogtle 1&2	1	30.3	Bayes-7	1	30.3	Bayes-7
Waterford	0	18.3	Bayes-25	0	18.3	Bayes-25
Watts Bar	0	7.4	Bayes-16	0	7.4	Bayes-16
WNP-2	0	19.3	Bayes-27	0	19.3	Bayes-27
Wolf Creek	0	18.1	Bayes-24	0	18.1	Bayes-24
Yankee Rowe	0	12.2	Bayes-19	1	12.2	Bayes-53
Zion 1&2	0	36.2	Bayes-35	1	36.2	Bayes-58
Total	23	**2278.1**		67	**2278.1**	

Table 3-9 Comparison of Stage 2 Bayes Updates with and without Screening for Design Differences

Case	No. Events	Reactor Years	Distribution Parameters			
			5%tile	Mean	50%tile	95%tile
Total LOOP Screened	Prior Distribution		1.49E-05	2.73E-02	1.01E-03	6.98E-02
	0	23.3	1.24E-05	3.62E-03	6.62E-04	1.69E-02
	1	23.3	1.12E-03	2.62E-02	1.56E-02	8.55E-02
	0	32	1.20E-05	3.05E-03	6.13E-04	1.42E-02
	1	32	9.40E-04	2.02E-02	1.23E-02	6.48E-02
Total LOOP Unscreened	Prior Distribution		1.88E-05	3.45E-02	1.28E-03	8.82E-02
	0	23.3	1.34E-05	3.90E-03	7.31E-04	1.82E-02
	2	23.3	8.91E-03	6.27E-02	4.94E-02	1.58E-01
	0	32	1.47E-05	3.39E-03	7.27E-04	1.56E-02
	2	32	6.93E-03	4.69E-02	3.72E-02	1.17E-01

4. CONCLUSIONS

The following conclusions were reached in this study:

- The most appropriate treatment of loss of offsite power frequency in addressing the risk significance of the March 25, 2003 event at Palisades is via Bayes analysis of industry and plant specific data. The frequentist approach does not lend itself to gaining risk insights and overstates the change in LOOP frequency. It is inappropriate to mix a frequentist estimate of the change in LOOP frequency with the Bayes estimate of the conditional core damage probability that is produced by the Palisades PRA.
- In developing the prior distributions for the Palisades plant specific Bayes' updates, the plant to plant variability in the industry data needs to be accounted for. This has been accomplished in this study for future use in PRA updates and risk significance determinations at Palisades.
- The priors developed in Reference [1] are too narrow as they do not account for plant to plant variability. This results in an understatement of the estimate of the change in frequency of loss of offsite power due to the March 25, 2003 event.
- The process of screening the industry loss of offsite power data for applicability to the Palisades design performed by Palisades is reasonable, however the author is not qualified to pass judgment on the screening of specific events due to lack of knowledge of the Palisades design.
- The sensitivity of the data analysis to effects of data screening has been quantified and shown to make a significant but not dominant effect. The results based on screening of events due to design differences should be used for any risk informed decision making and future PRA updates.

5. REFERENCES

[1] Palisades Nuclear Plant Calculation, "Impact of the Loss of Off-Site Power at Palisades on March 25, 2003, on the Initiating Event Frequency", EA-PSA-LOOP-IE-03-04 (Rev 0), June 9, 2003

[2] Palisades Nuclear Plant Calculation, "Method for Calculating the Gamma, Beta, and Lognormal Prior and Posterior Distributions", EA-PSA-DATA-99-0016, June 21, 2001

[3] Wycoff, Harvey L., "Losses of Offsite Power at Nuclear Power Plants Through 2001", EPRI Report 1002987, April 2002

[4] Kaplan, S. 1983. On a "Two-Stage" Bayesian Procedure for Determining Failure Rates from Experiential Data, in IEEE Transactions on Power Systems Apparatus and Systems, Vol. PAS-102, No. 1 pp 195-202.

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[8] Computer files used to generate this report provided under separate cover to Palisades Nuclear Plant.

[9] Computer File: "industry LOOP4.xls" last updated September 22, 2003 provided by Palisades PRA team

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