Attachment 2 [redacted]

GPU Nuclear

TECHNICAL DATA REPORT

TDR NO. 517	**REVISION NO.** 1	
BUDGET ACTIVITY NO. 121005	**PAGE** 1 **OF** 82	

PROJECT: TMI-1

DEPARTMENT/SECTION Safety Analysis/Plant Control

RELEASE DATE 1-17-84 **REVISION DATE** 5-18-84

DOCUMENT TITLE: TMI-1 Plant Specific Guidelines Derived from ATOG

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ABSTRACT:

This report provides the plant specific guidelines which form the technical content of the new abnormal plant transient procedures. These guidelines are compared to the baseline documents from which they are derived. Any differences from the baseline documents are explained. The baseline documents for the guidelines are: The Oconee and TMI-1 ATOGs; a July 2, 1983 supplemental guidance to ATOG issued by B&W; and TDR 406, "Steam Generator Tube Rupture Guidelines".

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GPU Nuclear	TDR NO. 517
TITLE TMI-1 Plant Specific Guidelines Drived from ATOG	PAGE 2 OF 82

REV	SUMMARY OF CHANGE	APPROVAL	DATE
1	PSG 2.6 - - Added step to open LPI cross connect valves if only one LPI train is operating. - Revised Step 7 to call for opening the PORV only if cooldown rate is less than 100F/hr. - Revised Step 13 to state "and primary to secondary heat transfer is available" and to instruct the operator that he should go the HPI cooling guideline. - Added a new step to have the operator start/verify LPI at 500 psi so that it will begin injection as soon as RCS pressure is low enough. - Consolidated guidance for DHR initiation/operation into PSG 2.6 (Steps 23 & 24). - Added Step 20 to address LPI throttling and maintenance of seal injection flow.	LEL 9127	5-14-84
1	PSG 2.7 - - Added caution in Step 3 to address loading of diesel generator. - Added guidance to open LPI cross-connect if only one LPI train is operating. - Deleted Step 22 (monitor for containment hydrogen) since it was redundant to Step 16.	LEL 9127	5-14-84
1	PSG 2.8 - - Moved wording about steam pressure required for EFW pump operation to Step 8.2 from Step 8.4. - Changed opening of high point vents to occur only when RCPs are off. - Changed Step 8.6 and 8.9 to state that RCPs should be left on and the operator should go to PSG 2.6. - Changed Step 9.12 to direct the operator to PSG 2.6 instead of PSG 2.9.	LEL 9127	5-14-84
1	PSG 2.9 - - Added guidance in Step 10 to initiate makeup and letdown as part of the recovery from solid operations.	LEL 9127	5-14-84
1	PSG 2.0 - - Changed HPI initiation criteria to state that the HPI pumps must be ES aligned (i.e. have proper auxiliaries and suction source). - Added guidance to RCP restart criteria that after one hour, minimum subcooling is not required in order to restart an RCP.	LEL 9127	5-14-84

GPU Nuclear

TITLE: TMI-1 Plant Specific Guidelines Derived from ATOG	TDR NO. 517
	PAGE 3 OF 82

REV	SUMMARY OF CHANGE	APPROVAL	DATE
1	Changed all references from "tube rupture" to "tube leak/rupture".	[illegible]	5-14-84
1	Changed all appropriate references from "heat transfer" to "primary to secondary heat transfer".	[illegible]	5-14-84
1	Changed all references from "feed and bleed cooling" to "HPI cooling".		
1	PSG 2.1 - Added directions to manually trip the reactor and turbine. Corrected action on loss of ICS subfeed and power to take control of ADVs instead of TBVs.	[illegible]	5-14-84
1	PSG 2.3 - Revised Step 5 to isolate both OTSGs only if: 1) leaking OTSG is not discernable and 2) it is in the intermediate building.	[illegible]	5-14-84
1	Added Steps 8 & 9 to address exits from the procedure if OTSG level/pressure or RCS flow are not established.	[illegible]	5-14-84
1	PSG 2.4 - Re-arranged steps on opening PORV and tripping one RCP per loop. Revised Step 11 to state that this action should not cause a loss of subcooling margin.	[illegible]	5-14-84
1	PSG 2.5 - Specified pressurizer level and deleted reference to "Pressurizer Level Guide". - Specified that both NPSH and fuel pin in compression limits should be waived when leak is above 50 gpm (Step 7). - New Step 8 was moved from further back in procedure to assure that ESAS was bypassed above 1600 psig. - Step 19 was changed to reference TDR 406 for emergency NPSH limits. - New Step 21 was added to clarify that steaming of the leak should be terminated once DHR initiation conditions are reached. - Rewrote the ESD guidance to be clearer.	[illegible]	5-14-84

GPU Nuclear	TDR NO. 517	
TITLE TMI-1 Plant Specific Guidelines Derived from ATOG	PAGE 4	OF 82

REV	SUMMARY OF CHANGE	APPROVAL	DATE
1	PSG 2.10: Added a section on Guideline (vice rules) - Clarified the need for NPSH for pump restart - Generalized step for Rx trip and HPI initiation at 150 inches of pressurizer level into a guideline. - Made the existing actions for restoration of EFW into a guideline. - Made criteria for natural circulation and primary to secondary heat transfer into a guideline. - Revised actions for feeding a dry OTSG and made them a guideline. - Specified the sequence of RCP pump bumps, specified the duration of a bump, and turned it into a guideline. - Provided CFT isolation criteria.	LEL MAI	5-14-84
1	Revised Sections 3.1 and 3.2 to respond to NRC questions (see Appendix A)..	LEL MAI	5-14-84
1	Added Appendix A which addressed NRC questions on TDR 517, Revision 0.	LEL MAI	5-14-84
1	Added Section 3.3 to discuss changes made to the PSGs as a result of simulator training sessions in the first half of 1984.	LEL MAI	5-14-84

TABLE OF CONTENTS

PAGE

TABLE OF CONTENTS
(Cont'd)

LIST OF FIGURES

TMI-1 PLANT SPECIFIC TECHNICAL GUIDELINES DERIVED FROM ATOG

1.0 PURPOSE

This report provides plant specific technical guidelines derived from the B&W Abnormal Transient Operating Guidelines (ATOG) developed for TMI-1. Guidelines provided in this report are the baseline document from which plant emergency procedures have been written. This report does not address the format of the procedures, nor does it include every step in the plant procedures. Other actions which are required for equipment protection, emergency plan implementation, Tech Spec compliance or which provide additional safety measures beyond the TMI-1 ATOG are not included.

This report also describes and explains differences between the TMI-1 plant specific guidelines and TMI-1 ATOG (Reference 1).

In the future in addition to other considerations regarding unreviewed safety questions, approval of the emergency procedures will include a review of the guidelines included in this report. Signature on a Procedure Change Request (PCR) will signify that the procedure meets the technical requirements of the plant specific guidelines; that the format is consistent with the procedure writers guide; and, that all other appropriate considerations have been considered i.e. that the change does not represent an unreviewed safety question.

2.0 TMI-1 PLANT SPECIFIC GUIDELINES

The TMI-1 plant specific guidelines were derived from the ATOG developed for TMI-1 by Babcock and Wilcox. That document in turn developed from the Oconee-3 ATOG which was submitted to the NRC staff for review in support of the B&W Owners Group Operator Support Committee response to staff requirements for improved emergency operating procedures.

The TMI-1 ATOG were reviewed in detail by a committee representing various disciplines. Comments from this review were discussed with B&W. As a result, the final TMI-1 ATOG was issued in April 1983. By this time, NRC staff comments on the Oconee document had in part also been incorporated into the TMI-1 volumes. Finally, on July 2, 1983, B&W provided the B&W Owners Operator Support Committee with supplementary material dealing with anticipatory transients without scram (ATWS) and interruption of natural circulation during small break LOCAs.

The plant specific guidelines were developed from the TMI-1 ATOG, the July 2, 1983 letter and existing plant emergency procedures.

Each new ATP has been compared to the baseline documents. Figures 1 through 7 provide comparisons of plant specific guidelines to the TMI-1 ATOG. ATOG steps are designated by dashed lines. Any steps deleted from ATOG are shaded. Section 3.2 explains the reasons for the differences.

The steam generator tube rupture procedures have not been compared to ATOG. The development work used to provide those guidelines not only included ATOG as source material, but also used other more recent experience and analyses. Furthermore, plant tests at TMI-1 have been used to confirm some of the analytical work upon which those procedures were based.

2.1 REACTOR TRIP (PSG 2.1)

VERIFY THE FOLLOWING:	IF VERIFICATION CANNOT BE MADE, THEN PERFORM THE FOLLOWING:
1. MANUALLY TRIP THE REACTOR	
1a. REACTOR POWER DECREASING ON INTERMEDIATE RANGE AND LESS THAN 10%	o Start full HPI from the BWST o Initiate maximum letdown flow o Maintain primary to secondary heat transfer o Manually trip 1G-02 and 1L-02

NOTE: Do not take any subsequent actions which will reduce primary to secondary heat removal until power decreases below 10%.

1b. ALL RODS HAVE INSERTED	o Begin emergency boration
2. MANUALLY TRIP THE TURBINE	
2a. ALL MAIN TURBINE STOP VALVES SHUT	Trip EH-P-1A and EH-P-1B when power is less than 10%
3. FEEDWATER HAS RUNBACK	o Verify ICS automatically running back MFW flow. o If ICS is not controlling MFW flow, take hand control and run MFW back to control OTSG level. o If MFW flow is still excessive, then trip both MFW pumps.
4. NNI/ICS POWER ON	o If all subfeed power lights are off, trip MFW pumps, and control EFW and ADVs using backup manual loader. Refer to EP 1202-40. o If any (but not all) subfeed power lights are off, then refer to plant procedures for corrective action. Remaining steps in reactor trip procedure are of higher priority than restoration of ICS/NNI subfeed power at this point.

5. AT LEAST ONE AUXILIARY TRANSFORMER HAS NORMAL VOLTAGE ON ITS SECONDARY	o Start or verify auto start and loading of at least one diesel generator. o Verify EFW. o Ensure a makeup pump is started and RCP seal injection is reestablished. o Refer to plant procedures for loss of offsite power if either one or both diesel generators fail to start.
6. VERIFY PRESSURIZER LEVEL IS ABOVE 100 INCHES	o If unable to maintain pressurizer level above 100" then open MU-V217 o If MU tank is less than 55 inches, open MU-V14A or B as necessary to maintain MU tank level greater than 55 inches. o If unable to maintain pressurizer level above 20 inches, then initiate HPI
7. NO ESAS ALARMS	<u>RCS 1600 PSIG ALARM ON COMPUTER</u> o Verify HPI and LPI channels have actuated o Verify seal injection flow <u>HI-HI BUILDING PRESSURE</u> o Verify RB spray and RB isolation have actuated

NOTE: Do not proceed beyond Step 7 unless reactor power is below 10%.

8. NO SLRDS ALARMS	o Verify main feedwater isolation of affected OTSG
9. ADEQUATE SUBCOOLING MARGIN	o Trip all RCPs o Initiate HPI o Initiate EFW and raise OTSG level to 90-95% o Go to loss of subcooling guideline (PSG 2.2)

10. PROPER PRIMARY TO SECONDARY HEAT TRANSFER EXISTS	<u>FOR EXCESSIVE HEAT TRANSFER</u> o Throttle feedwater o Isolate the steam leak o Increase makeup as necessary o Go to guideline for excess heat transfer (PSG 2.3) <u>FOR LACK OF HEAT TRANSFER</u> o Verify MFW/EFW flow and go to lack of heat transfer guideline (PSG 2.4)
11. NO MAIN STEAM LINE OR CONDENSER OFF-GAS RADIATION MONITOR ALARMS	o Refer to OTSG tube rupture guideline (PSG 2.5)
12. PROCEED TO FOLLOW-UP ACTIONS. FURTHER ACTIONS ARE THE DECISION OF THE SHIFT SUPERVISOR.	

2.2 LOSS OF SUBCOOLED MARGIN (PSG 2.2)

1. Trip all RCPs.

2. Initiate HPI. (2 pumps full flow)

3. Verify EFW has auto started.

4. Raise OTSG level to 90-95%.

5. If excessive heat transfer exists, go to excessive heat transfer guideline (PSG 2.3).

6. Isolate possible sources of leakage.

   NOTE: Do not close the PORV or block valve if the plant has been placed on feed and bleed cooling.

   (PORV Block)
   (Spray Block)
   (Letdown Block)

7. If subcooled margin has been established, go to step 13, otherwise continue.

8. If incore thermocouples indicate superheat, then go to superheat guideline (PSG 2.8).

9. If core flood tanks are emptying, go to guideline for cooldown with a large LOCA (PSG 2.7).

10. If there is lack of primary to secondary heat transfer, go to lack of heat transfer guideline (PSG 2.4).

11. If there is indication of an OTSG tube leak/rupture, go to SGTR guideline.

12. If there is primary to secondary heat transfer and subcooled margin is not being recovered, then go to procedure governing cooldown with a small break LOCA (PSG 2.6).

13. Start RCPs, when restart criteria are met, and establish pressurizer spray as follows:

    13.1 Start one RCP per loop.

    13.2 Monitor RCS pressure while opening pressurizer spray valve to detect either a failed open spray valve or a spray line leak.

    13.3 Throttle HPI in accordance with rules for HPI throttling.

14. If there is lack of primary to secondary heat transfer, go to lack of heat transfer guideline (PSG 2.4).

15. If there is indication of an OTSG tube leak/rupture, go to SGTR guideline (PSG 2.5).

16. If RCS is solid, go to procedure which governs establishment of a steam bubble or for performance of a solid RCS cooldown, otherwise continue.

17. Go to reactor trip guideline (PSG 2.1).

2.3 EXCESSIVE COOLING (PSG 2.3)

1. If HPI has not been initiated, increase makeup to maintain pressurizer level.

2. If pressurizer level cannot be maintained above 20 inches, initiate HPI.

3. If OTSG level greater than 95%, trip the mainfeed pumps.

4. Isolate the affected OTSG(s) (both if affected generator cannot be identified). Verify that SLRDS has actuated.

VALVE	OTSG A	OTSG B
MFW Startup	FW-V-16A	FW-V-16B
Main FW	FW-V-17A	FW-V-17B
TBV	MS-V-3D	MS-V-3A
	MS-V-3E	MS-V-3B
	MS-V-3F	MS-V-3C
ADV	MS-V-4A	MS-V-4B
MSIV	MS-V-1A	MS-V-1C
	MS-V-1B	MS-V-1D

5. If OTSG level and pressure did not stabilize, close the following valves on the OTSG with lower pressure.

VALVE	OTSG A	OTSG B
EFW	EF-V-30A	EF-V-30B
MS to EFW	MS-V-2A	MS-V-2B
TBVs & ADVs		

NOTE: If there is no discernable pressure difference, then isolate both OTSGs if the leak is in the intermediate building.

6. If OTSG pressure and level stabilize on either generator, restore main or emergency feed to the good generator(s).

7. If subcooled margin is lost, go to loss of subcooling procedure.

8. If unable to restore level and pressure control in at least one OTSG before primary to secondary heat transfer is lost, then initiate HPI cooling and go to guideline governing HPI cooling.

9. If RCS flow is interrupted but OTSG level and pressure control exists, then go to guideline governing lack of heat transfer.

10. If OTSG tube rupture/leak is indicated, then go to tube rupture guideline (PSG 2.5).

11. Feed one or both OTSGs to maintain level and control OTSG pressure to stabilize RCS cold leg temperature.

12. Control RCS heatup and pressurization to prevent pressurized thermal shock.

13. Control cooldown rate to limit shell/tube delta T less than 70F°.

14. Go to reactor trip guideline (PSG 2.1).

2.4 LACK OF HEAT TRANSFER (PSG 2.4)

1. If feedwater is available, go to step 8, otherwise continue.

2. Initiate FW.

   2.1 Start all the EFW pumps and open EFW injection valves.

   2.2 If EFW is not available, use main FW.

   2.3 If neither MFW nor EFW are available, then attempt to restore EFW using plant procedure

3. Reduce the number of RCPs to one per loop.

4. If RC pressure increases to the PORV setpoint, go to step 6, otherwise continue.

5. If feedwater is re-established, go to step 8, otherwise continue.

6. Establish HPI Cooling.

   6.1 Initiate HPI (2 pumps full flow)

   6.2 Open PORV block valve

   6.3 Open PORV

   6.4 Run one RCP as long as adequate subcooled margin exists.

7. Go to HPI cooling guideline (PSG 2.9).

8. Reduce the number of RCPs to one per loop.

9. Attain appropriate OTSG level based on RCP availability and subcooled margin.

10. If the CFTs are emptying, then cool down using procedures that govern cooldown from a large LOCA with CFTs emptying.

11. If while attempting to re-establish heat transfer, RCS pressure increases to the PORV setpoint, then open the PORV until RCS pressure decreases to about 100 psi above OTSG pressure. Do not cause a loss of subcooling margin due to the depressurization.

12. Lower OTSG pressure until secondary Tsat is 40 to 60F° lower than incore T/C temperature. Maintain OTSG level.

13. If primary to secondary heat transfer is re-established, go to step 19, otherwise continue.

14. If RCPs are not available, then initiate HPI cooling and go to guideline governing HPI cooling (PSG 2.9).

15. If RCS cooldown rate is less than the maximum allowable by Tech Specs, then use RCP bumps to induce heat transfer (note: pump NPSH limits do not apply).

    Note - during the pump bumping process, continue at Step 2.15 and use all other appropriate procedures.

    15.1 Bump either RCP in the loop with the highest OTSG level.

    15.2 Allow RCS pressure to stabilize and determine whether heat transfer is established.

    15.3 If primary to secondary heat transfer is established by the pump bumps, then go to 2.11, otherwise continue.

    15.4 After 15 minutes repeat 2.7.1 through 2.7.3 using another RCP. Continue until heat transfer is established or all four RCP bumps have been completed. Do not bump any one pump at less than 30 minute intervals. (Refer to OP 1101-1).

    15.5 If cooldown rate cannot be controlled below Tech Spec limit, then go to small break LOCA procedure without trying to induce primary to secondary heat transfer.

16. Lower OTSG pressure to induce primary to secondary heat transfer.

    16.1 Decrease OTSG pressure until secondary Tsat is 90 to 100F° lower than incore T/C temperature. Maintain OTSG level.

17. If one hour has passed since reactor trip and an RCP is operable, then start and run one RCP. Observe all pump limits, including emergency NPSH limits.

18. If primary to secondary heat transfer has not been re-established, then initiate HPI cooling and go to procedure governing feed and bleed cooling.

19. Verify primary to secondary heat transfer is established then recover from HPI cooling, if initiated.

    19.1 Close PORV

    19.2 If the PORV does not close, then close PORV block valve

    19.3 Throttle HPI, if permitted

20. Control OTSG pressure to stabilize RC temperature.

21. If OTSG tube rupture/leak is indicated, then go to tube rupture procedure.

22. If subcooled margin does not exist, cooldown per procedure governing cooldown after a small break LOCA.

23. Return to reactor trip guideline (PSG 2.1).

2.5 OTSG TUBE LEAK/RUPTURE (PSG 2.5)

NOTE

Entry point condition for this guideline is either from another ATP or when tube leakage is greater than or equal to 1 gpm.

NOTE

For guidance within the abnormal transient procedure an OTSG tube leak is defined as a greater than 1 and less than 50 gpm, while a rupture is greater than or equal to 50 gpm.

IMMEDIATE ACTIONS

1. If the reactor was not tripped;	THEN close MU-V-3 and begin to reduce load at a rate specified by Shift Supervisor to minimize the risk of a MSSV lifting.
2. If the reactor was tripped;	Then complete the immediate actions of the reactor trip procedure and, proceed with plant cooldown per this procedure.

FOLLOW-UP ACTIONS

1. Continue to reduce power to less than 20 percent at the selected load reduction rate.

NOTE

When removing the first main feed pump (40 percent power), remove the feed pump that is being steam fed from the affected OTSG if known. Remove the feed pump per OP 1102-10.

2. By sampling OTSG's, surveying steam lines, observation of OTSG levels and feed rates, determine affected OTSG.

NOTE

Most affected OTSG should indicate higher level, lower feed rate, and/or higher Beta-Gamma, H^3, Na^{24}, I-133 and CS^{-137} sample results.

CAUTION

When the turbine is tripped it may be necessary to take manual control of turbine bypass valves to maintain secondary pressure below the main steam safety valve setpoints.

3. At less than 15 percent PWR take the turbine to manual and unload to "0" MWE. Verify that the turbine bypass valves automatically control header pressure below safety valve setpoints. At "0" MWE trip the turbine while closely monitoring OTSG pressure. Observe turbine stop valves closed.

CAUTION

The following power reduction and Rx trip will cause a significant RCS shrinkage, insure sufficient makeup to maintain normal pressurizer level. If pressurizer level cannot be maintained above 150 inches, initiate HPI.

4. Place the diamond in manual and continue reducing Rx Pwr to less than 5%. When less than 5% reactor power, take manual control of the turbine bypass valves and then trip the reactor. Immediately adjust TBV closed to control the initial cool down following reactor trip and control OTSG pressure to prevent safety valve operation.

5. If the OTSG level rule of 90-95% is in effect, raise the unaffected OTSG to 90-95% before raising the affected OTSG to 90-95%.

6. Steam both OTSGs to reduce RCS to less than 540°F.

7. While reducing the RCS temperature to 540F, turn off PZR heaters and start pressurizer spray to depressurize RCS, which minimizes the subcooled margin. The pressurizer vent may be used to reduce RCS pressure. If the pressurizer vent is not sufficient, the PORV may also be used.

NOTE

a. Minimizing subcooling margins above 25F° will cause RCS temp/press to violate the fuel pin compression curve. For tube leaks (less than 50 gpm), fuel pin compression curves should not be violated.

b. If tube leaks are greater than 50 gpm, follow emergency NPSH limits.

8. When RCS pressure is controlled and subcooling margin exists, bypass ESAS at normal bypass pressure setpoints.

9. When SCM has been minimized, control the turbine bypass valves and commence plant cooldown at less than 100°F/hr (1.6°F/min).

10. Reduce RCPs to one per loop, when the additional spray is no longer required to control SCM. RCPs must be reduced to less than 4 RCPs before RCS temp is decreased below 500°F.

NOTE

Keep RC-P-1A on for PZR spray.

11. Monitor shell to tube delta T and maintain it less than 70F° using MFW. If the OTSG is dry feed with minimal MFW. If the shell to tube limit is approached while steaming, reduce or secure the cooldown rate as necessary.

12. Confirm affected OTSG by sampling.

13. With RCS hot leg and incore thermocouples temperatures less than 540°F, only isolate the affected OTSG if BWST level is less than 21 ft. or off-site dose projections approach 50 mr/hr whole body or 250 mr/hr thyroid.

14. If required to isolate the affected OTSG(s), close the following:

NOTE

Assure MFP is being fed from unaffected OTSG or auxiliary steam. Assure gland steam is from the auxiliary boiler.

MS-V-1A and B or C and D
FW-V-17 A or B
FW-V-5 A or B
FW-V-16 A or B

FW-V-92 A or B
FW-V-85 A or B
EF-V-30 A or B
MS-V-92
MS-V-89 A and B or C and D
MS-V-13 A or B (close manual hand wheel)
MS-V-10 A or B
MS-V-3 D/E/F or A/B/C

15. If both OTSGs are required to be isolated and can no longer be used as a heat sink use guideline governing HPI cooling (PSG 2.9) in conjunction with this guideline.

NOTE

If OTSG pressure cannot be maintained less than 1000 psig, protect against any challenge to the MS code safety valves by opening the turbine bypass and/or atmospheric dump valves. This step must be followed regardless of other isolation criteria.

16. Affected OTSG must be steamed without exceeding the cooldown rate limits to maintain less than 95 percent on operate range and less than 70F° tube to shell delta T, unless either the BWST less than 21 ft. or off-site dose projections approach 50 mr/hr whole body or 250 mr/hr thyroid.

NOTE

Under emergency conditions, blocking/pinning of MS hangers when flooding the applicable MS lines is not necessary. If the MS lines are filled without blocking/pinning of the MS hangers, an engineering evaluation of the structural integrity of the MS lines must be performed prior to resuming normal operations.

17. Maintain less than or equal to 100F°/hr (1.6°F/min) cooldown rate by steaming both OTSGs. If the cooldown rate is greater than 100F°/hr (1.6°F/min) due to three pump HPI cooling, secure the non-ES selected MU pump and observe HPI throttling criteria below for the two ES selected MU pumps.

18. If subcooled margin exists, isolate CF-V-1A/B when RCS pressure is less than or equal to 700 psig.

19. For other than tube rupture, refer to NPSH curve in Figure 1 and 1A of OP 1102-11. Refer to TDR 406 for rupture emergency NPSH limits for one RCP in each loop operation.

NOTE

> The emergency NPSH and SCM limits are plotted on a composite graph but are verified using different instruments. Therefore, due to differing instrument accuracies, verify correct and safe relative position using other available instrumentation (i.e. SCM meter).

20. Decay heat removal may be initiated at 300°F by first tripping all RCPs if the consequences of losing RCS loop forced flow are acceptable (i.e. hot leg steam bubble or high shell/tube differential pressure).

21. Steaming of the affected OTSG should be terminated once DHR initiation conditions have been reached.

EMERGENCY SUPPORT DIRECTORS ISOLATION GUIDE

GENERAL INFORMATION

RCS COOLDOWN RATE

Isolation of one or both OTSGs reduces cooldown rate: this increases time to cold shutdown and leak termination.

DOSE RATE

Isolation of OTSGs when both are leaking may increase the integrated dose: this is because releases will continue from the other OTSG while cooldown time is increased.

ATMOSPHERIC RELEASES

1. Isolation of both OTSGs requires feed and bleed cooling, which might result in releases of steam or steam and water directly to the atmosphere if the ADVs or safety valves fail open.

2. Stopping direct steam releases to the atmosphere reduces offsite thyroid dose by a factor of at least 8.

OTSG FLOODING

Isolated OTSGs may flood after which it may not be possible to re-initiate steaming.

AVOID ISOLATING OTSGs WHEN:

A. RCPs ARE NOT AVAILABLE - natural circulation cooldown may not be possible with one OTSG since flow in one loop might stagnate and a bubble could form in the hot leg as primary pressure is reduced.

B. BOTH OTSGs LEAK BUT THE DIFFERENCE IN LEAK RATE IS LESS THAN A FACTOR OF EIGHT - otherwise, the delay in cooldown may negate the dose reduction from isolating one OTSG.

CONSIDER ISOLATION WHEN

1. RCPs ARE OPERATING
2. CONDENSER UNAVAILABLE
3. ONLY ONE OTSG IS LEAKING

   AND

4. IODINE DOSE RATES ARE UNDESIRABLE

NOTE

Although cooldown time is increased, radioactivity releases will be terminated and RCP operation enables control of the RCS which in turn allows cooldown of the leaking OTSG.

RE-EVALUATE OTSG ISOLATING CRITERIA WHEN

A. 1. RCPS OPERATING
2. CONDENSER UNAVAILABLE
3. BOTH OTSGs LEAKING
AND
4. IODINE DOSE RATES ARE UNDESIRABLE

Isolation of one OTSG may be desirable if the leak rate in one OTSG is significantly (about 8 times) greater than in the other. The reduced dose rate from isolation of one OTSG must be weighed against the shorter cooldown time with steaming both OTSGs.

B. CONDENSER AVAILABLE

Isolation of one or both OTSGs greatly increases cooldown times and increases risk of inadvertent or uncontrolled releases. A decision to isolate earlier than required by procedural guidelines should be based on measured dose rates if possible. In the absence of fuel failures, actual releases under such conditions are expected to be quite low.

C. ONLY ONE OTSG IS LEAKING AND BWST LEVEL IS BELOW 21 FEET

If the good OTSG is not expected to leak because shell/tube delta T is being controlled, then isolation is not required. Recall that the BWST level was based on both steam lines being flooded. If only one OTSG may be flooded, then BWST depletion could not occur until level reaches 15 feet.

TEMPORARY DOSE REDUCTION

The following short term measures will temporarily reduce or terminate releases. These steps may provide enough time to return an RCP to operation, restore a condenser to service, or initiate protective actions, while delaying the initiation of feed and bleed cooling.

A. While one RCP is running DO NOT steam to the atmosphere OR to the condenser.

B. IF forced circulation is lost THEN steam again.

C. IF steam generator pressure increases to 1000 psig THEN steam again.

NOTE

RCS heatup rate will be about 100-170F°/hr at one hour after reactor trip.

SUMMARY

STATUS		8 TIMES MORE LEAKAGE IN ONE OTSG THAN THE OTHER	
ANY RCP AVAILABLE	CONDENSER	YES	NO
Yes	Available	Avoid Isolation	Avoid Isolation
Yes	Not Available	Consider Isolation	Avoid Isolation Of One OTSG
No	Available	Avoid Isolation Of One OTSG	Avoid Isolation Of One OTSG
No	Not Available	Avoid Isolation Of One OTSG	Avoid Isolation Of One OTSG

2.6 COOLDOWN AFTER A SMALL BREAK LOCA (PSG 2.6)

1. Verify that loss of subcooled margin is being treated.

   1.1 HPI initiated (2 pumps full flow).

   1.2 All RCPs are tripped.

   1.3 EFW actuated and OTSG levels being increased to 95%.

2. Verify that reactor trip containment isolation has occurred.

3. Verify that 1600 psi and 4 psi containment isolation has occurred.

4. If only one LPI train is operating, open cross-connect valves (DH-V38 A/B) and provide at least 1000 gpm per line.

5. If CFTs have emptied, go to large break LOCA guideline (PSG 2.7).

6. Maintain primary to secondary heat transfer by reducing OTSG pressure.

7. If primary to secondary heat transfer cannot be established in accordance with lack of heat transfer procedure and the RCS cooldown rate is less than 100F/hr, open the PORV and keep it open until heat transfer established or LPI is in operation.

8. If at any time the RCS becomes superheated, then go to ICC procedure.

9. If at any time indications of OTSG tube rupture occur, then go to tube rupture procedure.

10. Verify containment cooling.

11. Maintain RCP seal injection and seal cooling to assure long term availability of the RCPs.

12. Control HPI and restart RCPs when conditions are met.

13. If RCS is solid and subcooled and primary to secondary heat transfer is available, refer to guideline for establishing pressurizer steam bubble (PSG 2.9).

14. Monitor steam generator shell to tube delta T. Maintain 70F by either using MFW, steaming the OTSG, or limiting the cooldown rate.

15. Cooldown at approximately 100F°/hour (1.6F°/minute) while complying with shell to tube delta T limit.

16. If subcooling margin is regained, then core flood isolation valves may be closed when RCS pressure goes below 700 psig.

17. Verify or start LPI when RCS pressure is below 500 psi.

18. Monitor BWST level. If a source of borated water is available, makeup to the BWST to avoid transfer to the RB sump while the HPI pumps are on.

19. When BWST level reaches 36 inches (Lo-Lo level alarm) switch LPI suction to the building sump. Establish HPI/LPI operation in the "piggyback" mode.

20. When LPI flow has been in excess of 1000 gpm in each injection line for at least 20 minutes, then stop HPI. Maintain RCP seal injection.

21. Monitor RB hydrogen levels. Start the Hydrogen Recombiner if hydrogen level reaches 0.5%.

22. Monitor RB sump for ph, boron concentration, and isotopic analysis. Add sodium hydroxide through the DHR system as required to control ph.

23. When DHRS cut-in conditions are met and the flow in a single LPI injection line alone is sufficient to make up RC inventory, align the LPI in the following manner.

    If BWST level is above 36 inches:

    23.1 Continue to supply RCP seal injection with HPI/LPI piggyback.

    23.2 Establish core cooling with LPI Loop A (or B) in DH mode.

    23.3 Maintain LPI Loop B (or A) suction from the RB sump.

    23.4 Close the PORV.

    23.5 Close the PORV block valve if necessary.

    23.6 Establish a bubble in the PZR if possible.

    23.7 Stop RCPs if on.

If BWST level is below 36 inches:

23.8 Place both LPI pumps in the DH mode taking suction from the DH drop line. Continue to supply makeup, as necessary with the HPI pumps.

23.9 Close the PORV.

23.10 Close block valve, if necessary.

23.11 Establish pressurizer bubble.

24. Continue cooldown to cold shutdown

24.1 When the RCS depressurizes to less than 150 psig, then verify closed all high point vents.

24.2 Monitor core delta T by comparing incore thermocouple and DH cooler outlet temperature.

24.3 Continue RCS cooldown to 140F.

2.7 COOLDOWN WITH A LARGE BREAK LOCA (PSG 2.7)

1. Verify that HPI and LPI pumps are operating and valves have opened.

2. Verify that both core flood valves are operating and that 30 psig containment isolation has occurred.

3. Verify that RB spray / RB cooling are operating.

CAUTION: 1 DO NOT START ANY 4kv OR 6.9kv DURING BLOCK LOADING.
2. DO NOT ATTEMPT TO OPERATE ES VALVES TO THE NON-ES POSITION UNTIL THE ES SIGNAL IS BYPASSED.

4. Verify RB isolation by checking the indicating lights for each valve on control room panel.

5. If only one LPI train is operating, open cross-connect valves and provide at least 1000 gpm per line.

6. Monitor steam generator shell to tube delta T. Maintain 70F by either using MFW, steaming the OTSG, or limiting the cooldown rate.

7. If RCS pressure is above the maximum pressure for LPI operation, then establish primary to secondary heat transfer.

   7.1 If RCS is not below the pressure for LPI operation in about 20 minutes, then go to the procedure for cooldown from a small break LOCA.

8. Close MS-V-1A, B, C and D.

9. If superheat is indicated by incore T/C then go to ICC procedure.

   NOTE: Superheat may be indicated for 5-10 minutes after a large break LOCA.

10. Monitor BWST and Sodium Hydroxide tank levels. Verify Hydroxide is being injected to control ph.

11. Stop non-essential secondary equipment when time permits.

12. Throttle LPI/BS pumps only if required to prevent pump runout (LPI 3500 gpm, BS 1800 gpm).

13. If LPI flow has been greater than 1000 gpm in each line for 20 minutes, then, when HPI throttling criteria is met, HPI pumps may be secured.

14. Open DH-V-64 and MU-V-198 before recirculation is established from the RB sump.

15. If BWST level reaches 36 inches (LO-LO level alarm) before HPI flow can be secured, then establish HPI/LPI operation in the "piggyback" mode.

    Otherwise, switch LPI suction to the building sump when BWST level reaches 36 inches.

16. Monitor RB hydrogen levels per plant procedures. Start the hydrogen recombiner if hydrogen level reaches 0.5% using plant procedures.

17. Stop emergency feedwater when LPI or DHR is in operation.

18. Start spent fuel cooling if electrical load permits.

19. Stop RB spray pumps when RB pressure is less than 4 psig.

20. Assess auxiliary building radiation levels and establish one of the long term recirculation modes within 24 hours to provide a boron dilution path.

21. Monitor RB sump for ph, boron concentration, and isotopic analysis. Add sodium hydroxide through the DHR system as required to control ph.

2.8 RCS SUPERHEAT (PSG 2.8)

1. Verify HPI and LPI have been initiated (all available pumps).

2. Verify OTSG levels between 90-95% on the operating range.

3. Decrease OTSG pressure to achieve 100F°/hr decrease in secondary saturation temperature.

4. Verify core flood valves are open.

5. Initiate 4 psig containment isolation.

6. If RCS pressure is greater than 2300 psig, open the PORV. Close the PORV when RCS pressure decreases to 100 psig above OTSG pressure.

7. Determine region on PT curve of Figure 9.

REGION	PROCEDURE
Lack of Subcooling Margin	Lack of subcooling margin procedure.
1	Steps 1-6 above
2	Step 2
3	Step 3

8. Incore Thermocouple Temperature in Region 2 of Figure 9 (clad temperature above 1400F)

   8.1 Start one RCP per loop if possible without defeating interlocks.

   8.2 Decrease OTSG pressure to 400 psig or to achieve a 100F° decrease in secondary Tsat. Do not go below steam pressure required for turbine driven EFW pump (150 psig) unless both motor driven pumps or auxiliary steam is available.

   8.3 If the RCPs are off, open hot leg, head and pressurizer vents.

   8.4 Continue to decrease OTSG pressure to maintain a 100F°/hr decrease in secondary Tsat.

   8.5 Monitor reactor building hydrogen levels, start the recombiner if hydrogen concentration is greater than 0.5% and RB pressure is less than 10 psig.

8.6 If primary to secondary heat transfer cannot be established, open the PORV and block valve and keep them open. When RCS returns to saturation, leave RCPs on and go to guideline governing cooldown from a small break LOCA (PSG 2.6).

8.7 If primary to secondary heat transfer is established, cycle the PORV to maintain RCS pressure at 25 to 100 psig above OTSG pressure.

8.8 Continue to monitor incore thermocouple temperature using Step 7.

8.9 If the RCS returns to saturation condition, then leave the RCPs on and go to the guideline governing cooldown following a small break LOCA (PSG 2.6).

9. Incore Thermocouple Temperature in Region 3 of Figure 9 (clad temperature above 1800F).

9.1 Defeat starting interlocks and start all available RCPs. Do not defeat overload trips.

9.2 Decrease OTSG pressure as rapidly as possible. If auxiliary steam or EF-P-2A and EF-P-2B are available (150 psig if not), then decrease OTSG pressure to atmospheric pressure. Otherwise keep pressure above the minimum necessary to power the steam driven EFW pump.

9.3 Open the PORV block valve and PORV.

9.4 Open hot leg vents, head vent and pressurizer vents.

9.5 Operate all available normal and emergency RB fans to promote mixing of RB atmosphere. Caution: Do not use emergency fans in high speed.

9.6 Monitor reactor building hydrogen levels start the recombiner if hydrogen concentration is greater than 0.5% and RB pressure is less than 10 psig.

9.7 Continue full HPI and LPI and maximum available primary to secondary cooling until incore T/C temperatures reach saturation temperature, then continue.

9.8 If RCS pressure is less than 150 psig, then close the PORV and high point vents. Re-open the PORV and/or vents to maintain RCS pressure less than 150 psi.

9.9 Decrease running RCPs to one per loop.

9.10 Maintain OTSG pressure as per step 9.2.

9.11 If RCS becomes superheated, go to step 1 of this procedure.

9.12 Go to guideline governing cooldown from a small break LOCA (PSG 2.6).

2.9 HPI COOLING/RECOVERY FROM SOLID OPERATIONS (PSG 2.9)

1. If HPI cooling is required, then start two HPI pumps and open the PORV block and PORV.

2. Initiate 4 psig containment isolation.

3. If subcooled margin is regained, then throttle HPI and start one RCP.

4. If superheat occurs, then go to superheat guideline (PSG 2.8).

5. Attempt to establish OTSG heat removal if plant conditions permit, in accordance with PSG 2.4

6. If OTSG tube leak/rupture is indicated, use guideline for OTSG tube rupture concurrently with this guideline.

7. Monitor shell/tube delta T. Maintain 70F° by either using MFW, steaming the OTSG, or controlling the cooldown rate, depending on equipment availability and limitation on OTSG steaming.

8. If OTSG heat removal capability does not exist, go to PSG 2.6.

9. If subcooled margin is maintained and RCS pressure is below 700 psia, then the core flood tank isolation valves may be closed.

10. If OTSG heat removal is established, then recover from HPI cooling. Otherwise, go to Step 12.

    10.1 Establish makeup and letdown.

    10.2 Run one RCP in each loop per ATP 1210-10.

    10.3 Close PORV and all high point vents, while steaming the OTSGs sufficiently to control RCS temperature and pressure.

    10.4 Establish a steam bubble in accordance with plant procedure.

11. If subcooling margin is not restored, or if a known RCS leak exists, then go to guideline governing cooldown with a small break LOCA (PSG 2.6).

12. Continue cooldown using OP 1102-11.

2.10 RULES AND GUIDELINES (PSG 2.10)

I. The following rules are to be followed whenever the plant is at power, heating up, or cooling down.

1. Determination Margin to Saturation

   a. The margin to saturation is determined by: The saturation monitor and/or the average of the five highest operable incore thermocouples; and RC narrow or wide range pressure indication.

   b. Minimum margin to subcooling is 25F°.

2. High Pressure Injection (HPI) Initiation Criteria

   Initiate two HPI pumps must be initiated at full capacity, and ES aligned when:

   a. 1600 psig ESAS has auto initiated or

   b. Subcooling margin is less than 25F°, or

   c. Neither OTSG is available as a heat sink

3. High Pressure Injection (HPI) Throttling Criteria

   Throttle HPI only if one or more of the following criteria are met:

   a. HPI must be throttled to prevent pump runout (550 gpm/pump).

      NOTE: Do not throttle to less than 500 gpm/pump unless one of the below criteria (b, c or d) is met.

   b. HPI must be throttled to prevent violation of the applicable brittle fraction/thermal shock curve limitations.

   c. HPI may be throttled if LPI flow is greater than 1000 gpm in each line and stable for 20 minutes.

   d. HPI may be throttled if the required 25F° subcooling margin exists and pressurizer level is established greater than 0".

      CAUTION: Monitor total make-up flow to maintain at least 40 gpm per pump. Open MU-V-36 and MU-V-37 whenever HPI is manually throttled to less than 400 gpm per pump.

4. Reactor Coolant Pump (RCP) Trip Criteria

   a. If 25F° subcooling margin is lost, immediately trip all operating Reactor Coolant Pumps (RCPs).

      NOTE: If 25F° subcooling margin is lost and all operating RCPs are not tripped within two minutes, then run one RCP per loop for at least two hours.

   b. If 25F° subcooling margin is lost immediately following an RCP restart and does not return within 2 minutes, the RCPs must be tripped again and not restarted until 25F° subcooling margin is regained.

   c. If one hour has passed since reactor trip, lack of SCM does not prevent RCP restart.

5. Emergency Feedwater (EFW) Throttling Criteria

   a. To prevent RCS overcooling due to excessive feed rates, manually control EFW flow as necessary to maintain OTSG pressure to within 100 psig of desired pressure. Monitor RCS cold leg temperature to insure that EFW flow is not causing a significant RCS temperature transient.

   b. To insure adequate EFW flow, verify decreasing incore T/C temperature. If incore T/C temperatures are not decreasing increase EFW flow to at least 450 gpm (225 gpm per SG) until level setpoint is reached. If incore T/C's are decreasing, the overcooling criterion takes priority.

6. OTSG Level Rule

   a. If 25F° subcooling margin is lost, raise level in the operable OTSG(s) to 90-95% on the operating range.

      NOTE: If the loss of subcooling margin was due to a loss of secondary system pressure, do not raise level in the affected OTSG(s) until pressure control is regained.

   b. At least 30 inches startup range with RCPs on.

   c. At least 50% with RCPs off.

II. GUIDELINES

The following guidelines are to be treated as procedural steps which are applicable any time the plant is at power, heating up or shutting down.

1. Reactor Coolant Pump (RCP) Restart Criteria

   A. RCP(s) may be restarted if the minimum emergency NPSH is available and subcooling margin is greater than or equal to 25F°.

   B. If one hour has passed since reactor trip, lack of SCM does not prevent RCP restart.

2. Pressurizer Level Control

   If the reactor is not tripped and pressurizer level cannot be maintained greate~ than or equal to 150 inches, then trip the reactor and init te HPI.

3. Emergency Feedwater (EFW) Actuation Response

   When EFW actuates, respond as follows:

   A. Verify EF-P-1, 2A, 2B start.

   B. Verify discharge pressure greater than 1010 psig.

   C. Verify EFW flow by flow indication if below OTSG level setpoint.

   D. Dispatch an Auxiliary Operator (AO) to EF-V-30A/B. Take manual control of these valves in the event that emergency feedwater cannot be established from the control room.

   -

   NOTE

   This AO shall perform no other duties until EFW flow to the OTSG(s) has been verified by the control room.

   -

   E. Verify EF-V-30A/B control OTSG(s) level at setpoint.

4. Reactor Coolant System (RCS) Natural Circulation Verification

   Verify natural circulation by each of the following:

- -

NOTE

Indication of natural circulation may not stabilize for 15 to 30 minutes.

- -

1. RCS Delta T increases to approximately 30°F to 50°F (dependent on decay heat) and stabilizes and Th is less than 600°F.

2. Incore thermocouple temperatures stabilize, and are tracking T_H.

3. Cold leg temperatures approach saturation temperature for secondary side pressure (normally within 5 minutes).

4. Verify heat removal from OTSGs.

   a. Steam flow indication.
   b. Feed flow indication.

5. Primary to Secondary Heat Transfer Recognition

Primary to secondary heat transfer is defined by all of the following:

1. OTSG level and pressure control;
2. RCS T_C controlled by OTSG pressure;
3. Forced or verified natural RCS circulation

- -

NOTE

Boiler-condenser cooling is not primary to secondary heat transfer in the context of the actions following re-establishment of primary to secondary heat transfer.

- -

6. Feeding Dry OTSG

1. Feed a dry (less than 18" SU range) OTSG with main feedwater if available.

2. Feedrate not to exceed 0.05×10^5 lbm/hr until OTSG pressure has been restored and is stable.

3. If MFW is not available, use EFW in accordance with EFW throttling criteria (maintain shell to tube delta T less than 70°F).

7. RCP Bump Guide

An RCP "bump" is closure of the pump breaker for 10 seconds to establish momentary flow over the hot leg.

If less than four (4) RCPs are available, the following sequence should be used:

Three (3) RCPs - "bump" a pump every 15 minutes, alternating loops.

Two (2) RCPs - "bump" a pump every 15 minutes alternating pumps.

One (1) RCP - "bump" the pump two times, 30 minutes apart.

NOTE

NPSH limit does not apply for RCP bumps.

1. Determine which RCP is to be bumped based on primary pressure and temperature, OTSG level and pressure and the desired effect of the RCP bump.

2. Bump the selected RCP.

3. Allow RCS pressure to stabilize and determine whether primary to secondary heat transfer is established.

8. CFT Isolation Guide

CAUTION

Do not isolate CFTs if there is no other source of core cooling available and CFT pressure is above 250 psig.

Isolate the core flood tanks if: 1) subcooling margin exists and RCS pressure is below 700 psig, or; 2) when CFT pressure goes below 250 psig.

3.0 DIFFERENCES BETWEEN PLANT SPECIFIC GUIDELINES AND ATOG

This section describes differences between the TMI-1 Abnormal Transient Operator Guidelines (ATOG) and the plant specific guidelines of Section 2.0. Each difference is described below, with an explanation of ATOG, the plant specific guidelines, and the reason for the difference.

3.1 DIFFERENCES IDENTIFIED DURING REVIEW OF FINAL ATOG

The TMI-1 ATOG Implementation Committee reviewed the final TMI-1 ATOG (issued April 1983) to confirm that it represented an appropriate basis for the plant specific guidelines. That review showed that the committee's comments on the technical content of the TMI-1 ATOG had been incorporated. However, some changes to the TMI-1 ATOG were identified as desirable before use in the plant specific guidelines. Section 3.1 discusses differences between ATOG and the plant specific guidelines which were identified by the Implementation Committee.

3.1.1 HPI Start Criteria

ATOG requires initiation of HPI whenever subcooling margin is lost or Engineered Safeguards Actuation System (ESAS) is automatically initiated. ATOG requires HPI initiation within the loss of heat transfer section if feedwater cannot be restored.

The TMI-1 plant specific guidelines require HPI to be initiated if neither OTSG is available as a heat sink rather than if feedwater cannot be restored. Moreover, this requirement was made a rule to keep all of the conditions for HPI initiation in one location. Loss of the OTSG heat sink is considered a better criterion than feedwater unavailability. At low power levels, the OTSG may take a long time to boil dry even if feedwater is unavailable. Conversely, at high power levels, loss of the OTSG as a heat sink will occur rapidly and does not require the operator to interpret when feedwater is unavailable (i.e. how long should the operator continue trying to restore feedwater before initiating HPI).

Lack of primary to secondary heat transfer can be determined from a number of existing plant indications:

1. The P-T plot shows a lack of OTSG heat transfer as a condition in which RCS cold leg temperature is about 35F higher than the OTSG saturation temperature.

2. Guideline (PSG 2.10 II.4) defines primary to secondary heat transfer as:

   a. OTSG level and pressure control
   b. RCS cold leg temperature being controlled by OTSG pressure, and
   c. Forced or natural RCS circulation

3. Natural circulation is defined in PSG 2.10) as:

   a. Core dT of about 30-50F
   b. Incore thermocouples stable and tracking hot leg temperature
   c. Cold leg temperature approaching saturation temperature for OTSG saturation pressure, and
   d. Indication of steam and feed flow

Without all of these above indications, the operator treats a lack of primary to secondary heat transfer. When this diagnosis is made, PSG 2.4 directs starting HPI if main and EFW cannot be established. This is the Oconee ATOG action.

TMI-1 ATOG Part II, Volume 1, illustrates the timing during a loss of heat sink. Figure 15 of the section entitled "P-T Diagram", shows that the OTSGs are nearly dry at 100 seconds, and pressure begins to decrease and cold leg temperature trends away from OTSG saturation temperature. Subcooling margin is not lost until 30-40 minutes after the trip. Therefore, HPI initiation on indication of a loss of heat sink will occur well before loss of subcooling margin. All of the seven conditions discussed above are manifested before a loss of subcooling margin.

3.1.2 HPI Throttling Criteria

TMI-1 ATOG does not recommend the operation of all three HPI pumps except under conditions of inadequate core cooling. The plant specific guidelines only tells the operator to shut off the third pump if the RCS cooldown rate exceeds 100F°/hr. If an ESAS signal occurs, all three HPI pumps would be running if offsite power were available. The B&W guidance would require the operator to take action to stop a pump. If the non-ES pump is tripped, it can only be restarted after operating a switch on switchgear outside the control room. If an ES pump is tripped, it can only be restarted after the ESAS signal is bypassed. Leaving all three HPI pumps running improves overall availability. Cavitating venturies limit HPI flow, and excessive cooldown is precluded by guidance to stop the third pump if cooldown rates exceed 100F°/hr. Guidance is provided to the operator for preventing depletion of the MU tank. The elevation of the tank at Unit 1 prevents drawdown once HPI is being drawn from the BWST. On the other hand, the operator is not required to run three pumps, so that one pump can be stopped once the plant condition is stabilized.

3.1.3 RCP Trip Criteria

ATOG calls for all four reactor coolant pumps to be tripped within two minutes of a loss of subcooling margin. If the pumps are not tripped within two minutes, then all four pumps should be left on unless mechanical damage is likely. In this case, only one pump per loop should be left running.

The plant specific guidelines have the operator trip the pumps upon loss of SCM; however, if they are not tripped within two minutes then he should run one pump per loop, regardless of whether mechanical damage is likely. Otherwise, the plant specific guidelines are the same as ATOG. This difference in the pump trip criteria was taken because it is easier for the operator (i.e. one RCP per loop is standard practice) and eliminates an evaluation of whether mechanical damage is likely.

3.1.4 RCP Bump Criteria

ATOG calls for the bump of any one pump at no more than a one hour interval. The plant specific guidelines allow any one pump to be bumped at 30 minute intervals instead of at 1 hour intervals as specified by TMI-1 ATOG; a different pump will be bumped at 15 minute intervals. This change allows four "bumps" within an hour even when only two RCPs are operable. OP 1101-1 "Plants Limits and Precautions" specifies at least 40 minutes between starts on a non-running motor after 2 consecutive starts but no time limits for the first two starts. Therefore, with two or more pumps available for bumps, the limits and precautions are met by bumping every 15 minutes. With one pump running, that pump would be bumped at 30 minute intervals in order to meet the limits and precautions. A guideline has been added to PSG 2.10 that explicitly states the criteria for all possible pumps being available.

3.1.5 Flooding of Steam Lines

TMI-1 ATOG recommends that the steam lines should not be flooded but acknowledges that a GPU analysis indicates that the steam lines will not be damaged (TMI-1 ATOG, Volume 2, page A-2).

Flooding of the steam lines is not a preferable plant condition. However, since the effects are acceptable, flooding of the steam lines will be allowed under certain tube rupture conditions.

3.1.6 Response to OTSG High Level Alarm

The ATOG reactor trip actions include tripping of the main feedwater pumps on high level if main feedwater has not run back. The basis for this action is the short response time required before the OTSG overfills (only several minutes). Since there are so many potential failures in the ICS, the ATOG philosophy is not to try and use this control system.

The plant specific guidelines do attempt to close the feedwater valves by putting the ICS in hand. The results of this action will take a very short time, and its effectiveness will be immediately recognized. If the valves can be closed, then a loss of main feedwater pumps can be avoided. Since TMI-1 has a manual control station which bypasses much of the ICS, valve closure is a prudent step to take before tripping the pumps.

Alarm response procedures H-1-1 and H-1-2 specify the operator actions which are taken during high OTSG level. The actions are taken as follows :

- If OTSG level reaches 82.5%, close the following valves:
  - Main feedwater startup and control valve
  - Startup feedwater and control valves
  - EFW control and header cross-connect valves
- If OTSG level reaches 90%, trip one MFW pump.
- If OTSG level reaches 95%, trip the second MFW pump.

This guidance was developed specifically for the main feedwater overfill concern and does not affect the event sequence. This guidance gives the operator some flexibility in responding to a spectrum of overfill events. However, the design basis overfill occurs rapidly so that the operator responds by tripping the main feedwater pumps.

3.1.7 ATWS

In a submittal dated July 2, 1983, (Reference 3) B&W provided supplemental ATOG material dealing with ATWS events. This guidance has been incorporated into the TMI-1 with certain changes.

1. ATOG recommends that the operator not proceed with the reactor trip procedure until all rods are inserted or a 1% shutdown margin has been established. The plant specific guidelines do not prevent the operator from verifying plant conditions in a number of subsequent steps in the reactor trip procedure. Both the guidelines and training material emphasize that primary to secondary heat transfer must be maintained until the core is shut down. This action is what was intended in ATOG.

2. ATOG has the operator drive rods into the core until power to the CRDMs can be interrupted. At TMI-1, however, power can be interrupted from a control room panel. Therefore, the guidance to drive in rods in the interim has been deleted.

3. ATOG tells the operator to initiate full HPI and isolate normal makeup. The plant specific guidelines do not address the isolation of normal makeup since this action is implied in any HPI initiation along with a number of other actions such as assuring that cooling and lubrication services are available to the pump.

3.1.8 PORV Cycling During Inadequate Core Cooling

When cladding temperatures are above 1400F, ATOG tells the operator to "Maintain the primary to secondary heat transfer by cycling the PORV to keep RCS pressure 25-50 psig greater than SG pressure". The basis for a lower limit on the pressure differential is to assure heat transfer into the OTSGs from the RCS. The upper limit of 50 psig limits RCS pressure, thereby maximizing HPI flow and minimizing break flow.

The plant specific guidelines specify a band of 25-100 psi in order to decrease the potential for cycling of the PORV. This action is always taken with the OTSG pressure at 400 psig or less. Therefore, a 50 psi pressure increase in the RCS will have no effect on HPI flow and a minimal effect on break flow.

3.1.9 Containment Isolation and Protection

The TMI-1 ATOG containment isolation actions were written generically for all the B&W operating plants. TMI-1 has a redundant and diverse isolation signal on all required penetrations in accordance with the general design criteria. Due to this automatic isolation scheme, less emphasis is placed on certain actions:

1. Letdown isolation after a reactor trip; this is an automatic action.

2. Verification of building isolation on 4 psig building pressure. All penetrations communicating with the RCS or containment atmosphere are isolated upon reactor trip.

3.1.10 EFW Throttling Criteria

The EFW throttling criteria in PSG 2.10 differ from the Oconee EFW throttling criteria in the following areas:

A. Loss of natural circulation - Oconee guidelines have the operator maintain full EFW flow if natural circulation flow is lost. The TMI-1 PSGs require the operator to maintain a minimum flow if incore T/Cs are not decreasing. This guidance assures that the core will not be uncovered during a small break LOCA (Reference 6). Note that the referenced analysis was performed subsequent to the submission of Oconee ATOG. For non-LOCA situations in which natural circulation is lost, the operator is directed to PSG 2.4 and given other actions which will restore natural circulation.

   Full EFW flow to an OTSG without heat transfer may result in a large overcooling of that OTSG and result in tube stresses. Therefore, the combination of the PSG throttling criteria in conjunction with PSG 2.4 provides a more suitable response to loss of natural circulation.

b. Continuous level increase - Oconee ATOG requires that EFW flow be continuous and that level not be allowed to decrease. The PSGs require that if incore T/Cs are not decreasing EFW flow must not be reduced below the minimum flow required to keep the core covered (Reference 6). Therefore, the PSGs also require a continuous EFW flow for any situation where OTSG level may be necessary for core cooling. As noted above, the analyses that support this conclusion were not available at the time Oconee ATOG was developed. The PSGs assure that the core remains covered without inducing stresses in the OTSG due to overcooling. With a continuous minimum EFW flow, level would decrease only if the OTSG were being steamed. If there is no heat transfer into the OTSG, then steaming will have to be stopped since pressure will rapidly decrease. If there is OTSG heat transfer, then OTSG pressure will be maintained, and the operator will increase EFW flow, since he is required to establish either a 50% or 95% (see PSG 2.10.6).

3.2 DIFFERENCES IDENTIFIED DURING WRITING AND USE OF THE PROCEDURES

Once the technical guidelines and plant procedures had been written, a series of other comments were developed. The process of writing plant procedures, using them on the B&W simulator, and putting the procedures through the safety review process showed the need for additional revisions to the guidelines. The changes to each guideline are discussed in the following sections. The discussion is keyed to Figures 1-7 which show the differences between the PSGs and TMI-1 ATOG. The figures further show the differences between the TMI-1 and Oconee ATOGs.

3.2.1 Reactor Trip

As shown in Figure 1, the reactor trip plant specific guideline (PSG-1) follows ATOG very closely. Two differences have already been discussed in Sections 3.1.6 and 3.1.9. Letdown isolation is automatic and, therefore, is not an immediate trip action. Part of the response to a high OTSG level will be to place the ICS in "HAND" and close the MFW valves. If this action is ineffective, then the MFW pumps will be tripped.

Other differences between the guideline and TMI-1 ATOG are minor. A loss of offsite power (see 7.0) will require the same basic actions as ATOG. However, several steps have been deleted. OTSG level control is a rule; therefore, there is no explicit step regarding raising level. Insuring the availability of HPI pump auxiliaries is required any time a pump is started and is addressed in other plant procedures. Instrument air is supplied by a bottled supply after a loss of power and does not require immediate verification. OTSG pressure control is covered by the EFW throttling criteria. Besides the deletion of these steps, a final difference is that the operator is referred to plant procedures which give specific detailed actions for a partial or complete loss of AC power. These additional actions enhance the operators ability to restore the plant to a normal post trip condition.

Steps have been added to assure that pressurizer and makeup tank level are properly controlled. These actions reduce the chances of uncovering the pressurizer heaters, voiding the pressurizer or losing suction to the makeup pump.

Certain actions have been removed from the response to ESAS actuation (see 8.0 on Figure 1). Makeup tank level has been already checked in the previous step, so these actions are not necessary in the response to ESAS. Seal injection is not isolated and is available as long as the "A" or "B" HPI pump is running. Closure of the PORV is verified upon lack of subcooling margin (SCM). A loss of SCM would normally occur before 4 psig building pressure. The RB spray and containment isolation functions (including NSCCW and ICCW) have already been verified. Verification of sodium hydroxide valves is performed as a follow-up. The NaOH injection system is single failure proof and automatic; therefore, immediate verification is not required.

The priority for treating excess and lack of heat transfer are modified from ATOG. ATOG considers both symptoms as an equal priority. The PSGs require, if both symptoms occur at once (e.g. one OTSG dry and the other overcooled), then excess heat transfer must be treated first.

None of these changes represents a significant difference between TMI-1 ATOG and the plant specific guidelines.

3.2.1.1 TMI-1 vs. Oconee ATOG

Besides the differences between TMI-1 ATOG and the TMI-1 PSGs, there is also a difference between TMI-1 and Oconee ATOG (indicated by the vertical lines). Oconee ATOG does not respond to a depressurized OTSG in the reactor trip procedure. TMI-1 ATOG does. This is an appropriate post-trip verification requiring immediate action, and hence is included in PSG 2.1.

3.2.2 Lack of Subcooling Margin

Figure 2 provides a comparison of the TMI-1 ATOG and PSG 2.2 "Lack of Subcooling Margin". The only differences occur in the exits to of long term cooldown procedures. ATOG exits to a guideline (CP-105) that results in a normal plant cooldown procedure when there is primary to secondary heat transfer, but subcooling margin cannot be restored. PSG 2.2 instead directs the operator to the small break LOCA guideline for cooldown. This approach exemplifies one philosophical difference between ATOG and the PSGs. If there is a RCS water going into containment, either due to a break or feed and bleed cooling, the operator follows the small break procedure. This procedure insures containment temperature/pressure control and integrity. It also assures a suction source for the ECCS equipment.

Another difference occurs between the PSG and TMI-1 ATOG if there is both primary/secondary heat transfer and adequate subcooling margin (see Figure 2, 6.0 and 12.0-15.0). In this case, the operator has two options. If the RCS is water solid, then he is directed to PSG 2.9 and re-establishes a pressurizer steam bubble. If there is a steam bubble in the pressurizer, then he returns to the reactor trip procedure, reverifies the plant condition and takes further action based on management direction (i.e. cooldown per plant procedure or start up). ATOG would direct the operator through CP-105 and into a normal cooldown procedure, so that the difference is procedural flow only. The PSGs assure that any leak is treated like a LOCA until management evaluates the situation.

3.2.2.1 TMI-1 vs. Oconee ATOG

There are several differences between TMI-1 and Oconee ATOG. First, a check is made in TMI-1 ATOG for OTSG tube rupture (see Figure 2, 10.0 and 14.0). Treating tube rupture symptoms rather than exiting to a cooldown procedure is correct and represents an enhancement of ATOG.

A second change is that Oconee ATOG checks for OTSG heat transfer before checking for a large break LOCA (see 7.0 through 8.0). Since heat transfer will be lost for a large LOCA, it is expeditious to exit before checking for OTSG heat transfer.

Oconee ATOG exits upon excessive heat transfer much later than TMI-1 ATOG (see 4.0, 13.0 and 14.0). If a loss of subcooling has resulted from an overcooling, then it is appropriate to correct the overcooling immediately after taking actions to assure that the core is cooled (1.0 through 3.0). Moreover, if excessive cooling exists at this point, it should be corrected before taking the remaining procedure steps for treating lack of SCM. Also, raising OTSG level to 95% can contribute to an overcooling and should be corrected.

A final minor difference is that Oconee has a specific step instructing (see 6.0 and 12.0) the operator to control HPI; however, the PSG HPI throttling criteria make the step unnecessary.

3.2.3 Excessive Heat Transfer

Figure 3 compares TMI-1 ATOG and PSG 2.3 "Excessive Heat Transfer". The primary difference between the two is economy of words. ATOG branches out if one or both OTSGs are affected and treats the affected and unaffected OTSGs in separate portions of the guideline. The PSG takes the same actions, but tells the operator to take those steps on the affected OTSGs and continues with all steps in series. Besides the arrangement of steps, the sequence of isolation of the affected OTSG(s) is slightly different. ATOG isolates the affected OTSGs in three steps (see Figure 3, 16.0 to 22.0). PSG 2.3 isolates the OTSG in two steps. First it isolates feedwater, closes the TBVs and ADVs, then re-evaluates the OTSG pressure response. If one exhibits a lower pressure, then steam to the EFW pumps and the inlet to the ADVs and TBVs is isolated; ATOG isolates steam to the EFW pump as a separate and final step. TMI-1 has two motor driven EFW pumps which are each capable of removing decay heat. Moreover, the turbine driven EFW pumps can be supplied steam from either OTSG from one of two valves (MSV-10 A/B or MSV-3A,B) as well as from the auxiliary boiler.

3.2.3.1 Differences Between TMI-1 and Oconee ATOG

The differences between TMI-1 and Oconee ATOG are minor (refer to Figure 3). Oconee ATOG requires initiation of full HPI whenever pressurizer level goes below 50 inches indicated level. (Since the Oconee lower level tap is 20 inches higher than the TMI-1 tap, this would be the equivalent of 70 inches indicated level at Unit 1). The physical significance of this level is that it keeps the pressurizer heaters covered. At TMI-1, the heaters are uncovered below approximately 85 inches. In short, the intent of ATOG is to provide sufficient HPI to keep the heaters covered, if possible. TMI-1 has additional makeup capacity via MU-V217 which allows about 200 gpm additional flow beyond the normal makeup capacity of Oconee. The valve was installed for the express purpose of controlling post trip pressurizer level shrink without initiating HPI. Therefore, the TMI-1 PSGs substitute the opening of MU-V217 for the initiation of full HPI.

It may be possible to uncover the heaters even with this additional makeup capacity, for very severe overcoolings. The initiation of HPI at 20 inches is the final manual action for maintaining pressurizer level on scale. Restart Report Figure 8A-23. This transient cooled the RCS to below 500F, yet initiation of HPI at 20 inches level would have been sufficient to maintain level on scale (see sheets 1 and 2). If the level loss is slow, the delay in initiating full HPI is prudent. If the loss of level is due to an overcooling, then repressurization will be smaller after the overcooling is terminated if less inventory has been added to the RCS. If the level loss is due to a large leak, th- the leak will decrease as RCS pressure goes down. ^- long as subcooling margin is being maintained (note the loss of subcooling margin would require full HPI initiation), then control of RCS inventory via the high capacity normal makeup is appropriate).

Finally, the loss of inventory can be due to a tube rupture. If inventory can be controlled with normal makeup, then RCS subcooling margin can be more easily controlled via normal makeup. Since the RCS inventory loss is to an OTSG at about 1000 psig, the leak rate will drop off more rapidly than during a LOCA and the chances of maintaining inventory control via normal makeup is increased.

3.2.4 Lack of Heat Transfer

Figure 4 compares TMI-1 ATOG and PSG 2.4 "Lack of Heat Transfer". A difference is the exit condition if heat transfer is re-established. ATOG recovers from HPI cooling, checks for other symptoms and goes to a cooldown procedure for a saturated RCS. PSG 2.4 recovers from HPI cooling and goes to the reactor trip procedure. In reactor trip, the operator checks for other symptoms and if there are none, proceeds based on management direction.

The major area of discussion for operators during the December simulator session was the use of pump bumps. As written, the guideline appeared to hold the operator at the pump bumping steps in the guideline without proceeding to other steps (i.e. cooldown during a SB LOCA). The Implementation Committee, therefore, re-evaluated this procedure based on that experience. The procedure was clarified to assure that the operator would continue while attempting to bump pumps. If OTSG heat transfer cannot be re-established, but the RCS is cooling down at more than 100F/hr (i.e. cooldown cannot be controlled because of a saturated RCS in a LOCA condition), then pump bumps will not be required. In this situation, the operator exits the lack of heat transfer procedure, goes to reactor trip, and will proceed through PSG 2.1 and be directed to treatment of the appropriate symptoms.

The Staffs' SER on the July 2, 1983 was transmitted to D. Whitney on December 14, 1983 by Dennis Crutchfield, Chief Operating Reactors Branch #5, Division of Licensing. That SER addressed the opening of the PORV and concluded that the use of this guidance was suitable for near term implementation, but that "longer term concerns specified in the staff SER, remain to be resolved. With this resolution of near-term open items, the B&W Owners Group should proceed with timely implementation of ATOG". The long term response to the issue of PORV opening has been committed to by the Operator Support Committee of the B&W Owners Group (see letter dated December 9, 1983 from D. Whitney to D. G. Eisenhut entitled "B&W Owners Group Plan and Schedule for Addressing the SER of ATOG", Item 4.2.3, Paragraph 3.10).

The guidance to open the PORV at 2300 psi occurs when feedwater is available, but primary to secondary heat transfer has been lost. This condition can only be sustained during a small break LOCA which results in repressurization. In this case, opening of the PORV and rupturing of the drain tank rupture disk is not important. Opening the PORV during a small break LOCA which repressurizes will result in RCS depressurization. Even liquid relief out of the PORV (whose flow area is .007 ft^2) combined with liquid relief out the break (.005 to .01ft^2) is sufficient to remove decay heat. Once the pressurizer surge line is uncovered, steam relief out the PORV is sufficient to remove decay heat even ignoring energy relief out of the break.

It is not likely that a lack of heat transfer with feedwater available will last for any length of time in a non-LOCA condition. Pump "bumps", lowering of the OTSG pressure, and raising the secondary side water level should restore heat transfer rapidly. However, if these actions are not effective, then opening the PORV at 2300 psi will prevent cycling and the chance of open failure.

3.2.4.1 Differences Between TMI-1 and Oconee ATOG

The primary difference between TMI-1 ATOG and Oconee ATOG is the procedural flow during inadequate core cooling. Oconee ATOG directed the operator out of Lack of Heat Transfer to Inadequate Core Cooling. TMI-1 ATOG philosophy was changed to direct the operator to Loss of Subcooling Margin and then to ICC if required. Since the first step in the ICC procedure reiterates the immediate actions for lack of subcooling, this change is not a departure from the technical content of ATOG.

TMI-1 ATOG (Figure 4, 15.0) allows the operator to start an RCP one hour after reactor trip. After this period of time, mass loss out of a break in the RCS is not sufficient to cause a core uncovery if the RCPs are subsequently tripped. This step implements an action which has already been recommended in Oconee ATOG (see p. 127 "Best Methods of Equipment Protection").

3.2.5 Steam Generator Tube Rupture

As indicated previously, the OTSG tube rupture guideline was based on the existing plant procedure that was developed from ATOG as well as additional analyses and plant experience (refer to TDR 406). Only minor changes have been made in developing the tube rupture guideline from the then-existing plant procedure:

1. Pressurizer depressurization is begun immediately in order to minimize subcooling margin by the time the plant cooldown begins.

2. Some additional clarification was added for use of the feed and bleed procedure in parallel with the tube rupture procedure.

3. The addition of rules for treating a lack of subcooling margin eliminated the need for a separate section of the guideline to treat lack of subcooling margin during a tube rupture.

3.2.6 Cooldown with a Small Break LOCA

Figure 5 illustrates the differences between TMI-1 ATOG CP 103 (RC Cooldown with a Saturated RCS and OTSGs Removing Heat) and PSG 2.6 (Cooldown with a Small Break LOCA). ATOG distinguishes among LOCA cooldowns with/without primary to secondary heat transfer and subcooled cooldowns. The PSG's have all cooldowns in which RCS inventory is being put in containment controlled by the small break LOCA cooldown procedure. HPI cooling (PSG 2.9) also is controlled via this procedure. The manner of controlling the plant is not different, however. Except for the differences in exit points, PSG 2.6 varies from TMI-1 ATOG only by the addition of guidance that appears elsewhere in ATOG. One additional exit has been added to allow treatment of tube rupture symptoms.

3.2.6.1 Differences Between TMI-1 and Oconee ATOG

The differences between TMI-1 and Oconee ATOG are minor. TMI-1 uses a lack of primary to secondary heat transfer as a condition for exiting to the HPI cooling guideline. Oconee ATOG used a loss of natural circulation.

3.2.7 Cooldown with a Large Break LOCA

As discussed in Section 3.2.6, the SB LOCA procedure is used for more plant cooldowns than in ATOG. As seen in Figure 5, TMI-1 ATOG distinguishes between a small break LOCA with and without primary to secondary heat transfer. On the other hand, PSG 2.7 directs the operator to the small break LOCA guideline regardless of heat transfer. For the case where there is no primary/ secondary heat transfer, TMI-1 ATOG goes to an HPI cooling guideline. Instead, PSG 2.6 initiates HPI cooling and takes the steps for HPI cooling without exiting the procedure.

3.2.7.1 Differences Between TMI-1 and Oconee ATOG

TMI-1 and Oconee ATOG differ by the deletion of several steps from Oconee. TMI-1 does not include a notification of personnel in the guideline. This is a procedural item that does not belong in guidelines. TMI-1 also deletes two steps verifying that the CFT isolation valves are open and that building spray valves have operated. Again, these are specific steps that can be treated in the plant procedure, but not in the guideline.

Oconee does not exit the large break LOCA procedure if pressure stays above LPI initiation pressure. Rather it checks for a core flood line break accident. The TMI-1 guidance handles the more generalized condition of any large small break LOCA in which the RCS does not immediately depressurize to LPI pressure.

Finally, the Oconee guidelines use a different BWST level setpoint for pump suction switchover. This is a plant specific item.

3.2.8 RCS Superheat

The TMI-1 ATOG and plant specific guidelines do not differ except for the items identified in Section 3.1.8.

3.2.8.1 Differences Between TMI-1 and Oconee ATOG

There are several differences between the TMI-1 and Oconee inadequate core cooling guidelines.

First, TMI-1 ATOG includes a step (refer to TMI-1 ATOG, 5.0) to open the PORV when RCS pressure reaches 2300 psig. This step is consistent with the lack of heat transfer guideline (see Section 3.2.4). The intention is to reduce RCS pressure and maximize HPI flow, reduce break flow and possibly reach CFT pressures. The PORV is closed at 100 psig above OTSG pressure to assure a primary/secondary differential temperature. This additional guidance increases the ability to cool the core and improves the inadequate core cooling guideline.

Step 8.2 of TMI-1 ATOG requires the operator to continue to depressurize the OTSG at 100F°/hr after the initial depressurization called for in this step. This step is more explicit than the Oconee step which only calls for a step decrease in temperature. The continued cooldown of the OTSG enhances the chances of inducing natural circulation or a cooldown of the RCS.

Step 14.0 of TMI-1 ATOG adds a step requiring that high point vents as well as the PORV be opened when fuel clad temperature goes above 1400F. The vents are intended to remove non-condensible gases which could potentially be blocking natural circulation.

Oconee ATOG Step 11.3 differs from TMI-1. The step relates to loss of RC pump service. TMI-1 requires tripping of the RCP on loss of motor cooling in the pump operating procedure.

Step 16.0 of Oconee ATOG (see Oconee ATOG) requires isolation of the core flood tanks. This step is deleted in TMI-1 ATOG. The step is taken after the RCS returns to saturation. Since it is possible that the CFTs are the only source of core cooling, they should not be isolated until the operator has verified that another source of core cooling is available. In order to clarify jthe appropriate CFT isolation actions, a guideline has been added to

PSG 2.10. The guidelines assure that the CFTs will not be isolated if there is no other source of core cooling. They also assure that the tanks will be isolated when appropriate to prevent nitrogen injection into the RCS and to prevent the CFTs from holding up RCS pressure.

The only way that CFTs could delay DHR initiation is if the RCS temperature was at 275F and the RCS pressure was above 400F (the DHR initiation conditions). This condition represents a subcooled RCS, however, and isolation is allowed by the guideline.

Based on Tech Spec 3.2.1.2, the CFT water volume must be 1040 $\pm$ 30 ft^3 and pressure must be 600 psig $\pm$ 25. With a CFT volume of 1040 ft^3 (see FSAR table 6.1-1), the tanks will just begin to empty below 250 psig.

Step 16.0 of TMI-1 ATOG does not exist in Oconee ATOG. It directs the operators to close the high point vents when RCS pressure goes below 150 psig, but to reopen them if pressure increases above this value. Oconee ATOG did not address high point vents. The step tries to close RCS leakage paths at a condition when LPI operating and relief of non-condensible gases is no longer important. If the vents are helping to control RCS pressure, then they should be reopened to prevent a loss of LPI flow. Oconee ATOG does have the operator close the PORV, but at 250 psig instead of 150 psig. This difference is due to the difference in the LPI shutoff head in the two plants.

Step 18.0 of TMI-1 ATOG emphasizes that SG pressure should be maintained as low as possible. Oconee does not. This step occurs in the section dealing with return to saturation from 1800F clad temperatures. Previous steps (refer to Oconee Step 12.0 and TMI-1 Step 13.0) in the guideline have already required the operator to reduce the SG pressure as low as possible. There is no actual change to the procedural steps, just a re-emphasis of the action to be taken.

Finally, Oconee and TMI-1 ATOG differ in the location of the guidance for cooldown once the RCS is saturated. Oconee ATOG maintains the operator within the ICC guideline but duplicates the guidance of CP-103. TMI-1 directs the operator to CP-103. The TMI-1 PSG directs the operator to loss of subcooling margin, which would result in cooldown via the small break LOCA procedure. Once again, however, the guidance is put in a different location rather than representing difference guidance.

3.2.9 Feed and Bleed Cooling

The differences between PSG 2.9 and TMI-1 ATOG (CPs 104, 105) are illustrated in Figure 7. The reason for the differences flows from the PSG concept of the small break LOCA procedure. The PSG 2.6 provides guidance that ATOG provides in the HPI cooling procedure. PSG 2.9 assures that if HPI cooling is required, it is initiated. The operator is directed to PSG 2.6. Another difference is that the TMI-1 ATOG for establishing a bubble in the pressurizer has been incorporated into PSG 2.9. If a bubble is established in the pressurizer and there is no RCS leak, the operator is then directed to a normal cooldown. If a bubble is not re-established, then the operator cools down within the small break LOCA procedure, whereas ATOG would cool down using a normal plant procedure. The advantage of being in the LOCA procedure for this case is the guidance available for the transition to DHR system operation. The differences between ATOG and the PSGs represent a re-arrangement of material.

3.2.9.1 Differences Between TMI-1 and Oconee ATOG

Figure 7a depicts the Oconee ATOG HPI cooling guideline (CP-104). Because the two ATOGs were arranged differently, it was not possible to represent all their re-arrangement on one figure. However, they both share the same common elements. First, each maintains full HPI flow with the PORV open in order to assure core cooling. Second, the plant is maintained within allowable pressurized thermal shock limits (TMI-1 accomplishes this by virtue of a general guideline to do so, as specified in plant procedure ATP 1210-10.

If the OTSG becomes available as a heat sink, the operator attempts to restore heat transfer by pump bumps and pressure reduction.

3.3 DIFFERENCES IDENTIFIED DURING 1984 SIMULATOR TRAINING

Simulator training sessions at the B&W Lynchburg simulator were monitored by the ATOG Implementation Committee members. Comments were generated both by the operators and the committee members. Several changes to the guidelines were made as a result of these training sessions. The changes and bases are discussed in the following sections.

3.3.1 Excessive Cooling

Old Step 9 of PSG was revised, Step 8 was deleted, and a new step was inserted into the excessive cooling PSG. These steps clarify the operator actions during a recovery from an overcooling in which OTSG level and pressure are not restored or in which natural circulation is lost. The original Step 9 was direction to go to the loss of subcooling margin if margin was lost and main or emergency feedwater could not be initiated. Oconee ATOG (and Rev. 0 of PSG 2.3) had the operator exit to loss of subcooling, but not to a lack of heat transfer procedure. This procedural exit was replaced with steps which lead to either HPI cooling or lack of heat transfer guidelines depending on the OTSG and RCS conditions. These are actions which are consistent with the ATOG approach, but which cause direct exits to the appropriate guideline rather than indirectly through the lack of subcooling procedure.

3.3.2 Lack of Heat Transfer

The procedural step requiring opening of the PORV at 2300 psig RCS pressure was moved below the step requiring feedwater initiation to make the priorities clear.

Exit to the large break LOCA procedure was clarified to direct the operator to that procedure if the CFTs are emptying rather than only if they have emptied. This wording is consistent with the procedure structure which places the operator into the large break procedure but exits him to the small break procedure if the CFTs have not emptied.

A third revision was to the step requiring that the OTSG pressure be reduced to about 100 psi above OTSG pressure. This ATOG step was written for small break LOCAs in which subcooling was lost and primary to secondary heat transfer needed to be restored. The step is correct for this plant conition. However, in a classroom session, it was recognized that this step could be reached with the RCS subcooled. Reducing the RCS to within 100 psi of OTSG pressure would result in loss of subcooling margin depending on the OTSG pressure. Therefore, the step has been clarified to tell operator not to cause a loss of subcooling margin.

3.3.3 Cooldown with A Small Break LOCA

The guidance for DHR operation has been rearranged to incorporate the ATOG material in one place. This reorganization is consistent with the TMI PSG structure which uses PSG 2.6 as the cooldown guidance.

3.3.4 RCS Superheat

The RCS superheat guideline was revised to only have the operator open the high point vents when the RCPs were off. The purpose of opening the vents is to remove non-condensible gases during an inadequate core cooling situation. This goal is still accomplished in the revised PSG 2.8. However, the vents will not be opened if the RCPs are on since there will not be effective venting of non-condensible gases.

A second change to the superheat procedure was in Steps 8.6 and 8.9. In Rev. 0, the operator was directed to the HPI cooling guideline if: primary to secondary heat transfer could not be re-established; or to lack of subcocling if the RCS returned to saturation. The incore thermocouple temperatures were above 1400F but the RCS subsequently returned to saturation. This step has been revised to clearly state that the RCPs should be left on and directs the operator to the procedure governing cooldown following a small break LOCA. The direction to a small break LOCA guideline is consistent with the TMI-1 PSGs which have cooldowhn guidance in the SB LOCA, rather than in the HPI cooling procedure. (This guidance has also been added to Step 9.12). The guidance to keep the RCPs on is a clarification of the ICC guidelines. RCPs are supposed to be started, if possible. Operation of the RCPs may be the reason that the RCS has returned to saturation, so the pump should not be shut off.

3.3.5 Rules and Guidelines

A new section was added to PSG 2.10 entitled "Guidelines". Guidelines are procedural steps which apply any time the PSGs are being used. Rules represent steps that prevent core uncovery. Guidelines are not directly related to core protection. The key features of these guidelines are as follows:

a. A guideline is provided to clarify that emergency NPSH is required before an RCP can be restarted.

b. The reactor should be tripped and HPI initiated any time pressurizer level cannot be maintained above 150 inches.

c. The response to a loss of EFW has been moved from the emergency procedures for loss of feedwater to the PSG guideline.

d. The limits and precautions for pump starts has been spelled out for the various pump availabilities. The Oconee ATOG definition of a "pump bump" has been included in the guideline.

e. The verification of natural circulation has been moved from the natural circulation procedure to the PSGs. Moreover, the guideline has been clarified to show that all four specified conditions should be present to indicate natural circulation flow.

f. Guidance has been provided for identifying primary to secondary heat transfer. A differentiation has also been made between heat transfer via boiler-condenser cooling. When ATOG specifies actions to be taken when primary to secondary heat transfer has been established (e.g. close the PORV) it does not intend those actions to be taken if boiler-condenser heat transfer has been added.

g. Guidance has been provided on how to feed a dry OTSG with main feedwater. Flow is kept low to minimize any thermal shock on the lower tube support plate. Once steam pressure is re-established in the OTSG, flow can be increased since aspirated steam will be available to heat the main feedwater. Use of main feedwater is preferred since it reduces the number of thermal cycles on the EFW nozzles and it provides shell cooling to prevent tube tensile stresses.

h. Core flood tank isolation guidance is provided (refer to Section 3.2.8 for a discussion of these guidelines).

4.0 REFERENCES

1. Babcock and Wilcox Co. Three Mile Island Unit 1 Abnormal Transient Operating Guidelines. April 1983. #74-1124158-00. Lynchburg, VA.

2. GPU Nuclear Corp. "Acceptability of Intentionally Loading Main Steam Lines During an OTSG Tube Rupture Event". Document No. 1101X-5320-A18. July 30, 1982 - Engineering Mechanics Section.

3. D. D. Whitney. "Supplement to ONS-3 Final ATOG". Letter from D. D. Whitney to D. G. Eisenhut. July 2, 1983.

4. Babcock and Wilcox Co. Oconee Nuclear Station Unit 3 Abnormal Transient Operating Guidelines. March 1982. #74-1123297-00. Lynchburg, VA.

5. Darrell G. Eisenhut. Safety Evaluation of 'Abnormal Transient Operating Guidelines' (Generic Letter 83-31). September 19, 1983. U. S. NRC. Washington, DC.

6. Babock & Wilcox Co. Evaluation of SBLOCA Operating Procedures and Effectiveness of Emergency Feedwater Spray for B&W - Designed NSSS. February 1983. B&W Doc ID 77-1141270-00. Lynchburg, VA.

APPENDIX A

NRC REQUEST FOR ADDITION INFORMATION

TMI-1, PGP SPECIFIC GUIDELINES

Response to NRC Request for Additional Information *

TMI-1, PGP, Plant Specific Guidelines

1. QUESTION: TDR 517, Section 3.1.1 identifies a difference between the TMI-1 PSG and Oconee ATOG in HPI start criteria. Discuss further the justification for this difference (e.g., different instrumentation or parameters used to determine when criteria are met, the influence on the timeliness of HPI start, and the impact on event consequences).

   RESPONSE: TDR 517, Section 3.1.1 has been expanded to explain the suitability of initiation of HPI upon loss of heat sink rather than on loss of feedwater.

2. QUESTION: TDR 517, Section 3.1.4, discusses RCP bump criteria. Clarify how the OP 1101-1 specification of "at least 40 minutes between starts," etc. is met by bumping pumps "... at 30 minute intervals in order to meet the limits and precautions".

   RESPONSE: TDR 517, Section 3.1.4, has been revised to clarify how the limits and precautions of OP 1101-1 are met. As a result of simulator training experience, the pump bump guidelines were expanded and have now been included in PSG 2.10.

3. QUESTION: TDR 517, Section 3.1.6, discusses response to OTSG high level alarm. Clarify which valves the operator is instructed to close and how the difference from Oconee ATOG impacts event consequences.

   RESPONSE: Section 3.1.6 of TDR 517 has been revised to further explain the response to a high level alarm.

4. QUESTION: TDR 517, Section 3.1.7, discusses TMI-1 PSG treatment of ATWS but does not identify that TMI-1 PSG does not feature an immediate manual scram in the reactor trip guideline as does Oconee ATOG. PSG 2.1 (Reactor Trip) does not contain this feature. In subsequent dialogue with the licensee, GPU stated that immediate manual scram would be added to PSG 2.1. Conform that this addition has been made.

   RESPONSE: TDR 517, PSG 2.1 has been revised to include an immediate manual trip of the reactor. While this was an oversight in the PSGs, plant procedure ATP 1210-1 has always specifically required a manual trip of the reactor.

* Transmitted via letter from John F. Stolz, Operating Reactors Branch #4 Division of Licensing to H. D. Hukill, Vice President and Director, TMI-1. Docket No. 50-289. March 28, 1984.

5. QUESTION: TDR 517, Section 3.2.3.1, identifies that TMI-1 PSGs instruct the operator to initiate HPI at 20 inches of pressurizer level versus the 50 inches noted in Oconee ATOG. Justify this difference.

RESPONSE: TDR 517, Section 3.2.3.1 has been revised to address the basis for the Oconee ATOG setpoint of 50 inches versus the TMI-1 setpoint of 20 inches for initiating HPI. An explanation for the suitability of the 20 inch level setpoint has been included.

6. QUESTION: TDR 517, Section 3.2.4, states that the initial check for the availability of feedwater has been deleted from the Lack of Heat Transfer guideline, PSG 2.4 (to simplify the immediate actions and instruct the operator to follow more important steps first). However, this was apparently not the case in PSG 2.4, and checks for adequate core cooling have apparently been deleted. Justify this difference and identify the "more important steps" which the operator should follow first.

RESPONSE: TDR 517, Section 3.2.4 has been revised based on operator simulator training experience. A step directing the operator out of the immediate actions (as per ATOG) has been left in PSG 2.4 and plant procedures have been revised accordingly.

PSG 2.4 does not have a check for inadequate core cooling. This is a difference that developed between the Oconee and TMI-1 ATOGs. Section 3.2.4 has been revised to explain and justify this difference.

7. QUESTION: TDR 517, Section 3.2.4, and dialogue with the licensee indicate that for lack of heat transfer and other situations, if RCS pressure reaches 2300 psi the PORV is opened and left open until the primary system has depressurized to within 100 psi of the secondary system pressure. Identify the emergency conditions for which this maneuver would be performed and address possible negative effects, such as rupture of the drain tank disc with consequential adverse containment environment. Also, provide analyses to show the viability of depressurization with the PORV during these conditions.

RESPONSE: TDR 517, Section 3.2.4 was in error describing the opening of the PORV at 2300 psig as a difference from Oconee ATOG. By letter dated July 2, 1983 from D. Whitney to D. G. Eisenhut, this step was added by reference to Oconee ATOG.

8. QUESTION: TDR 517, Section 3.2.8.1, indicates that the Superheat Guideline (PSG 2.8) does not instruct the operator to isolate the core flood tanks after the RCS returns to saturation and does the Oconee ATOG. The reason stated is that the CFTs could be the only source of core cooling. Provide further justification of this difference, addressing possible adverse consequences, such as nitrogen injection and compromising pressure reduction.

RESPONSE: TDR 517, Section 3.2.8.1 of TDR 517 explains why the core flood tanks will not be isolated per Oconee ATOG. Based on operator simulator experience, a CFT isolation guideline has been added to PSG 2.10 to clarify when it is appropriate to isolate the CFTs.

9. QUESTION: TDR 517, PSG 2.10 (step 3.d), allows throttling of HPI if 25°F subcooling margin exists and pressurizer level is established greater than 0 inches. This criterion differs from the corresponding Oconee ATOG instruction (Specific Rule 2.1.d) which requires a pressurizer level of 100 inches. The 0-inch criterion was approved for TDR 406 based on the need to rapidly depressurize after a SGTR; however, the suitability of this throttling criterion as a general rule has not yet been justified.

RESPONSE: The justification for throttling HPI at 0 versus 100 inches is the same for tube ruptures as for other events. Indication of subcooling assures core coolability. The basis for throttling HPI at 100 inches is to assure that the pressurizer heaters are covered, not to assure the core is covered. However, rapid filling of the pressurizer with HPI can cause a repressurization of the RCS. This repressurization is undesirable for events other than a tube rupture e.g. small break LOCA, overcooling or loss of heat sink. It is preferable to maintain pressure low to allow the operator more margin to the PTS limits (100F subcooling). For LOCAs, repressurization also delays cooldown, increases leakage, and decreases HPI flow.

Given the desirability to control insurge to the pressurizer, it is more desirable for the operator to throttle HPI and recover the pressurizer heaters under his control rather than with full HPI flow.

10. QUESTION: TDR 517 does not identify that its EFW throttling criteria differ from those specified in Oconee ATOG. Discuss and justify the differences in EFW throttling criteria.

RESPONSE: TDR 517 has been revised to address the differences between Oconee ATOG and PSG 2.10.

11. QUESTION: TDR 517, PSG 2.8, "Superheat" instructs the operator to close the PORV and high point vents at 150 psig and use those relief paths to maintain pressure below 150 psi, which differs from the 250 psi specification in Oconee ATOG. Explain and justify the reason for this change.

RESPONSE: Oconee ATOG instructs the operator to close the PORV and high point vents at 250 psig because LPI will be established at full flow. TMI-1 ATOG and PSG 2.8 specify 150 psig for this action because the TMI-1 pumps achieve full flow at this pressure.

12a. QUESTION: With regard to the SGTR guidelines, provide the following:

The information provided in TDR 406 to support the intention to steam the damaged OTSG for the duration of the SGTR event is largely qualitative and has not adequately demonstrated the need for continuous steaming of the damaged OTSG. Therefore, for both the earlier and existing methods (i.e. isolation of the damaged OTSG at the predetermined RCS temperature versus continued steaming), provide the following systems analyses. Provide the assumed sequence of events including timing of automatic and operator action. Include the projected radiological consequences (whole body and thyroid): (1) Design basis SGTR accident with offsite power (and condenser) available; and (2) SGTR accident with offsite power unavailable. The analyses should assume that the accident begins with the primary coolant iodine concentration at the technical specification limit of 1.0 uci/gm and that an iodine spike occurs as a result of the primary system depressurization. Provide the following information from these analyses: RCS (Pressurizer) and OTSG (both) pressure, temperature, mass and level, break flow, atmospheric dump and main steam safety valve flows, and safety injection flow. These analyses should include the period of RCS cooldown to decay heat removal (DHR) system initiation. Compare the offsite doses in the above calculations to the FSAR assumption and results. Use these analyses to show the need for using the techniques of TDR 406 for either limiting offsite dose or avoiding more serious events (i.e. filling the faulted OTSG, lifting the damaged OTSG safety valves, etc.).

RESPONSE: GPUN has worked closely with the Electric Power Research Institute (EPRI) over the past 18 months to provide RELAP5 analyses of tube ruptures in B&W NSSS plants. The results of these analyses are expected to be completed by June 30, 1984. Thermal hydraulic analysis results will be used by GPUN to calculate dose consequences based on the assumptions specified in this question. Transmittal of the report and radiological consequences should be transmitted to the staff August 1984.

12b. QUESTION: Recent test data at TMI-1 has indicated that if the emergency feedwater system (EFWS) is utilized instead of the main feedwater system (MFWS) to maintain secondary water inventory, a rapid cooldown rate would result in exceeding the allowable tube/shell delta T of 70°F.* Since the EFWS would be initiated for a variety of conditions, provide the maximum cooldown rate for these conditions that would maintain the tube/shell delta T 70°F. If different from the cooldown rate assumed in Question 12a, calculate the projected radiological consequences assuming the TDR 406 guidelines or show that this cooldown rate would not be more limiting than that used in the analyses to address Question 12a.

* A 90°F/hour cooldown rate resulted in a tube/shell T of 112°F in OTSG "A" and 99°F in OTSG "B" (Reference - TDR 488).

RESPONSE: The tube rupture analyses being performed (see response to Question 12a) will consider the effect of shell/tube differential temperatures. Note that the quoted high shell/tube differential temperatures were deliberately propogated as a proof test of the tubes. In fact, two separate proof tests with MFW were conducted without producing a differential temperature greater than 70F. As a result, a third test was required using EFW with the OTSG level controlled at 30. The differential temperature was successfully increased to above 70F in the test. This analysis is expected to confirm that use of EFW with a high OTSG level will effectively cool the downcomer shell and limit shell/tube differential temperature.

12c. QUESTION: Provide the technical assessments demonstrating that the decay heat removal system (DHRS), previously rated for a maximum temperature of 275°F, can be safely operated at 300°F.

RESPONSE: The design conditions for the DHR system are 300F and 400 psia. However, the DHR system cannot be operated simultaneously with RCPs between 275F and 300F (See "Limits and Precautions OP 1101-01). TDR 517, PSG 2.5, therefore has guidance allowing DHR cut-in at 300F if:

1. The RCPs are tripped, and;
2. The consequences of losing RCP loop forced flow are acceptable

DHR would be used with RCPs off in any situation where loss of forced flow was warranted by a reduction in radiation releases.

12d. QUESTION: After DHRS cut-in, will the OTSGs still be steamed and for how long? If the answer is yes and this steaming was not included in the analyses for Question 12a, what will be the additional projected radiological consequences, assuming the iodine concentration and scenarios from Question 12a.

RESPONSE: The OTSGs are steamed during a tube rupture to

1. Cooldown to DHR conditions as expeditiously as possible
2. Provide for natural circulation cooldown
3. Prevent situations in which water might be forced out the safety valves
4. Aid in controlling stress on the OTSG tubes

Once DHR initiation conditions are reached, there is no need to continue steaming of the OTSG.

1. OTSG steaming is no longer required since the DHR system is capable of removing decay heat
2. If RCPs are not available, termination of steaming could result in the formation of a hot leg steam bubble. Under these conditions, the plant would be stabilized until RCPs were available. No releases would occur in the interim. Under forced flow conditions, this concern will not exist.
3. When the RCS is at a pressure that allows DHR initiation the safety valves will no longer be challenged, even if the OTSG is filled with water.
4. Once the DHR is initiated, RCS temperature and OTSG level can be controlled to prevent tube stresses. Steaming will not be required.

In conclusion, it can be seen that doses can be terminated once the DHR system is initiated. PSG 2.5 has been revised to tell the operator to terminate steaming once DHR has been initiated.

12e. QUESTION: Previous calculations showed that using one steam generator, the plant could be brought to DHR system cut-in conditions (300°F) in about 4 to 5 hours (limited by atmospheric dump valve capacity); and, using two steam generators, in about 3 hours (limited by a 100°F per hour cooldown rate). However, the Oconee Unit 2 steam generator tube leak of September 18, 1981, indicated that cooldown of the RCS to the cold shutdown condition can take much longer should there be equipment problems. Should similar problems occur at TMI-1, will steaming be continued for the entire period until DHRS cut-in, or will alternate procedures be employed? Justify the absence of a total, integrated limit on offsite releases by citing specific technical issues and the consequences of damaged steam generator isolation.

RESPONSE: As indicated in the response to Question 12d, steaming a leaking OTSG will not be required to hold the RCS temperature at the DHR initiation temperature. This question does have relevance if there are leaks in both steam generators. The procedure was not written to address long term contingency actions for events such as the one postulated. By this time, the emergency plan will have been implemented and alternatives weighed against equipment availability and offsite doses.

12f. QUESTION: TDR 406 is not clear regarding operation of the RCPs following a SGTR. For example, Section 2.1.6 (page 20), Table 1 and Figure 6 indicate that the RCPs should be tripped if the emergency NPSH requirements are not met. However, recommendation 2 (page 39) states that the existing RCP trip criteria should be replaced with trip on loss of subcooling. Figure 6 shows that the emergency NPSH and the subcooling margin (SCM) curves are different. Clarify how these criteria would be used for pump trips and pump restart.

RESPONSE: The PSGs (see TDR 517) specify several RCP trip and restart criteria. Pump trip on loss of subcooling margin is required to prevent core uncovery under certain small break LOCAs using Appendix K assumptions. Subcooling margin is prominently displayed in the control room, and the operator takes immediate actions upon loss of subcooling margin. One of these actions is to trip the RCPs.

RCPs cannot be restarted in the first hour after reactor trip until subcooling margin has been restored. This also is a core cooling consideration.

RCP NPSH limits are an equipment protection consideration. Above about 525F, the 25F subcooling margin is more restrictive than NPSH requirements. Below this temperature, NPSH is more restrictive and the operator will follow the NPSH limits to protect the RCP.

The limits have been separated in order to provide the operator with one number to remember for core protection. Had the two curves been consolidated, he would have had to determine if the RCS conditions went below a line representing a variable subcooling margin. Moreover, with RCPs off, the 25F margin still has core protection significance, i.e. initiate HPI and raise OTSG level to 95%. If the subcooling and NPSH curves were combined, then this action would also be dependent on a variable subcooling margin.

12g. QUESTION: Section 4.2.2.5 indicates that one RCP in each loop should be kept running on loss of SCM, since if the RCPs are subsequently tripped, the RCS may be voided enough to uncover the core. RCPs should be run for at least 7000 seconds to assure that the core will not uncover. If pump damage may occur, then one pump in each loop should be tripped. What assurance is provided that all 4 RCPs will not be incapacitated within 7000 seconds if run with insufficient NPSH and SCM? Can additional guidelines be provided that will enable RCP operation within a more realistic time span than the 2 minute-7000 second envelope? In particular, the SBLOCA analyses, which showed delayed RCP trip could lead to unacceptable core uncovery, were based on continuous 4 pump operation. Analyses by other vendors indicate that operation of only one pump in each loop can substantially reduce the inventory loss. Moreover, it is our understanding that RCP trip within two minutes was only required to meet the 10 CFR 50.46 criteria using conservative evaluation models. Please discuss the rationale for your proposed criteria in light of these concerns.

RESPONSE: This issue is being resolved by a generic assessment in response to the NRC Staff's generic letter 83-10. The guidance to run the RCPs for 7000 seconds is derived from Oconee ATOG ("Best Methods for Equipment Operation").

12h. QUESTION: Section 2.1.2 of TDR 406 states "isolation of the damaged OTSG at 1000 psig is not the best means of reducing the tube stresses," and "cooldown/depressurization is preferred". Provide the technical justification to substantiate this assertion". Clarify how isolation of the damaged OTSG results in increased pressure stress on the tubes.

RESPONSE: Technical data report (TDR) 417 entitled "TMI-1 OTSG Tube Axial Loads and Leakage Monitoring" summarizes the calculated effect of temperature and pressure effects. The primary tensile stress is contributed by shell/tube differential temperature which increases by 10 lbf for each 1F° in shell/tube differential temperature. Steaming of the OTSG reduces tensile loads by cooling the lower downcomer and is therefore preferred to a generator in which the shell is not being cooled. For example, if OTSG steaming controls shell/tube differential temperature at 70F instead of 100F, the tube stress is reduced by 300 lbf.

There are also three pressure components that contribute to tube stresses. First, there is axial tensile loading resulting from the OTSG and RCS pressure. The OTSG pressure force causes a tensile tube load by exerting a force on the upper and lower tube support plates. RCS pressure also causes an axial load. The normal surface area of the OTSG shell is greater than the normal area of the tube support plates (since the tube ID is subtracted from the tube support plate). The resultant force causes an axial tensile load on the tubes. A decrease of 1 psi in either the RCS or OTSG pressure decreases the tube axial loading by .21 lbf. Therefore, the more rapid the depressurization of the plant, the more quickly the load component is reduced.

Steaming results in an OTSG pressure lower than the RCS pressure by an amount necessary to maintain the RCS subcooled. For example, at an RCS pressure of 1000 psia, the OTSG must be at a pressure of 810 psia to maintain the RCS 25F° subcooled. If the OTSG were isolated, RCS and OTSG pressure would both be at 1000 psig. Thus, the OTSG load would be reduced by 39.9 lbf then if the OTSG were isolated.

The third component of the pressure loading is the differential between the RCS and OTSG pressure. Differential pressure between the RCS and OTSG results in a uniformly applied pressure load on the tube support plates. As a result, the tube support plate deflection causes the greatest compressive load on the center tubes. This deflection of the tube sheet foreshortens the tube sheet and results in a tensile loading on the more peripheral tubes. However, because the tensile load is distributed among a large number of tubes, the tensile loading is small. For each 1 psi increase in RCS over OTSG pressure, the tensile axial load on the center tubes is reduced by .176 lbf. Once again, maintaining the RCS subcooled relative to the RCS reduces tube stresses. For the above example, the core tube loading would be decreased by 33.4 lbf. TDR 417 provides a detailed discussion of the load components acting on the OTSG.

12i. QUESTION: Section 2.1.3 states that the rate of RCS pressure reduction, while the damaged OTSG is being steamed, has not been determined in order to meet the four stated objectives. If the RCS depressurization rate has not been determined, how can it be stated that steaming is preferred and what guidance is given to the operators so that the objectives can be met?

RESPONSE: The four criteria stated in Section 2.1.3 are:

a. Depressurization of the OTSG without causing large shell/tube differential temperatures. The TMI-1 cooldown tests demonstrated that a 100F/hr cooldown rate can be accomplished without propogating large differential temperatures (see the response to Question 12b for further discussion).

b. Minimize RCS leakage - Leakage is minimized by reducing subcooling margin while achieving the maximum cooldown rate consistent with (a) i.e. 100F/hr with a 25F subcooling margin. Simulator sessions at the B&W Lynchburg simulator confirm that these two criteria can be met simultaneously.

c. Promote natural circulation in the hot leg. RCS cooldown with the OTSG continuously being steamed will promote natural circulation

d. Positive leakage from the RCS into the OTSG to assure hot leg cooling in the absence of natural circulation. The maintenance of minimum subcooling margin assures a positive pressure difference between the RCS and OTSG.

The TMI-1 cooldown tests and simulator experience have provided data to resolve the two principal areas of uncertainty. First a 100F/hr cooldown rate does not prevent limiting shell/tube differential temperature. Second, the subcooling margin can be maintained at a minimum value while cooling the RCS down at 100F/hr.

12j. QUESTION: Clarify the TDR 406 assessment (Section 2.2.2) of the control of the damaged and intact OTSG levels, as function of HPI pumps, EFW pumps and number of broken tubes. The discussion regarding raising the OTSG level of 95% "tempered with the need to control the RCS cooldown rate" is particularly unclear. The discussion regarding simulator experience (Item 4.2.1) is also not clear (Was it not possible to raise OTSG level to 95% with full HPI on, while steaming the OTSG and maintaining a 100°F/hr cooldown?).

RESPONSE: Based on the simulator experience in June 1983, it was very difficult with a saturated RCS for the operators to raise OTSG level to 95% while HPI was on full flow. At the simulator, all three pumps were running, providing about 1800 gpm. GPUN has conducted small break LOCA analyses using the RELAP5 computer code and the TMI-1 HPI capacity as limited by cavitating venturies. Those analyses demonstrate that the RCS cooldown rate can be controlled while still maintaining a continuous, minimum flow to the OTSGs. Section 2.2.2 of TDR 406 will be revised to reflect the results of these analyses.

12k. QUESTION: Section 2.3 indicates that a large portion of the analytical effort required to resolve the issues identified in TDR 406 is still ongoing. This includes simulation of single and multi-tube ruptures under various conditions, including unavailability of RCPs, unavailability of condenser, high radiation releases, steam line flooding, loss of SCM, and PORV availability versus unavailability. Describe how these aspects are being evaluated and provide a schedule for their resolution.

RESPONSE: GPUN and EPRI/NSAC have been involved in analysis of tube ruptures for approximately the past 18 months. The attached Table 12k-1 provides a summary of the cases being analyzed. These thermal hydraulic analyses will then be used to evaluate the radiological consequences of the events assuming condenser availability/unavailability and varying primary system source terms.

12l. QUESTION: Section 2.2.3 discusses the viability of feed and bleed as a means of mitigating multiple SGTR events. The section indicates that below 1000 psig RCS pressure, the PORV is capable of removing decay heat event (SIC) with liquid relief, within two hours of the reactor trip. Demonstrate that the PORV is capable of not only removing decay heat, but of lowering RCS pressure and temperature to achieve cold shutdown conditions. Figure 4 shows that the PORV flowrate is below the single HPI flow, thus it is not clear that with HPI flow, which may be required to maintain RCS subcooling, depressurization is possible. Provide calculations demonstrating the viability of feed-and-bleed cooling using only the PORV.

TABLE 12K-1

PROPOSED ANALYSIS CASES

Case No.	Number of Tubes	Pump Trip	Other Plant Equipment Assumptions	Purpose
1	1-OTSGA	at rupture	Loss of offsite power at rupture	ATOG benchmark
2	1-OTSGA	at scram		Baseline tube rupture
3	1-OTSGA	at scram	Continue steaming OTSG-A	Latest SGTR procedure
4	10-OTSGA	on 20F° subcooling		Effect of larger number of ruptures
5	10-OTSGA	on 0F° subcooling	Bounds instrument error in SCM Evaluates saturated RCS cooldown	Effect of less restrictive pump trip criterion
6	10-OTSGA	on 20F° subcooling	Continue steaming OTSGA	Compare latest SGTR procedure to previous procedure
7	5-OTSGA 5-OTSGB	on 20F°subcooling		Effect of leaks in both steam generators
8	10-OTSGA	on 20F° subcooling	Ruptures at bottom of OTSG	Effect of different rupture location (MIST case)
9	10-OTSGA	on 20F° subcooling	Failure of water level indication and control	Effect of overfilling the OTSG (MIST case)
10	1-OTSGA	on 20F° subcooling	Secondary safety valve sticks open on first challenge	Effect of credible secondary system breach
11	1-OTSGA	at scram	PORV sticks open on first use	Feed and bleed cooling, including solid RCS pressure control
12*	1-OTSGA	On 20F° subcooling	Loss of offsite power at rupture	Effect of delayed pump trip on baseline SGTR
12a*	1-OTSGA	on 20F° subcooling	Will evaluate effect of head bubble	Carried out to DHR initiation conditions

RESPONSE: Figure 4 of TDR 406 depicts the PORV energy removal for 100F subcooled water as a function of RCS pressure. A subcooling of 100F was chosen because it minimized the enthalpy of the fluid. The figure shows that the RCS can be at 400 psi (344F based on 100F° subcooling) in less than 3 hours. The short term response to tube rupture, then is adequately covered in the procedure and shows that the plant can be maintained at a pressure/temperature condition that will terminate releases and cool the core.

Cooldown to the DHR initiation conditions relying solely on feed and bleed cooling will be dependent on a number of items.

1. The amount of cooling out of the ruptured tubes.
2. Availability of the RCPs, which would allow cooldown following the brittle fracture rather than PTS limits (i.e. higher subcooling and hence, higher PORV flow rate).
3. Availability of letdown flow to increase the cooldown rate.
4. Determination of the maximum allowable temperature for DHR initiation.
5. Availability of the condenser to allow liquid draining out of the OTSG.

12m. QUESTION: The new SGTR procedures direct the operator to steam the damaged OTSG to the condenser, if available, and to isolate the damaged OTSG should the dose exceed 50m rem/hr. Further, if after isolation the dose exceeds 50m rem/hr, the intact OTSG is isolated and primary system "feed and bleed" is initiated. The staff has the following concerns:

1. As a result of steaming the damaged SG to the condenser, the condenser hotwell, condensate and feedwater systems may become contaminated. Therefore, isolation of the damaged OTSG would not necessarily stop the releases. The intact SG would presumably continue to be steamed, the contaminated feedwater would result in continued releases. Thus, a point could be reached at which the feedwater becomes so contaminated that the criterion for intact OTSG isolation (50m rem/hr) could be reached and feed and bleed would have to be initiated. The necessity for this should be carefully reviewed. Feed and bleed should be only a last ditch method of mitigating any accident.

2. The proposed procedure (pg. 37, section 5.2.7.1) states that the damaged OTSG is to be steamed to keep the pressure below 1000 psig, and if the plant is on feed and bleed, to prevent the level from exceeding 600 inches. If the steam lines are qualified for dead-weight load of water, what is the necessity for continuing to steam the damaged OTSG?

3. We are concerned that the operators, in an effort to avoid contaminating the condenser, hot well, and feedwater systems, may elect to steam the generators to the atmosphere anyway. What assurance is there that actions which minimize offsite releases will always take precedence over actions which minimize maintenance or cleanup concerns?

RESPONSE:

1. Before the water from the affected OTSG reaches the unaffected OTSG, it has passed through the condenser. Virtually all noble gases will have been stripped from the feedwater before it is returned to the OTSGs. There does not appear to be a mechanism for subsequently releasing a significant fraction of the radiodine in solution as long as steaming continues to the condenser. If the condenser is subsequently lost and the unaffected OTSG is steamed to the atmosphere, suction can be drawn from the condensate storage tank. This would only leave the volume of water in the OTSG and feedwater as an iodine source term. This would reduce the releases precluding the need for feed and bleed cooling.

2. Steaming of the OTSGs is not related to dead weight loads on the lines. Steaming the OTSG has the advantages discussed in Sections 2.1.2, 2.1.3, and 2.2.2 of TDR 406. The primary benefits are:

   a. to reduce OTSG tube stresses;
   b. prevent the OTSG from becoming a large heat source;
   c. prevent filling and pressurization to the point of where the OTSG safety valves are forced to relieve water;
   d. promote natural circulation in the affected loop;
   e. more rapid cooldown to the DHR initiation temperature.

3. Operator training for response to OTSG tube ruptures emphasizes that actions are taken to minimize releases. All of the emergency procedure actions taken are structured to either reduce existing releases or to prevent plant conditions which might increase releases. The outage time associated with a leaking or ruptured OTSG tube exceeds the time required to clean up the feedwater system (or to justify the actions taken in allowing a radiological release).

13a. QUESTION: TDR 517, PSG 2.5, "Steam Generator Isolation Considerations for the E/D with Concurrence by the ESD", was added to the TMI-1 guidelines to address the "flexibility" requirement stated in NUREG-1019, Suppl. No. 1, Section 4.3.1. With regard to this new section, provide the following:

a. This section was not identified as a difference from Oconee ATOG or TDR 406. Verify that TDR 406 has been amended to include this section.

RESPONSE: TDR 406, Rev. 3, dated December 2, 1983 was amended to include the additional considerations regarding steam generator steaming/isolation criteria. This guidance was subsequently included into TDR 517, Rev. 0, dated January 20, 1984.

13b. QUESTION: Consideration "General, c" states that feed and bleed cooling would result in releases of steam or steam and water directly to the atmosphere. Provide the basis for this statement and relate your discussion to the response to 12m.1.

RESPONSE: Feed and bleed cooling cannot match decay heat for about 2 hours. Therefore, the RCS pressure may remain above 1000 psi. If the OTSG fills and pressurizes during this time, then the operator is instructed to steam the OTSG to maintain pressure below 1000 psig in order to prevent challenging of the main steam safety valves. If the condenser or turbine bypass system are not available then the ADVs would be used and the releases would be vented to the atmosphere. If level in the OTSG is sufficiently high, the flow out of the valves could contain some entrained liquid. Once RCS pressure is below 1000 psig, releases would terminate. This situation is not easily achievable, however. In order to flood the OTSG within 2 hours, the leak rate from the RCS has to be large. However, a large leak rate will remove energy from the RCS. When added to the PORV flow, it will depressurize the RCS. Again, once the RCS pressure is below 1000 psi, there will not be any secondary side releases.

13c. QUESTION: Consideration "General, D" states that an isolated OTSG may flood and it may be impossible to unisolate the OTSG and return it to service. Provide the bases for both of these statements. Explain the differences between this statement and consideration II.A which states that releases will be terminated. Provide the basis for the inference that a flooded, isolated OTSG will not produce releases.

RESPONSE: Leakage will continue into an isolated OTSG as long as RCS pressure is greater than the pressure in the isolated OTSG. If pressure in the RCS stays above 1000 psig for a long period of time, then the OTSG could fill. Since the operator is instructed to steam the OTSG to keep pressure below 1000 psig, complete flooding would only result if the turbine bypass system and atmospheric dump valve on an OTSG were inoperable. While this is not a likely sequence of events, it has been considered as a plant symptom that might have to be dealt with in an emergency.

Item II.A addresses the situation where "high iodine release rates could (emphasis added) be terminated by isolation of the leaking condenser". This section was written for the E/D and ESD to consider when it is known that the OTSG can be isolated and remain isolated.

13.d QUESTION: Provide the basis for Consideration I.A that a bubble in a hot leg may form and prevent natural circulation cooldown.

RESPONSE: Under natural circulation cooldowns, isolation of one loop could result in a flow interruption in that loop. Hot fluid at the top of the candy cane might subsequently flash to steam and hold up RCS pressure (see Oconee ATOG, Appendix C, Page C-15). On the other hand, the ruptured tube provides communication to the OTSG. Flow in the isolated loop may continue and prevent flashing to steam. Alternatively, the steam bubble may simply remain at the RCS saturation pressure. The ruptured OTSG tube provides a pressure relief path for the stagnant hot leg.

Consideration I.A simply provides a contingency for a situation in which a hot leg bubble has interrupted natural circulation. Treatment of this plant state without consideration of the likelihood of the mechanism for its occurrence.

13e. QUESTION: The "Summary" table is not clear. Clarify the wording of the table headings and the numbering of parenthetical reference entries.

RESPONSE: TDR 517 and TDR 406 will both be revised to clarify the table headings and references of the summary table.

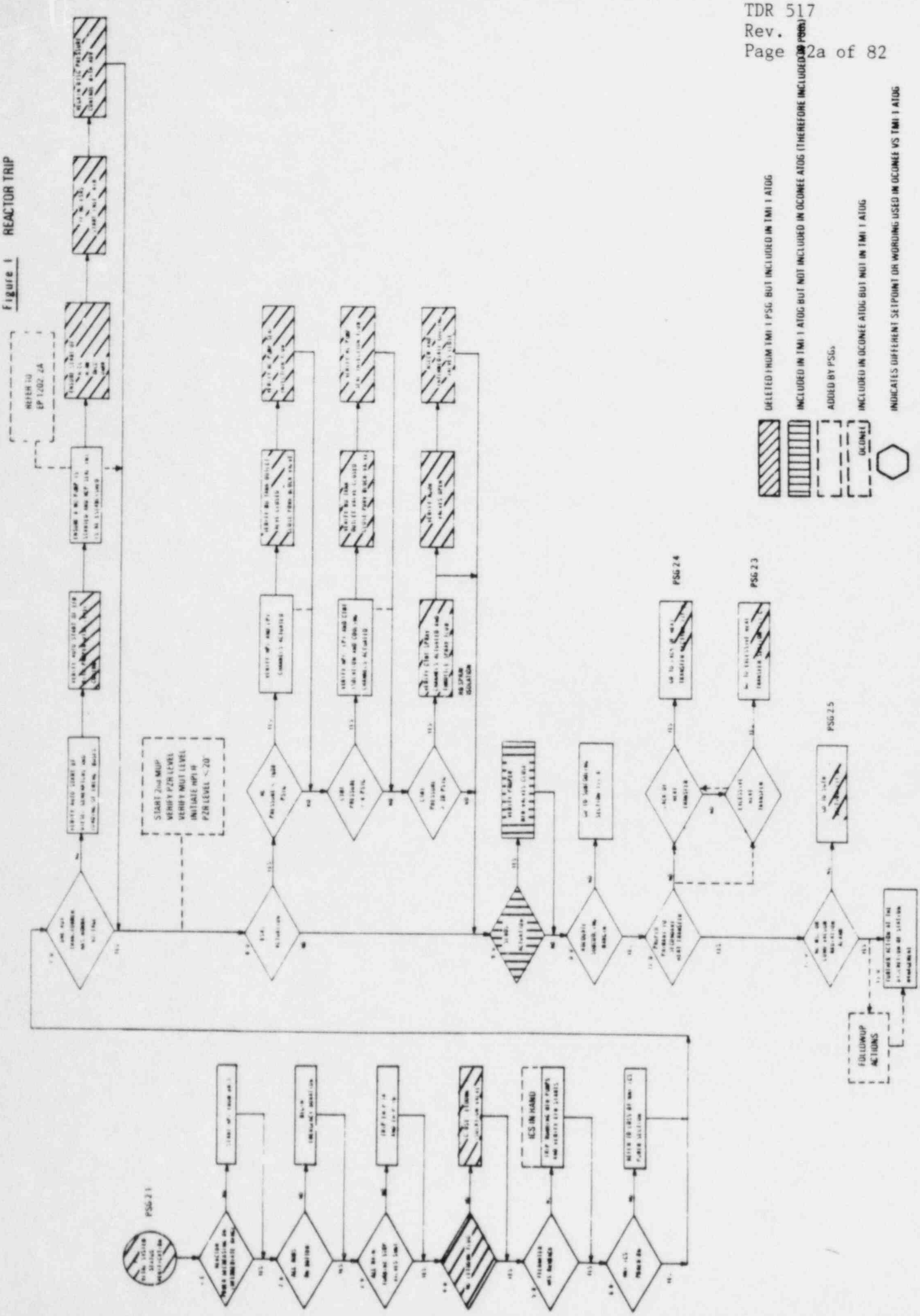
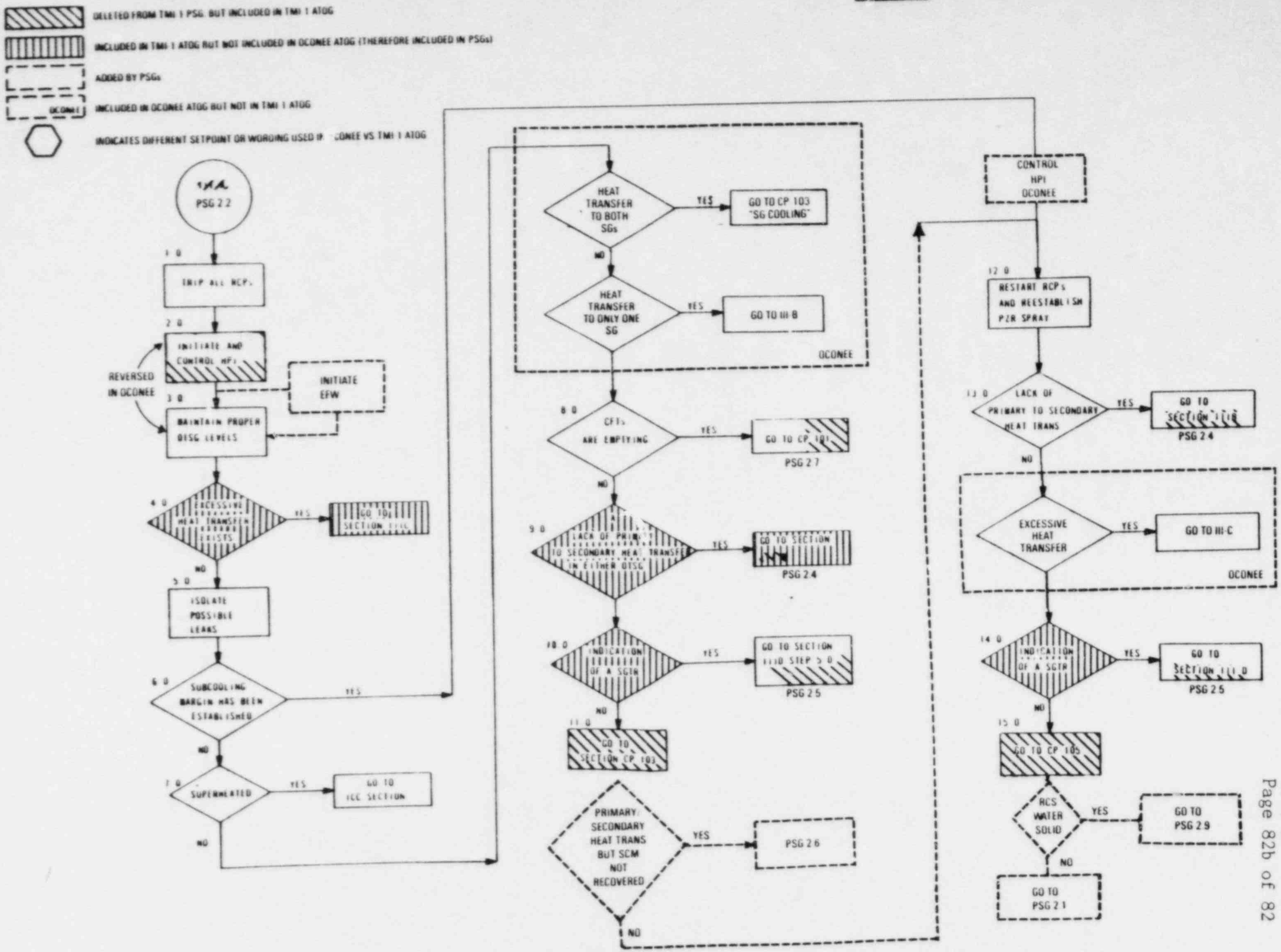


Figure I
REACTOR TRIP
REFER TO
EP 1202 2A
START 2nd MUP
VERIFY PZR LEVEL
VERIFY MUIT LEVEL
INITIATE HPI IF
PZR LEVEL <20"
PSG 21
ICS IN HAND
PSG 24
PSG 23
PSG 25
FOLLOWUP
ACTIONS
DELETED FROM TMI 1 PSG BUT INCLUDED IN TMI 1 ATOG
INCLUDED IN TMI 1 ATOG BUT NOT INCLUDED IN OCONEE ATOG (THEREFORE INCLUDED IN PSGs)
ADDED BY PSGs
INCLUDED IN OCONEE ATOG BUT NOT IN TMI 1 ATOG
OCONEE
INDICATES DIFFERENT SETPOINT OR WORDING USED IN OCONEE VS TMI 1 ATOG

Figure 2 LACK OF ADEQUATE SUBCOOLING MARGIN



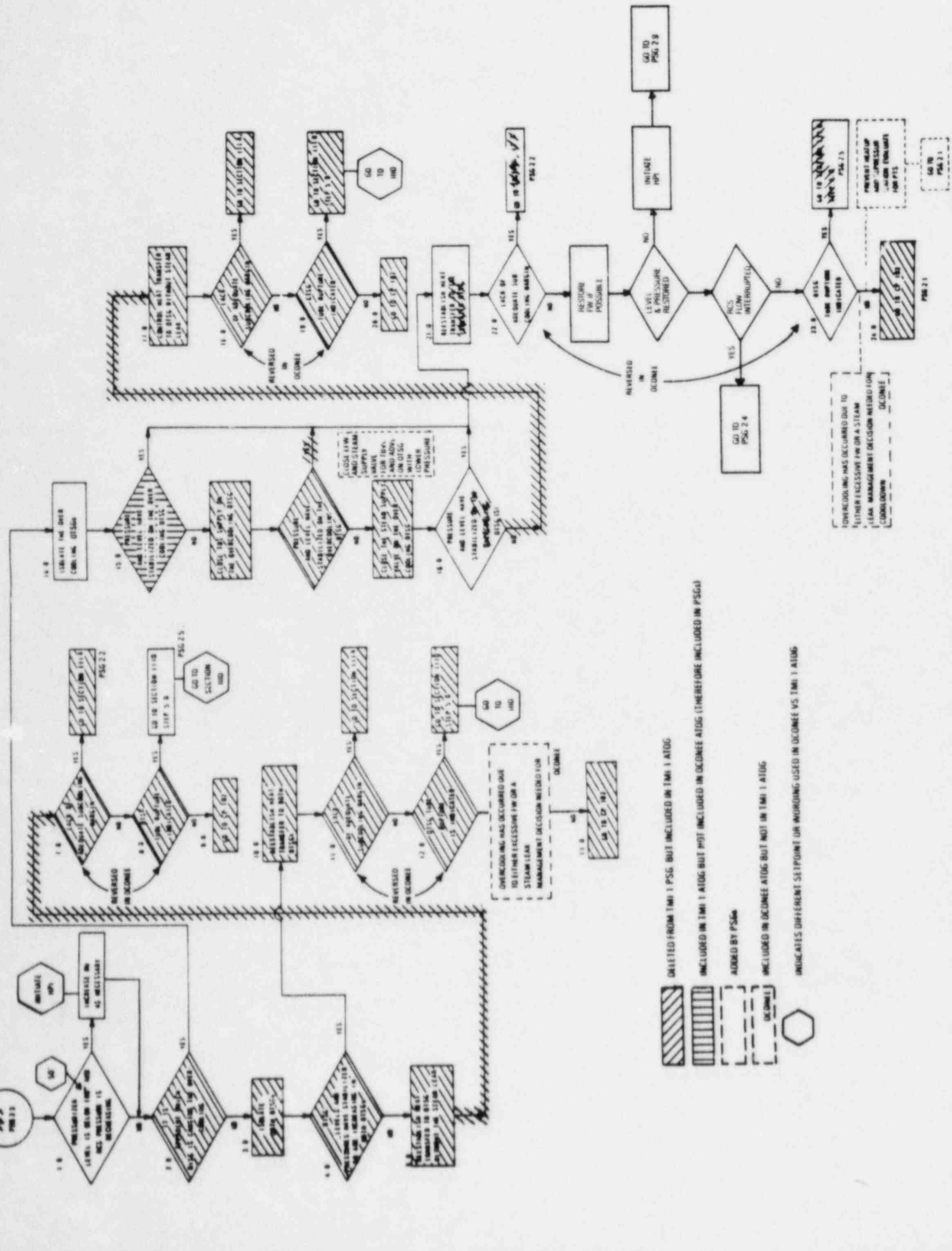


Figure 3 EXCESSIVE HEAT TRANSFER

Figure 4 LACK OF HEAT TRANSFER

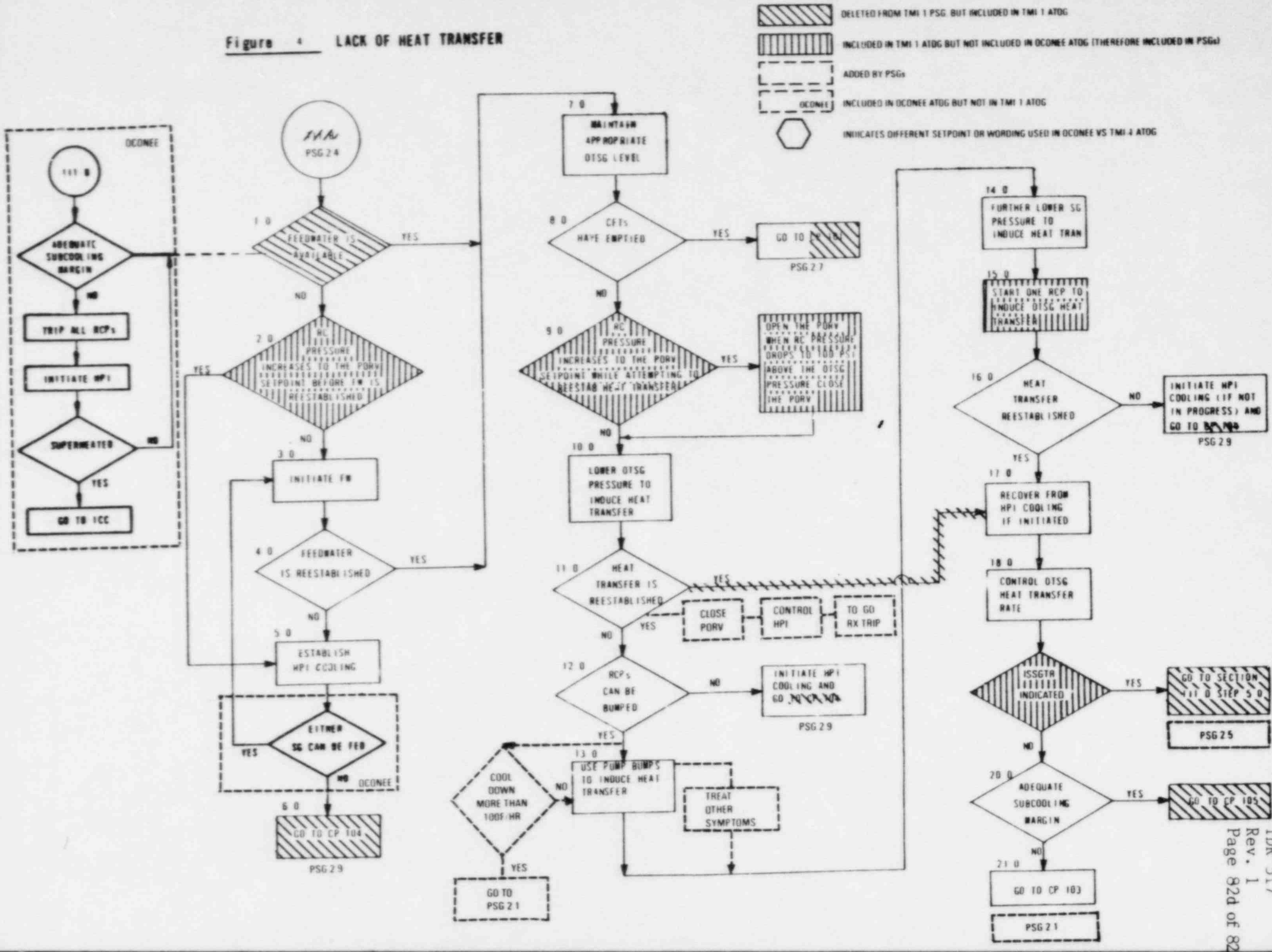


Figure 5

CP 101/PSG 2.7
LARGE LOCA AND CFTS ARE EMPTYING

CP 103/PSG 2.6
SATURATED RC COOLDOWN WITH SGS REMOVING HEAT

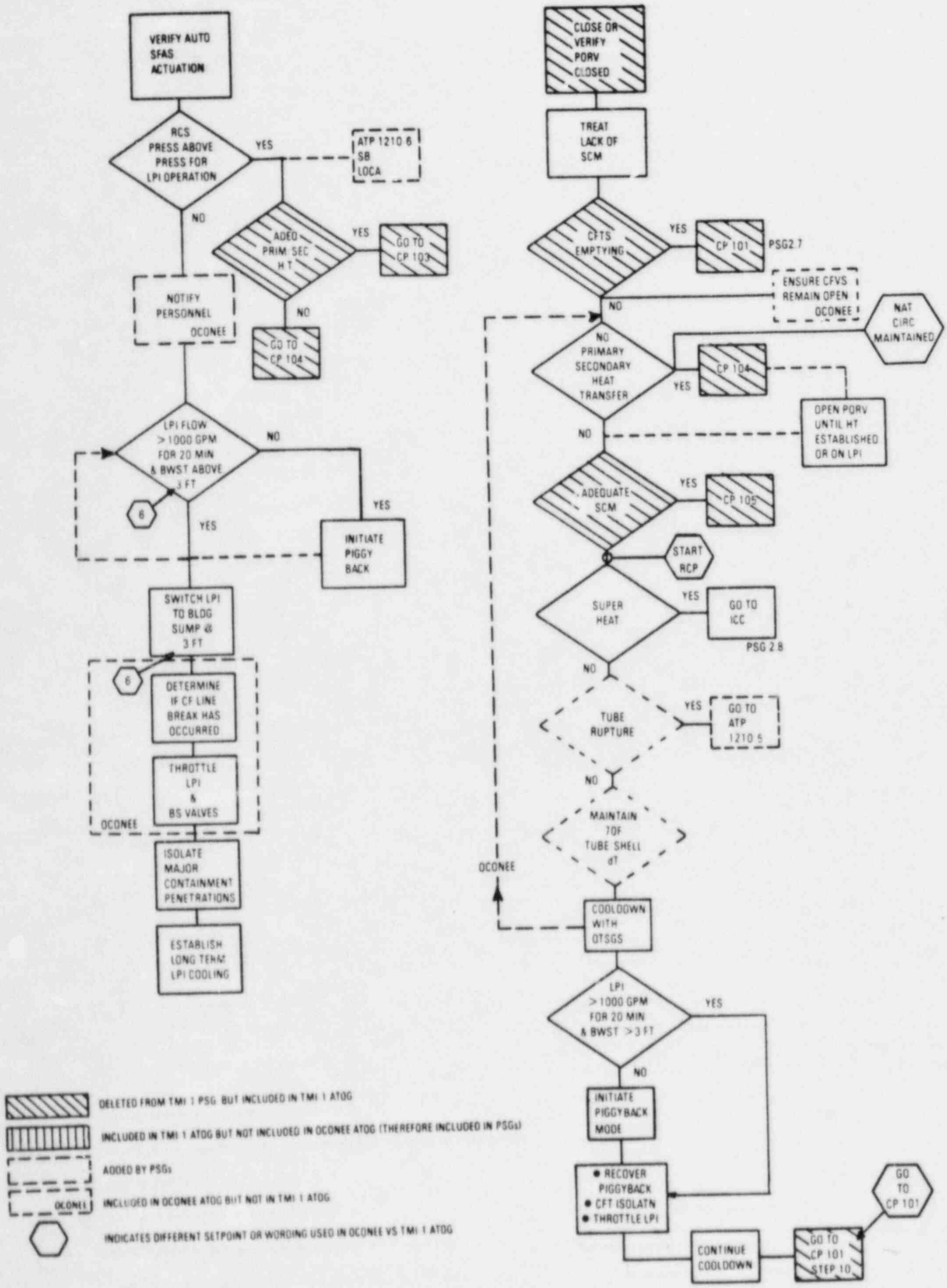


Figure 6

CP 102/OP 1102-16&11
COOLDOWN ON ONE OR TWO OTSGS
RCS SUBCOOLED & PZR STEAM BUBBLE

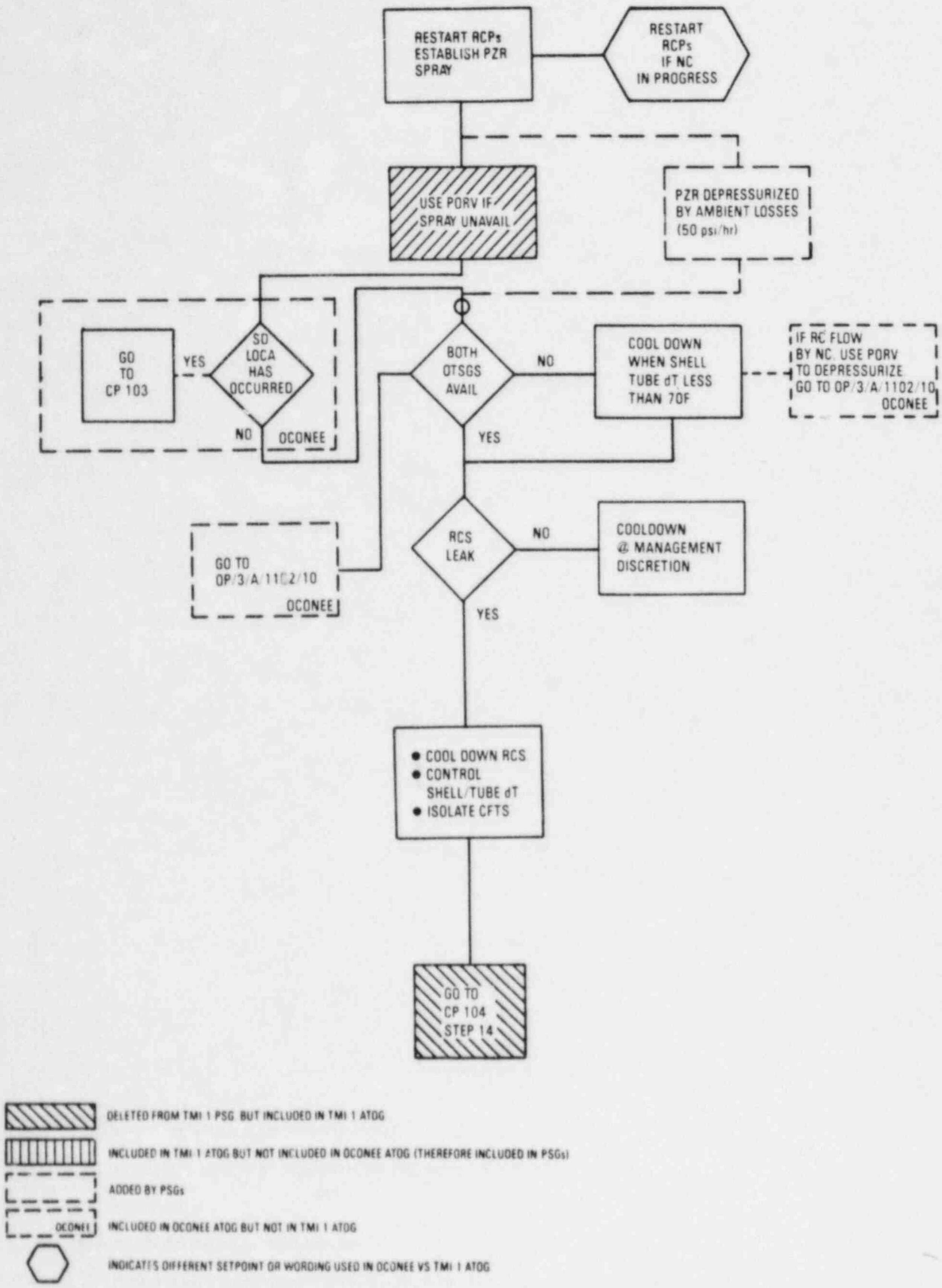
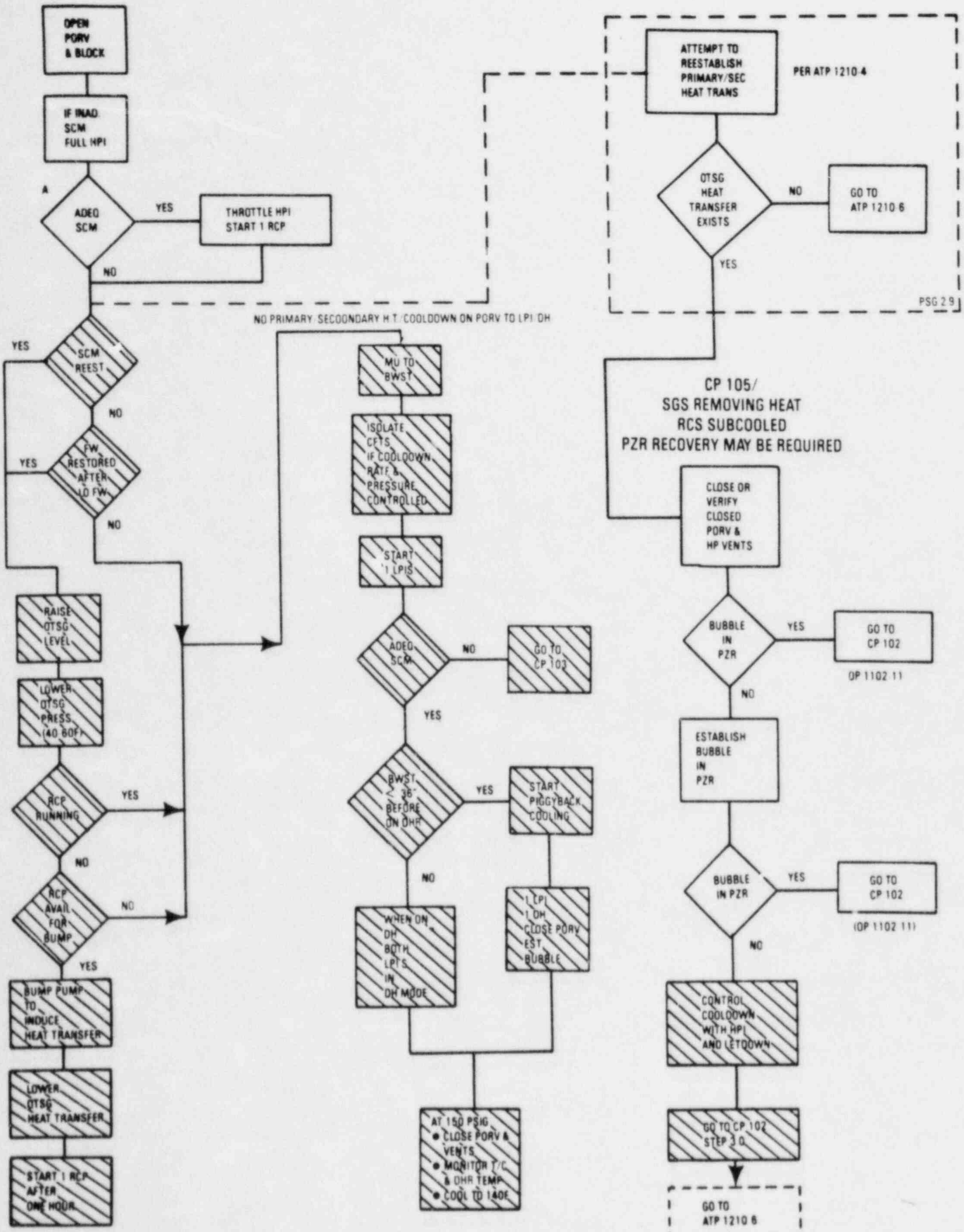
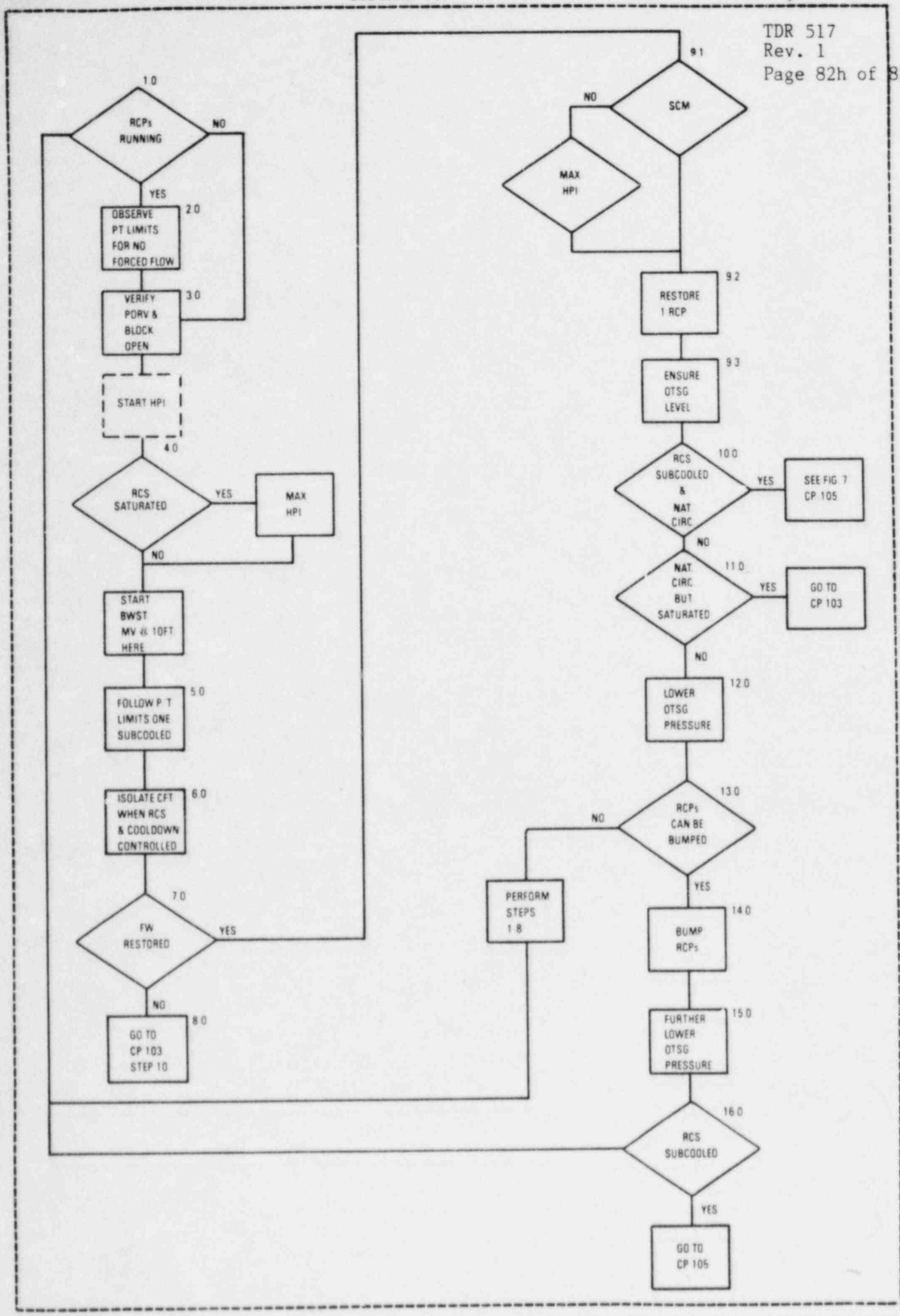


Figure 7

CP 104 AND 105/PSG 2.8 HPI COOLING HPI/PORV-OPEN COOLING WITHOUT SG(S) REMOVING HEAT




1.0
RCPs RUNNING
NO
YES
2.0
OBSERVE PT LIMITS FOR NO FORCED FLOW
3.0
VERIFY PORV & BLOCK OPEN
START HPI
4.0
RCS SATURATED
YES
MAX HPI
NO
START BWST MV @ 10FT HERE
5.0
FOLLOW P-T LIMITS ONE SUBCOOLED
6.0
ISOLATE CFT WHEN RCS & COOLDOWN CONTROLLED
7.0
FW RESTORED
YES
NO
8.0
GO TO CP 103 STEP 10
9.1
SCM
NO
MAX HPI
9.2
RESTORE 1 RCP
9.3
ENSURE OTSG LEVEL
10.0
RCS SUBCOOLED & NAT CIRC
YES
SEE FIG. 7 CP 105
NO
11.0
NAT. CIRC. BUT SATURATED
YES
GO TO CP 103
NO
12.0
LOWER OTSG PRESSURE
13.0
RCPs CAN BE BUMPED
NO
PERFORM STEPS 1-8
YES
14.0
BUMP RCPs
15.0
FURTHER LOWER OTSG PRESSURE
16.0
RCS SUBCOOLED
YES
GO TO CP 105

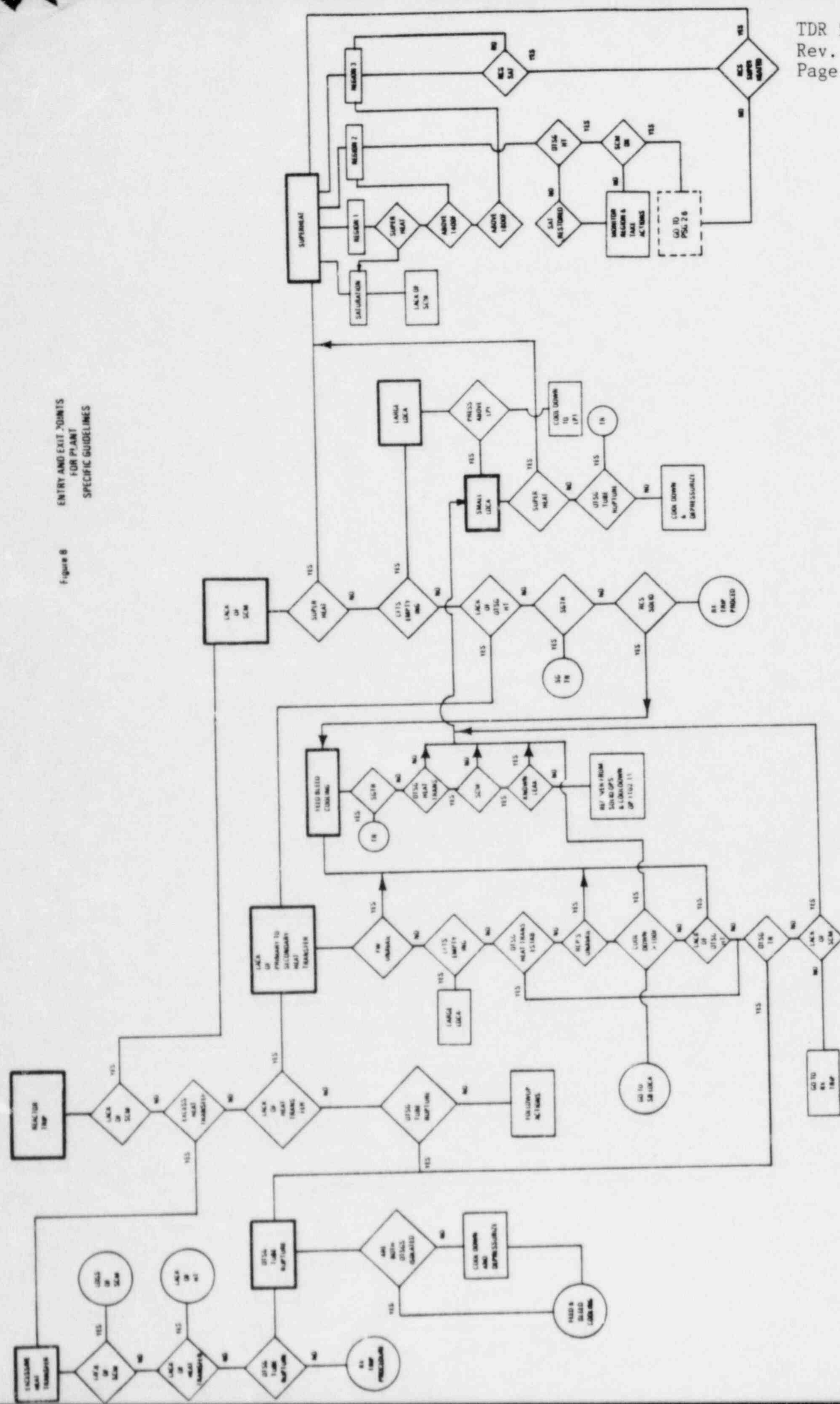


Figure 8 ENTRY AND EXIT POINTS FOR PLANT SPECIFIC GUIDELINES

Figure 9 CORE EXIT FLUID TEMPERATURE FOR INADEQUATE CORE COOLING