EMERGENCY RESPONSE PLAN IMPLEMENTATION PROCEDURE

REVIEW/APPROVAL

Calvert Cliffs Nuclear Power Plant

Emergency Response Plan Implementation Procedure

CANDIDATE HIGH LEVEL ACTIONS BD/B

ERPIP 606

Revision 1

Effective Date: MAR 21 2001

Writer: ______ 01/02/01
James C. Kellum — Date

Reviewer: ______ 2/26/01
Mark T. Finley — Date

Director - EP: ______ 2/28/01
Anthony J. O'Donnell — Date

POSRC Mtg. #: 01-019 ______ 3-14-01
(Signature indicates procedure was reviewed according to NS-2-101) — Date

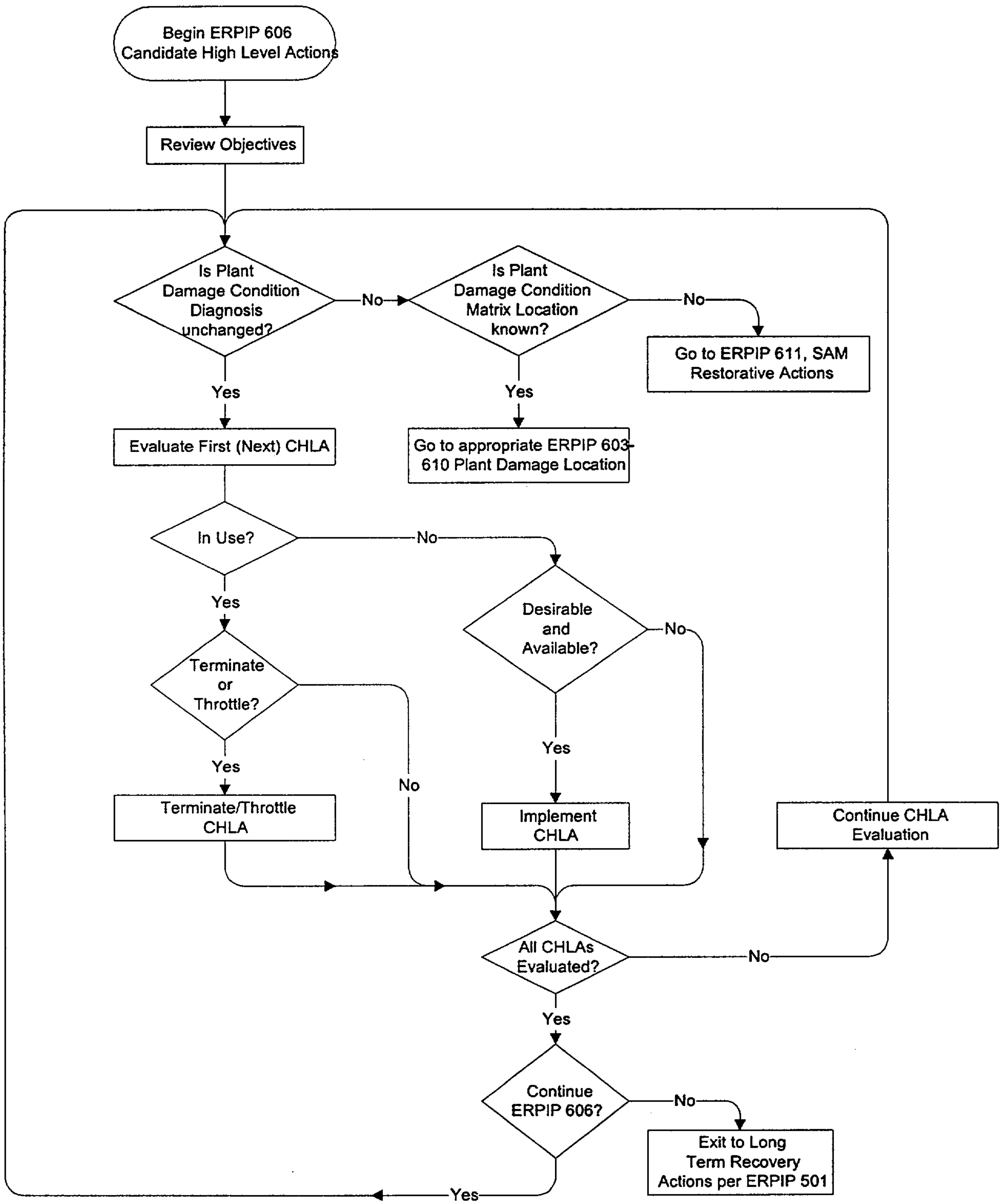
Approved: ______ 3/14/01
Plant General Manager — Date

Candidate High Level Actions
BD/B

RESPONSIBLE INDIVIDUAL: Reactor Engineer

CONDITION: Severe Accident

Instructions



1. OBJECTIVES

A. This ERPIP (BD/B) is being implemented because the CNMNT barrier is being bypassed. The highest priorities are to gain control of the RCS inventory and core and RCS heat removal, and to minimize the release due to the bypass.

B. The objectives of the **BD/B CHLA** are to:

1. Regain RCS inventory control
2. Regain core & RCS heat removal
3. Prevent creep rupture
4. Avoid high pressure melt ejection and resultant Direct Containment Heating
5. Maintain vessel integrity
6. Ensure all containment penetrations are isolated, except those needed to recover from the accident (e.g., containment sump suction for SI recirculation).
7. Minimize on-site and off-site radiological doses.
8. Minimize any further breaches in containment integrity.

1.C. The following table provides the prioritized list of Candidate High Level Actions for BD/B. The CHLAs are listed in recommended order of implementation. However, the TSC may re-prioritize them depending on plant conditions. The associated objectives, in general, for each CHLA are listed below.

Prioritized CHLA for BD/B	Objectives
1. Inject into RCS	Regain RCS inventory control. Regain core heat removal.
2. Depressurize the RCS	Enable CHLA 1 Prevent creep rupture Avoid high pressure melt ejection
3. Feed the Steam Generators	Accomplish CHLA 2 Regain RCS heat removal (using S/Gs). Cover SGTR (if present) to reduce fission product release.
4. Depressurize the Steam Generators	Enable CHLA 2. Regain RCS heat removal (using S/Gs). Accomplish CHLA 3
5. Spray into Containment	Accomplish CHLA 9. Reduce containment airborne radiation/contamination levels. Reduce containment temperature and pressure to minimize leakage to the environment. Quench hot surfaces/components to reduce containment heat load.
6. Operate Containment Air Coolers	Reduce containment airborne radiation and contamination levels. Reduce containment temperature and pressure to minimize leakage to the environment Provide a heat sink for core decay heat transferred to the containment environment.
7. Restart Reactor Coolant Pumps	Regain core and RCS heat removal (sweep non-condensible gases from U-tubes).
8. Vent the RCS	Regain RCS heat removal (vent gases).
9. Flood Reactor Cavity	Regain core heat removal. Prevent reactor vessel failure.
10. Spray the Auxiliary Building	Reduce Auxiliary Building airborne contamination levels. Reduce Auxiliary Building temperature.
11. Operate Hydrogen Recombiners	Reduce hydrogen concentration.

CHLA Tracking Table

This tracking table may be used as an aid in monitoring CHLA status.

Time									
CHLA									
Inject Into the RCS									
Depressurize the RCS									
Feed the Steam Generators									
Depressurize the Steam Generators									
Spray into Containment									
Operate Containment Air Coolers									
Restart the Reactor Coolant Pumps									
Vent the RCS									
Flood the Reactor Cavity									
Spray the Auxiliary Building									
Operate Hydrogen Recombiners									

X = Not available
I = In Use
E = Evaluated
S = Stopped
N/A = Not applicable to Matrix Location

Y = Available
N/I = Not In Use
N/E = Not Evaluated
T = Throttled

2. CHLA 1 - INJECT INTO RCS

A. Purpose/Benefits:

1. The purpose of this CHLA is to:
   - Cool the reactor core materials to restore the Core and RCS Heat Removal Safety Function
   - Restore RCS inventory to provide core cooling
   - Help collapse upper head steam voids during recovery

B. Initiation Criteria:

1. This action should be considered if any of the following conditions exist:
   - Less than 25°F subcooling
   - PRZR level less than 101 inches. Due to potential RCS voiding, RVLMS should be used to determine if the core is covered
   - RVLMS indicates less than 10 inches (all lights lit)

C. Termination/Throttling Criteria:

1. Termination of this action or throttling of injection flow should be considered if any of the following are true:
   - The generation of steam and/or hydrogen is challenging containment integrity.
   - The loss of coolant through the bypass is depleting the sources of water for injection.
   - Unborated water is the only source for injection.
   - It is considered necessary to prolong the time to receive a Recirculation Signal. Throttling could be desirable if:

     (1) Recirculation is unavailable, or

     (2) Recirculation could compromise restoration activities due to increased radiation levels caused by radioactive sump water.

D. Concurrent Actions:

1. DEPRESSURIZE THE RCS CHLA - This action should be considered based on the following:
   - If the S/Gs are required as a heat sink but cannot be used (e.g., total loss Feedwater), then once-through core cooling should be considered.
   - Injecting water to the overheated core will result in a pressure spike which exceeds 3000 psia, then consideration should be given to depressurizing only enough to avoid the 3000 psia pressure. This avoids unnecessary inventory loss. (Refer to ERPIP 611, Attachment 5 CA-3b.)

- If RCS pressure is above the shut-off head of the safety injection pumps (1270 psia) and RCS make-up is needed, the RCS should be depressurized to allow flow to the RCS.
- Depressurization will slow the loss of inventory through the bypass.
- If a SGTR exists, makeup to the RCS can be accomplished via backflow from the S/G if RCS pressure is reduced below S/G pressure. (This will be a low boration source.)

2.E. Equipment Required:

> - **NOTE** -
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Safety Injection Pumps (HPSI and LPSI)
  - RWT Level greater than 0.5 ft or CNMNT sump recirc alignment and,
  - At least one HPSI or LPSI Pump
- Charging Pumps (if available)
- Alternate water sources (Refer to Attachment 1 of ERPIP 611)
- Main or Auxiliary Feedwater (for backflow to RCS if SGTR exists)
  - Auxiliary Feedwater System
    (1) At least one AFW Pump and,
    (2) Source of makeup water
  - Main Feedwater System (unavailable if SIAS, SGIS or CSAS actuated unless bypassed, blocked or overridden):
    (1) At least one SGFP (except for Condensate Booster Pump Injection) and,
    (2) At least two Condensate Pumps (only require for Condensate Booster Pump injection) and,
    (3) At least one Condensate Booster Pump and,
    (4) Source of makeup water

F. Cautions:

1. Injecting water into an overheated core can generate large volumes of superheated steam which forces steam through the hot legs and into the S/G U-tubes, creating a creep rupture concern. If the S/G secondary-side water level is at least -350 inches on WR S/G level indicator, then the threat of creep rupture failure in S/G U-tubes is greatly reduced. If SI is available but feeding the S/Gs is not, then consider using hot-leg injection or pressurizer injection.

2.F.2. A large RCS pressure spike may be generated when water is added to an overheated core. If the estimated pressure spike exceeds 3000 psia, depressurization of the RCS is required prior to RCS injection (Refer to ERPIP 611, Attachment 5 CA-3b).

3. A large rate of water injection may not result in removing more heat from the core. Depending on the existing core characteristics (e.g., compaction, porosity, etc.), the amount of heat that can be removed from the damaged core may be limited. The rate of water injection should be monitored to ensure it is being effectively used.

4. Hydrogen may be generated as a result of the zirconium-water reaction.

5. Injection of unborated water could lead to a return to criticality. Monitor the ex-core detectors for power spikes. If power spikes occur, reduce the rate of safety injection to eliminate power spikes and take actions to restore borated water to the RCS.

6. Cool ECCS water may cause thermal shock to fuel pins and result in more fuel damage. A slower rate of injection may be better (≈250 gpm, for a more detailed value, refer to ERPIP 611, Attachment 5 CA-2a and CA-2b for minimum flows required for core heat removal.

7. In the bypass containment damage condition, coolant is being discharged outside the containment. Long tern injection could result in depleting inventories to the point that loss of injection and accompanying loss of cooling flow to the core could result.

G. **<u>Expected Plant Response:</u>**

- Increase reactor vessel water level.
- Decrease core exit temperature.
- Possible RCS pressure spike.
- Possible increase in RCS and/or containment hydrogen concentration.
- Possible increase in containment pressure.

H. **<u>Conflicts with EOPs</u>:**

1. Potential conflicts are:

    - The use of maximum safety injection flow as advocated by the EOPs may not be desirable due to RCS creep rupture concerns of injecting to an overheated core causing a pressure spike which may cause creep failure
    - If unborated safety injection water is considered, the return to power implications are outside the scope of the EOPs where only borated water is available.
    - EOP termination criteria for safety injection flow are prescriptive (e.g., core coverage, pressurizer level, subcooling, and S/G heat removal) whereas specific severe accident conditions may dictate other more appropriate actions, such as throttling unborated flow if a power spike occurs.

2.I. **Consistency with EOPs**:

1. This CHLA is consistent with EOP-8 Functional Recovery Procedure, RCS Pressure and Inventory Control, except for the conflicts listed above.

J. **Recommended Actions**:

1. Recommend the Control Room perform any of the following:

   - Makeup to the RCS via Safety Injection/Charging Systems (Refer to EOP-8, PIC series).
   - Initiate CNMNT Sump recirculation (Refer to EOP-8, PIC series).
   - Commence Hot Leg or Pressurizer injection (Refer to EOP-8, PIC series).
   - Commence backfill to the RCS via a ruptured S/G (Refer to EOP-8, HR series).
   - Provide makeup to the RCS from alternate sources (Refer to Attachment 1 of ERPIP 611).
   - Depressurize the RCS per CHLA 6, (to enhance makeup, including backflow from S/Gs if SGTR exists).

3. CHLA 2 - DEPRESSURIZE THE RCS

A. Purpose/Benefits:

1. The purposes of this CHLA are to:

- Increase injection flow to the RCS or to allow low pressure sources to be used
- Enable Once-through Core Cooling via feed and bleed (e.g., after a total loss of Main and Auxiliary Feedwater).
- Reduce potential creep failure on sensitive RCS components such as the hot leg, surge line, and S/G tubes.
- Minimize peak pressure from the pressure spike caused by addition of water to an overheated core.
- Reduce flow out an RCS break or to the S/G in the event of a SGTR.
- Reduce the driving potential for high pressure melt ejection and the resulting direct containment heating potential.

This CHLA may be accomplished by reducing RCS temperature (and therefore pressure) through the Concurrent Actions noted below or by venting of the RCS using the PORVs, Reactor Vessel Head Vents and/or the Pressurizer Vents.

B. Initiation Criteria:

1. This action should be considered if any of the following exist:

- RCS pressure should be reduced to minimize the potential for creep failure.
- A high pressure melt ejection is anticipated. Depressurize the RCS to as close to containment pressure as possible when CETs exceed 2300°F. Depressurizing the RCS is also appropriate if fuel pellet overheating is evident as indicated by the PASS:
  (1) Cesium-134 concentrations between 10% to 50% of source inventory.
  (2) Tellurium-129 or Rubidium-88 concentrations between 10% and 50% of source inventory (less than 30 days after refueling).
- Natural circulation is not effective in removing core heat. (Depressurization will result in an initial drop in temperature. A sustained decrease must be accomplished through other actions.)
- RCS pressure spikes could exceed 3000 psia due to RCP restart or ECCS injection. Depressurization of the RCS should be performed prior to these actions. Reducing RCS pressure will minimize the potential for creep failure. (Refer to ERPIP 611, Attachment 5 CA-3a, 3b, 4c).
- Injection flow to the RCS is desired, or needs to be increased.

3.C. **Termination Criteria**:

1. Termination of this action should be considered if:

- The addition of hydrogen and/or steam to the containment is leading to a challenge of the containment (if venting is the means of depressurization).
- A steam explosion is anticipated. If RCS pressure is less than 150 psi and the core debris slumps to the lower plenum or large amounts of water are added to the molten debris, a steam explosion is possible.
- The desired RCS pressure decrease has been obtained.

D. **Concurrent Actions**:

- INJECT INTO RCS CHLA - If depressurization is being performed to increase injection flow to the RCS.
- DEPRESSURIZE THE S/Gs CHLA - Depressurization via aggressive heat removal by the S/Gs is the preferred method of RCS depressurization, since RCS water inventory is conserved.
- FEED THE STEAM GENERATORS CHLA - Accelerated feed into the steam generators can have a short term effect on RCS pressure.
- SPRAY INTO CONTAINMENT CHLA - If associated CHLA Initiation Criteria are met.
- OPERATE CONTAINMENT AIR COOLERS CHLA - If associated CHLA Initiation Criteria are met.

E. **Equipment Required**:

> - **NOTE** -
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- PORV(s), Reactor Vessel Head Vents, and/or PZR Vent
- S/Gs (with TBVs, ADVs and/or HP drains)

F. **Cautions**:

1. Depressurization of the RCS could cause flashing of water in the core and increase the cladding oxidation and H2 generation.
2. Depressurizing the RCS to containment will increase hydrogen concentration in containment and could result in a hydrogen burn.

G. **Expected Plant Response**:

1. Decrease in primary system pressure and temperature.

3.H. **Conflicts with EOPs:**

1. The EOPs do not provide guidance on avoiding creep rupture, high pressure melt ejection, or large RCS pressure spikes. Where the EOPs do depressurize the RCS by steaming, it is done with the expectation of having safety injection available. For severe accident use, this action may be taken even if safety injection is not available.

I. **Consistency with EOPs:**

1. This CHLA is consistent with EOP-8 Functional Recovery Procedure, Core and RCS Heat Removal, for establishing once-through core cooling via feed and bleed. If secondary heat removal capability is lost, it is likely OTCC bleed will be in progress per EOP actions prior to entering the SAM ERPIPs.

J. **Recommended Actions:**

1. Recommend one or more of the following actions to the Control Room:
   - Cooldown the RCS using TBVs (Refer to EOP-8, HR series).
   - Cooldown the RCS using ADVs (Refer to the Alternate Actions of EOP-8, HR series).
     a. IF a SGTR exists, THEN notify the Chemistry Director to determine if ERPIP 810, Main Steam System Radioactivity Release Rate Estimate, needs to be performed.
   - Cooldown the RCS using manual operation of the TBVs (Refer to the Alternate Actions of EOP-8, HR series).
   - Cooldown the RCS by aligning the steam drains to the condenser (Refer to the Alternate Actions of EOP-8, HR series).
   - Depressurize the RCS using vents or PORVs per guidance provided by OI-1G, REACTOR VESSEL HEAD AND PRESSURIZER VENT SYSTEM.

4. **CHLA 3 - FEED THE STEAM GENERATORS.**

A. **Purpose/Benefits**:

- Provides inventory for removal of heat from the RCS by steaming the S/Gs.
- Removes heat from the RCS to lower RCS pressure and promotes injection from available sources.
- Protects the S/G tubes from over temperature conditions (and therefore creep rupture).
- Scrubs fission products released to the secondary if a SGTR exists.
- If a SGTR exists, this CHLA may also provide water to the RCS via backflow.

B. **Initiation Criteria**:

1. This action should be considered if either:

   a. S/G level drops below (-)59 inches (top of U-tubes, refer to EOP Att. 16 for correction factor).

   b. A SGTR exists and RCS pressure is less than or can be lowered to less than S/G pressure to provide flow to the RCS.

C. **Termination/Throttling Criteria**:

1. Termination of this action and/or throttling of injection should be considered if normal water level has been restored in the S/Gs (-24 to +30 inches).

D. **Concurrent Actions**:

1. DEPRESSURIZE THE STEAM GENERATORS CHLA - Depressurizing the S/Gs can aid in establishing adequate injection to the generators.

E. **Equipment Required**:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

1. One of the following sets of equipment:

   - Main or Auxiliary Feedwater (for backflow to RCS if SGTR exists)
     - Auxiliary Feedwater System
       - (a) At least one AFW Pump
       - (b) Source of makeup water

- Main Feedwater System (unavailable if SIAS, SGIS or CSAS actuated unless bypassed, blocked or overridden):
  - (a) At least one SGFP (except for Condensate Booster Pump Injection)
  - (b) At least two Condensate Pumps (only one required for Condensate Booster Pump Injection)
  - (c) At least one Condensate Booster Pump
  - (d) Source of makeup water

4.F. <u>Cautions</u>:

1. Aggressive depressurization of the S/Gs should not be performed before S/G feed flow can be ensured, since this can result in premature loss of the heat sinks which may result in unneeded thermal stress to the S/Gs at a later time (injecting cold feedwater into a dry S/G).
2. The rate of feedwater injection should be slow to minimize thermal stress and water hammer potential (5 minutes at 150 gpm per S/G) to feedwater piping, feedwater, and S/G U-tubes.
3. Resulting heat transfer promotes primary side coolant circulation which could result in hydrogen gas accumulation in the S/G tubes. This could degrade primary side coolant circulation.
4. Maintain level in both steam generators above –59 inches (top of the u-tubes). Allowing either generator to dry out could result in creep failure of that generator's U-tubes. In this regard, feeding a dry S/G to establish a level is considered acceptable. A water level of about -350 inches is sufficient to prevent creep rupture.

G. <u>Expected Plant Response</u>:

- Increase in S/G level and steam flow.
- Decrease in core exit temperature and hot leg temperatures.
- Possible hydrogen accumulation in U-tubes.

H. <u>Conflicts with EOPs</u>:

1. None.

I. <u>Consistency with EOPs</u>:

1. This CHLA is consistent with the EOP's.

4.J **Recommended Actions**:

1. Recommend one or more of the following actions to the Control Room:

   - Verify CST availability and establish feed flow using Auxiliary Feedwater (Refer to EOP-8, HR series).
   - Verify CST availability and establish Feedwater flow using the other Unit's electric-driven AFW pump (Refer to EOP-8, HR series).
   - Establish feed flow using Main Feedwater (Refer to EOP-8, HR series).
   - Establish feed flow using Condensate Booster Pump injection (Refer to EOP-8, HR series). Steam Generator pressure must be less than 500 psia for this method to be effective.

5. CHLA 4 - DEPRESSURIZE THE STEAM GENERATORS

A. Purpose/Benefits:

- This CHLA ensures a heat transfer path from the core by ensuring there is a temperature difference between the RCS and S/Gs. After RCS subcooling is regained and the S/Gs are being used for heat removal, a ΔP ensures a ΔT between the RCS and S/Gs.

- Increased heat transfer from the RCS can depressurize the primary system, which would increase the opportunity for injecting water into the RCS from LPSIs or the SITs.

B. Initiation Criteria:

1. This action should be considered if either:
   - An increase in heat transfer from the primary to the secondary systems is desired or,
   - Increased flow to the S/Gs is desired and flow would be increased by lowering pressure in the generators.

C. Termination Criteria:

1. Termination of this action should be considered if any of the following occurs:
   - A SGTR exists and depressurization of the secondary side would significantly increase the leakage.
   - Depressurization could lead to creep rupture of the S/G U-tubes. (Not a concern until primary gas temperature is >1500°F.)
   - Sufficient feed flow to the steam generators is established.
   - SDC has been initiated.

D. Concurrent Actions:

1. FEED THE STEAM GENERATORS CHLA - Once S/G inventory can be maintained by ensuring makeup water can be supplied to the S/Gs, this CHLA can be performed so a heat transfer path can be established between the RCS and S/Gs.
2. DEPRESSURIZE THE RCS CHLA - If a S/G tube leak exists, minimizing the ΔP between the RCS and S/Gs will minimize the leak rate and the potential for overfilling the affected S/G.

E. Equipment Required :

- NOTE -
If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Any set of equipment below can be used for this CHLA:

5.E.1.a.

- Turbine Bypass Valves (TBVs)
- Electrical power (except for local operation)
- Instrument Air System pressure at least 40 psig (except for local operation)
- Condenser vacuum at least 22.5 inches Hg. (Unit-1) or 20 inches Hg. (Unit-2) (except for local operation)

- **NOTE** -
Use of TBVs is preferable to minimize potential offsite radiological doses.

- Atmospheric Dump Valves.
  - (1) Electrical power (except for local operation)
  - (2) Instrument Air System or Saltwater Air Compressors (except for local operation)
- S/G Blowdown to Miscellaneous Waste System
  - (1) Electrical power
  - (2) Service Water to the Blowdown HXs

F. **Cautions**:

1. This CHLA increases the ΔP across the S/G tubes which increases the stress on the tubes and could lead to creep rupture conditions. This is **NOT** a concern if sufficient S/G water level exists (>-350 inches) and there is no pre-existing damage to the S/G tubes.
2. Resulting heat transfer decreases RCS pressure which could result in hydrogen gas accumulation in the S/G tubes.
3. If a SGTR exists, increased ΔP across the S/G tubes increases the leak rate increases off-site radiological doses if the ADVs are being used.

G. **Expected Plant Response**:

- Decrease in S/G pressure and temperature
- Decrease in RCS hot and cold leg temperatures
- Decrease in RCS core exit thermocouple temperature
- Decrease in RCS pressure

H. **Conflicts with EOPs**:

1. None.

I. **Consistency with EOPs**:

1. This CHLA is consistent with EOP-8 Functional Recovery Procedure, with regard to plant cooldown/depressurization.

5.J. <u>Recommended Actions</u>:

1. Recommend one or more of the following actions to the Control Room:

   - Cooldown the RCS using TBVs (Refer to EOP-8, HR series).
   - Cooldown the RCS using manual operation of the TBVs (Refer to the Alternate Actions of EOP-8, HR series).
   - Cooldown the RCS using ADVs (Refer to the Alternate Actions of EOP-8, HR series).
     a. IF a SGTR exists, THEN notify the Chemistry Director to determine if ERPIP 810, Main Steam System Radioactivity Release Rate Estimate, needs to be performed.
   - Cooldown the RCS by aligning the steam drains to the condenser (Refer to the Alternate Actions of EOP-8, HR series).
   - Cooldown the RCS by draining via S/G Blowdown to the Miscellaneous Waste System (Refer to EOP-8, HR series).

6. CHLA 5 - SPRAY INTO CONTAINMENT

A. Purpose/Benefits:

1. The purposes of this CHLA are:

- To reduce containment pressure and temperature to prevent challenging containment integrity.
- To flood the reactor cavity
- To Scrub fission products from the containment atmosphere to minimize offsite radiological doses
- To reduce the temperature of zinc and aluminum surfaces, reducing hydrogen production.

B. Initiation Criteria:

1. This action should be considered if either:

- Containment pressure is rising and continued rise could challenge containment integrity or,
- Flooding Reactor Cavity using sprays is desired.

C. Termination/Throttling Criteria:

1. Termination of this action or throttling of spray flow should be considered if:

- Reduction in containment pressure would result in a challenge to the containment as a result of combustible gas concentration (refer to ERPIP 611, Attachment 5 CA-7) or,
- FLOOD THE REACTOR CAVITY CHLA Termination Criteria are met.

D. Concurrent Actions:

- OPERATE CONTAINMENT AIR COOLERS CHLA - If associated CHLA Initiation Criteria are met.
- OPERATE HYDROGEN RECOMBINERS CHLA - The Hydrogen Recombiners may be operating, if containment hydrogen concentration is greater than 0.5%.
- FLOOD THE REACTOR CAVITY CHLA - If associated CHLA Initiation Criteria are met.

E. Equipment Required:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Containment Spray Pumps
  - Water supply
  - Electrical power for pumps and valves

  - Control Air System for air operated valves
- SDCHXs when heat removal is necessary.

6.F. Cautions:

1. This action will reduce the concentration of steam in the containment atmosphere. The concentration of steam may be maintaining inert conditions in the containment. This should be considered in evaluating this action if hydrogen concentration is near the burn limit of 4% (refer to ERPIP 611, Attachment 5 CA-7).

G. Expected Plant Response:

- Decrease in containment pressure and temperature.
- Increase in containment sump level.
- Increase in reactor cavity level as containment sump level increases.

H. Conflicts with EOPs:

1. This CHLA conflicts with the EOPs in that CNMNT spray might not be used due to deinerting concerns.

I. Consistency with EOPs:

1. This CHLA is consistent with EOP-8 Functional Recovery Procedure, Containment Environment.

J. Recommended Actions:

1. Recommend the Control Room initiate containment spray. Refer to EOP-8 CE series.

7. CHLA 6 - OPERATE CONTAINMENT AIR COOLERS (CACs)

A. Purpose/Benefits:

1. The purposes of this CHLA are to:
   - Reduce containment pressure and temperature to reduce the potential for a challenge to containment integrity.
   - Scrub containment atmosphere of fission products.
   - Reduce the temperature of zinc and aluminum surfaces, reducing the production of hydrogen.
   - Promote mixing of containment atmosphere and reduce the probability of a localized accumulation of Hydrogen.

B. Initiation Criteria:

1. This action should be considered if:
   - Containment integrity is challenged as indicated by high containment pressure or is challenged by hydrogen as indicated by the Containment Challenged Calc. Aid ERPIP 611, Attachment 5, CA-7.
   - It is desired to promote mixing of the containment atmosphere.

C. Termination Criteria:

1. Termination of this action should be considered if:
   a. Reduction in containment pressure and/or steam content due to this action would cause a challenge to the containment as a result of establishing a combustible gas concentration.

Reducing SRW flow to the CACs may aid in stabilizing containment pressure, thereby minimizing the potential for a hydrogen burn due to de-inerting. Cycling the CACs or reducing the number of CACs in operation may also be effective.

D. Concurrent Actions:

- SPRAY INTO CONTAINMENT CHLA - If associated CHLA Initiation Criteria are met.
- OPERATE HYDROGEN RECOMBINERS CHLA - If containment hydrogen concentration is greater than 0.5%.

E. Equipment Required:

> - **NOTE** -
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Containment Air Coolers (CACs)
  - Cooling water supply to CACs
  - Electrical power for fan motors and valves
  - Control Air System for air operated valves

7.F. Cautions:

1. Operation of the CACs can deinert the containment and allow a hydrogen burn. Refer to Containment Challenged Calculational Aid ERPIP 611, Attachment 5 CA-7 as a guide and the containment fails at much higher pressure/temperature than the design basis values, approximately 90 psig.
2. Operation of any electrical equipment in containment, such as CACs, may result in ignition of hydrogen or CO gas.

G. Expected Plant Response:

- Decrease in containment pressure and temperature.
- Small rise in CNMNT sump level

H. Conflicts with EOPs:

1. None.

I. Consistency with EOPs:

1. This CHLA is consistent with the EOP-8 Functional Recovery Procedure, Containment Environment, with respect to preventing damage to containment.

J. Recommended Actions:

1. Recommend the Control Room:
   a. Place the Containment Air Coolers in service on low speed with maximum Service Water Flow using OI-5A as guidance. The provisions of 10CFR50.54(x) and (y) should be considered if the conditions of OI-5A cannot be met and operation of the system is deemed essential.

8. CHLA 7 - RESTART REACTOR COOLANT PUMPS

A. Purpose/Benefits:

- To sweep non-condensible gas that has accumulated in the U-tube bends to restore natural circulation..
- Jogging of RCPs to clear a loop seal in the pump suction line to allow unidirectional natural circulation flow of gases through the associated steam generator.
- Provide forced circulation of gases within the RCS to increase heat transfer rate to the steam generators. The RCPs may be run periodically to establish forced circulation of the gases through the RCS.

B. Initiation Criteria:

> - **NOTE** -
> In most cases, restarting an RCP will be of little use if the loops are voided.

1. This action should be considered if either:
   - There is a large accumulation of non-condensible gases in the upper portions of the U-tubes, by a degrading in heat removal from the S/Gs or,
   - It is suspected the RCS loop seals are filled and preventing full natural convection flow of the fluids/gases in the RCS system.
   - Increased heat removal by forced circulation is deemed necessary.

C. Termination Criteria:

1. Termination of this action should be considered if:
   - RCP restart criteria will most likely not be met in this plant condition. If it is deemed necessary to run an RCP, use the following as indication of pump damage or imminent failure:
   - Control Bleed-off (CBO) temperature greater than 200°F
   - RCP Motor Thrust Bearing 195°F or greater
   - Guide Bearing temperature 195°F or greater
   - CBO flow less than 1.0 GPM
   - CBO flow greater than 2.6 GPM
   - Less than 300 PSID across an RCP seal

c. Natural circulation impairments have been removed.

D. Concurrent Actions:

- VENT THE RCS CHLA - Consider venting of non-condensible gases from the pressurizer or upper head in conjunction with this action. (Refer to ERPIP 611, Attachment 5 CA-4a, 4b.)

- DEPRESSURIZE THE RCS CHLA - If an RCS pressure spike could be sufficient to challenge RCS integrity (3000 psia), depressurize the RCS first. (Refer to ERPIP 611, Attachment 5 CA-3a, 4c.)

8.E. **Equipment Required**:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Electrical power to RCPs and auxiliaries.
- RCP auxiliaries.
- Component Cooling Water
- RCP oil supply/coolers

F. **Cautions**:

1. S/G water level greater than –350 inches in the steam generators will prevent creep failure of the S/G tubes.
2. Forced circulation may cause core debris to partially plug S/G tubes and may lead to future loss of natural circulation.
3. There is a potential for return to criticality if unborated water was used for prior injection to the RCS. Stop the RCPs if ex-core detectors indicate large power spikes and inject borated water to the RCS. Sufficient shutdown margin should be weighed against possible boron precipitation.
4. A significant RCS pressure spike could result due to flashing of water in an overheated core. If the expected pressure spike exceeds 3000 psia, first depressurize the RCS to avoid a pressure of 3000 psia. (Refer to ERPIP 611, Attachment 5 CA-3a.)
5. May cause thermal shock to intact fuel rods and "shatter" the fuel cladding and pellets.

G. **Expected Plant Response**:

- Decrease in core exit temperature and hot leg temperatures.
- Help establish natural circulation.
- Possible RCS pressure spike.

H. **Conflicts with EOPs**:

- The EOPs do not address use of the RCPs for sweeping gases from U-tubes, nor explicitly address jogging RCPs.
- EOPs do not address use of RCPs without all restart criteria being met.

8.I. **Consistency with EOPs**:

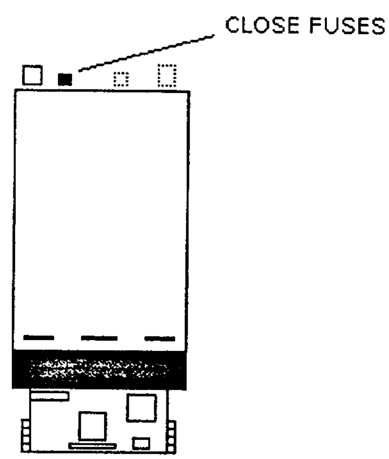
1. This CHLA is consistent with EOP-8 Functional Recovery Procedure, in that all RCPs would be tripped as a result of actions in the EOPs prior to entering the SAM ERPIPs.

J. **Recommended Actions**:

> **- NOTE -**
> RCP restart is not recommended in most cases, especially if the loops are voided. Only restart an RCP if an immediate, substantial benefit is anticipated.

1. Recommend the following actions to the Control Room:

   a. Restart RCP(s) (Refer to EOP-8, HR series). If the RCP restart criteria cannot be met and RCP restart is deemed essential, then consider the provisions of 10CFR50.54(x) and (y). If RCP auxiliaries are not available, removing the CLOSE fuses at the RCP breaker will disable all interlocks and allow the RCP breaker to be closed locally if the Control Room handswitch is not in Pull-to-Lock.



RCP BREAKER
(typical)

9. CHLA 8 - VENT THE RCS

A. Purpose/Benefits:

- The purpose of this CHLA is to remove non-condensible gas from the RCS to enhance natural circulation or forced circulation of primary coolant through the steam generators. A Reactor Vessel Head Vent, a PZR Vent and/or actuation of a PORV may be used. This CHLA, is more effective with RCP operation especially with gases in the S/G U-tubes.
- Reduces the likelihood of creep rupture by reducing RCS pressure.

B. Initiation Criteria:

1. This action should be considered if:
   - Natural circulation is being impeded as indicated by the CET temperatures continuing to increase and cannot be stabilized via secondary heat removal, and once-through core cooling is not being used for core heat removal.

C. Termination Criteria:

1. Termination of this action should be considered if either:
   - The addition of hydrogen to the containment is leading to challenge of the containment or,
   - Natural circulation has been restored.

D. Concurrent Actions:

1. RESTART REACTOR COOLANT PUMPS CHLA - Consider restarting/jogging the RCPs to help sweep non-condensible gases from the upper portion of the S/G U-tubes.

E. Equipment Required:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- PORVs, Reactor Vessel Head Vent, and/or Pressurizer Vent.
- Electrical power for associated equipment.

F. Cautions:

1. Venting will increase containment pressure and hydrogen concentration. If hydrogen concentration and containment pressure can be used to determine whether the containment remains inert (refer to Containment Challenged Calculational Aid Att. CA-7).

9.F.2. RCS venting (via small vents) will probably not remove hydrogen from the U-tubes. Consideration should be given to opening a PORV (refer to ERPIP 611, Attachment 5 CA-4a, 4b.) or starting a RCP to promote removing hydrogen from the U-tubes (see CHLA-7, RESTART RCPs before attempting a restart).

3. Refer to Containment Challenged Calculational Aid ERPIP 611, Attachment 5 CA-7 and containment hydrogen gas levels to determine if containment hydrogen concentrations will approach theoretical burn limits.

4. Venting may decrease RCS pressure which reduces steam/gaseous natural circulation flows (when the core is uncovered and two phase natural circulation does not exist), which results in increasing CET temperatures.

G. **Expected Plant Response**:

- Decrease in CET and hot leg temperatures.
- Establishment of two-phase natural circulation or reflux condensation.
- Possible increase in containment pressure, temperature, and hydrogen concentration.
- Decrease (minimal for Reactor Vessel Head or PZR Vents) in RCS pressure.
- Increase in containment radiation levels.

H. **Conflicts with EOPs**:

1. None.

I. **Consistency with EOPs**:

1. This CHLA is consistent with EOP-8 Functional Recovery Procedure, Core and RCS Heat Removal, with regard to elimination of RCS non-condensible voids (except for conflict noted above).

J. **Recommended Actions**:

1. Recommend the Control Room:

   a. Vent the RCS through the Reactor Vessel Head Vents, the Pressurizer Vents and/or the PORVs using OI-1G, REACTOR VESSEL HEAD AND PRESSURIZER VENT SYSTEM.

10. CHLA 9 -FLOOD REACTOR CAVITY

A. Purpose/Benefits:

- Cool the Reactor Vessel Lower Head to prevent or delay the failure of the lower portion of the reactor vessel (using the Containment Spray System or Safety Injection out the break).
- Prevents or delays re-vaporization of fission products deposited in the RCS.
- Provides a heat sink for the reactor vessel and reduces boil-off of reactor coolant.

B. Initiation Criteria:

1. This action should be considered if any of the following exist:
   - CETs exceed 2300°F or when the event is expected to lead to vessel failure.

   > - **NOTE** -
   > The PASS may be very slow to provide the following information.

   - The PASS indicates fuel pellet overheating as evidenced by the following:
     (1) Cesium-134 concentrations between 10% to 50% of source inventory.
     (2) Tellurium-129 or Rubidium-88 concentrations between 10% and 50% of source inventory (less than 30 days after refueling).
   - Natural circulation is **NOT** removing core heat.

C. Termination Criteria:

1. Termination of this action should be considered if:

   > - **NOTE** -
   > If two RWT volumes can be injected vessel melt through can be prevented.

   - Sufficient water has been added to containment to cover the Reactor Vessel Lower Head. One RWT injected into the containment submerges the bottom five feet of the Reactor Vessel Lower Head.
   - CNMNT spray will de-inert the CNMNT and allow a hydrogen burn or explosion.

D. Concurrent Actions:

- DEPRESSURIZE THE RCS CHLA - The CCNPP IPE indicates depressurization of the RCS before vessel melt-through is desirable for all high pressure accident sequences.
- SPRAY INTO CONTAINMENT CHLA - The preferred method would be by actuation of containment sprays.

10.E. Equipment Required:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Containment Spray Pumps
- Containment Spray Valves
- PORVs

F. Cautions:

1. Flooding the cavity with one RWT volume places the bottom five to six feet of the reactor vessel underwater. The associated cooling can delay vessel melt-through. However, the additional delay allows more core debris to accumulate in the vessel bottom and the top of the debris may be above the water level on the outside of the vessel. This could exacerbate the ring or circumferential failure mode of the reactor vessel. Raising the water level in the reactor cavity by injecting two RWT volumes will likely contain the core debris in the vessel. Lowering RCS pressure will minimize the possibility of vessel melt through.
2. This action may deinert containment and allow a hydrogen burn if the containment sprays are being used to flood the reactor cavity. CNMNT hydrogen concentration and CNMNT pressure can be used to determine whether the containment remains inerted (Refer to Containment Challenged Calculational Aid ERPIP 611, Attachment 5 CA-7).

G. Expected Plant Response:

1. Possible slight decrease in hot and cold leg temperatures.

H. Conflicts with EOPs:

1. None.

I. Consistency with EOPs:

1. None.

J. Recommended Actions:

1. Recommend the Control Room:
   - Depressurize the RCS per CHLA 2.
   - Initiate Containment Spray per CHLA 5.
   - Provide additional sources of water to raise level in containment to approximately 10 feet (Refer to Attachment 1 of ERPIP 611).

11. CHLA 10 - SPRAY THE AUXILIARY BUILDING

A. Purpose/Benefits:

1. The purpose of this CHLA is:
   a. To reduce temperature and/or airborne fission products in a localized area of the Aux. Bldg., to establish conditions allowing access of plant personnel for equipment operation, repair, or monitoring of critical plant equipment.

B. Initiation Criteria:

1. This action should be considered:
   - To reduce temperature for personnel access to the Aux. Bldg.
   - To scrub fission products released to the Aux. Bldg.
   - To reduce radiation and contamination levels for personnel access.

C. Termination Criteria:

1. Termination of this action should be considered if either:
   - The spray is affecting equipment being used to mitigate the event or,
   - Personnel access to the Aux. Bldg. is no longer required.

D. Concurrent Actions:

1. None. However, ALARA goals and requirements of Special Work Permits (SWPs) should be complied with.

E. Equipment Required :

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Fire suppression system
- Fire hoses and spray nozzles

F. Cautions:

1. May have to temporarily isolate ventilation to the area to avoid reintroduction of airborne contamination.
2. Leaks and crud traps could develop in drainage piping in the Aux. Bldg. as a result of using this CHLA, which would restrict personnel access to affected areas.
3. The use of the Fire Suppression System will challenge the capacity (4,000 gals) of the Miscellaneous Waste Receiver Tank (MWRT) and cause floor drains to back up and overflow.

11.G. Expected Plant Response:

- Decrease in Aux. Bldg. area temperature.
- Decrease in Aux. Bldg. airborne radiation/contamination levels.

H. Conflicts with EOPs:

1. None.

I. Consistency with EOPs:

1. None.

J. Recommended Actions:

1. Recommend the OSC and Control Room:
   - Use fire hoses with spray nozzles to spray down selected areas of the Aux. Bldg.
   - Closely monitor MWRT level and pump to RCWPS as necessary to prevent overflowing floor drains.

12. CHLA 11 - OPERATE HYDROGEN RECOMBINERS

A. Purpose/Benefits:

1. The purpose of this CHLA is to reduce containment combustible gas concentrations to keep the containment inert.

B. Initiation Criteria:

1. This action should be considered if containment hydrogen concentration is greater than 0.5%.

C. Termination Criteria:

1. Consider securing the Hydrogen Recombiners if hydrogen concentration reaches 4.0% if the CNMNT is not deinerted. If H_2 Analyzers are not available then use Calc. Aid ERPIP 611, Attachment 5 CA-5a, 5b, 5c.

D. Concurrent Actions:

- VENT CONTAINMENT CHLA - Containment venting via the Hydrogen Purge System may also be in progress. OI-41B is the governing procedure for this system. Normally, operation of this system is prohibited until two days post-accident. If operation of the Hydrogen Purge System is deemed essential prior to that time, consideration should be given to the provisions of 10CFR50.54(x) and (y).

In addition:

- Recirculation with the Safety Injection System and containment spray operation may be in progress.
- Operation of all systems which will help mix the containment atmosphere helps to prevent localized buildup of hydrogen gas. These systems include the CACs, Iodine Removal Units, Cavity Cooling System and Pressurizer Ventilation Fan.

E. Equipment Required:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Electrical power
- Appropriate system alignment

12.F. **Cautions:**

1. Operation of Hydrogen Recombiners could lead to ignition of hydrogen or CO gas. Removal of hydrogen with these systems is slow and it may be advantageous to wait until containment pressure and temperature are under control before activating this system.

G. **Expected Plant Response**:

1. Decrease in containment hydrogen concentrations.

H. **Conflicts with EOPs**:

1. None.

I. **Consistency with EOPs:**

1. This CHLA is consistent with EOP-8 Functional Recovery Procedure, Containment Environment with respect to operating as many containment air circulation systems as possible (CACs, Pressurizer Ventilation Fan, Iodine Removal Units, and Cavity Cooling Fans) to prevent local hydrogen accumulation.

J. **Recommended Actions**:

1. Recommend one or more of the following actions to the Control Room:

   - Start the Hydrogen Recombiners using OI-41A for guidance. The provisions of 10CFR50.54(x) and (y) should be considered if the conditions of OI-41A cannot be met and operation of the system is deemed essential. In addition, for better mixing:
     - Verify all available CACs are operating
     - Start all available Cavity Cooling Fans
     - Start the Iodine Removal Units
     - Start the Pressurizer Ventilation Fan
   - Operate the Hydrogen Purge System using OI-41B as guidance. The provisions of 10CFR50.54(x) and (y) should be considered if the conditions of OI-41B cannot be met and operation of the system is deemed essential.

LIST OF EFFECTIVE PAGES

Cumulative NORMs changes to this revision: 0

PAGE	REVISION	EDITORIAL CORRECTION
1	1	
2	1	
3	1	
4	1	
5	1	
6	1	
7	1	
8	1	
9	1	
10	1	
11	1	
12	1	
13	1	
14	1	
15	1	
16	1	
17	1	
18	1	
19	1	
20	1	
21	1	
22	1	
23	1	
24	1	
25	1	
26	1	
27	1	
28	1	
29	1	
30	1	
31	1	
32	1	
33	1	

ATTACHMENT	REVISION	EDITORIAL CORRECTION

EMERGENCY RESPONSE PLAN IMPLEMENTATION PROCEDURE

REVIEW/APPROVAL

Calvert Cliffs Nuclear Power Plant

Emergency Response Plan Implementation Procedure

CANDIDATE HIGH LEVEL ACTIONS EX/CC

ERPIP 607

Revision 1

Effective Date: MAR 21 2001

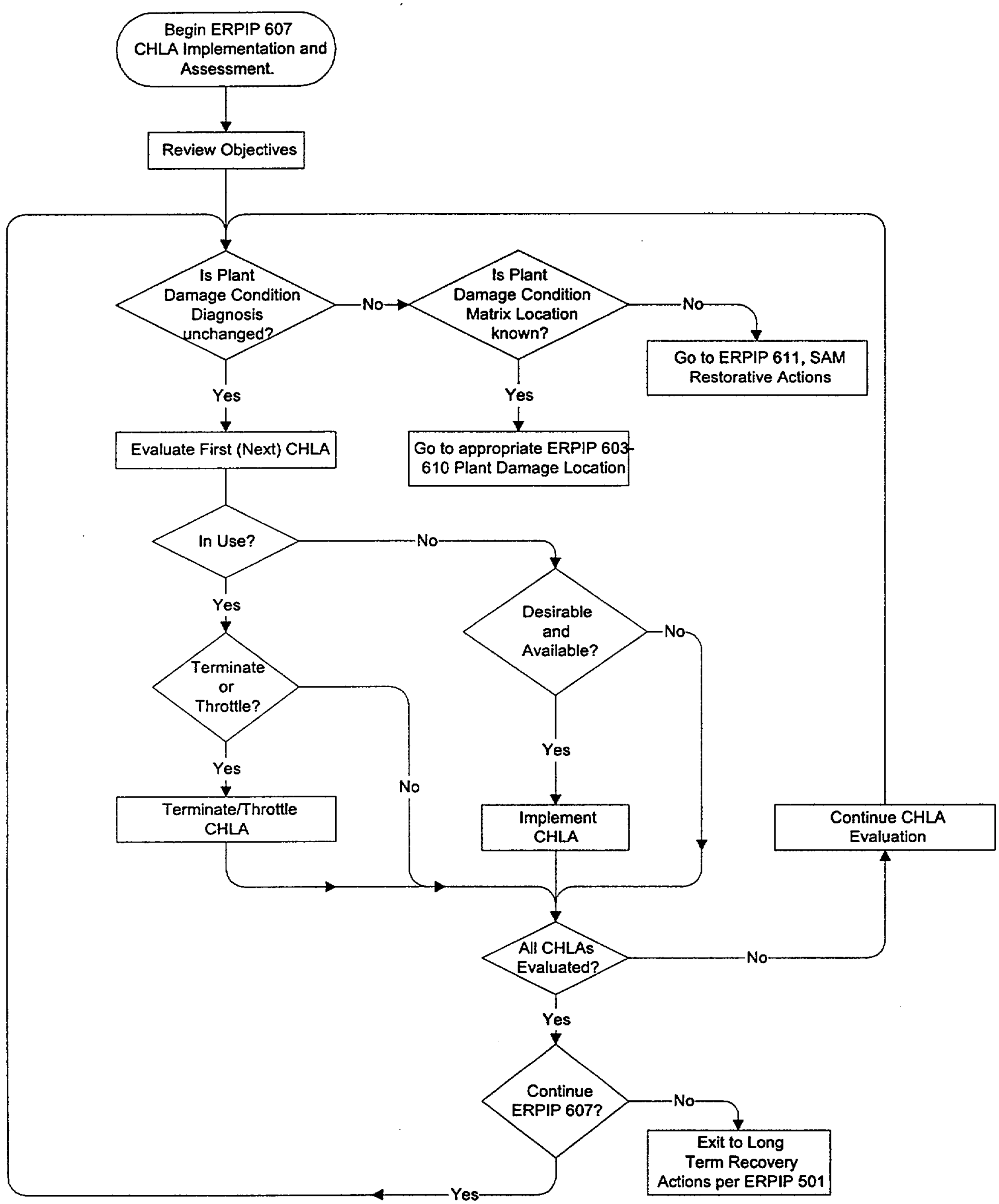
Writer:	James C. Kellum	01/02/01 Date
Reviewer:	Mark T. Finley	2/26/01 Date
Director - EP:	Anthony J. O'Donnell	2/28/01 Date
POSRC Mtg. #: 01-019	(Signature indicates procedure was reviewed according to NS-2-101)	3-14-01 Date
Approved:	Plant General Manager	3/14/01 Date

Candidate High Level Actions
EX/CC

RESPONSIBLE INDIVIDUAL: Reactor Engineer

CONDITION: Severe Accident

Instructions



1. OBJECTIVES

A. This ERPIP (EX/CC) is being implemented because the core has now gone Ex-vessel. The RCS barrier has been lost. The goal is to cool the corium debris and to protect the intact CNMNT barrier.

B. The objectives of the **EX/CC CHLAs** are to:

1. Maintain submergence of the ex-vessel corium debris
2. Reduce containment airborne radiation/contamination levels
3. Establish long term cooling of the ex-vessel corium debris and any remaining in-vessel corium debris
4. Minimize onsite and offsite radiological doses
5. Remove heat from the containment atmosphere
6. Reduce containment hydrogen concentration
7. Reduce Auxiliary Building airborne contamination
8. Reduce Auxiliary Building temperature
9. Remove heat from any corium debris in the Auxiliary Building

1.C. The following table provides the prioritized list of Candidate High Level Actions for EX/CC. The CHLAs are listed in recommended order of implementation. However, the TSC may re-prioritize them depending on plant conditions. The associated objectives, in general, for each CHLA are listed below.

Prioritized CHLA for EX/CC	Objectives
1. Spray into Containment	Reduce containment airborne radiation/contamination levels. Maintain submergence of ex-vessel corium debris. Reduce containment temperature/pressure to minimize leakage to the environment. Quench hot surfaces/components to reduce containment heat load.
2. Inject into RCS/Flood Reactor Cavity	Establish/maintain submergence of corium debris. Establish long term cooling of the corium debris. Establish long term cooling of any remaining in-vessel corium debris.
3. Operate Containment Air Coolers	Reduce containment airborne radiation/contamination levels. Reduce containment temperature/pressure to minimize leakage to the environment. Provide a heat sink for core decay heat transferred to the containment environment.
4. Operate Hydrogen Recombiners	Reduce hydrogen concentration.
5. Spray the Auxiliary Building	Reduce Auxiliary Building airborne contamination levels. Reduce Auxiliary Building temperature.
6. Feed the Steam Generator(s)	Inject into RCS and flood reactor cavity/core debris by backflow to the RCS, if a SGTR exists.
7. Flood the Auxiliary Building	Remove heat from core debris in Auxiliary Building.
8. Spray the Outside of the Containment	Remove heat from containment.

CHLA Tracking Table

This tracking table may be used as an aid in monitoring CHLA status.

Time									
CHLA									
Spray into Containment									
Inject Into the RCS/Flood Reactor Cavity									
Operate Containment Air Coolers									
Operate Hydrogen Recombiners									
Spray the Auxiliary Building									
Feed the Steam Generators									
Flood the Auxiliary Building									
Spray the Outside of the Containment									

X = Not available
I = In Use
E = Evaluated
S = Stopped
N/A = Not applicable to Matrix Location

Y = Available
N/I = Not In Use
N/E = Not Evaluated
T = Throttled

2. CHLA 1 - SPRAY INTO CONTAINMENT

A. Purpose/Benefits:

1. The purposes of this CHLA are to:
   - Supplement flooding of the reactor cavity and to quench dispersed ex-core debris.
   - Reduce and maintain containment pressure and temperature to avert challenging containment integrity.
   - Scrub fission products from the containment atmosphere. This will minimize offsite radiological doses.
   - Reduce the temperature of zinc and aluminum surfaces, reducing hydrogen production and minimize fission product re-vaporization.

B. Initiation Criteria:

1. This action should be considered if any of the following occur:
   - Flooding the reactor cavity using sprays is desired.
   - Containment integrity is challenged as indicated by high containment pressure or by hydrogen as indicated by the Containment Challenged Calc. Aid Attachment, CA-7.
   - To decrease airborne contamination levels.

C. Termination/Throttling Criteria:

1. Termination of this action or throttling of spray flow should be considered if:
   - Throttling of containment spray flow or cycling spray pumps should be performed to stabilize pressure at a value that will not result in a challenge to the containment while maintaining the containment atmosphere inert.
   - Sufficient water has been added to containment to cover the debris.

D. Concurrent Actions:

- OPERATE CONTAINMENT AIR COOLERS CHLA - If associated CHLA Initiation Criteria are met.
- OPERATE HYDROGEN RECOMBINERS CHLA - If containment hydrogen concentration is greater than 0.5%.

E. Equipment Required:

> **-NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Containment Spray Pumps
  - Water supply
  - Electrical power for pumps and valves

- Control Air System for air operated valves

- Shutdown Cooling Heat Exchangers when heat removal is necessary

2.F. **Cautions**:

1. Containment sump water will become highly radioactive and upon a RAS will be circulated through various areas of the Aux. Bldg., making some areas of the Aux. Bldg. inaccessible.
2. Reaction of core debris with the concrete basemat may generate significant non-condensible gas (H_2, $C0_2$ and C0). Consequently, this CHLA may not be able to lower containment pressure.

G. **Expected Plant Response**:

- Decrease in containment pressure and temperature.
- Increase in containment sump level.
- Increase in reactor cavity level as containment sump level increases.

H. **Conflicts with EOPs:**

1. This CHLA conflicts with the EOPs in that CNMNT spray might not be used due to deinerting concerns.

I. **Consistency with EOPs:**

1. This CHLA is consistent with EOP-8 Functional Recovery Procedure, Containment Environment, with respect to preventing damage to containment and using containment spray to reduce airborne iodine concentration.

J. **Recommended Actions:**

1. Recommend the Control Room initiate containment spray. Refer to EOP-8 CE series.

3. CHLA 2 - INJECT INTO RCS/FLOOD REACTOR CAVITY

A. Purpose/Benefits:

1. The intent of these actions are:
   - To establish/maintain cooling through submergence of the corium debris.
   - Injection into the RCS will provide cooling to any debris remaining in the vessel.
   - Scrub and cool fission products in the corium debris which minimizes the spread of radioactive contamination throughout containment.
   - Prevent concrete basemat erosion.
   - Sets up the long term corium cooling of the ex-vessel corium debris via recirculation with the SI system and heat removal via the SDCHXs.
   - Prevent increased containment pressure due to both non-combustible and combustible gas generated by the core-concrete reaction.

B. Initiation Criteria:

1. This action should be considered if:
   - The containment sump water level is less than required to submerge the corium debris (less than 5 feet of water in the containment basement).
   - The need to continue or make-up SI water to the reactor cavity is determined by containment sump level (Containment WR Level range is 0-120 inches above the basement floor).
   - If the containment sump level instrumentation is inoperable and as a comparison to operable containment sump level instrumentation, estimate containment sump level to help determine when to start or stop water addition to the reactor cavity (approximately 80,000 gallons per foot in the containment sump).

C. Termination/Throttling Criteria:

1. Termination of this action or throttling of injection flow should be considered if any of the following exist:
   - The generation of steam and/or hydrogen is challenging containment integrity.
   - Sufficient water has been added to containment to cover the debris.
   - Unborated water is the only source for injection.
   - It is considered necessary to prolong the time to receive a Recirculation Actuation Signal (RAS). Throttling could be desirable if:
     (1) Recirculation is unavailable, or
     (2) Recirculation could compromise restoration activities due to increased radiation levels caused by radioactive sump water

3.D. Concurrent Actions:

- SPRAY INTO CONTAINMENT CHLA - Operate one or more containment spray trains during the initial quenching of the ex-vessel corium debris, and as required by the Spray into Containment CHLA Initiation Criteria.
- OPERATE CONTAINMENT AIR COOLERS (CACs) CHLA - If associated CHLA Initiation Criteria are met.
- OPERATE HYDROGEN RECOMBINERS CHLA - if containment hydrogen concentration is greater than 0.5%.

E. Equipment Required:

> **-NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- ECCS Pumps (HPSI, LPSI and Containment Spray)
    - a. RWT Level greater than 0.5 ft or containment sump recirc alignment and,
    - b. At least one HPSI, LPSI or Containment Spray Pump
- Charging Pumps (if available)
- Shutdown Cooling Heat Exchangers when heat removal is necessary
- Alternate water sources (Refer to Attachment 1 of ERPIP 611)
- Main or Auxiliary Feedwater (for backflow to RCS if SGTR exists)
    - Auxiliary Feedwater System
        - (1) At least one AFW Pump and,
        - (2) Source of makeup water
    - Main Feedwater System (unavailable if SIAS, SGIS or CSAS actuated unless bypassed, blocked or overridden):
        - (1) At least one SGFP (except for Condensate Booster Pump Injection) and,
        - (2) At least two Condensate Pumps (only one required for Condensate Booster Pump Injection) and,
        - (3) At least one Condensate Booster Pump and,
        - (4) Source of makeup water

3.F. **Cautions**:

1. A high rate of water injection may not result in removing more heat from the ex-vessel corium debris due to existing core debris characteristics. The goal is to keep the corium debris sufficiently submerged so a heat transfer mechanism exists.

2. Containment sump level instrumentation could become damaged and inoperable due to the corium going ex-vessel. Estimate containment sump level (≈80,000 gallons per foot in the containment sump) if level instrumentation is unavailabe.

3. The corium could plug the containment emergency sump disabling the SI Recirculation Mode (long term corium cooling) and containment spray recirculation. In this case, supplemental sources of borated water for the refueling water tank should be obtained as this will be the primary source of cooling water for the ex-vessel core debris. Long term corium cooling would be by cycling the containment sprays/CACs based on containment pressure and temperature increases and also providing some make-up borated water to the ex-vessel corium via the SI pumps.

4. The direct hydraulic connection (drain line and cavity access tunnel) between the containment sump and reactor cavity may become plugged with core debris. If the containment sump level instrumentation is operable, this condition temporarily disables the ability of this level instrumentation to provide the degree of submergence of the reactor vessel/corium, until the reactor cavity is sufficiently filled so an overflow occurs at the hot/cold leg penetrations.

5. The CACs and containment spray should be throttled, if possible, and eventually terminated if the required sump level is reached. (See Initiation Criteria of this CHLA).

6. Core debris may be entrained into the recirculation suction pipes which could damage the SI and spray pumps and plug the SDCHX tubes. Monitor inlet/outlet temperatures of the SDCHXs (if in SDC lineup) and SI/containment spray flow rates in order to detect damage/degradation.

7. Containment sump water will become highly radioactive and upon a RAS will be circulated through various areas of the Aux. Bldg., limiting personnel access.

8. Operation of the CACs is preferred over containment spray with respect to conservation of borated RWT water for use as the SI suction source for core debris remaining in the vessel, especially if recirculation with the containment sump cannot be performed.

9 If the ex-vessel core debris is not sufficiently cooled, the core-concrete reaction will create additional combustible gases. Additional hydrogen and CO would be created. (Refer to Attachments CA-5b, 5c.)

10. Injection of unborated water could lead to a return to criticality, and the potential for this increases with increasing SI flow rate. Monitor the ex-core detectors for power spikes. If fission power spikes occur, reduce the SI flowrate to eliminate power spikes and take action to restore borated water to the reactor cavity.

3.F.11. The solubility limit of boric acid needs to be monitored to minimize boron precipitation in the ex-vessel core debris, which may restrict cooling flow to the entire core. Temperature of the reactor cavity sump water needs to be above precipitation temperature. (1/2-TI-303X & 303Y, SDCHX OUT TEMP, can be used, if in the recirc mode, as a conservative indicator of cavity water temperature).

12. It is difficult to distinguish a hydrogen burn from a rapid containment pressurization caused by steaming of reactor cavity water when the corium debris goes ex-vessel, unless it is known the reactor cavity has sufficient water inventory prior to the ex-vessel breach. (Refer to ERPIP 611, Attachment 5 CA-8.)

13. Due to resolidifying of the corium debris during the transition from BD to EX, RCS pressure control may still be possible and the decay heat from both the corium in the reactor cavity and in the RCS will have to be removed. Decay heat removal from the portion of the corium in the RCS would be performed by recovering RCS inventory via SI, with energy removal by venting steam out any existing RCS opening.

G. **Expected Plant Response:**

- Increase in Containment Sump water level.
- Containment pressure spike will likely result during the initial quenching of the corium debris.

H. **Conflicts with EOPs**:

1. None.

I. **Consistency with EOPs**:

1. None.

J. **Recommended Actions**:

1. Recommend the Control Room perform one or more of the following:
   - Initiate Containment Spray (Refer to EOP-8, CE series).
   - Makeup to the RCS via Safety Injection/Charging System (Refer to EOP-8, PIC series).
   - Initiate Containment Sump Recirculation per (Refer to EOP-8, PIC series).
   - Commence Hot Leg Injection (Refer to EOP-8, PIC series).
   - Commence backfill to the RCS via a ruptured S/G (Refer to EOP-8, HR series).
   - Provide makeup to the RCS from alternate sources (Refer to Attachment 1 of ERPIP 611).

4. CHLA 3 - OPERATE CONTAINMENT AIR COOLERS (CACs)

A. Purpose/Benefits:

1. The purposes of this CHLA are to:
   - Reduce containment pressure and temperature to reduce the potential for a challenge to containment integrity.
   - Scrub containment atmosphere of fission products.
   - Reduce the temperature of zinc and aluminum surfaces, reducing the production of hydrogen.
   - Promote mixing of containment atmosphere and reduce the probability of a localized accumulation of Hydrogen.

B. Initiation Criteria:

1. This action should be considered if:
   - Containment pressure is rising and continued rise could challenge containment integrity or,
   - It is desired to promote mixing of the containment atmosphere or,
   - It is desired to reduce CNMNT atmosphere fission product aerosols.

C. Termination Criteria:

1. Termination of this action should be considered if:
   a. Reduction in containment pressure and/or steam content due to this action would cause a challenge to the containment as a result of establishing a combustible gas concentration.

Reducing SRW flow to the CACs may aid in stabilizing containment pressure, thereby minimizing the potential for a hydrogen burn due to de-inerting. Cycling the CACs or reducing the number of CACs in operation may also be effective.

D. Concurrent Actions:

- SPRAY INTO CONTAINMENT CHLA - If associated CHLA Initiation Criteria are met.
- OPERATE HYDROGEN RECOMBINERS CHLA - If containment hydrogen concentration is greater than 0.5%.

E. Equipment Required:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

4.E.1. Containment Air Coolers (CACs)

- Cooling water supply to CACs
- Electrical power for fan motors and valves
- Control Air System for any air operated valves

F. **Cautions:**

1. Operation of the CACs can deinert the containment and allow a hydrogen burn. Refer to Containment Challenged Calculational Aid ERPIP 611, Attachment 5 CA-7 as a guide. The containment fails at much higher pressure/temperature than the design basis values, approximately 90 psig.

2. Reaction of core debris with the concrete basemat can cause significant non-condensible gas generation (H_2, CO_2 and CO). Consequently, this CHLA may not be able to lower CNMNT pressure.

3. Operation of any electrical equipment in containment, such as CACs, may result in ignition of hydrogen or CO gas.

4. Aerosols produced from the core-concrete reaction may accumulate in the air coolers and degrade their perfromance.

G. **Expected Plant Response:**

- Decrease in containment pressure and temperature.
- Small rise in CNMNT sump level

H. **Conflicts with EOPs:**

1. None.

I. **Consistency with EOPs:**

1. This CHLA is consistent with the EOP-8 Functional Recovery Procedure, Containment Environment, with respect to preventing damage to containment.

J. **Recommended Actions:**

1. Recommend the Control Room:

   a. Place the Containment Air Coolers in service on low speed with maximum Service Water Flow using OI-5A as guidance. The provisions of 10CFR50.54(x) and (y) should be considered if the conditions of OI-5A cannot be met and operation of the system is deemed essential.

5. CHLA 4 - OPERATE HYDROGEN RECOMBINERS

A. Purpose/Benefits:

1. The purpose of this CHLA is to reduce containment combustible gas concentrations to keep the containment inert.

B. Initiation Criteria:

1. This action should be considered if containment hydrogen concentration is greater than 0.5%.

C. Termination Criteria:

1. Consider securing the Hydrogen Recombiners if hydrogen concentration reaches 4.0% (if the CNMNT is not deinerted). If H_2 Analyzers are not available then use Calc. Aid ERPIP 611, Attachment 5 CA-5a, 5b, 5c.

D. Concurrent Actions:

1. VENT CONTAINMENT CHLA - Containment venting via the Hydrogen Purge System may also be in progress. OI-41B is the governing procedure for this system. Normally, operation of this system is prohibited until two days post-accident. If operation of the Hydrogen Purge System is deemed essential prior to that time, consideration should be given to the provisions of 10CFR50.54(x) and (y).

In addition:

2. Recirculation with the Safety Injection System and containment spray operation may be in progress.
3. Operation of all systems which will help mix the containment atmosphere helps to prevent localized buildup of hydrogen gas. These systems include the CACs, Iodine Removal Units, Cavity Cooling System and Pressurizer Ventilation Fan.

E. Equipment Required:

-NOTE -

If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

1. Electrical power

F. Cautions:

1. Operation of Hydrogen Recombiners could lead to ignition of hydrogen or CO gas. Removal of hydrogen with these systems is slow and it may be advantageous to wait until containment pressure and temperature are under control before activating this system.

5.F.3. Aerosols produced from the core-concrete reaction may deposit in the Hydrogen Recombiners reducing their effectiveness and possibly preventing them from performing their function.

G. **Expected Plant Response**:

1. Decrease in containment hydrogen concentration.

H. **Conflicts with EOPs**:

1. None

I. **Consistency with EOPs**:

1. This CHLA is consistent with EOP-8 Functional Recovery Procedure, Containment Environment with respect to operating as many containment air circulation systems as possible (CACs, Cavity Cooling System, Iodine Removal Units and Pressurizer Ventilation Fan) to prevent localized hydrogen build-up.

J. **Recommended Actions**:

1. Recommend one or more of the following actions to the Control Room:

   - Start the Hydrogen Recombiners using OI-41A for guidance. The provisions of 10CFR50.54(x) and (y) should be considered if the conditions of OI-41A cannot be met and operation of the system is deemed essential. In addition, for better mixing:
     - Verify all available CACs are operating
     - Start all available Cavity Cooling Fans
     - Start the Iodine Removal Units
     - Start the Pressurizer Ventilation Fan
   - Operate the Hydrogen Purge System using OI-41B as guidance. The provisions of 10CFR50.54(x) and (y) should be considered if the conditions of OI-41B cannot be met and operation of the system is deemed essential.

6. CHLA 5 - SPRAY THE AUXILIARY BUILDING

A. Purpose/Benefits:

1. The purpose of this CHLA is to reduce temperature and/or airborne fission products in a localized area of the Aux. Bldg., to establish conditions which would allow access of plant personnel for equipment operation, repair, or monitoring of critical plant equipment.

With the core in an ex-vessel condition, actions which circulate fluids from the containment through piping in the Aux. Bldg. may result in the release of radioactivity to the Aux. Bldg.

B. Initiation Criteria:

1. This action should be considered if there are excessive temperatures in the Aux. Bldg. and/or area radiation monitors are in alarm and personnel access is required.

C. Termination Criteria:

1. Termination of this action should be considered if either:
   - The spray is affecting equipment being used to mitigate the event or,
   - Personnel access to the Aux. Bldg. is no longer required.

D. Concurrent Actions:

1. None. However, ALARA goals and requirements of Special Work Permits (SWPs) should be complied with.

E. Equipment Required :

-NOTE -

If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Fire Suppression System
- Fire hoses and spray nozzles

F. Cautions:

1. May have to temporarily isolate ventilation to the area, to avoid reintroduction of airborne contamination.
2. Leaks and crud traps could develop in drainage piping in the Aux. Bldg. as a result of using this CHLA, which would restrict personnel access to affected areas.
3. The use of the Fire Suppression System will challenge the capacity (4,000 gals) of the Miscellaneous Waste Receiver Tank (MWRT) and cause floor drains to back up and overflow.

6.G. **Expected Plant Response**:

- Decrease in Aux. Bldg. area temperature.
- Decrease in airborne radiation/contamination levels.

H. **Conflicts with EOPs**:

1. None.

I. **Consistency with EOPs**:

1. None.

J. **Recommended Actions**:

1. Recommend the OSC and Control Room:
   - Use fire hoses with spray nozzles to spray down selected areas of the Aux. Bldg.
   - Closely monitor MWRT level and pump to RCWPS as necessary to prevent overflowing floor drains.

7. CHLA 6 - FEED THE STEAM GENERATORS

A. Purpose/Benefits:

- To maintain a water level above any breach in the S/G U-tubes (SGTR)
- To scrub any fission products leaking from the RCS to the S/G if the pressure in containment is higher than the S/G.
- To inject water into the RCS to flood the reactor cavity. This CHLA will only be effective if a SGTR exists.

B. Initiation Criteria:

1. This action should be considered if either:
    - A SGTR exists and pressure in containment is greater than pressure in the S/G
    - A SGTR exists and RCS/containment pressure is less than or can be lowered to less than S/G pressure, if backflow to the RCS from the S/Gs is desired.

C. Termination/Throttling Criteria:

1. Termination of this action should be considered if either:
    - S/G level is greater than 30 inches
    - Backflow into the RCS is ineffective.

D. Concurrent Actions:

1. None.

E. Equipment Required:

> **-NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

1. One of the following sets of equipment:
    - Auxiliary Feedwater System
        - At least one AFW Pump
        - Source of makeup water
    - Main Feedwater System (unavailable if SIAS, SGIS or CSAS actuated unless bypassed, blocked or overridden):
        - At least one SGFP(except for Condensate Booster Pump Injection)
        - At least two Condensate Pumps (only one required for Condensate Booster Pump Injection)
        - At least one Condensate Booster Pump
        - Source of makeup water

7.F. **Cautions**:

1. None.

G. **Expected Plant Response**:

1. Increase in containment sump level.

H. **Conflicts with EOPs**:

1. None.

I. **Consistency with EOPs**:

1. None.

J. **Recommended Actions**:

1. Recommend one or more of the following actions to the Control Room:

- Verify CST availability and establish feedflow using Auxiliary Feedwater (Refer to EOP-8, HR series).
- Verify CST availability and establish Feedwater flow using the other Unit's electric-driven AFW pump (Refer to EOP-8, HR series).
- Establish feed flow using Main Feedwater (Refer to EOP-8, HR series).
- Establish feed flow using Condensate Booster Pump Injection (Refer to EOP-8, HR series). Steam Generator pressure must be less than 500 psia for this method to be effective.

8. CHLA 7 - FLOOD THE AUXILIARY BUILDING

A. Purpose/Benefits:

1. The purposes of this CHLA are:

   - To provide heat removal for core debris transported to the Aux. Bldg. The area may have to be re-flooded periodically due to boildown or draindown through the floor drains.
   - To scrub fission products released to the Aux. Bldg.

With the core ex-vessel, actions which circulate fluids from the containment through piping in the Aux. Bldg. may result in the release of radioactivity to the Aux. Bldg.

B. Initiation Criteria:

1. This action should be considered if there are excessive temperatures in the Aux. Bldg. and/or area radiation monitors in alarm.

C. Termination Criteria:

1. Termination of this action should be considered if either:

   - Flooding is jeopardizing the operation of equipment needed to mitigate the event or,
   - Sufficient level has been established in the areas of concern.

D. Concurrent Actions:

1. None. However, ALARA goals and requirements of SWPs should be complied with.

E. Equipment Required :

> **-NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Fire Suppression System
- Fire hoses and spray nozzles

F. Cautions:

1. If core debris has been transported to the Aux. Bldg., radiation levels can be expected to be extremely high in the area where deposited.
2. May cause damage to electrical equipment required for safe operation/shutdown of the unaffected unit.

8.G. **Expected Plant Response**:

1. Decrease in Aux. Bldg. area radiation levels.

H. **Conflicts with EOPs**:

1. None.

I. **Consistency with EOPs**:

1. None.

J. **Recommended Actions**:

1. Recommend the OSC and the Control Room use the fire system and/or hoses and nozzles as necessary to flood desired areas of the Aux. Bldg.

9. CHLA 8 - SPRAY DOWN OUTSIDE OF CONTAINMENT

A. Purpose/Benefits:

1. The purpose of this CHLA is to remove heat from containment by cooling the outside walls of the structure.

B. Initiation Criteria:

1. This action should be considered if an additional means of removing heat from containment is desirable.

C. Termination/Throttling Criteria:

1. Termination of this action should be considered if either:
   - The containment is being cooled sufficiently by other means
   - The water inventory must be conserved for other uses.

D. Concurrent Actions:

1. None.

E. Equipment Required:

> **-NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Fire hoses and nozzles.
- Possibly a pumper truck.

F. Cautions:

1. With the core in an ex-vessel condition, dose rates outside the containment can be expected to be significantly higher than normal.

G. Expected Plant Response:

1. Reduction in containment temperature and pressure.

H. Conflicts with EOPs:

1. None.

I. Consistency with EOPs:

1. None.

J. Recommended Actions:

1. Recommend the OSC and the Control Room:
   a. Commence spray-down of outside of containment using the Fire Suppression System and any other means available. The objective is to apply as such water to the outside of the containment as possible.

LIST OF EFFECTIVE PAGES

Cumulative NORMs changes to this revision: 0

PAGE	REVISION	EDITORIAL CORRECTION
1	1	
2	1	
3	1	
4	1	
5	1	
6	1	
7	1	
8	1	
9	1	
10	1	
11	1	
12	1	
13	1	
14	1	
15	1	
16	1	
17	1	
18	1	
19	1	
20	1	
21	1	
22	1	
23	1	

ATTACHMENT	REVISION	EDITORIAL CORRECTION

EMERGENCY RESPONSE PLAN IMPLEMENTATION PROCEDURE

REVIEW/APPROVAL

Calvert Cliffs Nuclear Power Plant

Emergency Response Plan Implementation Procedure

CANDIDATE HIGH LEVEL ACTIONS EX/CH

ERPIP 608

Revision 1

Effective Date: MAR 2 1 2001

Writer: J. C. Kellum 01/02/01
James C. Kellum Date

Reviewer: [signature] 02/26/01
Mark T. Finley Date

Director - EP: Anthony O'Donnell 2/28/01
Anthony J. O'Donnell Date

POSRC Mtg. #: 01-019 [signature] 3-14-01
(Signature indicates procedure was reviewed according to NS-2-101) Date

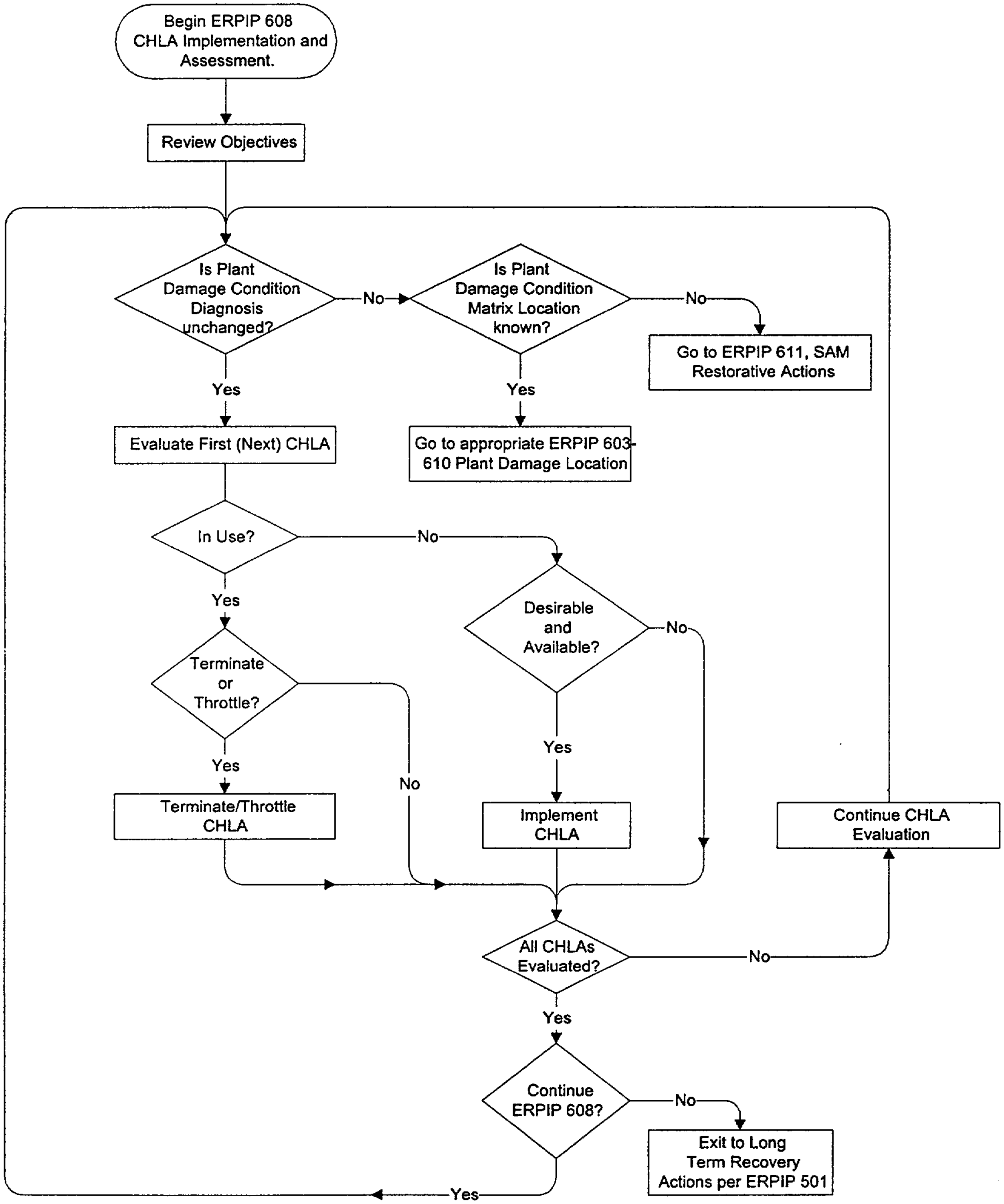
Approved: [signature] 3/14/01
Plant General Manager Date

Candidate High Level Actions
EX/CH

RESPONSIBLE INDIVIDUAL: Reactor Engineer

CONDITION: Severe Accident

Instructions



1. OBJECTIVES

A. This ERPIP (EX/CH) is being implemented because the core has now gone ex-vessel and now the CNMNT is being challenged. The CNMNT is the last remaining intact barrier. The goal is to cool the Corium debris and to reduce/eliminate the challenge to CNMNT.

B. The objectives of the **EX/CH CHLAs** are to:

1. Maintain submergence of the ex-vessel corium debris
2. Reduce Auxiliary Building airborne contamination levels
3. Establish long term cooling of the ex-vessel corium debris and any remaining in-vessel corium debris
4. Maintain the structural integrity of the containment pressure boundary
5. Minimize onsite and offsite radiological doses
6. Reduce containment airborne radiation/contamination levels
7. Remove heat from the containment atmosphere
8. Reduce hydrogen concentration
9. Reduce Auxiliary Building temperature
10. Remove heat from any corium debris in the Auxiliary Building

1.C. The following table provides the prioritized list of Candidate High Level Actions for EX/CH. The CHLAs are listed in recommended order of implementation. However, the TSC may re-prioritize them depending on plant conditions. The associated objectives, in general, for each CHLA are listed below.

Prioritized CHLA for EX/CH	Objectives
1. Spray into Containment	Reduce containment airborne radiation/contamination levels. Maintain submergence of ex-vessel corium debris. Reduce containment temperature and pressure. Quench hot surfaces/components to reduce containment heat load.
2. Inject into RCS/Flood Reactor Cavity	Establish/maintain submergence of corium debris. Establish long term cooling of the corium debris. Establish long term cooling of any remaining in-vessel corium debris.
3. Operate Containment Air Coolers	Reduce containment airborne radiation/contamination levels. Reduce containment temperature and pressure. Provide a heat sink for core decay heat transferred to the containment environment.
4. Operate Hydrogen Recombiners	Reduce hydrogen concentration.
5. Vent Containment	Reduce containment temperature. Reduce containment pressure. Reduce hydrogen inventory.
6. Spray the Auxiliary Building	Reduce Auxiliary Building airborne contamination levels.
7. Flood the Auxiliary Building	Remove heat from core debris in Auxiliary Building.
8. Feed the Steam Generator(s)	Inject into RCS and flood reactor cavity/core debris by backflow to the RCS, if a SGTR exists.
9. Spray the Outside of the Containment	Remove heat from containment.

CHLA Tracking Table

This tracking table may be used as an aid in monitoring CHLA status.

Time									
CHLA									
Spray into Containment									
Inject Into the RCS/Flood Reactor Cavity									
Operate Containment Air Coolers									
Operate Hydrogen Recombiners									
Vent Containment									
Spray the Auxiliary Building									
Flood the Auxiliary Building									
Feed the Steam Generators									
Spray the Outside of the Containment									

X = Not available
I = In Use
E = Evaluated
S = Stopped
N/A = Not applicable to Matrix Location

Y = Available
N/I = Not In Use
N/E = Not Evaluated
T = Throttled

2. CHLA 1 - SPRAY INTO CONTAINMENT

A. Purpose/Benefits:

1. The purposes of this CHLA are to:
   - Supplement flooding of the reactor cavity and to quench dispersed ex-core debris.
   - Reduce and maintain containment pressure and temperature to avert challenging containment integrity.
   - Scrub fission products from the containment atmosphere. This will minimize offsite radiological doses.
   - Reduce the temperature of zinc and aluminum surfaces, reducing hydrogen production and minimize fission product re-vaporization.

B. Initiation Criteria:

1. This action should be considered if any of the following occur:
   - Flooding the reactor cavity using sprays is desired.
   - Containment integrity is challenged as indicated by high containment pressure by hydrogen as indicated by the Containment Challenged Calc. Aid Attachment, CA-7.
   - To decrease airborne contamination levels.

C. Termination/Throttling Criteria:

1. Termination of this action or throttling of spray flow should be considered if:
   - Throttling of containment spray flow or cycling spray pumps should be performed to stabilize pressure at a value that will not result in a challenge to the containment while maintaining the containment atmosphere inert.
   - Sufficient water has been added to containment to cover the debris.

D. Concurrent Actions:

- OPERATE CONTAINMENT AIR COOLERS CHLA - If associated CHLA Initiation Criteria are met.
- OPERATE HYDROGEN RECOMBINERS CHLA - If containment hydrogen concentration is greater than 0.5%.

E. Equipment Required:

> **-NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Containment Spray Pumps
  - Water supply
  - Electrical power for pumps and valves

- Control Air System for air operated valves
- Shutdown Cooling Heat Exchangers when heat removal is necessary

2.F. Cautions:

1. Operation of CNMNT spray can act to deinert the CNMNT atmosphere and cause a hydrogen burn. Refer to the CNMNT Challenged Calc. Aid, ERPIP 611, Attachment 5 CA-7 as a guide.
2. Containment sump water will become highly radioactive and upon a RAS will be circulated through various areas of the Aux. Bldg., making some areas of the Aux. Bldg. inaccessible.
3. Reaction of core debris with the concrete basemat may generate significant non-condensible gas (H_2, $C0_2$ and C0). Consequently, this CHLA may not be able to lower containment pressure.

G. Expected Plant Response:

- Decrease in containment pressure and temperature.
- Increase in containment sump level.
- Increase in reactor cavity level as containment sump level increases.

H. Conflicts with EOPs:

1. The EOPs do not address deinerting the CNMNT or attenuating pressure spikes caused by initial quenching of corium debris.

I. Consistency with EOPs:

1. This CHLA is consistent with EOP-8 Functional Recovery Procedure, Containment Environment, with respect to preventing damage to containment and using containment spray to reduce airborne iodine concentration.

J. Recommended Actions:

1. Recommend the Control Room initiate containment spray. Refer to EOP-8 CE series

3. CHLA 2 - INJECT INTO RCS/FLOOD REACTOR CAVITY

A. Purpose/Benefits:

1. The intent of these actions are:
   - To establish/maintain cooling through submergence of the corium debris.
   - Injection into the RCS will provide cooling to any debris remaining in the vessel.
   - Scrub and cool fission products in the corium debris which minimizes the spread of radioactive contamination throughout containment.
   - Prevent concrete basemat erosion.
   - Sets up the long term corium cooling of the ex-vessel corium debris via recirculation with the SI system and heat removal via the SDCHXs.
   - Prevent increased containment pressure due to both non-combustible and combustible gas generated by the core-concrete reaction.

B. Initiation Criteria:

1. This action should be considered if:
   - The containment sump water level is less than required to submerge the corium debris (less than 5 feet of water in the containment basement).
   - The need to continue or make-up SI water to the reactor cavity is determined by containment sump level (Containment WR Level range is 0-120 inches above the basement floor).
   - If the containment sump level instrumentation is inoperable and as a comparison to operable containment sump level instrumentation, estimate containment sump level to help determine when to start or stop water addition to the reactor cavity (approximately 80,000 gallons per foot in the containment sump).

C. Termination/Throttling Criteria:

1. Termination of this action or throttling of injection flow should be considered if any of the following exist:
   - The generation of steam and/or hydrogen is challenging containment integrity.
   - Sufficient water has been added to containment to cover the debris.
   - Unborated water is the only source for injection.
   - It is considered necessary to prolong the time to receive a Recirculation Actuation Signal (RAS). Throttling could be desirable if:
     (1) Recirculation is unavailable, or
     (2) Recirculation could compromise restoration activities due to increased radiation levels caused by radioactive sump water

3.D. Concurrent Actions:

- SPRAY INTO CONTAINMENT CHLA - Operate one or more containment spray trains during the initial quenching of the ex-vessel corium debris, and as required by the Spray into Containment CHLA Initiation Criteria.
- OPERATE CONTAINMENT AIR COOLERS (CACs) CHLA - If associated CHLA Initiation Criteria are met.
- OPERATE HYDROGEN RECOMBINERS CHLA - if containment hydrogen concentration is greater than 0.5%.

E. Equipment Required:

> **-NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- ECCS Pumps (HPSI, LPSI and Containment Spray)
  - a. RWT Level greater than 0.5 ft or containment sump recirc alignment and,
  - b. At least one HPSI, LPSI or Containment Spray Pump
- Charging Pumps (if available)
- Shutdown Cooling Heat Exchangers when heat removal is necessary
- Alternate water sources (Refer to Attachment 1 of ERPIP 611)
- Main or Auxiliary Feedwater (for backflow to RCS if SGTR exists)
  - Auxiliary Feedwater System
    - (1) At least one AFW Pump and,
    - (2) Source of makeup water
- Main Feedwater System (unavailable if SIAS, SGIS or CSAS actuated unless bypassed, blocked or overridden):
  - (1) At least one SGFP (except for Condensate Booster Pump Injection) and,
  - (2) At least two Condensate Pumps (only one required for Condensate Booster Pump Injection) and,
  - (3) At least one Condensate Booster Pump and,
  - (4) Source of makeup water

3.F. Cautions:

1. A high rate of water injection may not result in removing more heat from the ex-vessel corium debris due to existing core debris characteristics. The goal is to keep the corium debris sufficiently submerged so a heat transfer mechanism exists.

2. Containment sump level instrumentation could become damaged and inoperable due to the corium going ex-vessel. Estimate containment sump level (≈80,000 gallons per foot in the containment sump) if level instrumentation is unavailable.

3. The corium could plug the containment emergency sump disabling the SI Recirculation Mode (long term corium cooling) and containment spray recirculation. In this case, supplemental sources of borated water for the refueling water tank should be obtained as this will be the primary source of cooling water for the ex-vessel core debris. Long term corium cooling would be by cycling the containment sprays/CACs based on containment pressure and temperature increases and also providing some make-up borated water to the ex-vessel corium via the SI pumps.

4. The direct hydraulic connection (drain line and cavity access tunnel) between the containment sump and reactor cavity may become plugged with core debris. If the containment sump level instrumentation is operable, this condition temporarily disables the ability of this level instrumentation to provide the degree of submergence of the reactor vessel/corium, until the reactor cavity is sufficiently filled so an overflow occurs at the hot/cold leg penetrations.

5. The CACs and containment spray should be throttled, if possible, and eventually terminated if the required sump level is reached. (See Initiation Criteria of this CHLA).

6. Core debris may be entrained into the recirculation suction pipes which could damage the SI and spray pumps and plug the SDCHX tubes. Monitor inlet/outlet temperatures of the SDCHXs (if in SDC lineup) and SI/containment spray flow rates in order to detect damage/degradation.

7. Containment sump water will become highly radioactive and upon a RAS will be circulated through various areas of the Aux. Bldg., limiting personnel access.

8. Operation of the CACs is preferred over containment spray with respect to conservation of borated RWT water for use as the SI suction source for core debris remaining in the vessel, especially if recirculation with the containment sump cannot be performed.

9 If the ex-vessel core debris is not sufficiently cooled, the core-concrete reaction will create additional combustible gases. Additional hydrogen and CO would be created. (Refer to Attachments CA-5b, 5c.)

10. Injection of unborated water could lead to a return to criticality, and the potential for this increases with increasing SI flow rate. Monitor the ex-core detectors for power spikes. If fission power spikes occur, reduce the SI flowrate to eliminate power spikes and take action to restore borated water to the reactor cavity.

3.F.11. The solubility limit of boric acid needs to be monitored to minimize boron precipitation in the ex-vessel core debris, which may restrict cooling flow to the entire core. Temperature of the reactor cavity sump water needs to be above precipitation temperature. (1/2-TI-303X & 303Y, SDCHX OUT TEMP, can be used, if in the recirc mode, as a conservative indicator of cavity water temperature).

12. It is difficult to distinguish a hydrogen burn from a rapid containment pressurization caused by steaming of reactor cavity water when the corium debris goes ex-vessel, unless it is known the reactor cavity has sufficient water inventory prior to the ex-vessel breach. (Refer to ERPIP 611, Attachment 5 CA-8.)

13. Due to resolidifying of the corium debris during the transition from BD to EX, RCS pressure control may still be possible and the decay heat from both the corium in the reactor cavity and in the RCS will have to be removed. Decay heat removal from the portion of the corium in the RCS would be performed by recovering RCS inventory via SI, with energy removal by venting steam out any existing RCS opening.

G. <u>Expected Plant Response:</u>

- Increase in Containment Sump water level.
- Containment pressure spike will likely result during the initial quenching of the corium debris.

H. <u>Conflicts with EOPs</u>:

1. None.

I. <u>Consistency with EOPs</u>:

1. None.

J. <u>Recommended Actions</u>:

1. Recommend the Control Room perform one or more of the following:
   - Initiate Containment Spray (Refer to EOP-8, CE series).
   - Makeup to the RCS via Safety Injection/Charging System (Refer to EOP-8, PIC series).
   - Initiate Containment Sump Recirculation per (Refer to EOP-8, PIC series).
   - Commence Hot Leg Injection (Refer to EOP-8, PIC series).
   - Commence backfill to the RCS via a ruptured S/G (Refer to EOP-8, HR series).
   - Provide makeup to the RCS from alternate sources (Refer to Attachment 1 of ERPIP 611).

4. CHLA 3 - OPERATE CONTAINMENT AIR COOLERS (CACs)

A. Purpose/Benefits:

1. The purposes of this CHLA are to:
   - Reduce containment pressure and temperature to reduce the potential for a challenge to containment integrity.
   - Scrub containment atmosphere of fission products.
   - Reduce the temperature of zinc and aluminum surfaces, reducing the production of hydrogen.
   - Promote mixing of containment atmosphere and reduce the probability of a localized accumulation of Hydrogen.

B. Initiation Criteria:

1. This action should be considered if:
   - Containment pressure is rising and continued rise could challenge containment integrity
   - It is desired to promote mixing of the containment atmosphere
   - It is desired to reduce CNMNT atmosphere fission products.

C. Termination Criteria:

1. Termination of this action should be considered if:
   a. Reduction in containment pressure and/or steam content as a result of this action would cause a challenge to the containment due to establishing a combustible gas concentration. (Refer to Containment Challenged Calculation Aid ERPIP 611, Attachment 5 CA-7).

Reducing SRW to the CACs or shifting them to slow, may be performed to stabilize containment pressure, thereby minimizing the potential for a hydrogen burn due to de-inerting. Cycling the CACs or reducing the number of CACs in operation can be considered.

D. Concurrent Actions:

- SPRAY INTO CONTAINMENT CHLA - If associated CHLA Initiation Criteria are met.
- OPERATE HYDROGEN RECOMBINERS CHLA - If containment hydrogen concentration is greater than 0.5%.
- VENT CONTAINMENT CHLA- If associated CHLA Initiation Criteria are met.

4.E. Equipment Required:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

1. Containment Air Coolers (CACs)
   - Cooling water supply to CACs
   - Electrical power for fan motors and valves
   - Control Air System for any air operated valves

F. Cautions:

1. Operation of the CACs can deinert the containment and allow a hydrogen burn. Refer to Containment Challenged Calculational Aid ERPIP 611, Attachment 5 CA-7 as a guide. The containment fails at much higher pressure/temperature than the design basis values, approximately 90 psig.

2. Reaction of core debris with the concrete basemat can cause significant non-condensible gas generation (H_2, CO_2 and CO). Consequently, this CHLA may not be able to lower CNMNT pressure.

3. Operation of any electrical equipment in containment, such as CACs, may result in ignition of hydrogen or CO gas.

4. Aerosols produced from the core-concrete reaction may accumulate in the air coolers and degrade their performance.

G. Expected Plant Response:

- Decrease in containment pressure and temperature.
- Small rise in CNMNT sump level

H. Conflicts with EOPs:

1. The EOPs do not contain concerning deinerting containment or to help attenuate pressure spikes caused by initial quenching of corium debris.

I. Consistency with EOPs:

1. This CHLA is consistent with the EOP-8 Functional Recovery Procedure, Containment Environment, with respect to preventing damage to containment.

J. **Recommended Actions**:

1. Recommend the Control Room:

   a. Place the Containment Air Coolers in service on low speed with maximum Service Water Flow using OI-5A as guidance. The provisions of 10CFR50.54(x) and (y) should be considered if the conditions of OI-5A cannot be met and operation of the system is deemed essential.

5. CHLA 4 - OPERATE HYDROGEN RECOMBINERS

A. Purpose/Benefits:

1. The purpose of this CHLA is to reduce containment combustible gas concentrations to keep the containment inert.

B. Initiation Criteria:

1. This action should be considered if containment hydrogen concentration is greater than 0.5%.

C. Termination Criteria:

1. Consider securing the Hydrogen Recombiners if hydrogen concentration reaches 4.0% (if the CNMNT is not deinerted). If H_2 Analyzers are not available then use Calc. Aid ERPIP 611, Attachment 5 CA-5a, 5b, 5c.

D. Concurrent Actions:

- VENT CONTAINMENT CHLA - Containment venting via the Hydrogen Purge System may also be in progress. OI-41B is the governing procedure for this system. Normally, operation of this system is prohibited until two days post-accident. If operation of the Hydrogen Purge System is deemed essential prior to that time, consideration should be given to the provisions of 10CFR50.54(x) and (y).

In addition:

- Recirculation with the Safety Injection System and containment spray operation may be in progress.
- Operation of all systems which will help mix the containment atmosphere helps to prevent localized buildup of hydrogen gas. These systems include the CACs, Iodine Removal Units, Cavity Cooling System and Pressurizer Ventilation Fan.

E. Equipment Required:

> **-NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

1. Hydrogen Recombiners

F. Cautions:

1. Operation of Hydrogen Recombiners could lead to ignition of hydrogen or CO gas. Removal of hydrogen with these systems is slow and it may be advantageous to wait until containment pressure and temperature are under control before activating this system.

5.F.3. Aerosols produced from the core-concrete reaction may deposit in the Hydrogen Recombiners reducing their effectiveness and possibly preventing them from performing their function.

G. **Expected Plant Response**:

1. Decrease in containment hydrogen concentration.

H. **Conflicts with EOPs**:

1. None

I. **Consistency with EOPs:**

1. This CHLA is consistent with EOP-8 Functional Recovery Procedure, Containment Environment with respect to operating as many containment air circulation systems as possible (CACs, Cavity Cooling System, Iodine Removal Units and Pressurizer Ventilation Fan) to prevent localized hydrogen build-up.

J. **Recommended Actions**:

1. Recommend one or more of the following actions to the Control Room:

- Start the Hydrogen Recombiners using OI-41A for guidance. The provisions of 10CFR50.54(x) and (y) should be considered if the conditions of OI-41A cannot be met and operation of the system is deemed essential. In addition, for better mixing:
    - Verify all available CACs are operating
    - Start all available Cavity Cooling Fans
    - Start the Iodine Removal Units
    - Start the Pressurizer Ventilation Fan
- Operate the Hydrogen Purge System using OI-41B as guidance. The provisions of 10CFR50.54(x) and (y) should be considered if the conditions of OI-41B cannot be met and operation of the system is deemed essential.

6. CHLA 5 - VENT CONTAINMENT

A. Purpose/Benefits:

1. The purposes of this CHLA are to reduce:
   - Containment pressure and temperature to avoid breaching containment, which would result in uncontrolled radioactive releases. Specifically, this action would prevent containment failure by using controlled radioactive releases.
   - Containment hydrogen inventory. Reducing hydrogen inventory reduces the pressure from a hydrogen burn.

The Containment Venting Calculational Aid ERPIP 611, Attachment 5 CA-9 can be used to help determine the estimated off-site radiological dose associated with the venting. This Aid should be used to supplement the release permit.

B. Initiation Criteria:

1. This action should be considered if any of the following conditions exist:
   - The Containment Spray System and the Containment Air Coolers are not available or not sufficient to control the containment pressure.
   - It is desired to use a controlled release (venting) versus an uncontrolled release (impairment) to reduce containment pressure.
   - All of the following conditions exist:
     (1) Containment hydrogen concentration is approaching the region where a burn could further challenge containment integrity (refer to Containment Challenged Calculational Aid ERPIP 611, Attachment 5 CA-7 as a guide in this determination), and
     (2) The Hydrogen Recombiners cannot be used or would be too slow in reducing the hydrogen concentration, and
     (3) The containment cannot be kept inerted by use of the Containment Spray System or the Containment Air Coolers.
   - Containment failure pressure (90 psig) is being approached.

C. Termination Criteria:

1. Termination of this action should be considered if:
   - Containment pressure has been lowered to the desired value, or
   - Other methods of reducing containment pressure become available (i.e., Containment Spray, CACs), or
   - Containment hydrogen levels have been reduced to the desired value.

D. Concurrent Actions:

- SPRAY INTO CONTAINMENT CHLA - Containment Spray System operation should be considered prior to and possibly during venting to scrub radiological fission products from the containment atmosphere.
- OPERATE CONTAINMENT AIR COOLERS (CACs) CHLA – If the associated CHLA initiation criteria are met.

- OPERATE HYDROGEN RECOMBINERS CHLA - If containment hydrogen concentration is greater than 0.5%.

6.E. **Equipment Required**:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

1. Hydrogen Purge System

F. **Cautions:**

1. The elevated containment pressure/temperature may exceed the design of the Hydrogen Purge System. Damage to the system may occur which may affect the ability to secure venting.
2. This action could increase radioactive releases to the environment in the short term. (Refer to ERPIP 611, Attachment 5 CA-9.)

G. **Expected Plant Response**:

- Decrease in containment pressure and temperature.
- Decrease in containment hydrogen concentration.

H. **Conflicts with EOPs:**

1. None.

I. **Consistency with EOPs:**

1. This CHLA is consistent with EOP-8 Functional Recovery Procedure, Containment Environment, with respect to operating the Hydrogen Purge System to reduce hydrogen concentration.

J. **Recommended Actions:**

1. Recommend the Control Room:

> **- NOTE -**
> If a SIAS signal is present, removing the SIAS 'A' and 'B' logic modules at the ESFAS logic panels will remove the SIAS signal.

a. Operate the Hydrogen Purge System using OI-41B as guidance. The provisions of 10CFR50.54(x) and (y) should be considered if the conditions of OI-41B cannot be met and operation of the system is deemed essential.

1. IF the CNMNT is to be vented, THEN inform the Chemistry Director so release monitoring and dose assessment can be performed per the appropriate ERPIP 800 series procedure.

7. CHLA 6 - SPRAY THE AUXILIARY BUILDING

A. Purpose/Benefits:

1. The purpose of this CHLA is:

   a. To reduce temperature and/or airborne fission products in a localized area of the Aux. Bldg., to establish conditions allowing access of plant personnel for equipment operation, repair, or monitoring of critical plant equipment.

With the core in an ex-vessel condition, actions which circulate fluids from the containment through piping in the Aux. Bldg. may result in the release of radioactivity to the Aux. Bldg.

B. Initiation Criteria:

1. This action should be considered if there are excessive temperatures in the Aux. Bldg. and/or area radiation monitors are in alarm and personnel access is required.

C. Termination Criteria:

1. Termination of this action should be considered if either:

   - The spray is affecting equipment being used to mitigate the event or,
   - Personnel access to the Aux. Bldg. is no longer required.

D. Concurrent Actions:

1. FLOOD THE AUXILIARY BUILDING CHLA - If the associated CHLA Initiation Criteria are met.

E. Equipment Required :

- NOTE -
If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Fire Suppression System
- Fire hoses and spray nozzles

F. Cautions:

1. May have to temporarily isolate ventilation to the area to avoid reintroduction of airborne contamination.

2. Leaks and crud traps could develop in drainage piping in the Aux. Bldg. as a result of using this CHLA, which would restrict personnel access to affected areas.

7.F.3. The use of the Fire Suppression System will challenge the capacity (4,000 gals) of the Miscellaneous Waste Receiver Tank (MWRT) and cause floor drains to back up and overflow.

G. **Expected Plant Response**:

- Decrease in Aux. Bldg. area temperature.
- Decrease in Aux. Bldg. airborne radiation/contamination levels.

H. **Conflicts with EOPs**:

1. None.

I. **Consistency with EOPs**:

1. None.

J. **Recommended Actions**:

1. Recommend the OSC and the Control Room:
   - Use fire hoses with spray nozzles to spray down selected areas of the Aux. Bldg.
   - Closely monitor MWRT level and pump to RCWPS as necessary to prevent overflowing floor drains.

8. CHLA 7 - FLOOD THE AUXILIARY BUILDING

A. Purpose/Benefits:

1. The purposes of this CHLA are:

   - To provide heat removal for core debris transported to the Aux. Bldg. The area may have to be re-flooded periodically due to boildown or draindown through the floor drains.
   - To scrub fission products released to the Aux. Bldg.

With the core ex-vessel, actions which circulate fluids from the containment through piping in the Aux. Bldg. may result in the release of radioactivity to the Aux. Bldg.

B. Initiation Criteria:

1. This action should be considered if there is excessive temperatures in the Aux. Bldg. and/or area radiation monitors in alarm.

C. Termination Criteria:

1. Termination of this action should be considered if either:

   - Flooding is jeopardizing the operation of equipment needed to mitigate the event
   - Sufficient level has been established in areas of concern.

D. Concurrent Actions:

1. SPRAY THE AUXILIARY BUILDING CHLA - If the associated CHLA Initiation Criteria are met.

E. Equipment Required :

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Fire Suppression System
- Fire hoses and spray nozzles

F. Cautions:

1. If core debris has been transported to the Aux. Bldg., radiation levels can be expected to be extremely high in the areas where deposited.
2. May cause damage to electrical equipment required for safe operation/shutdown of the unaffected unit.

8.G. Expected Plant Response:

1. Decrease in Aux. Bldg. area radiation levels.

H. Conflicts with EOPs:

1. None.

I. Consistency with EOPs:

1. None.

J. Recommended Actions:

1. Recommend the OSC and the Control Room use the fire system and/or hoses and nozzles as necessary to flood desired areas of the Aux. Bldg.

9. CHLA 8 - FEED THE STEAM GENERATORS

A. Purpose/Benefits:

- To maintain a water level above any breach in the S/G U-tubes (SGTR)
- To scrub any fission products leaking from the RCS to the S/G if the pressure in containment is higher than the S/G.
- To inject water into the RCS to flood the reactor cavity. This CHLA will only be effective if a SGTR exists.

B. Initiation Criteria:

1. This action should be considered if either:
   - A SGTR exists and pressure in containment is greater than pressure in the S/G
   - A SGTR exists and RCS/containment pressure is less than or can be lowered to less than S/G pressure, if backflow to the RCS from the S/Gs is desired.

C. Termination/Throttling Criteria:

1. Termination of this action should be considered if either:
   - S/G level is greater than 30 inches or,
   - Backflow into the RCS is ineffective.

D. Concurrent Actions:

1. None.

E. Equipment Required:

> **-NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

1. One of the following sets of equipment:
   - Auxiliary Feedwater System
     - At least one AFW Pump
     - Source of makeup water
   - Main Feedwater System (unavailable if SIAS, SGIS or CSAS actuated unless bypassed, blocked or overridden):
     - At least one SGFP(except for Condensate Booster Pump Injection)
     - At least two Condensate Pumps (only one required for Condensate Booster Pump Injection)
     - At least one Condensate Booster Pump
     - Source of makeup water

9.F. **Cautions**:

1. None.

G. **Expected Plant Response**:

1. Increase in containment sump level.

H. **Conflicts with EOPs**:

1. None.

I. **Consistency with EOPs**:

1. None.

J. **Recommended Actions**:

1. Recommend one or more of the following actions to the Control Room:

    - Verify CST availability and establish feedflow using Auxiliary Feedwater (Refer to EOP-8, HR series).
    - Verify CST availability and establish Feedwater flow using the other Unit's electric-driven AFW pump (Refer to EOP-8, HR series).
    - Establish feed flow using Main Feedwater (Refer to EOP-8, HR series).
    - Establish feed flow using Condensate Booster Pump Injection (Refer to EOP-8, HR series). Steam Generator pressure must be less than 500 psia for this method to be effective.

10. CHLA 9 - SPRAY DOWN OUTSIDE OF CONTAINMENT

A. Purpose/Benefits:

1. The purpose of this CHLA is to remove heat from containment by cooling the outside walls of the structure.

B. Initiation Criteria:

1. This action should be considered if an additional means of removing heat from containment is desirable.

C. Termination/Throttling Criteria:

1. Termination of this action should be considered if either:
   - The containment is being cooled sufficiently by other means
   - The water inventory must be conserved for other uses.

D. Concurrent Actions:

1. None.

E. Equipment Required:

> **-NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Fire hoses and nozzles.
- Possibly a pumper truck.

F. Cautions:

1. With the core in an ex-vessel condition, dose rates outside the containment can be expected to be significantly higher than normal.

G. Expected Plant Response:

1. Reduction in containment temperature and pressure.

H. Conflicts with EOPs:

1. None.

I. Consistency with EOPs:

1. None.

J. Recommended Actions:

1. Recommend the OSC and the Control Room:
   a. Commence spray-down of outside of containment using the Fire Suppression System and any other means available. The objective is to apply as such water to the outside of the containment as possible.

LIST OF EFFECTIVE PAGES

Cumulative NORMs changes to this revision: 0

PAGE	REVISION	EDITORIAL CORRECTION
1	1	
2	1	
3	1	
4	1	
5	1	
6	1	
7	1	
8	1	
9	1	
10	1	
11	1	
12	1	
13	1	
14	1	
15	1	
16	1	
17	1	
18	1	
19	1	
20	1	
21	1	
22	1	
23	1	
24	1	
25	1	

ATTACHMENT	REVISION	EDITORIAL CORRECTION

EMERGENCY RESPONSE PLAN IMPLEMENTATION PROCEDURE

REVIEW/APPROVAL

Calvert Cliffs Nuclear Power Plant

Emergency Response Plan Implementation Procedure

CANDIDATE HIGH LEVEL ACTIONS EX/I

ERPIP 609

Revision 1

Effective Date: MAR 21 2001

Writer: James C. Kellum — 01/02/01 Date

Reviewer: Mark T. Finley — 02/26/01 Date

Director - EP: Anthony J. O'Donnell — 2/28/01 Date

POSRC Mtg. #: 01-019 — 3-14-01 Date

(Signature indicates procedure was reviewed according to NS-2-101)

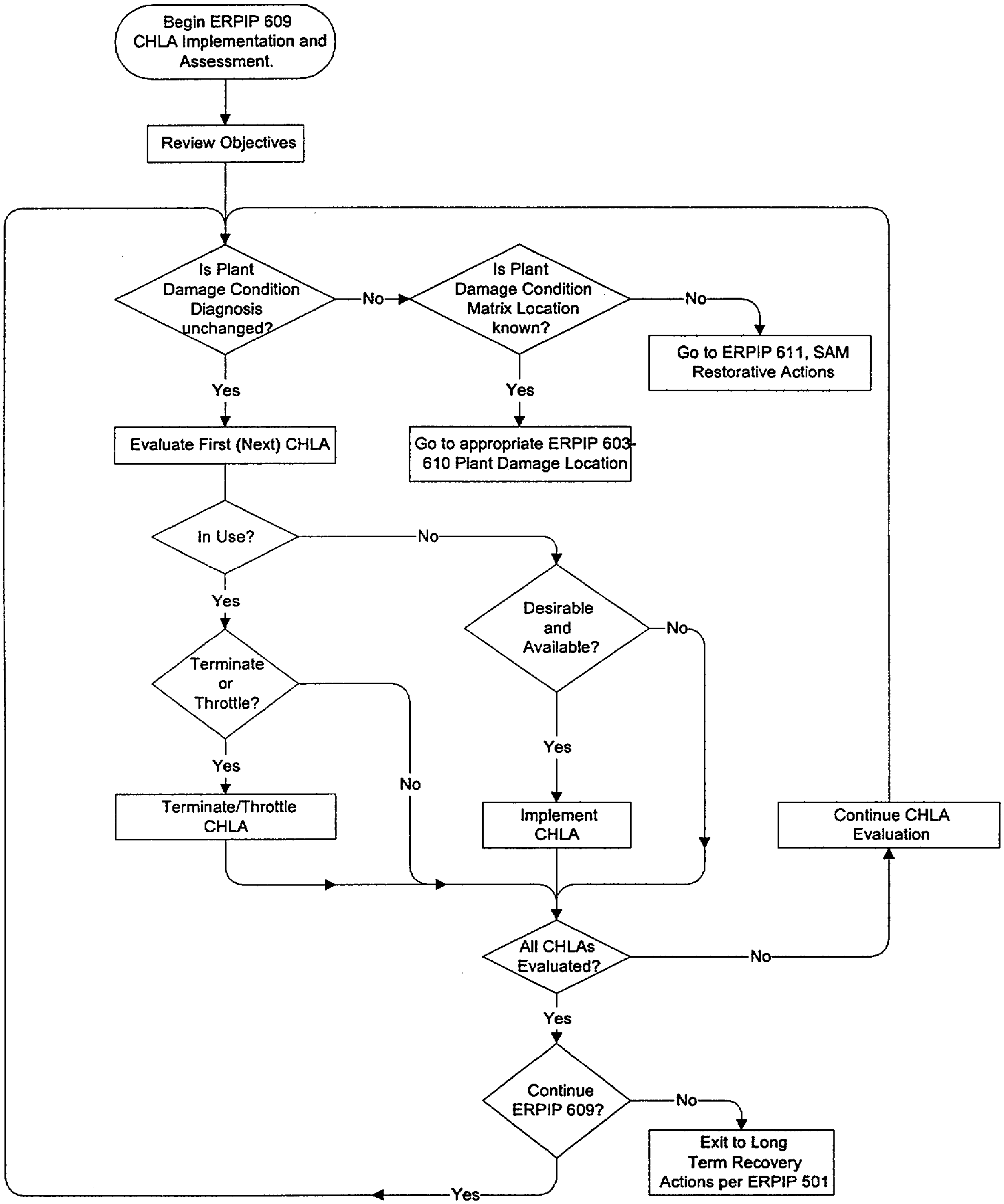
Approved: Plant General Manager — 3/14/01 Date

Candidate High Level Actions
EX/I

RESPONSIBLE INDIVIDUAL: Reactor Engineer

CONDITION: Severe Accident

Instructions



1. OBJECTIVES

A. This ERPIP (EX/I) is being implemented because the core is ex-vessel and the CNMNT has now become impaired. The focus now is to cool to the Corium and to reduce onsite and offsite dose.

B. The objectives of the **EX/I CHLAs** are to:

1. Maintain submergence of the ex-vessel corium debris
2. Establish long term cooling of the ex-vessel corium debris and any remaining in-vessel corium debris
3. Ensure all RCS/containment penetrations are isolated, except those needed to recover from the accident
4. Minimize onsite and offsite radiological doses
5. Minimize any further breaches in containment integrity
6. Reduce offsite radiological doses by scrubbing fission products from a known containment leak
7. Offsite radiological doses are minimized by scrubbing fission products from a known containment leak.

1.D. The following table provides the prioritized list of Candidate High Level Actions for EX/I. The CHLAs are listed in recommended order of implementation. However, the TSC may re-prioritize them depending on plant conditions. The associated objectives, in general, for each CHLA are listed below.

Prioritized CHLA for EX/I	Objectives
1. Spray into Containment	Reduce containment airborne radiation/contamination levels. Maintain submergence of ex-vessel corium debris. Reduce containment temperature and pressure. Quench hot surfaces/components to reduce containment heat load.
2. Inject into RCS/Flood Reactor Cavity	Establish/maintain submergence of corium debris. Establish long term cooling of the corium debris. Establish long term cooling of any remaining in-vessel corium debris.
3. Spray the Outside of the Containment	Reduce offsite radiological doses by scrubbing a known containment leak.
4. Operate Containment Air Coolers	Reduce containment airborne radiation/contamination levels. Reduce containment temperature and pressure. Provide a heat sink for core decay heat transferred to the containment environment.
5. Operate Hydrogen Recombiners	Reduce hydrogen concentration.
6. Vent Containment	Reduce containment temperature. Reduce containment pressure. Reduce hydrogen inventory.
7. Spray the Auxiliary Building	Reduce Auxiliary Building airborne contamination levels. Reduce Auxiliary Building temperature.
8. Flood the Auxiliary Building	Remove heat from core debris in Auxiliary Building.
9. Feed the Steam Generator(s)	Inject into RCS and flood reactor cavity/core debris by backflow to the RCS, if a SGTR exists.

CHLA Tracking Table

This tracking table may be used as an aid in monitoring CHLA status.

Time									
CHLA									
Spray into Containment									
Inject Into the RCS/Flood Reactor Cavity									
Spray the Outside of the Containment									
Operate Containment Air Coolers									
Operate Hydrogen Recombiners									
Vent Containment									
Spray the Auxiliary Building									
Flood the Auxiliary Building									
Feed the Steam Generators									

X = Not available
I = In Use
E = Evaluated
S = Stopped
N/A = Not applicable to Matrix Location

Y = Available
N/I = Not In Use
N/E = Not Evaluated
T = Throttled

2. CHLA 1 - SPRAY INTO CONTAINMENT

A. Purpose/Benefits:

1. The purposes of this CHLA are to:
   - Supplement flooding of the reactor cavity and to quench dispersed ex-core debris.
   - Reduce and maintain containment pressure and temperature to avert challenging containment integrity.
   - Scrub fission products from the containment atmosphere. This will minimize offsite radiological doses.
   - Reduce the temperature of zinc and aluminum surfaces, reducing hydrogen production and minimize fission product re-vaporization.

B. Initiation Criteria:

1. This action should be considered if any of the following occur:
   - Flooding the reactor cavity using sprays is desired.
   - Containment integrity is challenged as indicated by high containment pressure or by hydrogen as indicated by the Containment Challenged Calc. Aid Attachment, CA-7.
   - To decrease airborne contamination levels.

C. Termination/Throttling Criteria:

1. Termination of this action or throttling of spray flow should be considered if:
   - Throttling of containment spray flow or cycling spray pumps should be performed to stabilize pressure at a value that will not result in a challenge to the containment while maintaining the containment atmosphere inert.
   - Sufficient water has been added to containment to cover the debris.

D. Concurrent Actions:

- OPERATE CONTAINMENT AIR COOLERS CHLA - If associated CHLA Initiation Criteria are met.
- OPERATE HYDROGEN RECOMBINERS CHLA - If containment hydrogen concentration is greater than 0.5%.

E. Equipment Required:

> **-NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Containment Spray Pumps
  - Water supply
  - Electrical power for pumps and valves
  - Control Air System for air operated valves
- Shutdown Cooling Heat Exchangers when heat removal is necessary

2.F. Cautions:

1. Containment sump water will become highly radioactive and upon a RAS will be circulated through various areas of the Aux. Bldg., making some areas of the Aux. Bldg. inaccessible.
2. Reaction of core debris with the concrete basemat may generate significant non-condensible gas (H_2, $C0_2$ and C0). Consequently, this CHLA may not be able to lower containment pressure.

G. **Expected Plant Response**:

- Decrease in containment pressure and temperature.
- Increase in containment sump level.
- Increase in reactor cavity level as containment sump level increases.

H. **Conflicts with EOPs:**

1. This CHLA conflicts with the EOPs in that CNMNT spray might not be used due to deinerting concerns.

I. **Consistency with EOPs:**

1. This CHLA is consistent with EOP-8 Functional Recovery Procedure, Containment Environment, with respect to preventing damage to containment and using containment spray to reduce airborne iodine concentration.

J. **Recommended Actions:**

1. Recommend the Control Room initiate containment spray. Refer to EOP-8 CE series.

3. CHLA 2 - INJECT INTO RCS/FLOOD REACTOR CAVITY

A. Purpose/Benefits:

1. The intent of these actions are:
   - To establish/maintain cooling through submergence of the corium debris.
   - Injection into the RCS will provide cooling to any debris remaining in the vessel.
   - Scrub and cool fission products in the corium debris which minimizes the spread of radioactive contamination throughout containment.
   - Prevent concrete basemat erosion.
   - Sets up the long term corium cooling of the ex-vessel corium debris via recirculation with the SI system and heat removal via the SDCHXs.
   - Prevent increased containment pressure due to both non-combustible and combustible gas generated by the core-concrete reaction.

B. Initiation Criteria:

1. This action should be considered if:
   - The containment sump water level is less than required to submerge the corium debris (less than 5 feet of water in the containment basement).
   - The need to continue or make-up SI water to the reactor cavity is determined by containment sump level (Containment WR Level range is 0-120 inches above the basement floor).
   - If the containment sump level instrumentation is inoperable and as a comparison to operable containment sump level instrumentation, estimate containment sump level to help determine when to start or stop water addition to the reactor cavity (approximately 80,000 gallons per foot in the containment sump).

C. Termination/Throttling Criteria:

1. Termination of this action or throttling of injection flow should be considered if any of the following exist:
   - The generation of steam and/or hydrogen is challenging containment integrity.
   - Sufficient water has been added to containment to cover the debris.
   - Unborated water is the only source for injection.
   - It is considered necessary to prolong the time to receive a Recirculation Actuation Signal (RAS). Throttling could be desirable if:
     (1) Recirculation is unavailable, or
     (2) Recirculation could compromise restoration activities due to increased radiation levels caused by radioactive sump water

3.D. Concurrent Actions:

- SPRAY INTO CONTAINMENT CHLA - Operate one or more containment spray trains during the initial quenching of the ex-vessel corium debris, and as required by the Spray into Containment CHLA Initiation Criteria.
- OPERATE CONTAINMENT AIR COOLERS (CACs) CHLA - If associated CHLA Initiation Criteria are met.
- OPERATE HYDROGEN RECOMBINERS CHLA - if containment hydrogen concentration is greater than 0.5%.

E. Equipment Required:

> **-NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- ECCS Pumps (HPSI, LPSI and Containment Spray)
  - a. RWT Level greater than 0.5 ft or containment sump recirc alignment and,
  - b. At least one HPSI, LPSI or Containment Spray Pump
- Charging Pumps (if available)
- Shutdown Cooling Heat Exchangers when heat removal is necessary
- Alternate water sources (Refer to Attachment 1 of ERPIP 611)
- Main or Auxiliary Feedwater (for backflow to RCS if SGTR exists)
  - Auxiliary Feedwater System
    - (1) At least one AFW Pump and,
    - (2) Source of makeup water
  - Main Feedwater System (unavailable if SIAS, SGIS or CSAS actuated unless bypassed, blocked or overridden):
    - (1) At least one SGFP (except for Condensate Booster Pump Injection) and,
    - (2) At least two Condensate Pumps (only one required for Condensate Booster Pump Injection) and,
    - (3) At least one Condensate Booster Pump and,
    - (4) Source of makeup water

3.F. Cautions:

1. A high rate of water injection may not result in removing more heat from the ex-vessel corium debris due to existing core debris characteristics. The goal is to keep the corium debris sufficiently submerged so a heat transfer mechanism exists.

2. Containment sump level instrumentation could become damaged and inoperable due to the corium going ex-vessel. Estimate containment sump level (≈80,000 gallons per foot in the containment sump) if level instrumentation is unavailable.

3. The corium could plug the containment emergency sump disabling the SI Recirculation Mode (long term corium cooling) and containment spray recirculation. In this case, supplemental sources of borated water for the refueling water tank should be obtained as this will be the primary source of cooling water for the ex-vessel core debris. Long term corium cooling would be by cycling the containment sprays/CACs based on containment pressure and temperature increases and also providing some make-up borated water to the ex-vessel corium via the SI pumps.

4. The direct hydraulic connection (drain line and cavity access tunnel) between the containment sump and reactor cavity may become plugged with core debris. If the containment sump level instrumentation is operable, this condition temporarily disables the ability of this level instrumentation to provide the degree of submergence of the reactor vessel/corium, until the reactor cavity is sufficiently filled so an overflow occurs at the hot/cold leg penetrations.

5. The CACs and containment spray should be throttled, if possible, and eventually terminated if the required sump level is reached. (See Initiation Criteria of this CHLA).

6. Core debris may be entrained into the recirculation suction pipes which could damage the SI and spray pumps and plug the SDCHX tubes. Monitor inlet/outlet temperatures of the SDCHXs (if in SDC lineup) and SI/containment spray flow rates in order to detect damage/degradation.

7. Containment sump water will become highly radioactive and upon a RAS will be circulated through various areas of the Aux. Bldg., limiting personnel access.

8. Operation of the CACs is preferred over containment spray with respect to conservation of borated RWT water for use as the SI suction source for core debris remaining in the vessel, especially if recirculation with the containment sump cannot be performed.

9 If the ex-vessel core debris is not sufficiently cooled, the core-concrete reaction will create additional combustible gases. Additional hydrogen and CO would be created. (Refer to Attachments CA-5b, 5c.)

10. Injection of unborated water could lead to a return to criticality, and the potential for this increases with increasing SI flow rate. Monitor the ex-core detectors for power spikes. If fission power spikes occur, reduce the SI flowrate to eliminate power spikes and take action to restore borated water to the reactor cavity.

3.F.11. The solubility limit of boric acid needs to be monitored to minimize boron precipitation in the ex-vessel core debris, which may restrict cooling flow to the entire core. Temperature of the reactor cavity sump water needs to be above precipitation temperature. (1/2-TI-303X & 303Y, SDCHX OUT TEMP, can be used, if in the recirc mode, as a conservative indicator of cavity water temperature).

12. It is difficult to distinguish a hydrogen burn from a rapid containment pressurization caused by steaming of reactor cavity water when the corium debris goes ex-vessel, unless it is known the reactor cavity has sufficient water inventory prior to the ex-vessel breach. (Refer to ERPIP 611, Attachment 5 CA-8.)

13. Due to resolidifying of the corium debris during the transition from BD to EX, RCS pressure control may still be possible and the decay heat from both the corium in the reactor cavity and in the RCS will have to be removed. Decay heat removal from the portion of the corium in the RCS would be performed by recovering RCS inventory via SI, with energy removal by venting steam out any existing RCS opening.

G. **Expected Plant Response:**

- Increase in Containment Sump water level.
- Containment pressure spike will likely result during the initial quenching of the corium debris.

H. **Conflicts with EOPs:**

1. None.

I. **Consistency with EOPs**:

1. None.

J. **Recommended Actions**:

1. Recommend the Control Room perform one or more of the following:
   - Initiate Containment Spray (Refer to EOP-8, CE series).
   - Makeup to the RCS via Safety Injection/Charging System (Refer to EOP-8, PIC series).
   - Initiate Containment Sump Recirculation per (Refer to EOP-8, PIC series).
   - Commence Hot Leg Injection (Refer to EOP-8, PIC series).
   - Commence backfill to the RCS via a ruptured S/G (Refer to EOP-8, HR series).
   - Provide makeup to the RCS from alternate sources (Refer to Attachment 1 of ERPIP 611).

4. CHLA 3 - SPRAY DOWN OUTSIDE OF CONTAINMENT

A. Purpose/Benefits:

1. The purpose of this CHLA is to reduce offsite radiological doses by scrubbing fission products from a known containment leak.

B. Initiation Criteria:

1. This action should be considered if there is an identified containment leak.

C. Termination/Throttling Criteria:

1. Termination of this action should be considered if the ability to retain water used to spray down the outside of the containment becomes problematic. This must be weighed with the positive effects of reducing the atmospheric release.

D. Concurrent Actions:

1. The water will contain fission products. Efforts should be taken to contain the water for future processing. These actions include blocking off the inlets or outlets of the storm drain systems in order to pond and hold the waste water, if the leak is directly to outside atmosphere. Refer to Civil Drawing C-17, Final Grading and Drainage Plan, for locations and routing of storm drains.

E. Equipment Required:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Fire hoses and spray nozzles.
- Possibly a pumper truck.
- Equipment and material for blocking storm drains/ponding waste water.

F. Cautions:

1. Applicable radiological work practices to minimize exposure should be observed.
2. If the leak is into the Aux. Bldg., the use of the fire suppression system will challenge the capacity (4,000 gals) of the Miscellaneous Waste Receiver Tank (MWRT) and cause floor drains to back up and overflow.

G. Expected Plant Response:

1. Reduce release rate of aerosol fission products.

4.H. **Conflicts with EOPs:**

1. None.

I. **Consistency with EOPs:**

1. None.

J. **Recommended Actions:**

1. Recommend one (or both, if appropriate) of the following actions to the OSC and the Control Room:

   - If the leak is directly to the outside atmosphere, block off the storm drains and spraydown the outside of containment at the location of the leak using the Fire Suppression System.

     a. IF the CNMNT is impaired, THEN inform the Chemistry Director so release monitoring and dose assessment can be performed per the appropriate ERPIP 800 series procedure.

   - If the leak is into the Aux. Bldg., spray down the outside of Containment at the location of the leak using the Fire Suppression System. Closely monitor MWRT level and pump to RCWPS as necessary to prevent overflowing floor drains.

5. CHLA 4 - OPERATE CONTAINMENT AIR COOLERS (CACs)

A. Purpose/Benefits:

1. The purposes of this CHLA are to:
   - For significant damage to containment integrity, the primary action is to minimize leakage rates to the environment and scrub aerosols from the containment atmosphere to reduce offsite doses.
   - For less severe damage, the primary purpose is to prevent further breaches to containment integrity, reduce leakage rates to the environment, and scrub aerosols from the containment atmosphere.
   - Remove the decay heat in the containment from the ex-vessel corium.
   - Reduce the temperature of zinc and aluminum surfaces, reducing the production of hydrogen.
   - To promote mixing of containment atmosphere and reduce the probability of a localized accumulation of H2.

B. Initiation Criteria:

1. This action should be considered
   - To reduce containment temperature and pressure to minimize the ΔP between the containment and outside atmosphere.
   - To promote mixing of the containment atmosphere.
   - To remove fission products to reduce the release to the environment.
   - If the SDCHXs are not operable or recirculation from the containment sump is impeded and decay heat removal is required.

C. Termination/Throttling Criteria:

1. Termination of this action should be considered if either:
   - Containment temperature and pressure have been lowered to the desired values,
   - The release through the impairment has been stopped,
   - Reduction in containment pressure and/or steam content due to this action would cause further containment impairment as a result of establishing a combustible gas concentration. Refer to Containment Challenged Calculational Aid ERPIP 611, Attachment 5 CA-7.

Reducing SRW flow to the CACs may aid in stabilizing containment pressure, thereby minimizing the potential for a hydrogen burn due to de-inerting. Cycling the CACs or reducing the number of CACs in operation can be considered.

D. Concurrent Actions:

- SPRAY INTO CONTAINMENT CHLA - If associated CHLA Initiation Criteria are met.

- OPERATE HYDROGEN RECOMBINERS CHLA - If containment hydrogen concentration is greater than 0.5%.
- VENT CONTAINMENT CHLA - If associated CHLA Initiation Criteria are met.

5.E. **Equipment Required**:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

1. Containment Air Coolers (CACs)
   - Cooling water supply to CACs
   - Electrical power for fan motors and valves
   - Control Air System for any air operated valves

F. **Cautions:**

1. Operation of the CACs can deinert the containment and allow a hydrogen burn. Refer to Containment Challenged Calculational Aid ERPIP 611, Attachment 5 CA-7 as a guide and consider the containment fails at much higher pressure/temperature than the design basis values, approximately 90 psig
2. Reaction of core debris with the concrete basemat may generate significant non-condensible gas (H_2, CO_2 and CO). Consequently, this CHLA may not be able to lower containment pressure.
3. Operation of any electrical equipment in containment, such as CACs, may result in ignition of hydrogen or CO gas.
4. Aerosols produced from the core-concrete reaction may accumulate in the air coolers and degrade their performance.

G. **Expected Plant Response**:

- Decrease in containment pressure and temperature.
- Small rise in CNMNT sump level

H. **Conflicts with EOPs:**

1. The EOPs do not contain any caution concerning deinerting containment (especially relative to ultimate containment failure capability) or to help attenuate pressure spikes caused by initial quenching of corium debris.

I. **Consistency with EOPs:**

1. This CHLA is consistent with the EOP-8 Functional Recovery Procedure, Containment Environment, with respect to preventing damage to containment.

J. **Recommended Actions:**

1. Recommend the Control Room:
   a. Place the Containment Air Coolers in service on low speed with maximum Service Water Flow using OI-5A as guidance. The provisions of 10CFR50.54(x) and (y) should be considered if the conditions of OI-5A cannot be met and operation of the system is deemed essential.

6. CHLA 5 - OPERATE HYDROGEN RECOMBINERS

A. Purpose/Benefits:

1. The purpose of this CHLA is to reduce containment combustible gas concentrations to keep the containment inert.

B. Initiation Criteria:

1. This action should be considered if containment hydrogen concentration is greater than 0.5%.

C. Termination Criteria:

1. Consider securing the Hydrogen Recombiners if hydrogen concentration reaches 4.0% (if the CNMNT is not deinerted). If H_2 Analyzers are not available then use Calc. Aid ERPIP 611, Attachment 5 CA-5a, 5b, 5c.

D. Concurrent Actions:

- VENT CONTAINMENT CHLA - Containment venting via the Hydrogen Purge System may also be in progress. OI-41B is the governing procedure for this system. Normally, operation of this system is prohibited until two days post-accident. If operation of the Hydrogen Purge System is deemed essential prior to that time, consideration should be given to the provisions of 10CFR50.54(x) and (y).

In addition:

- Recirculation with the Safety Injection System and containment spray operation may be in progress.
- Operation of all systems which will help mix the containment atmosphere helps to prevent localized buildup of hydrogen gas. These systems include the CACs, Iodine Removal Units, Cavity Cooling System and Pressurizer Ventilation Fan.

E. Equipment Required:

> **-NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

1. Hydrogen Recombiners

F. Cautions:

1. Operation of Hydrogen Recombiners could lead to ignition of hydrogen or CO gas. Removal of hydrogen with these systems is slow and it may be advantageous to wait until containment pressure and temperature are under control before activating this system.

6.F.3. Aerosols produced from the core-concrete reaction may deposit in the Hydrogen Recombiners reducing their effectiveness and possibly preventing them from performing their function.

G. **<u>Expected Plant Response</u>**:

1. Decrease in containment hydrogen concentration.

H. **<u>Conflicts with EOPs</u>**:

1. None

I. **<u>Consistency with EOPs</u>**:

1. This CHLA is consistent with EOP-8 Functional Recovery Procedure, Containment Environment with respect to operating as many containment air circulation systems as possible (CACs, Cavity Cooling System, Iodine Removal Units and Pressurizer Ventilation Fan) to prevent localized hydrogen build-up.

J. **<u>Recommended Actions</u>**:

1. Recommend one or more of the following actions to the Control Room:

   - Start the Hydrogen Recombiners using OI-41A for guidance. The provisions of 10CFR50.54(x) and (y) should be considered if the conditions of OI-41A cannot be met and operation of the system is deemed essential. In addition, for better mixing:

     - Verify all available CACs are operating
     - Start all available Cavity Cooling Fans
     - Start the Iodine Removal Units
     - Start the Pressurizer Ventilation Fan

2. Operate the Hydrogen Purge System using OI-41B as guidance. The provisions of 10CFR50.54(x) and (y) should be considered if the conditions of OI-41B cannot be met and operation of the system is deemed essential.

7. CHLA 6 - VENT CONTAINMENT

A. Purpose/Benefits:

1. The purposes of this CHLA are to reduce:
   - Containment pressure and temperature to avoid further breaching of containment. This action uses a controlled release to accomplish this purpose.
   - Containment hydrogen inventory. Reducing hydrogen inventory reduces the pressure spike from a hydrogen burn.

The Containment Venting Calculational Aid ERPIP 611, Attachment 5 CA-9 can be used to help determine the estimated off-site radiological dose associated with the venting. This Aid should be used to supplement the release permit.

B. Initiation Criteria:

1. This action should be considered if:
   - Containment spray and the CACs are not available or not sufficient to control containment pressure
   - It is desired to use a controlled release (venting) versus an uncontrolled release (impairment) to reduce containment pressure
   - Containment failure pressure is being approached (90 psig) and containment failure is imminent.
   - All of the following conditions exist:
     - Containment hydrogen concentration is approaching the region where a burn could further challenge containment integrity (refer to Containment Challenged Calculation Aid ERPIP 611, Attachment 5 CA-7 as a guide in this determination) and,
     - The Hydrogen Recombiners cannot be used or would be too slow in reducing the hydrogen concentration increase, and
     - The containment cannot be kept inerted by use of containment spray and/or CACs.

C. Termination Criteria:

1. Termination of this action should be considered if:
   - Containment pressure has been lowered to the desired value
   - Other methods of reducing containment pressure become available (i.e., Containment Spray, CACs),
   - Containment hydrogen level has been reduced to the desired value.

D. Concurrent Actions:

- SPRAY INTO CONTAINMENT CHLA - Containment Spray System should be used prior to and possibly during venting to scrub radiological fission products from the containment atmosphere.
- OPERATE CONTAINMENT AIR COOLERS (CACs) CHLA – If associated CHLA initiation criteria are met.

- OPERATE HYDROGEN RECOMBINERS CHLA - If containment hydrogen concentration is greater than 0.5%.

Operation of all systems which will help mix the containment atmosphere helps to prevent localized buildup of hydrogen gas which could lead to a localized hydrogen burn. These systems include the CACs, Iodine Removal Units, Cavity Cooling System and Pressurizer Ventilation Fan

7.E. **Equipment Required**:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

1. Hydrogen Purge System

F. **Cautions**:

1. The elevated containment pressure/temperature may exceed the design of the Hydrogen Purge System. Damage to the system may occur which may affect the ability to secure venting.
2. This action could increase radioactive releases to the environment in the short term.

G. **Expected Plant Response**:

- Decrease in containment pressure and temperature.
- Decrease in containment hydrogen concentration.

H. **Conflicts with EOPs**:

1. None.

I. **Consistency with EOPs**:

1. This CHLA is consistent with EOP-8 Functional Recovery Procedure, Containment Environment, with respect to operating the Hydrogen Purge System to reduce hydrogen concentration.

J. **Recommended Actions**:

1. Recommend the Control Room:

> **- NOTE -**
> If a SIAS signal is present, removing the SIAS 'A' and 'B' logic modules at the ESFAS logic panels will remove the SIAS signal

a. Operate the Hydrogen Purge System using OI-41B as guidance. The provisions of 10CFR50.54(x) and (y) should be considered if the conditions of OI-41B cannot be met and operation of the system is deemed essential.

   1. IF the CNMNT is to be vented, THEN inform the Chemistry Director so release monitoring and dose assessment can be performed per the appropriate ERPIP 800 series procedure.

8. CHLA 7 - SPRAY THE AUXILIARY BUILDING

A. Purpose/Benefits:

1. The purpose of this CHLA is:

   a. To reduce temperature and/or airborne fission products in a localized area of the Aux. Bldg., to establish conditions allowing access of plant personnel for equipment operation, repair, or monitoring of critical plant equipment.

With the core in an ex-vessel condition, actions which circulate fluids from the containment through piping in the Aux. Bldg. may result in the release of radioactivity to the Aux. Bldg.

B. Initiation Criteria:

1. This action should be considered if there are excessive temperatures in the Aux. Bldg. and/or area radiation monitors are in alarm and personnel access is required.

C. Termination Criteria:

1. Termination of this action should be considered if either:

   - The spray is affecting equipment being used to mitigate the event
   - Personnel access to the Aux. Bldg. is no longer required.

D. Concurrent Actions:

1. FLOOD THE AUXILIARY BUILDING CHLA - If the associated CHLA Initiation Criteria are met.

E. Equipment Required :

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Fire Suppression System
- Fire hoses and spray nozzles

F. Cautions:

1. May have to temporarily isolate ventilation to the area to avoid reintroduction of airborne contamination.

2. Leaks and crud traps could develop in drainage piping in the Aux. Bldg. as a result of using this CHLA, which would restrict personnel access to affected areas.

8.F.3. The use of the Fire Suppression System will challenge the capacity (4,000 gals) of the Miscellaneous Waste Receiver Tank (MWRT) and cause floor drains to back up and overflow.

G. **Expected Plant Response**:

- Decrease in Aux. Bldg. area temperature.
- Decrease in Aux. Bldg. airborne radiation/contamination levels.

H. **Conflicts with EOPs**:

1. None.

I. **Consistency with EOPs**:

1. None.

J. **Recommended Actions**:

1. Recommend the OSC and the Control Room:
    - Use fire hoses with spray nozzles to spray down selected areas of the Aux. Bldg.
    - Closely monitor MWRT level and pump to RCWPS as necessary to prevent overflowing floor drains.

9. CHLA 8 - FLOOD THE AUXILIARY BUILDING

A. Purpose/Benefits:

1. The purposes of this CHLA are:

   - To provide heat removal for core debris transported to the Aux. Bldg. The area may have to be re-flooded periodically due to boildown or draindown through the floor drains.
   - To scrub fission products released to the Aux. Bldg.

With the core ex-vessel, actions which circulate fluids from the containment through piping in the Aux. Bldg. may result in the release of radioactivity to the Aux. Bldg.

B. Initiation Criteria:

1. This action should be considered if there is excessive temperatures in the Aux. Bldg. and/or area radiation monitors in alarm.

C. Termination Criteria:

1. Termination of this action should be considered if either:

   - Flooding is jeopardizing the operation of equipment available to mitigate the event
   - Sufficient level has been established in areas of concern.

D. Concurrent Actions:

1. SPRAY THE AUXILIARY BUILDING CHLA - If the associated CHLA Initiation Criteria are met.

E. Equipment Required :

- NOTE -
If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Fire Suppression System
- Fire hoses and spray nozzles

F. Cautions:

1. If core debris has been transported to the Aux. Bldg., radiation levels can be expected to be extremely high in the areas where deposited.
2. May cause damage to electrical equipment required for safe operation/shutdown of the unaffected unit.

9.G. **Expected Plant Response**:

1. Decrease in Aux. Bldg. area radiation levels.

H. **Conflicts with EOPs**:

1. None.

I. **Consistency with EOPs**:

1. None.

J. **Recommended Actions**:

1. Recommend the OSC and the Control Room use the fire system and/or hoses and nozzles as necessary to flood desired areas of the Aux. Bldg.

10. CHLA 9 - FEED THE STEAM GENERATORS

A. Purpose/Benefits:

- To maintain a water level above any breach in the S/G U-tubes (SGTR)
- To scrub any fission products leaking from the RCS to the S/G if the pressure in containment is higher than the S/G.
- To inject water into the RCS to flood the reactor cavity. This CHLA will only be effective if a SGTR exists.

B. Initiation Criteria:

1. This action should be considered if either:
    - A SGTR exists and pressure in containment is greater than pressure in the S/G
    - A SGTR exists and RCS/containment pressure is less than or can be lowered to less than S/G pressure, if backflow to the RCS from the S/Gs is desired.

C. Termination/Throttling Criteria:

1. Termination of this action should be considered if either:
    - S/G level is greater than 30 inches or,
    - Backflow into the RCS is ineffective.

D. Concurrent Actions:

1. None.

E. Equipment Required:

-NOTE -
If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

1. One of the following sets of equipment:
    - Auxiliary Feedwater System
        - At least one AFW Pump
        - Source of makeup water
    - Main Feedwater System (unavailable if SIAS, SGIS or CSAS actuated unless bypassed, blocked or overridden):
        - At least one SGFP(except for Condensate Booster Pump Injection)
        - At least two Condensate Pumps (only one required for Condensate Booster Pump Injection)
        - At least one Condensate Booster Pump
        - Source of makeup water

10.F. Cautions:

1. None.

G. Expected Plant Response:

1. Increase in containment sump level.

H. Conflicts with EOPs:

1. None.

I. Consistency with EOPs:

1. None.

J. Recommended Actions:

1. Recommend one or more of the following actions to the Control Room:
   - Verify CST availability and establish feedflow using Auxiliary Feedwater (Refer to EOP-8, HR series).
   - Verify CST availability and establish Feedwater flow using the other Unit's electric-driven AFW pump (Refer to EOP-8, HR series).
   - Establish feed flow using Main Feedwater (Refer to EOP-8, HR series).
   - Establish feed flow using Condensate Booster Pump Injection (Refer to EOP-8, HR series). Steam Generator pressure must be less than 500 psia for this method to be effective.

LIST OF EFFECTIVE PAGES

Cumulative NORMs changes to this revision: 0

PAGE	REVISION	EDITORIAL CORRECTION
1	1	
2	1	
3	1	
4	1	
5	1	
6	1	
7	1	
8	1	
9	1	
10	1	
11	1	
12	1	
13	1	
14	1	
15	1	
16	1	
17	1	
18	1	
19	1	
20	1	
21	1	
22	1	
23	1	
24	1	
25	1	

ATTACHMENT	REVISION	EDITORIAL CORRECTION

EMERGENCY RESPONSE PLAN IMPLEMENTATION PROCEDURE

REVIEW/APPROVAL

Calvert Cliffs Nuclear Power Plant

Emergency Response Plan Implementation Procedure

CANDIDATE HIGH LEVEL ACTIONS EX/B

ERPIP 610

Revision 1

Effective Date: MAR 21 2001

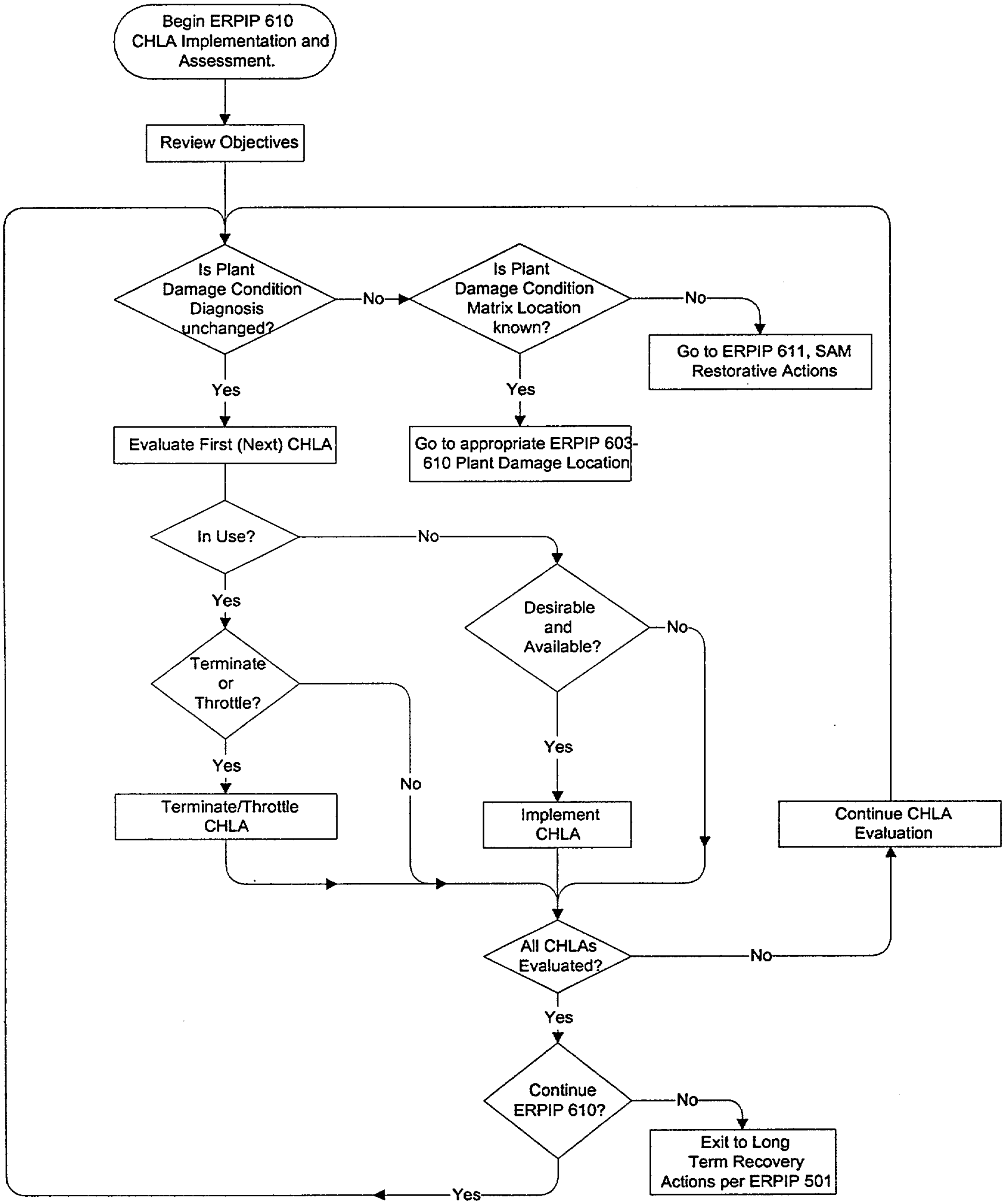
Writer:	James C. Kellum	01/02/01 Date
Reviewer:	Mark T. Finley	02/26/01 Date
Director - EP:	Anthony J. O'Donnell	2/28/01 Date
POSRC Mtg. #: 01-019	(Signature indicates procedure was reviewed according to NS-2-101)	3-14-01 Date
Approved:	Plant General Manager	3/14/01 Date

Candidate High Level Actions
EX/B

RESPONSIBLE INDIVIDUAL: Reactor Engineer

CONDITION: Severe Accident

Instructions



1. OBJECTIVES

A. This ERPIP (EX/B) is being implemented because the core is ex-vessel and the CNMNT is now being bypassed. The focus now is to cool the corium, reduce onsite dose and terminate the bypass if possible. It is desirable to restore/maintain the CNMNT barrier.

B. The objectives of the **EX/B CHLAs** are to:

1. Maintain submergence of the ex-vessel corium debris
2. Establish long term cooling of the ex-vessel corium debris and any remaining in-vessel corium debris
3. Ensure all RCS/containment penetrations are isolated, except those needed to recover from the accident
4. Minimize onsite and offsite radiological doses
5. Maintain containment integrity
6. Offsite radiological doses are minimized by scrubbing the containment atmosphere via the Containment Spray System and minimizing containment pressure.

1.D. The following table provides the prioritized list of Candidate High Level Actions for EX/B. The CHLAs are listed in recommended order of implementation. However, the TSC may re-prioritize them depending on plant conditions. The associated objectives, in general, for each CHLA are listed below.

Prioritized CHLA for EX/B	Objectives
1. Spray into Containment	Reduce containment airborne radiation/contamination levels. Maintain submergence of ex-vessel corium debris. Reduce containment temperature and pressure. Quench hot surfaces/components to reduce containment heat load.
2. Inject into RCS/Flood Reactor Cavity	Establish/maintain submergence of corium debris. Establish long term cooling of the corium debris. Establish long term cooling of any remaining in-vessel corium debris.
3. Operate Containment Air Coolers	Reduce containment airborne radiation/contamination levels. Reduce containment temperature and pressure. Provide a heat sink for core decay heat transferred to the containment environment.
4. Operate Hydrogen Recombiners	Reduce hydrogen concentration.
5. Vent Containment	Reduce hydrogen inventory. Reduce containment pressure and temperature.
6. Spray the Auxiliary Building	Reduce Auxiliary Building airborne contamination levels. Reduce Auxiliary Building temperature.
7. Flood the Auxiliary Building	Remove heat from core debris in Auxiliary Building.
8. Feed the Steam Generator(s)	Inject into RCS and flood reactor cavity/core debris by backflow to the RCS, if a SGTR exists.
9. Spray the Outside of the Containment	Remove heat from containment.

CHLA Tracking Table

This tracking table may be used as an aid in monitoring CHLA status.

Time									
CHLA									
Spray into Containment									
Inject Into the RCS/Flood Reactor Cavity									
Operate Containment Air Coolers									
Operate Hydrogen Recombiners									
Vent Containment									
Spray the Auxiliary Building									
Flood the Auxiliary Building									
Feed the Steam Generators									
Spray the Outside of the Containment									

X = Not available
I = In Use
E = Evaluated
S = Stopped
N/A = Not applicable to Matrix Location

Y = Available
N/I = Not In Use
N/E = Not Evaluated
T = Throttled

2. CHLA 1 - SPRAY INTO CONTAINMENT

A. Purpose/Benefits:

1. The purposes of this CHLA are to:
   - Supplement flooding of the reactor cavity and to quench dispersed ex-core debris.
   - Reduce and maintain containment pressure and temperature to avert challenging containment integrity.
   - Scrub fission products from the containment atmosphere. This will minimize offsite radiological doses.
   - Reduce the temperature of zinc and aluminum surfaces, reducing hydrogen production and minimize fission product re-vaporization.

B. Initiation Criteria:

1. This action should be considered if any of the following occur:
   - Flooding the reactor cavity using sprays is desired.
   - Containment integrity is challenged as indicated by high containment pressure or by hydrogen as indicated by the Containment Challenged Calc. Aid Attachment, CA-7.
   - To decrease airborne contamination levels.

C. Termination/Throttling Criteria:

1. Termination of this action or throttling of spray flow should be considered if:
   - Throttling of containment spray flow or cycling spray pumps should be performed to stabilize pressure at a value that will not result in a challenge to the containment while maintaining the containment atmosphere inert.
   - Sufficient water has been added to containment to cover the debris.

D. Concurrent Actions:

- OPERATE CONTAINMENT AIR COOLERS CHLA - If associated CHLA Initiation Criteria are met.
- OPERATE HYDROGEN RECOMBINERS CHLA - If containment hydrogen concentration is greater than 0.5%.

E. Equipment Required:

> **-NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Containment Spray Pumps
  - Water supply
  - Electrical power for pumps and valves
  - Control Air System for air operated valves
- Shutdown Cooling Heat Exchangers when heat removal is necessary

F. Cautions:

1. Containment sump water will become highly radioactive and upon a RAS will be circulated through various areas of the Aux. Bldg., making some areas of the Aux. Bldg. inaccessible.

2.F.2. Reaction of core debris with the concrete basemat may generate significant non-condensible gas (H_2, $C0_2$ and C0). Consequently, this CHLA may not be able to lower containment pressure.

3. Extended operation of containment spray or the CACs can cause containment pressure to go below atmosphere pressure to less than negative design basis pressure leading to containment damage.

G. <u>**Expected Plant Response**</u>:

- Decrease in containment pressure and temperature.
- Increase in containment sump level.
- Increase in reactor cavity level as containment sump level increases.

H. <u>**Conflicts with EOPs**</u>:

1. This CHLA conflicts with the EOPs in that CNMNT spray might not be used due to deinerting concerns.

I. <u>**Consistency with EOPs**</u>:

1. This CHLA is consistent with EOP-8 Functional Recovery Procedure, Containment Environment, with respect to preventing damage to containment and using containment spray to reduce airborne iodine concentration.

J. <u>**Recommended Actions**</u>:

1. Recommend the Control Room initiate containment spray. Refer to EOP-8 CE series.

3. CHLA 2 - INJECT INTO RCS/FLOOD REACTOR CAVITY

A. Purpose/Benefits:

1. The intent of these actions are:
   - To establish/maintain cooling through submergence of the corium debris.
   - Injection into the RCS will provide cooling to any debris remaining in the vessel.
   - Scrub and cool fission products in the corium debris which minimizes the spread of radioactive contamination throughout containment.
   - Prevent concrete basemat erosion.
   - Sets up the long term corium cooling of the ex-vessel corium debris via recirculation with the SI system and heat removal via the SDCHXs.
   - Prevent increased containment pressure due to both non-combustible and combustible gas generated by the core-concrete reaction.

B. Initiation Criteria:

1. This action should be considered if:
   - The containment sump water level is less than required to submerge the corium debris (less than 5 feet of water in the containment basement).
   - The need to continue or make-up SI water to the reactor cavity is determined by containment sump level (Containment WR Level range is 0-120 inches above the basement floor).
   - If the containment sump level instrumentation is inoperable and as a comparison to operable containment sump level instrumentation, estimate containment sump level to help determine when to start or stop water addition to the reactor cavity (approximately 80,000 gallons per foot in the containment sump).

C. Termination/Throttling Criteria:

1. Termination of this action or throttling of injection flow should be considered if any of the following exist:
   - The generation of steam and/or hydrogen is challenging containment integrity.
   - Sufficient water has been added to containment to cover the debris.
   - Unborated water is the only source for injection.
   - It is considered necessary to prolong the time to receive a Recirculation Actuation Signal (RAS). Throttling could be desirable if:
     - (1) Recirculation is unavailable, or
     - (2) Recirculation could compromise restoration activities due to increased radiation levels caused by radioactive sump water

3.D. Concurrent Actions:

- SPRAY INTO CONTAINMENT CHLA - Operate one or more containment spray trains during the initial quenching of the ex-vessel corium debris, and as required by the Spray into Containment CHLA Initiation Criteria.
- OPERATE CONTAINMENT AIR COOLERS (CACs) CHLA - If associated CHLA Initiation Criteria are met.
- OPERATE HYDROGEN RECOMBINERS CHLA - if containment hydrogen concentration is greater than 0.5%.

E. Equipment Required:

> **-NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- ECCS Pumps (HPSI, LPSI and Containment Spray)
  a. RWT Level greater than 0.5 ft or containment sump recirc alignment and,
  b. At least one HPSI, LPSI or Containment Spray Pump
- Charging Pumps (if available)
- Shutdown Cooling Heat Exchangers when heat removal is necessary
- Alternate water sources (Refer to Attachment 1 of ERPIP 611)
- Main or Auxiliary Feedwater (for backflow to RCS if SGTR exists)
  - Auxiliary Feedwater System
    (1) At least one AFW Pump and,
    (2) Source of makeup water
  - Main Feedwater System (unavailable if SIAS, SGIS or CSAS actuated unless bypassed, blocked or overridden):
    (1) At least one SGFP (except for Condensate Booster Pump Injection) and,
    (2) At least two Condensate Pumps (only one required for Condensate Booster Pump Injection) and,
    (3) At least one Condensate Booster Pump and,
    (4) Source of makeup water

3.F. Cautions:

1. A high rate of water injection may not result in removing more heat from the ex-vessel corium debris due to existing core debris characteristics. The goal is to keep the corium debris sufficiently submerged so a heat transfer mechanism exists.

2. Containment sump level instrumentation could become damaged and inoperable due to the corium going ex-vessel. Estimate containment sump level (≈80,000 gallons per foot in the containment sump) if level instrumentation is unavailabe.

3. The corium could plug the containment emergency sump disabling the SI Recirculation Mode (long term corium cooling) and containment spray recirculation. In this case, supplemental sources of borated water for the refueling water tank should be obtained as this will be the primary source of cooling water for the ex-vessel core debris. Long term corium cooling would be by cycling the containment sprays/CACs based on containment pressure and temperature increases and also providing some make-up borated water to the ex-vessel corium via the SI pumps.

4. The direct hydraulic connection (drain line and cavity access tunnel) between the containment sump and reactor cavity may become plugged with core debris. If the containment sump level instrumentation is operable, this condition temporarily disables the ability of this level instrumentation to provide the degree of submergence of the reactor vessel/corium, until the reactor cavity is sufficiently filled so an overflow occurs at the hot/cold leg penetrations.

5. The CACs and containment spray should be throttled, if possible, and eventually terminated if the required sump level is reached. (See Initiation Criteria of this CHLA).

6. Core debris may be entrained into the recirculation suction pipes which could damage the SI and spray pumps and plug the SDCHX tubes. Monitor inlet/outlet temperatures of the SDCHXs (if in SDC lineup) and SI/containment spray flow rates in order to detect damage/degradation.

7. Containment sump water will become highly radioactive and upon a RAS will be circulated through various areas of the Aux. Bldg., limiting personnel access.

8. Operation of the CACs is preferred over containment spray with respect to conservation of borated RWT water for use as the SI suction source for core debris remaining in the vessel, especially if recirculation with the containment sump cannot be performed.

9 If the ex-vessel core debris is not sufficiently cooled, the core-concrete reaction will create additional combustible gases. Additional hydrogen and CO would be created. (Refer to Attachments CA-5b, 5c.)

10. Injection of unborated water could lead to a return to criticality, and the potential for this increases with increasing SI flow rate. Monitor the ex-core detectors for power spikes. If fission power spikes occur, reduce the SI flowrate to eliminate power spikes and take action to restore borated water to the reactor cavity.

11. The solubility limit of boric acid needs to be monitored to minimize boron precipitation in the ex-vessel core debris, which may restrict cooling flow to the entire core. Temperature of the reactor cavity sump water needs to be above precipitation temperature. (1/2-TI-303X & 303Y, SDCHX OUT TEMP, can be used, if in the recirc mode, as a conservative indicator of cavity water temperature).

3.F.12. It is difficult to distinguish a hydrogen burn from a rapid containment pressurization caused by steaming of reactor cavity water when the corium debris goes ex-vessel, unless it is known the reactor cavity has sufficient water inventory prior to the ex-vessel breach. (Refer to ERPIP 611, Attachment 5 CA-8.)

13. Due to resolidifying of the corium debris during the transition from BD to EX, RCS pressure control may still be possible and the decay heat from both the corium in the reactor cavity and in the RCS will have to be removed. Decay heat removal from the portion of the corium in the RCS would be performed by recovering RCS inventory via SI, with energy removal by venting steam out any existing RCS opening.

G. **Expected Plant Response:**

- Increase in Containment Sump water level.
- Containment pressure spike will likely result during the initial quenching of the corium debris.

H. **Conflicts with EOPs:**

1. None.

I. **Consistency with EOPs:**

1. None.

J. **Recommended Actions:**

1. Recommend the Control Room perform one or more of the following:
   - Initiate Containment Spray (Refer to EOP-8, CE series).
   - Makeup to the RCS via Safety Injection/Charging System (Refer to EOP-8, PIC series).
   - Initiate Containment Sump Recirculation per (Refer to EOP-8, PIC series).
   - Commence Hot Leg Injection (Refer to EOP-8, PIC series).
   - Commence backfill to the RCS via a ruptured S/G (Refer to EOP-8, HR series).

     Provide makeup to the RCS from alternate sources (Refer to Attachment 1 of ERPIP 611).

4. CHLA 3 - OPERATE CONTAINMENT AIR COOLERS (CACs)

A. Purpose/Benefits:

1. The purposes of this CHLA are to:
   - For significant damage to containment integrity, the primary action is to minimize leakage rates to the environment and scrub aerosols from the containment atmosphere to reduce offsite doses.
   - For less severe damage, the primary purpose is to prevent further breaches to containment integrity, reduce leakage rates to the environment, and scrub aerosols from the containment atmosphere.
   - Remove the decay heat in the containment from the ex-vessel corium.
   - Reduce the temperature of zinc and aluminum surfaces, reducing the production of hydrogen.
   - Promote mixing of containment atmosphere and reduce the probability of a localized accumulation of H2.

B. Initiation Criteria:

1. This action should be considered
   - To reduce containment temperature and pressure to minimize the ΔP between the containment and outside atmosphere.
   - To promote mixing of the containment atmosphere.
   - To remove fission products to reduce the release to the environment.
   - If the SDCHXs are not operable or recirculation from the containment sump is impeded and decay heat removal is required.

C. Termination/Throttling Criteria:

1. Termination of this action should be considered if:
   - Containment temperature and pressure have been lowered to the desired values,
   - The relaese through the impairment has been stopped,
   - Reduction in containment pressure and/or steam content due to this action would cause further containment impairment as a result of establishing a combustible gas concentration. Refer to Containment Challenged Calculational Aid ERPIP 611, Attachment 5 (CA-7).

Reducing SRW flow to the CACs may aid in stabilizing containment pressure, thereby minimizing the potential for a hydrogen burn due to de-inerting. Cycling the CACs or reducing the number of CACs in operation can be considered.

D. Concurrent Actions:

- SPRAY INTO CONTAINMENT CHLA - If associated CHLA Initiation Criteria are met.
- OPERATE HYDROGEN RECOMBINERS CHLA - If containment hydrogen concentration is greater than 0.5%.
- VENT CONTAINMENT CHLA - If associated CHLA Initiation Criteria are met.

4.E. **Equipment Required**:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Containment Air Coolers (CACs)
    - Cooling water supply to CACs
    - Electrical power for fan motors and valves
    - Control Air System for any air operated valves

F. **Cautions**:

1. Operation of the CACs can deinert the containment and allow a hydrogen burn. Refer to Containment Challenged Calculational Aid ERPIP 611, Attachment 5 CA-7 as a guide and consider the containment fails at much higher pressure/temperature than the design basis values, approximately 90 psig
2. Reaction of core debris with the concrete basemat may generate significant non-condensible gas (H_2, CO_2 and CO). Consequently, this CHLA may not be able to lower containment pressure.
3. Operation of any electrical equipment in containment, such as CACs, may result in ignition of hydrogen or CO gas.
4. Aerosols produced from the core-concrete reaction may accumulate in the air coolers and degrade their performance.

G. **Expected Plant Response**:

- Decrease in containment pressure and temperature.
- Small rise in CNMNT sump level

H. **Conflicts with EOPs**:

1. The EOPs do not contain any caution concerning deinerting containment (especially relative to ultimate containment failure capability) or to help attenuate pressure spikes caused by initial quenching of corium debris.

I. **Consistency with EOPs**:

1. This CHLA is consistent with the EOP-8 Functional Recovery Procedure, Containment Environment, with respect to the ultimate goal of preventing damage to the containment building.

J. **Recommended Actions**:

1. Recommend the Control Room:
    a. Place the Containment Air Coolers in service on low speed with maximum Service Water Flow using OI-5A as guidance. The provisions of 10CFR50.54(x) and (y) should be considered if the conditions of OI-5A cannot be met and operation of the system is deemed essential.

6. CHLA 5 - OPERATE HYDROGEN RECOMBINERS

A. Purpose/Benefits:

1. The purpose of this CHLA is to reduce containment combustible gas concentrations to keep the containment inert.

B. Initiation Criteria:

1. This action should be considered if containment hydrogen concentration is greater than 0.5%.

C. Termination Criteria:

1. Consider securing the Hydrogen Recombiners if hydrogen concentration reaches 4.0% (if the CNMNT is not deinerted). If H_2 Analyzers are not available then use Calc. Aid ERPIP 611, Attachment 5 CA-5a, 5b, 5c.

D. Concurrent Actions:

- VENT CONTAINMENT CHLA - Containment venting via the Hydrogen Purge System may also be in progress. OI-41B is the governing procedure for this system. Normally, operation of this system is prohibited until two days post-accident. If operation of the Hydrogen Purge System is deemed essential prior to that time, consideration should be given to the provisions of 10CFR50.54(x) and (y).

In addition:

- Recirculation with the Safety Injection System and containment spray operation may be in progress.
- Operation of all systems which will help mix the containment atmosphere helps to prevent localized buildup of hydrogen gas. These systems include the CACs, Iodine Removal Units, Cavity Cooling System and Pressurizer Ventilation Fan.

E. Equipment Required:

> **-NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

1. Hydrogen Recombiners

F. Cautions:

1. Operation of Hydrogen Recombiners could lead to ignition of hydrogen or CO gas. Removal of hydrogen with these systems is slow and it may be advantageous to wait until containment pressure and temperature are under control before activating this system.
2. Aerosols produced from the core-concrete reaction may deposit in the Hydrogen Recombiners reducing their effectiveness and possibly preventing them from performing their function.

G. Expected Plant Response:

1. Decrease in containment hydrogen concentration.

H. Conflicts with EOPs:

1. None

6.I. Consistency with EOPs:

1. This CHLA is consistent with EOP-8 Functional Recovery Procedure, Containment Environment with respect to operating as many containment air circulation systems as possible (CACs, Cavity Cooling System, Iodine Removal Units and Pressurizer Ventilation Fan) to prevent localized hydrogen build-up.

J. Recommended Actions:

1. Recommend one or more of the following actions to the Control Room:

   - Start the Hydrogen Recombiners using OI-41A for guidance. The provisions of 10CFR50.54(x) and (y) should be considered if the conditions of OI-41A cannot be met and operation of the system is deemed essential. In addition, for better mixing:
     - Verify all available CACs are operating
     - Start all available Cavity Cooling Fans
     - Start the Iodine Removal Units
     - Start the Pressurizer Ventilation Fan
   - Operate the Hydrogen Purge System using OI-41B as guidance. The provisions of 10CFR50.54(x) and (y) should be considered if the conditions of OI-41B cannot be met and operation of the system is deemed essential.

6. CHLA 5 - VENT CONTAINMENT

A. Purpose/Benefits:

1. The purposes of this CHLA are to reduce:
   - Containment pressure and temperature to avoid further breaching of containment. This action uses a controlled release to accomplish this purpose.
   - Containment hydrogen inventory. Reducing hydrogen inventory reduces the pressure spike from a hydrogen burn.

The Containment Venting Calculational Aid ERPIP 611, Attachment 5 CA-9 can be used to help determine the estimated off-site radiological dose associated with the venting. This Aid should be used to supplement the release permit.

B. Initiation Criteria:

1. This action should be considered if:
   - Containment spray and the CACs are not available or not sufficient to control containment pressure or,
   - It is desired to use a controlled release (venting) versus an uncontrolled release (impairment) to reduce containment pressure and
   - Containment failure pressure is being approached (90 psig) and containment failure is imminent.
   - All of the following conditions exist:
     - Containment hydrogen concentration is approaching the region where a burn could further challenge containment integrity (refer to Containment Challenged Calculation Aid ERPIP 611, Attachment 5 CA-7 as a guide in this determination) and,
     - The Hydrogen Recombiners cannot be used or would be too slow in reducing the hydrogen concentration increase, and
     - The containment cannot be kept inerted by use of containment spray and/or CACs.

C. Termination Criteria:

1. Termination of this action should be considered if:
   - Containment pressure has been lowered to the desired value
   - Other methods of reducing containment pressure become available (i.e., Containment Spray, CACs),
   - Containment hydrogen level has been reduced to the desired value.

D. Concurrent Actions:

- SPRAY INTO CONTAINMENT CHLA - Containment Spray System should be used prior to and possibly during venting to scrub radiological fission products from the containment atmosphere.
- OPERATE CONTAINMENT AIR COOLERS (CACs) CHLA – If associated CHLA initiation criteria are met.

- OPERATE HYDROGEN RECOMBINERS CHLA - If containment hydrogen concentration is greater than 0.5%.

Operation of all systems which will help mix the containment atmosphere helps to prevent localized buildup of hydrogen gas which could lead to a localized hydrogen burn. These systems include the CACs, Iodine Removal Units, Cavity Cooling System and Pressurizer Ventilation Fan

6.E. **Equipment Required**:

> - **NOTE** -
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

1. Hydrogen Purge System

F. **Cautions**:

1. The elevated containment pressure/temperature may exceed the design of the Hydrogen Purge System. Damage to the system may occur which may affect the ability to secure venting.
2. This action could increase radioactive releases to the environment in the short term.

G. **Expected Plant Response**:

- Decrease in containment pressure and temperature.
- Decrease in containment hydrogen concentration.

H. **Conflicts with EOPs**:

1. None.

I. **Consistency with EOPs**:

1. This CHLA is consistent with EOP-8 Functional Recovery Procedure, Containment Environment, with respect to operating the Hydrogen Purge System to reduce hydrogen concentration.

J. **Recommended Actions**:

1. Recommend the Control Room:

> - **NOTE** -
> If a SIAS signal is present, removing the SIAS 'A' and 'B' logic modules at the ESFAS logic panels will remove the SIAS signal

a. Operate the Hydrogen Purge System using OI-41B as guidance. The provisions of 10CFR50.54(x) and (y) should be considered if the conditions of OI-41B cannot be met and operation of the system is deemed essential.

1. IF the CNMNT is to be vented, THEN inform the Chemistry Director so release monitoring and dose assessment can be performed per the appropriate ERPIP 800 series procedure.

7. CHLA 6 - SPRAY THE AUXILIARY BUILDING

A. Purpose/Benefits:

1. The purpose of this CHLA is to reduce temperature and/or airborne fission products in a localized area of the Aux. Bldg., to establish conditions allowing access of plant personnel for equipment operation or repair, or monitoring of critical plant equipment.

With the core in an ex-vessel condition, actions which circulate fluids from the containment through piping in the Aux. Bldg. may result in the release of radioactivity to the Aux. Bldg.

B. Initiation Criteria:

1. This action should be considered to reduce:
   - Temperature for personnel access to the Aux. Bldg,
   - Radiation and contamination levels for personnel access.

C. Termination Criteria:

1. Termination of this action should be considered if either:
   - The spray is affecting equipment being used to mitigate the event or,
   - Personnel access to the Aux. Bldg. is no longer required.

D. Concurrent Actions:

1. FLOOD THE AUXILIARY BUILDING CHLA - If the associated CHLA Initiation Criteria are met.

E. Equipment Required :

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Fire Suppression System
- Fire hoses and spray nozzles

F. Cautions:

1. May have to temporarily isolate ventilation to the area, in order to avoid reintroduction of airborne contamination.
2. Leaks and crud traps could develop in drainage piping in the Aux. Bldg. as a result of using this CHLA, which would restrict personnel access to affected areas.
3. The use of the Fire Suppression System will challenge the capacity (4,000 gals) of the Miscellaneous Waste Receiver Tank (MWRT) and cause floor drains to back up and overflow.

G. Expected Plant Response:

- Decrease in Aux. Bldg. area temperature.
- Decrease in Aux. Bldg. airborne radiation/contamination levels.

7.H. **<u>Conflicts with EOPs</u>:**

1. None.

I. **<u>Consistency with EOPs</u>:**

1. None.

J. **<u>Recommended Actions</u>:**

1. Recommend the OSC and the Control Room:
   - Use fire hoses with spray nozzles to spray down selected areas of the Aux. Bldg.
   - Closely monitor MWRT level and pump to RCWPS as necessary to prevent overflowing floor drains.

8. CHLA 7 - FLOOD THE AUXILIARY BUILDING

A. Purpose/Benefits:

1. The purposes of this CHLA are:
   - To provide heat removal for core debris transported to the Aux. Bldg. If core debris enters the Aux. Bldg., the associated decay heat would have to be removed. The area may have to be re-flooded periodically due to boildown or draindown through the floor drains.
   - To scrub fission products released to the Aux. Bldg.

With the core in an ex-vessel condition, actions which circulate fluids from the containment through piping in the Aux. Bldg. may result in the release of radioactivity to the Aux. Bldg. In addition, leakage through the bypass or existing (small) paths can transport fission products to the Aux. Bldg.

B. Initiation Criteria:

1. This action should be considered if there is excessive temperatures in the Aux. Bldg. and/or area radiation monitors are in alarm.

C. Termination Criteria:

1. Termination of this action should be considered if either:
   - Flooding is jeopardizing the operation of equipment available to mitigate the event or,
   - Sufficient level has been established in areas of concern.

D. Concurrent Actions:

1. SPRAY THE AUXILIARY BUILDING CHLA - If the associated CHLA Initiation Criteria are met.

E. Equipment Required :

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Fire Suppression System
- Fire hoses and spray nozzles

F. Cautions:

1. If core debris has been transported to the Aux. Bldg., radiation levels can be expected to be extremely high in areas where deposited.
2. This action may cause damage to electrical equipment required for safe operation/shutdown of the unaffected unit.

G. Expected Plant Response:

1. Decrease in Aux. Bldg. radiation levels.

H. Conflicts with EOPs:

1. None.

7.I. Consistency with EOPs:

1. None.

J. Recommended Actions:

1. Recommend the OSC and the Control Room to use the fire system or hoses and nozzles as necessary to flood desired areas of the Aux. Bldg.

9. CHLA 8 - FEED THE STEAM GENERATORS

A. Purpose/Benefits:

- To maintain a water level above any breach in the S/G U-tubes (SGTR)
- To scrub any fission products leaking from the RCS to the S/G if the pressure in containment is higher than the S/G.
- To inject water into the RCS to flood the reactor cavity. This CHLA will only be effective if a SGTR exists.

B. Initiation Criteria:

1. This action should be considered if either:
    - A SGTR exists and pressure in containment is greater than pressure in the S/G
    - A SGTR exists and RCS/containment pressure is less than or can be lowered to less than S/G pressure, if backflow to the RCS from the S/Gs is desired.

C. Termination/Throttling Criteria:

1. Termination of this action should be considered if either:
    - S/G level is greater than 30 inches
    - Backflow into the RCS is ineffective.

D. Concurrent Actions:

1. None.

E. Equipment Required:

> **-NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

1. One of the following sets of equipment:
    - Auxiliary Feedwater System
        - At least one AFW Pump
        - Source of makeup water
    - Main Feedwater System (unavailable if SIAS, SGIS or CSAS actuated unless bypassed, blocked or overridden):
        - At least one SGFP(except for Condensate Booster Pump Injection)
        - At least two Condensate Pumps (only one required for Condensate Booster Pump Injection)
        - At least one Condensate Booster Pump
        - Source of makeup water

9.F. Cautions:

1. None.

G. Expected Plant Response:

1. Increase in containment sump level.

H. Conflicts with EOPs:

1. None.

I. Consistency with EOPs:

1. None.

J. Recommended Actions:

1. Recommend one or more of the following actions to the Control Room:
   - Verify CST availability and establish feedflow using Auxiliary Feedwater (Refer to EOP-8, HR series).
   - Verify CST availability and establish Feedwater flow using the other Unit's electric-driven AFW pump (Refer to EOP-8, HR series).
   - Establish feed flow using Main Feedwater (Refer to EOP-8, HR series).
   - Establish feed flow using Condensate Booster Pump Injection (Refer to EOP-8, HR series). Steam Generator pressure must be less than 500 psia for this method to be effective.

10. CHLA 9 - SPRAY DOWN OUTSIDE OF CONTAINMENT

A. Purpose/Benefits:

1. The purpose of this CHLA is to remove heat from containment by cooling the outside walls of the structure.

B. Initiation Criteria:

1. This action should be considered if an additional means of removing heat from containment is desirable.

C. Termination/Throttling Criteria:

1. Termination of this action should be considered if either:
   - The containment is being cooled sufficiently by other means or,
   - The water inventory must be conserved for other uses.

D. Concurrent Actions:

1. None.

E. Equipment Required:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Fire hoses and nozzles.
- Possibly a pumper truck.

F. Cautions:

1. With the core in an ex-vessel condition, dose rates outside the containment can be expected to be significantly higher than normal.

G. Expected Plant Response:

1. Reduction in containment temperature and pressure.

H. Conflicts with EOPs:

1. None.

I. Consistency with EOPs:

1. None.

J. Recommended Actions:

1. Recommend the OSC and the Control Room:
   - Commence spray-down of outside of containment using the fire suppression system and any other means available. The objective is to apply as much water to the outside of the containment as possible.

LIST OF EFFECTIVE PAGES

Cumulative NORMs changes to this revision: 0

PAGE	REVISION	EDITORIAL CORRECTION
1	1	
2	1	
3	1	
4	1	
5	1	
6	1	
7	1	
8	1	
9	1	
10	1	
11	1	
12	1	
13	1	
14	1	
15	1	
16	1	
17	1	
18	1	
19	1	
20	1	
21	1	
22	1	
23	1	
24	1	

ATTACHMENT	REVISION	EDITORIAL CORRECTION

EMERGENCY RESPONSE PLAN IMPLEMENTATION PROCEDURE

REVIEW/APPROVAL

Calvert Cliffs Nuclear Power Plant

Emergency Response Plan Implementation Procedure

SEVERE ACCIDENT MANAGEMENT RESTORATIVE ACTIONS

ERPIP 611

Revision 1

Effective Date: MAR 2 1 2001

Writer: [signature] James C. Kellum — 01/02/01 Date

Reviewer: [signature] Mark T. Finley — 02/26/01 Date

Director - EP: [signature] Anthony J. O'Donnell — 2/28/01 Date

POSRC Mtg. #: 01-019 [signature] (Signature indicates procedure was reviewed according to NS-2-101) — 3-14-01 Date

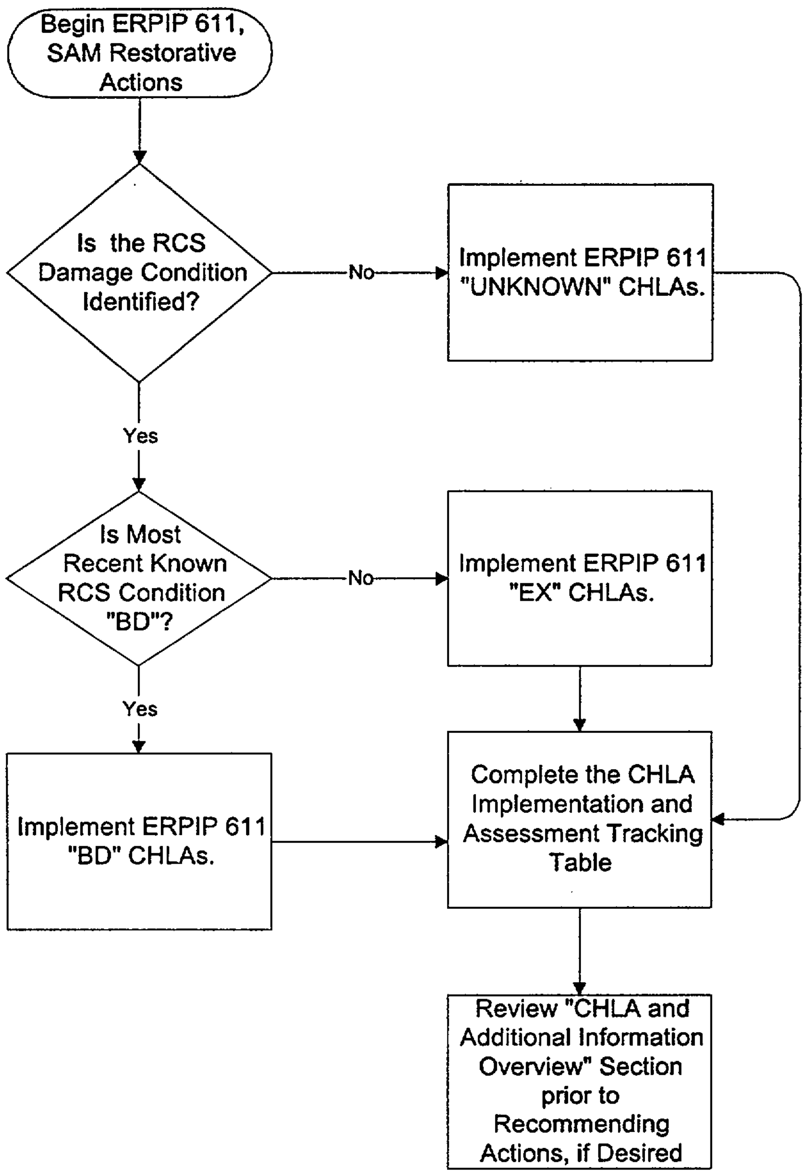
Approved: [signature] Plant General Manager — 3/14/01 Date

Severe Accident Management Restorative Actions

RESPONSIBLE INDIVIDUAL: Reactor Engineer
TSC Analyst
Ops Analyst

CONDITION: Severe Accident

Instructions



Note: If the Plant Condition changes to a reliable matrix SAM diagnosis, GO TO the appropriate ERPIP 603-610.

CHLAs AND ADDITIONAL OVERVIEW
FOR
RCS CONDITION: UNKNOWN

RCS Condition Unknown

CHLA Implementation and Assessment Tracking Table

PRI	CHLA / TIME							
	Inject into the RCS							
	Spray into CNTMT							
	Inject into the S/Gs							
	Depressurize the S/Gs							
	Operate CACs							
	Depressurize the RCS							
	Vent the RCS							
	Operate H_2 Recombiners							
	Restart the RCPs							
	Flood the Reactor Cavity							
	Vent CNTMT							
	Spray the Outside of the CNTMT							
	Spray the Aux Building							
	Flood the Aux Building							

NOTE: The CHLAs are listed in recommended order of implementation. However, the TSC may re-prioritize them depending on plant conditions.

I = In Use to Full Capacity
T = In Use but Throttled
N = Not In Use
N/E = Not Yet Evaluated
A = Available Immediately
P = Available Pending Alternate Power Source or Equipment Lineup
X = Not Available

1. CHLA 1: <u>Inject into the RCS</u>

A. Special Considerations When Protecting the Integrity of the RCS:

- Sudden restoration of flow through the cold leg injection path could cause hot gases in the core to travel to the S/G tubes, possibly causing creep failure.

B. Special Considerations When Protecting the Integrity of the Containment:

- Injecting into the RCS can facilitate cavity flooding once the RCS has reached condition "EX".

C. Equipment Required to Implement CHLA:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- HPSI Pump(s)
- LPSI Pump(s)
- Charging Pump(s)
- Source of water:
    1. RWT
    2. Containment Sump
    3. BASTs
    4. Plant Fire System

D. Recommended Actions:

- Recommend the Control Room perform one or more of the following:
    1. Makeup to the RCS via Safety Injection/Charging Systems (Refer to EOP-8, PIC series).
    2. Initiate CNMNT Sump recirculation (Refer to EOP-8, PIC series).
    3. Commence Hot Leg or Pressurizer Injection. (Refer to EOP-8, PIC series).
    4. Commence backfill to the RCS via a ruptured S/G. (Refer to EOP-8, HR series).
    5. Provide makeup to the SI/CVCS system from alternate water sources (Refer to Attachment 1 of ERPIP 611).
    6. Depressurize the RCS (to enhance makeup, including backflow from a S/G if a SGTR exists).

2. CHLA 2: <u>Spray into the Containment</u>

A. Special Considerations When Protecting the Integrity of the RCS:

- Spraying into the Containment can facilitate flooding the Reactor Cavity and prevent or delay vessel melt-through.

B. Special Considerations When Protecting the Integrity of the Containment:

- Spraying into the containment will scrub fission products from the atmosphere and reduce containment pressure. Use of containment spray should be coordinated with knowledge of the non-condensible gas volume in the containment to avoid undesired deinerting and potential hydrogen detonations.

C. Equipment Required to Implement CHLA:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Containment Spray Pump(s)
- Source of water:
  1. RWT
  2. Containment Sump

D. Recommended Actions:

- Recommend the Control Room initiate containment spray.

3. CHLA 3: <u>Feed the Steam Generators</u>

A. Special Considerations When Protecting the Integrity of the RCS:

- Water injection into the S/Gs will increase heat transfer from the primary side, resulting in RCS depressurization.
- Keeping the secondary side water level above the top of the U-tubes (-59") will provide over-temperature protection for the U-tubes and help preserve RCS integrity.

B. Special Considerations When Protecting the Integrity of the Containment:

- If a SGTR exists, this CHLA will provide inventory for backflow to the RCS. The additional water may be released to the containment as steam through any RCS openings and increase the containment pressure challenge.

C. Equipment Required to Implement CHLA:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- One of the following sets of equipment:
  1. Auxiliary Feedwater System
     - At least one AFW Pump
     - Source of makeup water
  2. Appropriate system lineup. Main Feedwater System (unavailable if SIAS, SGIS or CSAS actuated unless bypassed, blocked or overridden):
     - At least one SGFP (except for Condensate Booster Pump Injection)
     - At least two Condensate Pumps (only one required for Condensate Booster Pump Injection)
     - At least one Condensate Booster Pump
     - Source of makeup water
     - Appropriate system lineup

D. Recommended Actions:

- Recommend the Control Room perform the one or more of the following:
  1. Verify CST availability and establish feed flow using Auxiliary Feedwater. (Refer to EOP-8, HR series).
  2. Verify CST availability and establish feed flow using the other Unit's electric-driven AFW pump. (Refer to EOP-8, HR series).
  3. Establish feed flow using Main Feedwater. (Refer to EOP-8, HR series).
  4. Establish feed flow using Condensate Booster Pump Injection (Steam Generator pressure must be less than 500 psia for this method to be effective). (Refer to EOP-8, HR series).

4. CHLA 4: <u>Depressurize the S/Gs</u>

A. Special Considerations When Protecting the Integrity of the RCS:

- Depressurizing the S/Gs will increase heat transfer from the RCS and reduce primary pressure. This increases the potential for water injection from ESF systems to the RCS.

B. Special Considerations When Protecting the Integrity of the Containment:

- None

C. Equipment Required to Implement CHLA:

> - NOTE -
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

> - NOTE -
> Use of TBVs is preferable to minimize potential offsite radiological doses.

- Turbine Bypass Valves (TBVs)
  1. Electrical power (except for local operation)
  2. Instrument Air System pressure at least 40 psig (except for local operation)
  3. Condenser vacuum at least 22.5 inches Hg. (Unit-1) or 20 inches Hg. (Unit-2) (except for local operation)
  4. Associated system alignment
- Atmospheric Dump Valves
  5. Electrical power (except for local operation)
  6. Instrument Air System or Saltwater Air Compressors (except for local operation)
  7. Associated system alignment

4.D. Recommended Actions:

- Recommend the Control Room perform one or more of the following:
  1. Cooldown the RCS using TBVs Refer to EOP-8, HR series).
  2. Cooldown the RCS using manual operation of the TBVs (Refer to the Alternate Actions of EOP-8, HR series).
  3. Cooldown the RCS using ADVs (Refer to the Alternate Actions of EOP-8, HR series).
     a. IF a SGTR exists, THEN notify the Chemistry Director to determine if ERPIP 810, Main Steam System Radioactivity Release Rate Estimate, needs to be performed.
  4. Cooldown the RCS by aligning the steam drains to the condenser (Refer to the Alternate Actions of EOP-8, HR series).
  5. Cooldown the RCS by draining via S/G Blowdown to the Miscellaneous Waste System (Refer to EOP-8, HR series).

5. CHLA 5: Operate Containment Air Coolers (CACs)

A. Special Considerations When Protecting the Integrity of the RCS:

- None

B. Special Considerations When Protecting the Integrity of the Containment:

- CACs promote mixing of non-condensible gases, thus reducing local high concentration pockets inside containment that could easily detonate.
- CACs will facilitate reduction of containment pressure.
- CACs could provide an ignition source during operation.

C. Equipment Required to Implement CHLA:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Containment Air Cooler(s)
- Service Water

D. Recommended Actions:

- Recommend the Control Room start all available Containment Air Coolers in slow speed with maximum Service Water Flow using OI-5A as guidance. The provisions of 10CFR50.54(x) and (y) should be considered if the conditions of OI-5A cannot be met and operation of the system is deemed essential.

6. CHLA 6: <u>Depressurize the RCS</u>

A. Special Considerations When Protecting the Integrity of the RCS:

- Increases opportunity for injecting water into the RCS from HPSI, LPSI and SITs.
- Depressurization of the RCS can lead to increased injection to the system which can mitigate hot gas natural circulation through the hot legs and surge line and potentially prevent creep failure.

B. Special Considerations When Protecting the Integrity of the Containment:

- Depressurizing the RCS will mitigate a Direct Containment Heating Event upon vessel failure that could challenge containment integrity.
- Depressurizing the RCS reduces S/G tube stress which will mitigate a potential containment boundary failure path.

C. Equipment Required to Implement CHLA:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- PORVs
- Reactor Vessel Head Vent Valves
- Pressurizer Vent Valves

6.D. Recommended Actions:

- Recommend one or more of the following actions to the Control Room:
  1. Depressurize the RCS using PORVs per guidance provided by OI-1G, REACTOR VESSEL HEAD AND PRESSURIZER VENT SYSTEM.
  2. Depressurize the RCS using Reactor Head Vent Valves per guidance provided by OI-1G, REACTOR VESSEL HEAD AND PRESSURIZER VENT SYSTEM.
  3. Depressurize the RCS using Pressurizer Vent Valves per guidance provided by OI-1G, REACTOR VESSEL HEAD AND PRESSURIZER VENT SYSTEM.
  4. Cooldown the RCS using TBVs. (Refer to EOP-8, HR series).
  5. Cooldown the RCS using manual operation of the TBVs. (Refer to the Alternate Actions of EOP-8, HR series).
  6. Cooldown the RCS using ADVs. (Refer to EOP-8, HR series).
     a. IF a SGTR exists, THEN notify the Chemistry Director to determine if ERPIP 810, Main Steam System Radioactivity Release Rate Estimate, needs to be performed.
  7. Cooldown the RCS by aligning the steam drains to the condenser. (Refer to EOP-8, HR series).

7. CHLA 7: Vent the RCS

A. Special Considerations When Protecting the Integrity of the RCS:

- Venting the RCS concurrent with operation of the RCPs can sweep out non-condensible gases trapped in the S/G U-tubes. This will help enable natural or forced circulation of primary coolant and subsequent RCS heat removal.

B. Special Considerations When Protecting the Integrity of the Containment:

- Hydrogen gas vented into containment from the RCS can result in a H_2 burn.

C. Equipment Required to Implement CHLA:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- PORVs
- Reactor Vessel Head Vent Valves
- Pressurizer Vent Valves

D. Recommended Actions:

- Recommend one or more of the following actions to the Control Room:
  1. Depressurize the RCS using PORVs per guidance provided by OI-1G, REACTOR VESSEL HEAD AND PRESSURIZER VENT SYSTEM.
  2. Depressurize the RCS using Reactor Head Vent Valves per guidance provided by OI-1G, REACTOR VESSEL HEAD AND PRESSURIZER VENT SYSTEM.
  3. Depressurize the RCS using Pressurizer Vent Valves per guidance provided by OI-1G, REACTOR VESSEL HEAD AND PRESSURIZER VENT SYSTEM.

8. CHLA 8: Operate Hydrogen Recombiners

A. Special Considerations When Protecting the Integrity of the RCS:

- None

B. Special Considerations When Protecting the Integrity of the Containment:

- Hydrogen Recombiners should not be operated in H_2 environments exceeding 4% by volume, as their potential as an ignition source increases and they can be damaged by the exothermic reaction.

C. Equipment Required to Implement CHLA:

> - NOTE -
>
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Hydrogen Recombiner(s)

D. Recommended Actions:

- Recommend the Control Room start all available Hydrogen Recombiners using OI-41A for guidance. The provisions of 10CFR50.54(x) and (y) should be considered if the conditions of OI-41A cannot be met and operation of the system is deemed essential.

9. CHLA 9: <u>Restart Reactor Coolant Pumps</u>

A. Special Considerations When Protecting the Integrity of the RCS:

- Jogging RCPs can help sweep trapped non-condensible gases from the S/G U-tubes. This will help restore core and RCS heat removal via natural circulation.
- If water exists in the loop seals of the cold legs or at the bottom of the reactor vessel, then restarting RCPs may help to deliver a large amount of water to the core for a short period of time. However, the resulting primary system pressurization may also be sufficient to challenge reactor vessel integrity. (Refer to ERPIP 611, Attachment 5 CA-3a.)

B. Special Considerations When Protecting the Integrity of the Containment:

- If water is available in the S/Gs after the vessel fails, then the RCPs may provide circulation of hot gases (from remaining core materials) to the secondary side. This transfer of energy load away from the containment may extend containment overpressure lifetime.
- If RCPs are jogged, then the trapped hydrogen gas can be swept into containment (via a RCS break or a PORV), possibly resulting in a hydrogen burn in containment.

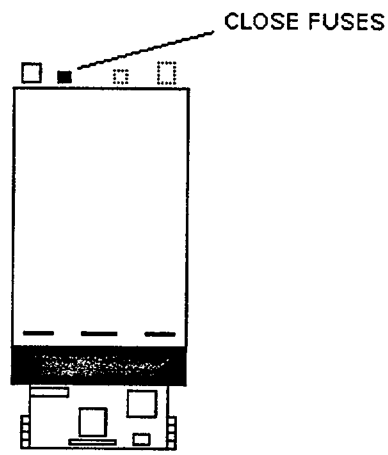
C. Equipment Required to Implement CHLA:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Electrical power to RCPs and auxiliaries.
- RCP auxiliaries.
  1. Component Cooling Water
  2. RCP Controlled Bleed-Off
  3. RCP oil supply/coolers

9.D. Recommended Actions:

- Recommend the Control Room perform the following:
  1. If the RCP restart criteria can be met, restart RCP(s) (Refer to EOP-8, HR series).
  2. If the RCP restart criteria cannot be met and RCP restart is deemed essential, then consider the provisions of 10CFR50.54(x) and (y). If RCP auxiliaries are not available, removing the CLOSE fuses at the RCP breaker will disable all interlocks and allow the RCP breaker to be closed locally if the Control Room handswitch is not in Pull-to-Lock.



RCP BREAKER
(typical)

10. CHLA 10: <u>Flood the Reactor Cavity</u>

A. Special Considerations When Protecting the Integrity of the RCS:

- Flooding the Reactor Cavity may provide external vessel cooling that may prevent vessel melt-through if sufficient water is injected.

  With one RWT injected, the bottom five to six feet of the vessel will be under water. Before vessel melt-through, the debris in the vessel will build up to about the same level. Although the bottom of the vessel is cooled, the region at and above the top of the debris is not cooled and will heat up by radiation from the debris to the vessel side wall. This may lead to a delayed vessel failure for high RCS pressure conditions.

  If the water level in containment can be raised by injecting twice the RWT volume then the debris may be contained in the vessel if the RCS has been depressurized.

B. Special Considerations When Protecting the Integrity of the Containment:

- Flooding the Reactor Cavity will facilitate pool scrubbing of fission products as well as the partial cessation of cavity concrete ablation. However, adding water to the cavity will increase containment steam concentration and result in large increases in containment pressure.

C. Equipment Required to Implement CHLA:

> **- NOTE -**
>
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Containment Spray Pump(s)
- HPSI or LPSI Pump(s)
- Charging Pump(s)
- Source of water:
  1. RWT(s)
  2. BAST(s)
  3. Plant Fire System

D. Recommended Actions:

- Recommend the Control Room perform one or more of the following:
  1. Initiate containment spray per the appropriate CHLA.
  2. Inject into the RCS per the appropriate CHLA.
  3. Depressurize the RCS (to facilitate RCS injection and prevent high pressure melt-through) per the appropriate CHLA.
  4. Provide additional sources of water to raise level in containment to approximately 10 feet (Refer to Attachment 1 of ERPIP 611).

11. CHLA 11: Vent Containment

A. Special Considerations When Protecting the Integrity of the RCS:

- None

B. Special Considerations When Protecting the Integrity of the Containment:

- Venting containment after severe core damage has occurred will lead to radionuclide release.
- Venting containment will likely lower the containment pressure, thus reducing the stress on the containment structure.
- Venting containment may actually increase the probability of a hydrogen burn in containment under certain circumstances (refer to Containment Challenged Calculational Aid ERPIP 611, Attachment 5 CA-7).

C. Equipment Required to Implement CHLA:

> - **NOTE** -
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Hydrogen Purge System

D. Recommended Actions:

- Recommend the Control Room perform the following:
  1. Operate the Hydrogen Purge System using OI-41B as guidance. The provisions of 10CFR50.54(x) and (y) should be considered if the conditions of OI-41B cannot be met and operation of the system is deemed essential.
     a. IF the CNMNT is to be vented, THEN inform the Chemistry Director so release monitoring and dose assessment can be performed per the appropriate ERPIP 800 series procedure.

12. CHLA 12: <u>Spray the Outside of the Containment</u>

A. Special Considerations When Protecting the Integrity of the RCS:

- None

B. Special Considerations When Protecting the Integrity of the Containment:

- Spraying the outside of the containment can provide an alternate means for removing heat from the containment, thus reducing pressure (and stress) on the containment structure.

C. Equipment Required to Implement CHLA:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Fire Suppression System
- Fire hoses and spray nozzles

D. Recommended Actions:

- Recommend the following action to the Control Room:

  1. Commence spray-down of outside of containment using the Fire Suppression System and any other means available. The objective is to apply as such water to the outside of the containment as possible.

13. CHLA 13: Spray the Auxiliary Building

A. Special Considerations When Protecting the Integrity of the RCS:

- None

B. Special Considerations When Protecting the Integrity of the Containment:

- Spraying the Aux. Bldg. can potentially jeopardize the operation of equipment needed for containment isolation and cooling.

C. Equipment Required to Implement CHLA:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Fire Suppression System
- Fire hoses and spray nozzles

D. Recommended Actions:

- Recommend the following actions to the Control Room:
  1. Use fire hoses with spray nozzles to spray down selected areas of the Aux. Bldg.
  2. Closely monitor MWRT level and pump to RCWPS as necessary to prevent overflowing floor drains.

14. CHLA 14: Flood the Auxiliary Building

A. Special Considerations When Protecting the Integrity of the RCS:

- Flooding the Aux Bldg. can compromise the performance of equipment necessary for adequate core cooling.

B. Special Considerations When Protecting the Integrity of the Containment:

- Flooding the Aux Bldg. can potentially jeopardize the operation of equipment needed for containment isolation and cooling.

C. Equipment Required to Implement CHLA:

> - NOTE -
>
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Fire Suppression System
- Fire hoses and spray nozzles

D. Recommended Actions:

- Recommend the Control Room use the fire system or hoses and nozzles as necessary to flood desired areas of the Aux. Bldg.

CHLAs AND ADDITIONAL OVERVIEW
FOR
RCS CONDITION: BD

RCS Condition BD

CHLA Implementation and Assessment Tracking Table

PRI	CHLA / TIME							
	1. Inject into the RCS							
	2. Depressurize the RCS							
	3. Inject into the S/Gs							
	4. Depressurize the S/Gs							
	5. Spray into CNTMT							
	6. Vent the RCS							
	7. Operate CACs							
	8. Restart the RCPs							
	9. Flood the Reactor Cavity							
	10. Operate H_2 Recombiners							
	11. Vent CNTMT							
	12. Spray the Outside of the CNTMT							
	13. Spray the Aux Building							
	14. Flood the Aux Building							

NOTE: The CHLAs are listed in recommended order of implementation. However, the TSC may re-prioritize them depending on plant conditions.

I = In Use to Full Capacity
T = In Use but Throttled
N = Not In Use
N/E = Not Yet Evaluated
A = Available Immediately
P = Available Pending Alternate Power Source or Equipment Lineup
X = Not Available

1. CHLA 1: Inject into the RCS

A. Special Considerations When Protecting the Integrity of the RCS:

- Sudden restoration of flow through the cold leg injection path could cause hot gases in the core to travel to the S/G tubes, possibly causing creep failure.

B. Special Considerations When Protecting the Integrity of the Containment:

- Injecting into the RCS can facilitate cavity flooding once the RCS has reached condition "EX".

C. Equipment Required to Implement CHLA:

> - NOTE -
>
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- HPSI Pump(s)
- LPSI Pump(s)
- Charging Pump(s)
- Source of water:
  1. RWT
  2. Containment Sump
  3. BASTs
  4. Plant Fire System

D. Recommended Actions:

- Recommend the Control Room perform one or more of the following:
  1. Makeup to the RCS via Safety Injection/Charging Systems (Refer to EOP-8, PIC series).
  2. Initiate CNMNT Sump recirculation (Refer to EOP-8, PIC series).
  3. Commence Hot Leg or Pressuizer Injection. (Refer to EOP-8, PIC series).
  4. Commence backfill to the RCS via a ruptured S/G. (Refer to EOP-8, HR series).
  5. Provide makeup to the SI/CVCS system from alternate water sources (Refer to Attachment 1 of ERPIP 611).
  6. Depressurize the RCS (to enhance makeup, including backflow from a S/G if a SGTR exists).

2. CHLA 2: Depressurize the RCS

A. Special Considerations When Protecting the Integrity of the RCS:

- Increases opportunity for injecting water into the RCS from HPSI, LPSI and SITs.
- Depressurization of the RCS can lead to increased injection to the system which can mitigate hot gas natural circulation through the hot legs and surge line and potentially prevent creep failure.

B. Special Considerations When Protecting the Integrity of the Containment:

- Depressurizing the RCS will mitigate a Direct Containment Heating Event upon vessel failure that could challenge containment integrity.
- Depressurizing the RCS reduces S/G tube stress which will mitigate a potential containment boundary failure path.

C. Equipment Required to Implement CHLA:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- PORVs
- Reactor Vessel Head Vent Valves
- Pressurizer Vent Valves

2.D. Recommended Actions:

- Recommend one or more of the following actions to the Control Room:
  1. Depressurize the RCS using PORVs per guidance provided by OI-1G, REACTOR VESSEL HEAD AND PRESSURIZER VENT SYSTEM.
  2. Depressurize the RCS using Reactor Head Vent Valves per guidance provided by OI-1G, REACTOR VESSEL HEAD AND PRESSURIZER VENT SYSTEM.
  3. Depressurize the RCS using Pressurizer Vent Valves per guidance provided by OI-1G, REACTOR VESSEL HEAD AND PRESSURIZER VENT SYSTEM.
  4. Cooldown the RCS using TBVs. (Refer to EOP-8, HR series).
  5. Cooldown the RCS using manual operation of the TBVs. (Refer to the Alternate Actions of EOP-8, HR series).
  6. Cooldown the RCS using ADVs. (Refer to EOP-8, HR series).
     a. IF a SGTR exists, THEN notify the Chemistry Director to determine if ERPIP 810, Main Steam System Radioactivity Release Rate Estimate, needs to be performed.
  7. Cooldown the RCS by aligning the steam drains to the condenser. (Refer to EOP-8, HR series).

3. CHLA 3: Feed the Steam Generators

A. **Special Considerations When Protecting the Integrity of the RCS:**

- Water injection into the S/Gs will increase heat transfer from the primary side, resulting in RCS depressurization.
- Keeping the secondary side water level above the top of the U-tubes (-59") will provide over-temperature protection for the U-tubes and help preserve RCS integrity.

B. **Special Considerations When Protecting the Integrity of the Containment:**

- If a SGTR exists, this CHLA will provide inventory for backflow to the RCS. The additional water may be released to the containment as steam through any RCS openings and increase the containment pressure challenge.

C. **Equipment Required to Implement CHLA:**

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- One of the following sets of equipment:
  1. Auxiliary Feedwater System
     - At least one AFW Pump
     - Source of makeup water
  2. Appropriate system lineup. Main Feedwater System (unavailable if SIAS, SGIS or CSAS actuated unless bypassed, blocked or overridden):
     - At least one SGFP (except for Condensate Booster Pump Injection)
     - At least two Condensate Pumps (only one required for Condensate Booster Pump Injection)
     - At least one Condensate Booster Pump
     - Source of makeup water
     - Appropriate system lineup

D. **Recommended Actions:**

- Recommend the Control Room perform the one or more of the following:
  1. Verify CST availability and establish feed flow using Auxiliary Feedwater. (Refer to EOP-8, HR series).
  2. Verify CST availability and establish feed flow using the other Unit's electric-driven AFW pump. (Refer to EOP-8, HR series).
  3. Establish feed flow using Main Feedwater. (Refer to EOP-8, HR series).
  4. Establish feed flow using Condensate Booster Pump Injection (Steam Generator pressure must be less than 500 psia for this method to be effective). (Refer to EOP-8, HR series).

4. **CHLA 4: Depressurize the S/Gs**

A. Special Considerations When Protecting the Integrity of the RCS:

- Depressurizing the S/Gs will increase heat transfer from the RCS and reduce primary pressure. This increases the potential for water injection from ESF systems to the RCS.

B. Special Considerations When Protecting the Integrity of the Containment:

- None

C. Equipment Required to Implement CHLA:

> - **NOTE** -
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

> - **NOTE** -
> Use of TBVs is preferable to minimize potential offsite radiological doses.

- Turbine Bypass Valves (TBVs)
  1. Electrical power (except for local operation)
  2. Instrument Air System pressure at least 40 psig (except for local operation)
  3. Condenser vacuum at least 22.5 inches Hg. (Unit-1) or 20 inches Hg. (Unit-2) (except for local operation)
  4. Associated system alignment
- Atmospheric Dump Valves
  5. Electrical power (except for local operation)
  6. Instrument Air System or Saltwater Air Compressors (except for local operation)
  7. Associated system alignment

4.D. Recommended Actions:

- Recommend the Control Room perform one or more of the following:
  1. Cooldown the RCS using TBVs Refer to EOP-8, HR series).
  2. Cooldown the RCS using manual operation of the TBVs (Refer to the Alternate Actions of EOP-8, HR series).
  3. Cooldown the RCS using ADVs (Refer to the Alternate Actions of EOP-8, HR series).
     a. IF a SGTR exists, THEN notify the Chemistry Director to determine if ERPIP 810, Main Steam System Radioactivity Release Rate Estimate, needs to be performed.
  4. Cooldown the RCS by aligning the steam drains to the condenser (Refer to the Alternate Actions of EOP-8, HR series).
  5. Cooldown the RCS by draining via S/G Blowdown to the Miscellaneous Waste System (Refer to EOP-8, HR series).

5. CHLA 5: Spray into the Containment

A. Special Considerations When Protecting the Integrity of the RCS:

- Spraying into containment can facilitate flooding the Reactor Cavity and prevent or delay vessel melt-through.

B. Special Considerations When Protecting the Integrity of the Containment:

- Spraying into containment will scrub fission products from the atmosphere and reduce containment pressure. Use of containment spray should be coordinated with knowledge of the non-condensible gas volume in the containment to avoid undesired deinerting and potential hydrogen detonations.

C. Equipment Required to Implement CHLA:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Containment Spray Pump(s)
- Source of water:
  1. RWT
  2. Containment Sump

D. Recommended Actions:

1. Recommend the Control Room initiate containment spray.

6. CHLA 6: Vent the RCS

A. Special Considerations When Protecting the Integrity of the RCS:

- Venting the RCS concurrent with operation of the RCPs can sweep out non-condensible gases trapped in the S/G U-tubes. This will help enable natural or forced circulation of primary coolant and subsequent RCS heat removal.

B. Special Considerations When Protecting the Integrity of the Containment:

- Hydrogen gas vented into the containment from the RCS can result in a H_2 burn.

C. Equipment Required to Implement CHLA:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- PORVs
- Reactor Vessel Head Vent Valves
- Pressurizer Vent Valves

D. Recommended Actions:

- Recommend one or more of the following actions to the Control Room:
  1. Depressurize the RCS using PORVs per guidance provided by OI-1G, REACTOR VESSEL HEAD AND PRESSURIZER VENT SYSTEM.
  2. Depressurize the RCS using Reactor Head Vent Valves per guidance provided by OI-1G, REACTOR VESSEL HEAD AND PRESSURIZER VENT SYSTEM.
  3. Depressurize the RCS using Pressurizer Vent Valves per guidance provided by OI-1G, REACTOR VESSEL HEAD AND PRESSURIZER VENT SYSTEM.

7. CHLA 7: <u>Operate Containment Air Coolers (CACs)</u>

A. Special Considerations When Protecting the Integrity of the RCS:

- None

B. Special Considerations When Protecting the Integrity of the Containment:

- CACs promote mixing of non-condensible gases, thus reducing local high concentration pockets inside containment that could easily detonate.
- CACs will facilitate reduction of containment pressure.
- CACs could provide an ignition source during operation.

C. Equipment Required to Implement CHLA:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Containment Air Cooler(s)
- Service Water

D. Recommended Actions:

- Recommend the Control Room start all available Containment Air Coolers in slow speed with maximum Service Water Flow using OI-5A as guidance. The provisions of 10CFR50.54(x) and (y) should be considered if the conditions of OI-5A cannot be met and operation of the system is deemed essential.

8. CHLA 8: Restart Reactor Coolant Pumps

A. Special Considerations When Protecting the Integrity of the RCS:

- Jogging RCPs can help sweep trapped non-condensible gases from the S/G U-tubes. This will help restore core and RCS heat removal via natural circulation.
- If water exists in the loop seals of the cold legs or at the bottom of the reactor vessel, then restarting RCPs may help to deliver a large amount of water to the core for a short period of time. However, the resulting primary system pressurization may also be sufficient to challenge the reactor vessel integrity. (Refer to ERPIP 611, Attachment 5 CA-3a.)

B. Special Considerations When Protecting the Integrity of the Containment:

- If water is available in the S/Gs after the vessel fails, then the RCPs may provide circulation of hot gases (from remaining core materials) to the secondary side. This transfer of energy load away from the containment may extend containment overpressure lifetime.
- If RCPs are jogged, then the trapped hydrogen gas can be swept into containment (via a RCS break or a PORV), possibly resulting in a hydrogen burn in containment.

C. Equipment Required to Implement CHLA:

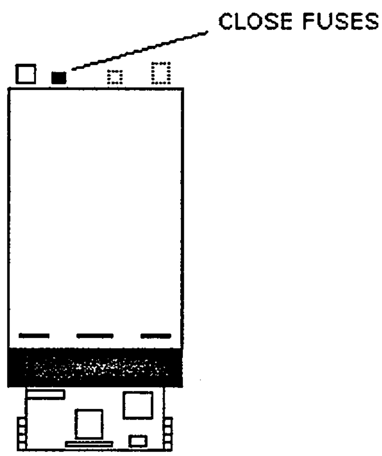
> - NOTE -
>
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Electrical power to RCPs and auxiliaries.
- RCP auxiliaries.

1. Component Cooling Water
2. RCP Controlled Bleed-Off
3. RCP oil supply/coolers

8.D. Recommended Actions:

- Recommend the Control Room perform the following:
  1. If the RCP restart criteria can be met, restart RCP(s). (Refer to EOP-8, HR series).
  2. If the RCP restart criteria cannot be met and RCP restart is deemed essential, then consider the provisions of 10CFR50.54(x) and (y). If RCP auxiliaries are not available, removing the CLOSE fuses at the RCP breaker will disable all interlocks and allow the RCP breaker to be closed locally if the Control Room handswitch is not in Pull-to-Lock.



RCP BREAKER
(typical)

9. CHLA 9: <u>Flood the Reactor Cavity</u>

A. Special Considerations When Protecting the Integrity of the RCS:

- Flooding the Reactor Cavity may provide external vessel cooling that may prevent vessel melt-through if sufficient water is injected.

  With one RWT injected, the bottom five to six feet of the vessel will be under water. Before vessel melt-through, the debris in the vessel will build up to about the same level. Although the bottom of the vessel is cooled, the region at and above the top of the debris is not cooled and will heat up by radiation from the debris to the vessel side wall. This may lead to a delayed vessel failure for high RCS pressure conditions.

  If the water level in the containment can be raised by injecting twice the RWT volume then the debris may be contained in the vessel if the RCS has been depressurized.

B. Special Considerations When Protecting the Integrity of the Containment:

- Flooding the Reactor Cavity will facilitate pool scrubbing of fission products as well as the partial cessation of cavity concrete ablation. However, adding water to the cavity will increase containment steam concentration and result in large increases in containment pressure.

C. Equipment Required to Implement CHLA:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Containment Spray Pump(s)
- HPSI or LPSI Pump(s)
- Charging Pump(s)
- Source of water:
  1. RWT(s)
  2. BAST(s)
  3. Plant Fire System

D. Recommended Actions:

- Recommend the Control Room perform one or more of the following:
  1. Initiate containment spray per the appropriate CHLA.
  2. Inject into the RCS per the appropriate CHLA.
  3. Depressurize the RCS (to facilitate RCS injection and prevent high pressure melt-through) per the appropriate CHLA.
  4. Provide additional sources of water to raise level in containment to approximately 10 feet (refer to Attachment 1 of ERPIP 611).

10. CHLA 10: Operate Hydrogen Recombiners

A. Special Considerations When Protecting the Integrity of the RCS:

- None

B. Special Considerations When Protecting the Integrity of the Containment:

- Hydrogen Recombiners should not be operated in H_2 environments exceeding 4% by volume, as their potential as an ignition source increases and they could be damaged by the exothermic reaction.

C. Equipment Required to Implement CHLA:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Hydrogen Recombiner(s)

D. Recommended Actions:

- Recommend the Control Room start all available Hydrogen Recombiners using OI-41A for guidance. The provisions of 10CFR50.54(x) and (y) should be considered if the conditions of OI-41A cannot be met and operation of the system is deemed essential.

11. CHLA 11: Vent Containment

A. Special Considerations When Protecting the Integrity of the RCS:

- None

B. Special Considerations When Protecting the Integrity of the Containment:

- Venting containment after severe core damage has occurred will lead to radionuclide release.
- Venting containment will likely lower the containment pressure, thus reducing the stress on the containment structure.
- Venting containment may actually increase the probability of a hydrogen burn in containment under certain circumstances (refer to Containment Challenged Calculational Aid ERPIP 611, Attachment 5 CA-7).

C. Equipment Required to Implement CHLA:

> - **NOTE** -
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Hydrogen Purge System

D. Recommended Actions:

- Recommend the Control Room perform the following:
  1. Operate the Hydrogen Purge System using OI-41B as guidance. The provisions of 10CFR50.54(x) and (y) should be considered if the conditions of OI-41B cannot be met and operation of the system is deemed essential.
     a. IF the CNMNT is to be vented, THEN inform the Chemistry Director so release monitoring and dose assessment can be performed per the appropriate ERPIP 800 series procedure.

12. CHLA 12: Spray the Outside of the Containment

A. Special Considerations When Protecting the Integrity of the RCS:

- None

B. Special Considerations When Protecting the Integrity of the Containment:

- Spraying the outside of the containment can provide an alternate means for removing heat from the containment, thus reducing pressure (and stress) on the containment structure.

C. Equipment Required to Implement CHLA:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Fire Suppression System
- Fire hoses and spray nozzles

D. Recommended Actions:

- Recommend the following action to the Control Room:
  1. Commence spray-down of outside of containment using the Fire Suppression System and any other means available. The objective is to apply as such water to the outside of the containment as possible.

13. CHLA 13: Spray the Auxiliary Building

A. Special Considerations When Protecting the Integrity of the RCS:

- None

B. Special Considerations When Protecting the Integrity of the Containment:

- Spraying the Aux. Bldg. can potentially jeopardize the operation of equipment needed for containment isolation and cooling.

C. Equipment Required to Implement CHLA:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Fire Suppression System
- Fire hoses and spray nozzles

D. Recommended Actions:

- Recommend the following actions to the Control Room:
  1. Use fire hoses with spray nozzles to spray down selected areas of the Aux. Bldg.
  2. Closely monitor MWRT level and pump to RCWPS as necessary to prevent overflowing floor drains.

14. CHLA 14: Flood the Auxiliary Building

A. Special Considerations When Protecting the Integrity of the RCS:

- Flooding the Aux Bldg. can compromise the performance of equipment necessary for adequate core cooling.

B. Special Considerations When Protecting the Integrity of the Containment:

- Flooding the Aux Bldg. can potentially jeopardize the operation of equipment needed for containment isolation and cooling.

C. Equipment Required to Implement CHLA:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Fire Suppression System
- Fire hoses and spray nozzles

D. Recommended Actions:

- Recommend the Control Room use the fire system or hoses and nozzles as necessary to flood desired areas of the Aux. Bldg.

CHLAs AND ADDITIONAL OVERVIEW

FOR

RCS CONDITION: EX

RCS Condition EX

CHLA Implementation and Assessment Tracking Table

PRI	CHLA / TIME							
	Spray into CNTMT							
	Inject into RCS/ Flood Rx Cavity							
	Operate CACs							
	Operate H_2 Recombiners							
	Inject into the S/Gs							
	Spray the Outside of the CNTMT							
	Vent CNTMT							
	Spray the Aux Building							
	Flood the Aux Building							

NOTE: The CHLAs are listed in recommended order of implementation. However, the TSC may re-prioritize them depending on plant conditions.

I = In Use to Full Capacity
T = In Use but Throttled
N = Not In Use
N/E = Not Yet Evaluated
A = Available Immediately
P = Available Pending Alternate Power Source or Equipment Lineup
X = Not Available

1. CHLA 1: <u>Spray into the Containment</u>

A. **Special Considerations When Protecting the Integrity of the RCS:**

- None.

B. **Special Considerations When Protecting the Integrity of the Containment:**

- Spraying into the containment will scrub fission products from the atmosphere and reduce containment pressure. Use of containment spray should be coordinated with knowledge of the non-condensible gas volume in the containment to avoid undesired deinerting and potential hydrogen detonations.

C. **Equipment Required to Implement CHLA:**

> - **NOTE** -
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Containment Spray Pump(s)
- Source of water:
  1. RWT
  2. Containment Sump

D. **Recommended Actions:**

1. Recommend the Control Room initiate containment spray.

2. CHLA 2: Inject into the RCS/Flood Reactor Cavity

A. Special Considerations When Protecting the Integrity of the RCS:

- Injection into the RCS will provide cooling to any debris remaining in the vessel. Water not vaporized will drain through the failed vessel and provide cooling to debris in the reactor cavity.

B. Special Considerations When Protecting the Integrity of the Containment:

- Rapid pressurization of the containment due to steam generation and production of hydrogen may challenge containment integrity. (Refer to ERPIP 611, Attachment 5 CA-7.)

C. Equipment Required to Implement CHLA:

> - **NOTE** -
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- HPSI Pump(s)
- LPSI Pump(s)
- Charging Pump(s)
- Source of water:
  1. RWT
  2. Containment Sump
  3. BASTs
  4. Plant Fire System

D. Recommended Actions:

- Recommend the Control Room perform one or more of the following:
  1. Initiate containment spray.
  2. Makeup to the RCS via Safety Injection/Charging Systems (Refer to EOP-8, PIC series).
  3. Initiate CNMNT Sump recirculation (Refer to EOP-8, PIC series).
  4. Commence Hot Leg or Pressurizer Injection. (Refer to EOP-8, PIC series).
  5. Commence backfill to the RCS via a ruptured S/G. (Refer to EOP-8, HR series).
  6. Provide makeup to the SI/CVCS system from alternate water sources (Refer to Attachment 1 of ERPIP 611).
  7. Depressurize the RCS (to enhance makeup, including backflow from a S/G if a SGTR exists).

3. CHLA 3: Operate Containment Air Coolers (CACs)

A. Special Considerations When Protecting the Integrity of the RCS:

- None

B. Special Considerations When Protecting the Integrity of the Containment:

- CACs promote mixing of non-condensible gases, thus reducing local high concentration pockets inside containment that could easily detonate.
- CACs will facilitate reduction of containment pressure.
- CACs could provide an ignition source during operation.

C. Equipment Required to Implement CHLA:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Containment Air Cooler(s)
- Service Water

D. Recommended Actions:

- Recommend the Control Room start all available Containment Air Coolers in slow speed with maximum Service Water Flow using OI-5A as guidance. The provisions of 10CFR50.54(x) and (y) should be considered if the conditions of OI-5A cannot be met and operation of the system is deemed essential.

4. CHLA 4: Operate Hydrogen Recombiners

A. Special Considerations When Protecting the Integrity of the RCS:

- None

B. Special Considerations When Protecting the Integrity of the Containment:

- Hydrogen Recombiners should not be operated in H_2 environments exceeding 4% by volume, as their potential as an ignition source increases and they could be damaged by the exothermic reaction.

C. Equipment Required to Implement CHLA:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Hydrogen Recombiner(s)

D. Recommended Actions:

- Recommend the Control Room start all available Hydrogen Recombiners using OI-41A for guidance. The provisions of 10CFR50.54(x) and (y) should be considered if the conditions of OI-41A cannot be met and operation of the system is deemed essential.

5. CHLA 5: <u>Feed the Steam Generators</u>

A. Special Considerations When Protecting the Integrity of the RCS:

- None.

B. Special Considerations When Protecting the Integrity of the Containment:

- If a SGTR exists, this CHLA will provide inventory for backflow to the RCS. The additional water may be released to the containment as steam through any RCS openings or out the bottom of the vessel onto the corium in the reactor cavity and increase the containment pressure challenge.

C. Equipment Required to Implement CHLA:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration

- One of the following sets of equipment:
  1. Auxiliary Feedwater System
     - At least one AFW Pump
     - Source of makeup water
  2. Appropriate system lineup. Main Feedwater System (unavailable if SIAS, SGIS or CSAS actuated unless bypassed, blocked or overridden):
     - At least one SGFP (except for Condensate Booster Pump Injection)
     - At least two Condensate Pumps (only one required for Condensate Booster Pump Injection)
     - At least one Condensate Booster Pump
     - Source of makeup water
     - Appropriate system lineup

D. Recommended Actions:

- Recommend the Control Room perform the one or more of the following:
  1. Verify CST availability and establish feed flow using Auxiliary Feedwater. (Refer to EOP-8, HR series).
  2. Verify CST availability and establish feed flow using the other Unit's electric-driven AFW pump. (Refer to EOP-8, HR series).
  3. Establish feed flow using Main Feedwater. (Refer to EOP-8, HR series).
  4. Establish feed flow using Condensate Booster Pump Injection (Steam Generator pressure must be less than 500 psia for this method to be effective). (Refer to EOP-8, HR series).

6. CHLA 6: <u>Spray the Outside of the Containment</u>

A. **Special Considerations When Protecting the Integrity of the RCS:**

- None

B. **Special Considerations When Protecting the Integrity of the Containment:**

- Spraying the outside of containment can provide an alternate means for removing heat from the containment, thus reducing pressure (and stress) on the containment structure.

C. **Equipment Required to Implement CHLA:**

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Fire Suppression System
- Fire hoses and spray nozzles

D. **Recommended Actions:**

- Recommend the following action to the Control Room:

1. Commence spray-down of outside of containment using the Fire Suppression System and any other means available. The objective is to apply as much water to the outside of the containment as possible.

7. CHLA 7: Vent Containment

A. Special Considerations When Protecting the Integrity of the RCS:

- None

B. Special Considerations When Protecting the Integrity of the Containment:

- Venting containment after severe core damage has occurred will lead to radionuclide release.
- Venting containment will likely lower the containment pressure, thus reducing the stress on the containment structure.
- Venting containment may actually increase the probability of a hydrogen burn in containment under certain circumstances (refer to Containment Challenged Calculational Aid ERPIP 611, Attachment 5 CA-7).

C. Equipment Required to Implement CHLA:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Hydrogen Purge System

D. Recommended Actions:

- Recommend the Control Room perform the following:
  1. Operate the Hydrogen Purge System using OI-41B as guidance. The provisions of 10CFR50.54(x) and (y) should be considered if the conditions of OI-41B cannot be met and operation of the system is deemed essential.
     a. IF the CNMNT is to be vented, THEN inform the Chemistry Director so release monitoring and dose assessment can be performed per the appropriate ERPIP 800 series procedure.

8. CHLA 8: Spray the Auxiliary Building

A. Special Considerations When Protecting the Integrity of the RCS:

- None

B. Special Considerations When Protecting the Integrity of the Containment:

- Spraying the Aux. Bldg. can potentially jeopardize the operation of equipment needed for containment isolation and cooling.

C. Equipment Required to Implement CHLA:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Fire Suppression System
- Fire hoses and spray nozzles

D. Recommended Actions:

- Recommend the following actions to the Control Room:
  1. Use fire hoses with spray nozzles to spray down selected areas of the Aux. Bldg.
  2. Closely monitor MWRT level and pump to RCWPS as necessary to prevent overflowing floor drains.

9. CHLA 9: Flood the Auxiliary Building

A. Special Considerations When Protecting the Integrity of the RCS:

- None.

B. Special Considerations When Protecting the Integrity of the Containment:

- Flooding the Aux Bldg. can potentially jeopardize the operation of equipment needed for containment isolation and cooling.

C. Equipment Required to Implement CHLA:

> **- NOTE -**
> If use of an essential component or system is precluded by lack of power and/or interlocks/trips and normal restoration methods have not been successful, then refer to Attachments 2 and 3 of ERPIP 611 for additional possibilities for restoration.

- Fire Suppression System
- Fire hoses and spray nozzles

D. Recommended Actions:

- Recommend the Control Room use the fire system or hoses and nozzles as necessary to flood desired areas of the Aux. Bldg.

1. DISCUSSION

A. Two alternate sources of water to be considered for the affected Unit's RCS and Containment are the unaffected Unit's RWT and the Spent Fuel Pool. The use of either of these systems would require specialized system lineups and procedures for those lineups and would likely require application of the provisions of 10CFR50.54(x) and (y).

B. If the Safety Injection Pumps and/or the Containment Spray pumps for the affected Unit are unavailable, it is possible to use the corresponding pumps from the unaffected unit. Again, the use of these systems would require specialized system lineups and procedures and would likely require application of the provisions of 10CFR50.54(x) and (y).

C. Figures 1-19 of this attachment illustrate possible flowpaths for the altermate water sources mentioned above. These figures are for illustrative purposes only. When developing procedures based on these attachments always use the latest controlled copies of plant drawings and approved procedures for performing plant operations. The plant drawings used to develop Figures 1-19 are:

1. OM-58 (60-716) Spent Fuel Pool Cooling, Pool Fill & Drain Systems.

2. OM-74 (60-731) Unit-1 Safety Injection & Containment Spray Systems.

3. OM-462 (62-731) Unit 2 Safety Injection & Containment Spray Systems.

4. OM-800 (60-583-E) Unit 1 Auxiliary Feedwater System.

5. OM-801 (62-583-E) Unit 2 Auxiliary Feedwater System.

D. Figures 9 & 10 and 18 & 19 cross connect the SI System and the AFW System.

E. Additional water can be supplied through the Spent Fuel Pools by use of the plant fire system and fire hoses to add water to the Spent Fuel Pools. Because this is unborated water, consideration should be given to adding boric acid to the Spent Fuel Pool if fire system water is used, possibly by manually dumping bags of boric acid directly into the Pools.

F. The Plant Fire System can be used to provide water to the S/Gs through the AFW system via a siamese hose connection as follows: (Use current AFW System drawing for actual valve alignments.)

1. Isolate and drain (depressurize) 13 (23) AFW Pump.

2. Remove 13 (23) AFW Pump Auto Recirc Valve.

3. Install the AFW System Spool Piece (spool piece is located in the Safe Shutdown Repair Locker in the Fire Pump House).

1.F.4. Connect fire hoses to stations, run both hoses through the Service Water Pump Room watertight double doors, and connect the hoses to the siamese connection installed in the AFW System.

5. Close AFW Pump Drain Valves, then pressurize the fire hoses.

6. Open ADVs to depressurize S/Gs and lower S/G level to approximately -350 inches, then via the AFW system feed the S/G using the fire system.

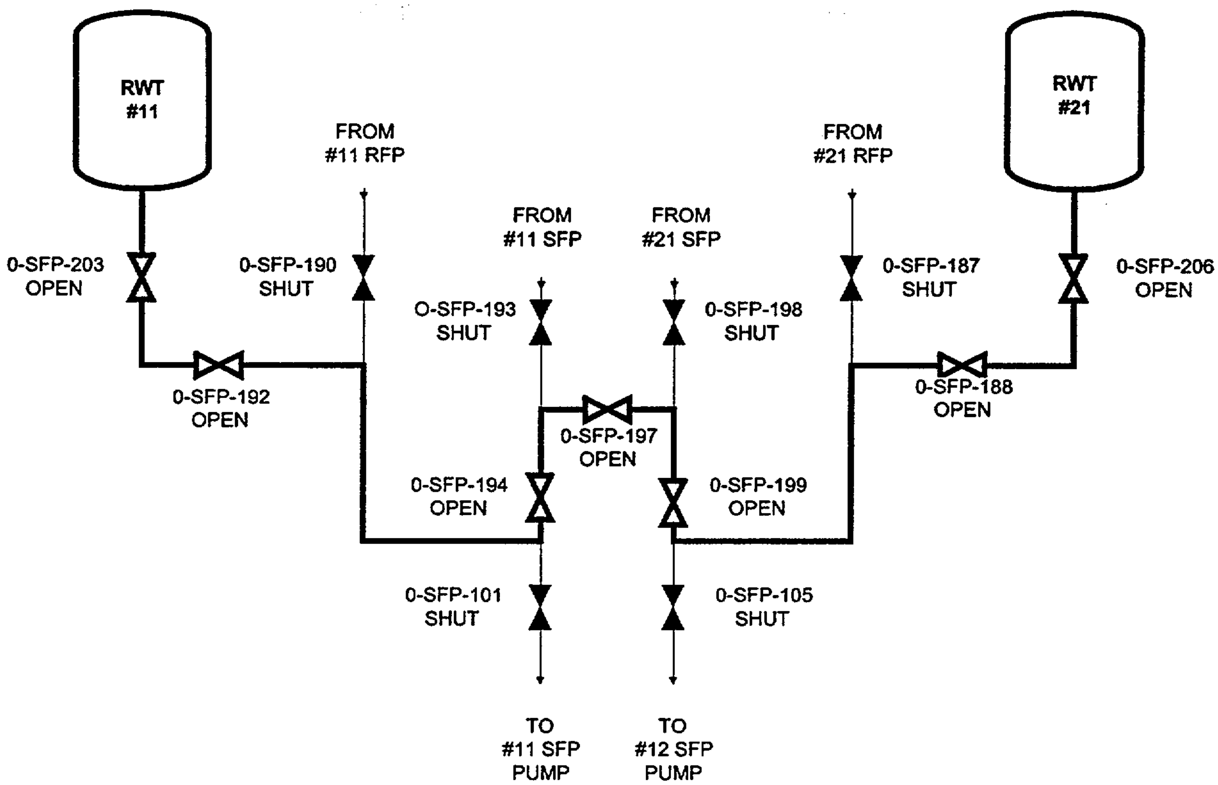
G. If the protected area plant fire system is unavailable, the plant fire system outside the protected area can be cross-connected to it through valve 0-FP-557. Refer to drawing OM-56 (60-714) Plant Fire Protection System. This provides an additional motor-driven and diesel engine-driven pump along with an additional storage tank capacity of 200,000 gallons of unborated water.

2. INDEX OF FIGURES: ALTERNATE WATER SOURCES

Either Unit Affected

Unit - 1 Affected

Unit -2 Affected



<u>NOTE</u>

This is an alternate lineup to OI-24 H

FIGURE 1
GRAVITY TRANSFER OF RWTs THROUGH SFP SYSTEM
(EITHER UNIT AFFECTED)

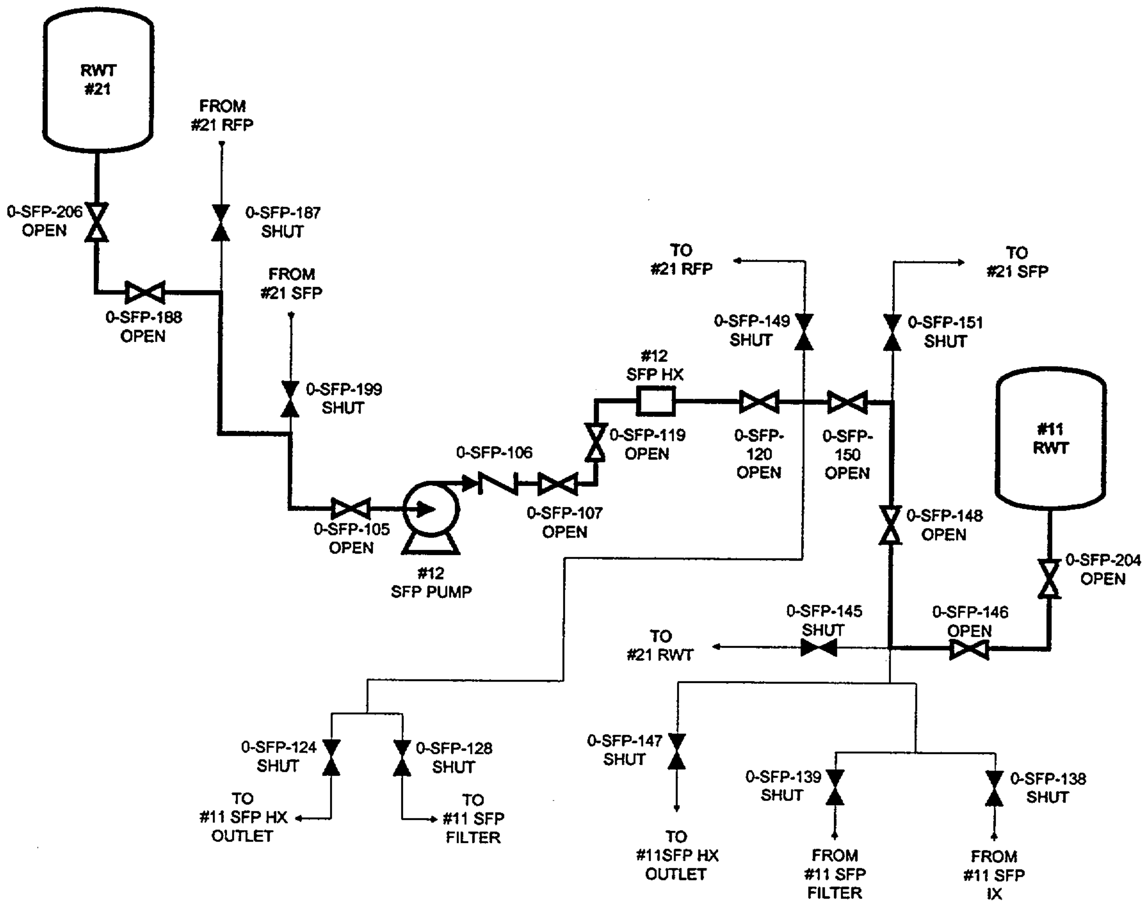


FIGURE 2
PUMPING UNIT 2 RWT TO UNIT-1 RWT WITH #12 SFP PUMP
(UNIT-1 AFFECTED)

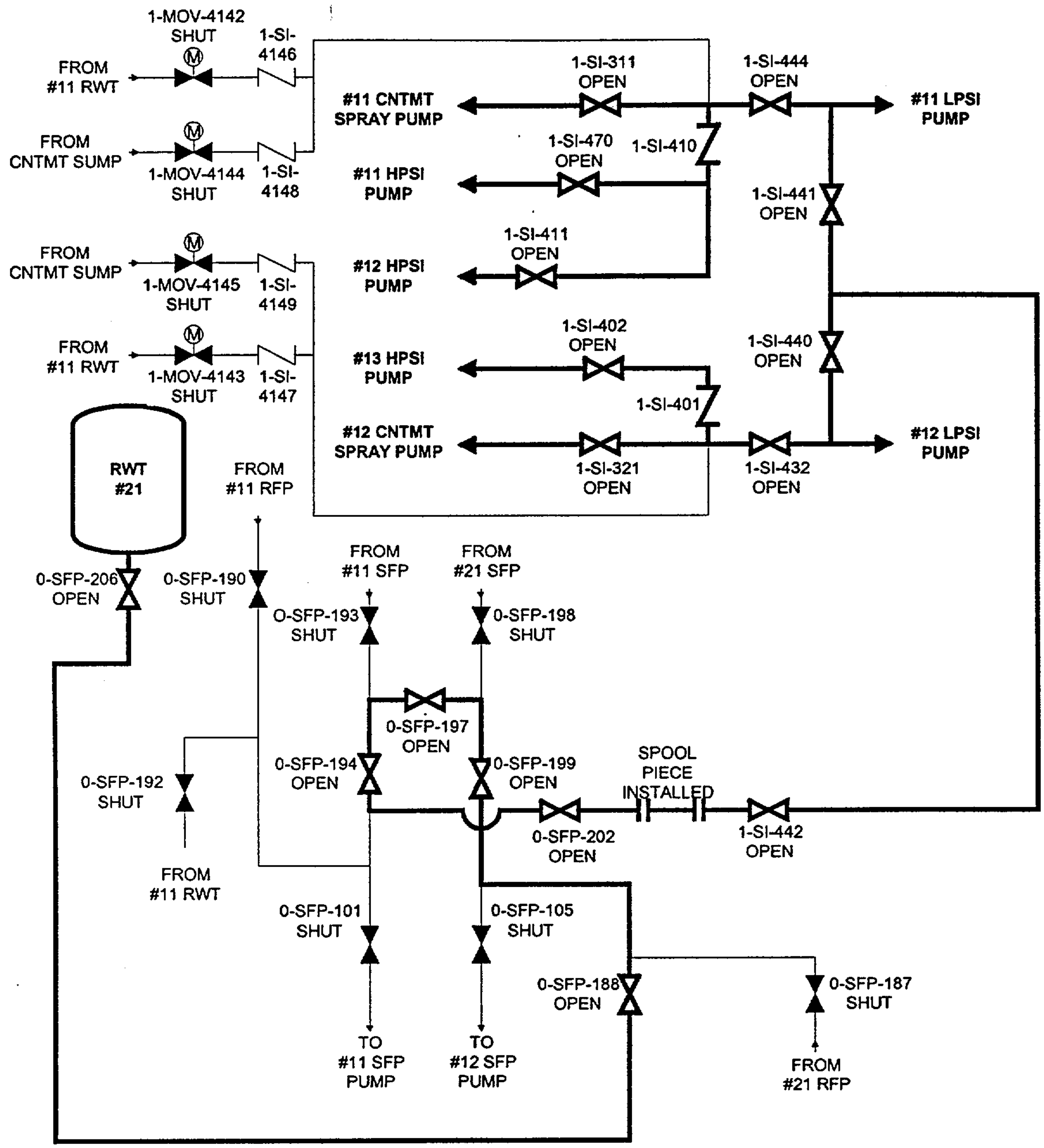


FIGURE 3
UNIT-2 RWT SUPPLYING UNIT-1 SI AND CS PUMPS
(UNIT-1 AFFECTED)

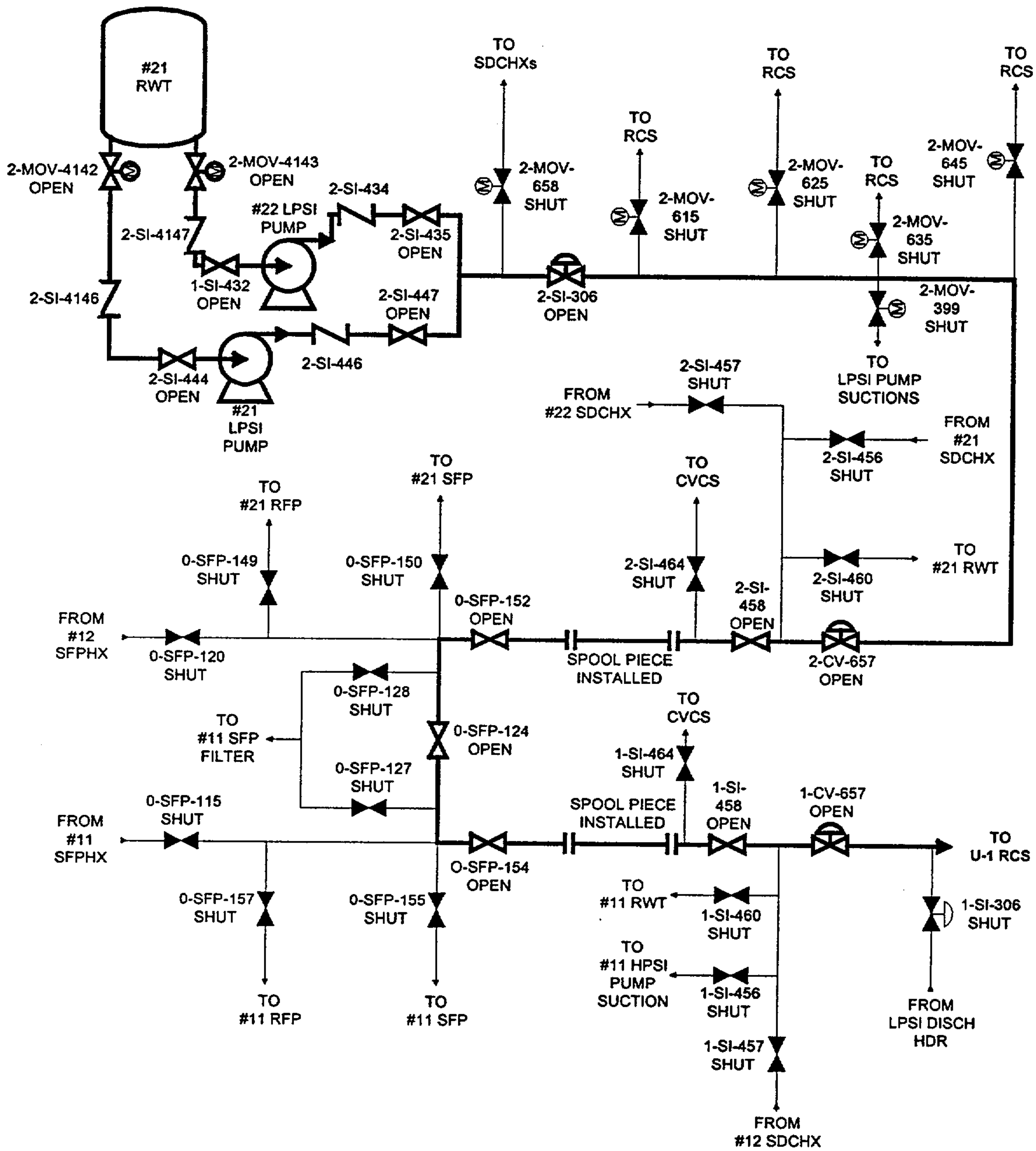


FIGURE 4
#21 (22) LPSI PUMP SUPPLYING UNIT-1 RCS FROM #21 RWT
(UNIT-1 AFFECTED)

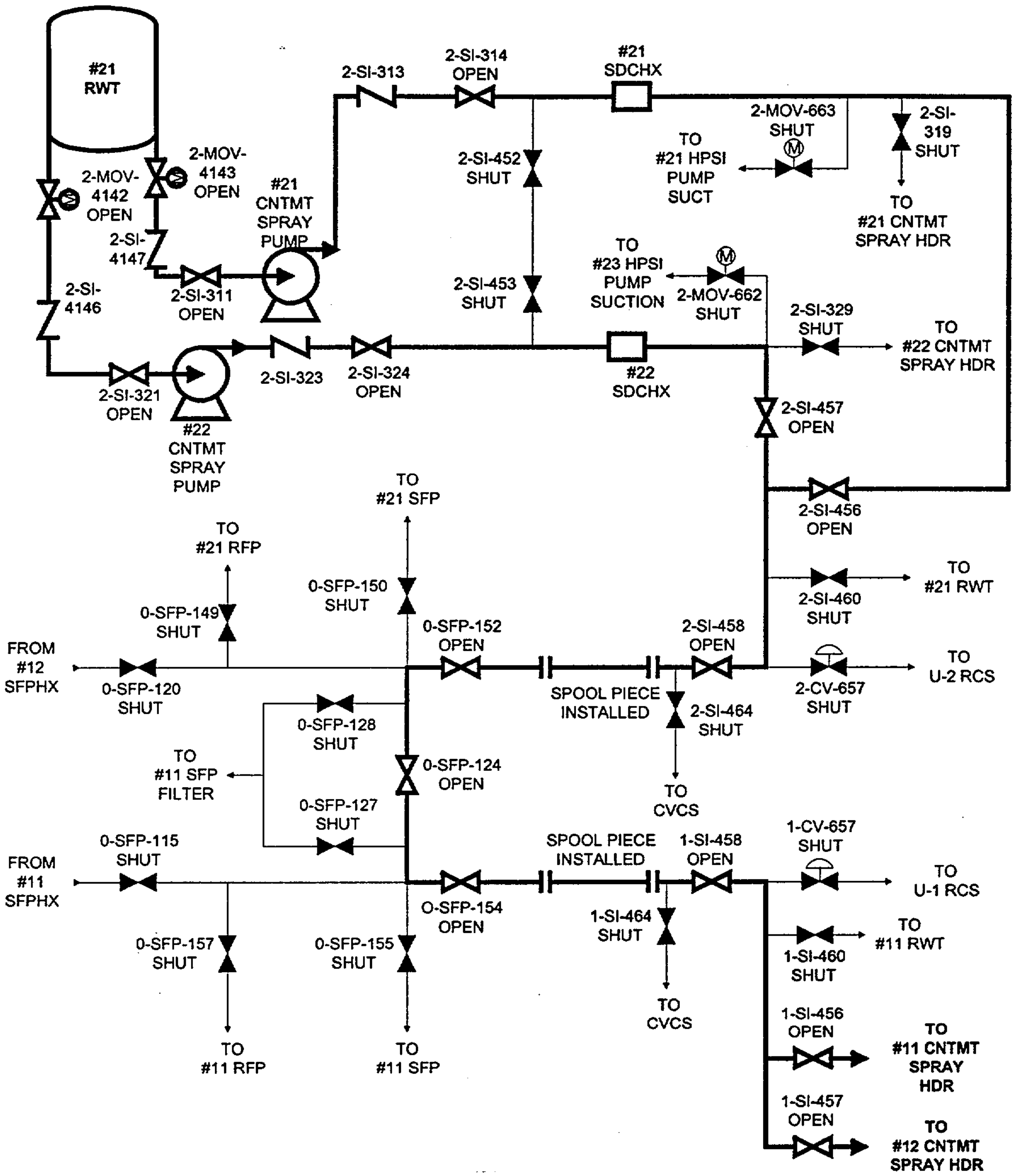


FIGURE 5
#21 (22) CS PUMP SUPPLYING UNIT-1 CNTMT FROM #21 RWT
(UNIT-1 AFFECTED)

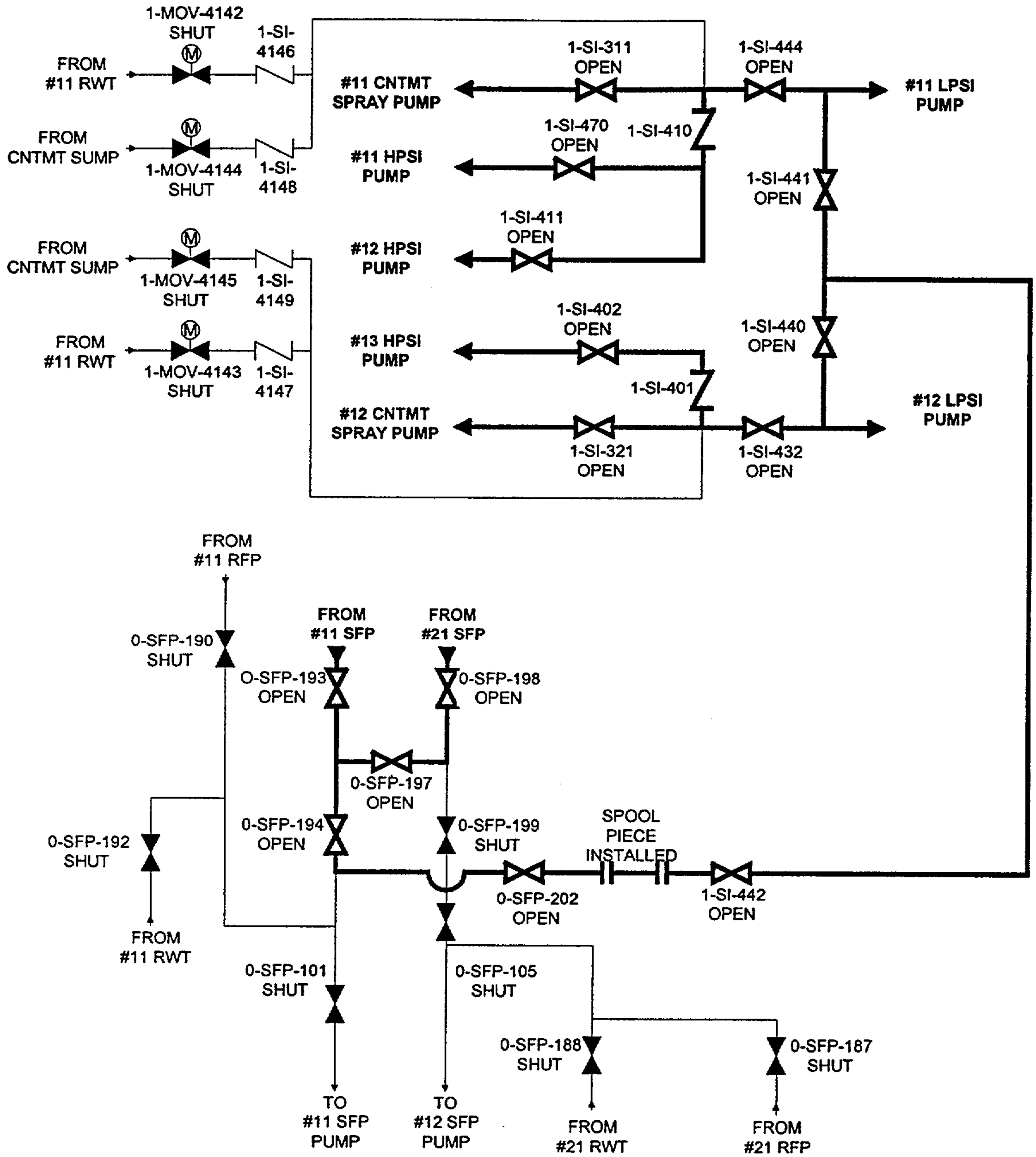


FIGURE 6
11 AND 21 SFPs SUPPLYING UNIT-1 SI AND CS PUMPS
(UNIT-1 AFFECTED)

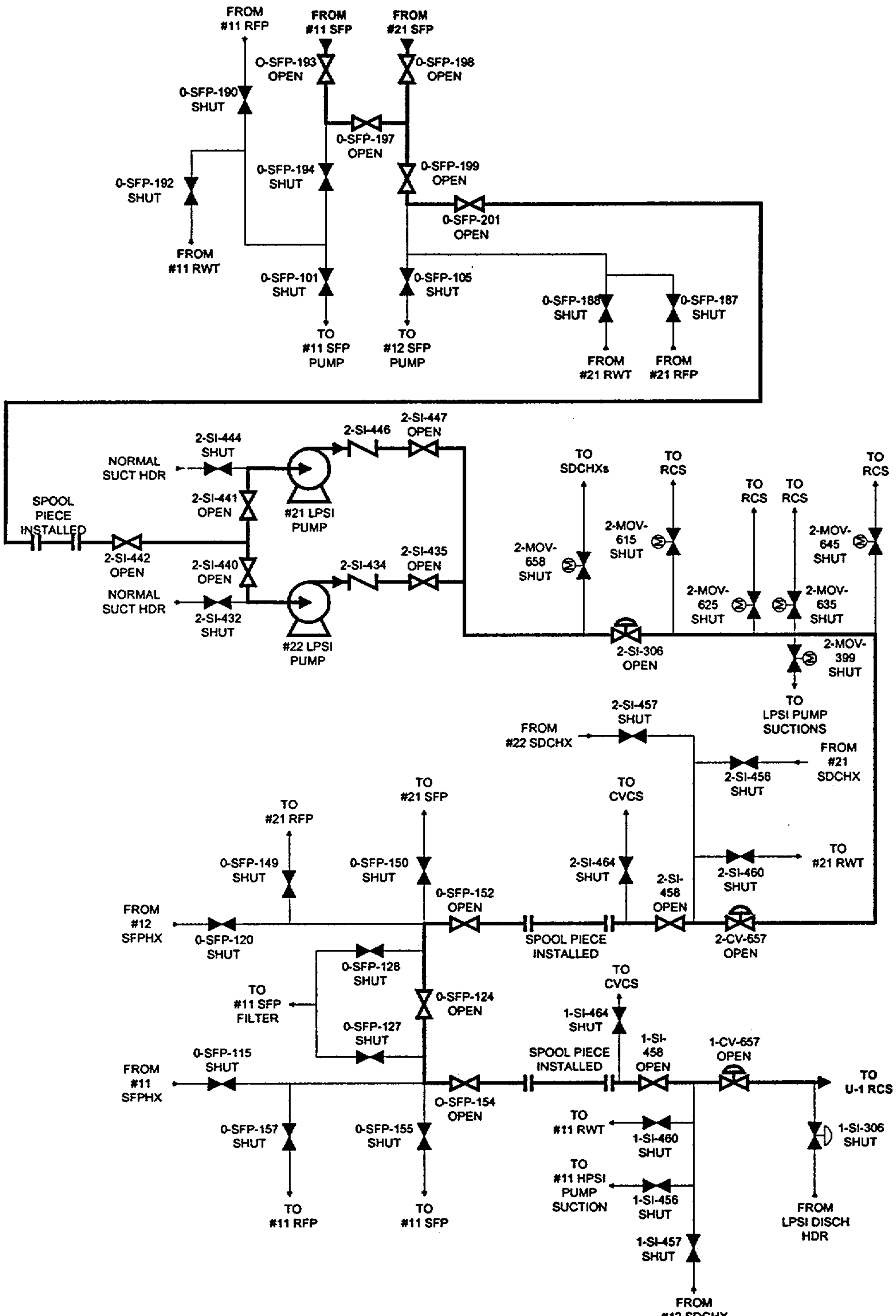


FIGURE 7
#21 (22) LPSI PUMP SUPPLYING UNIT-1 RCS FROM 11/21 SFPs
(UNIT-1 AFFECTED)

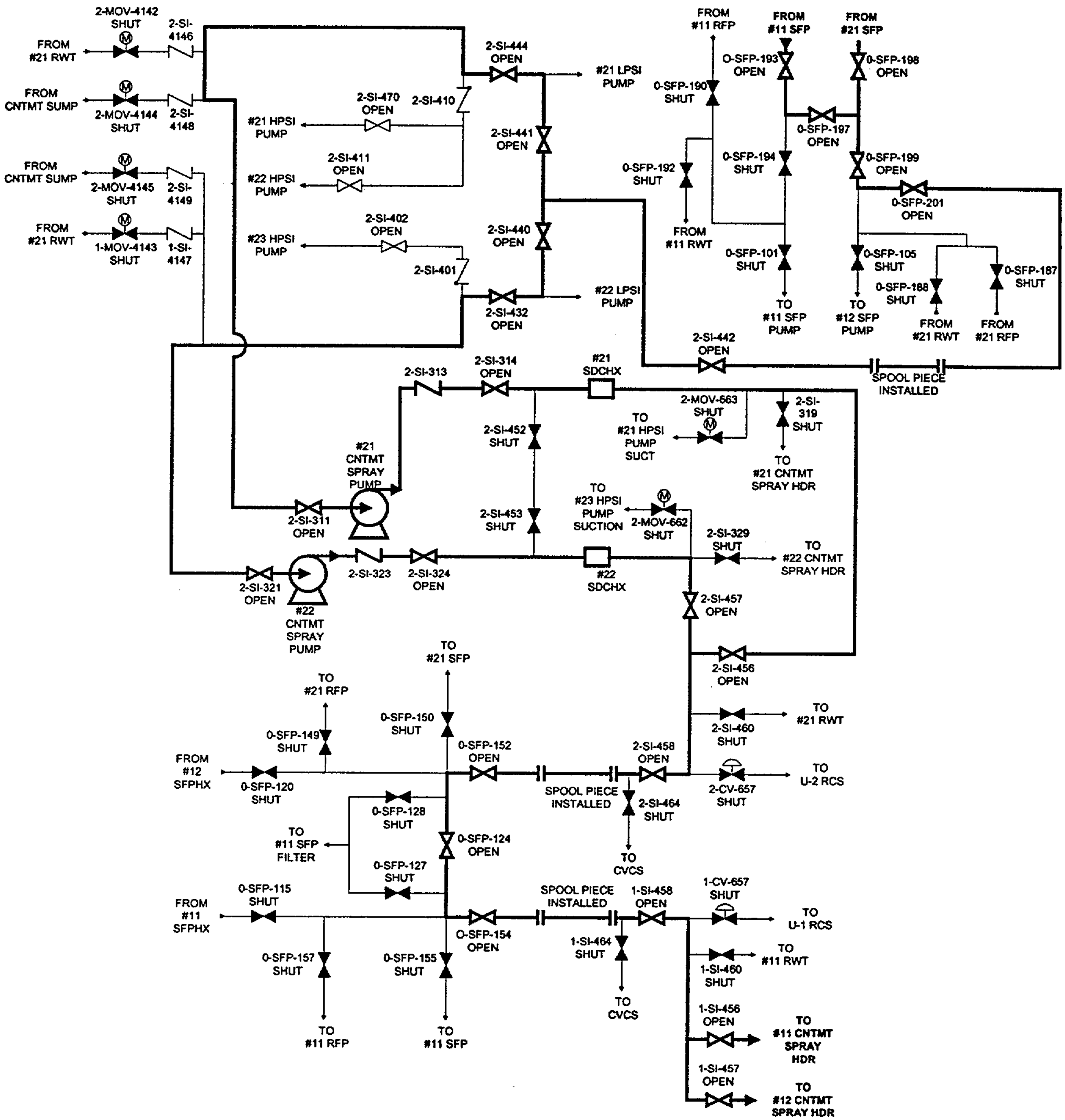
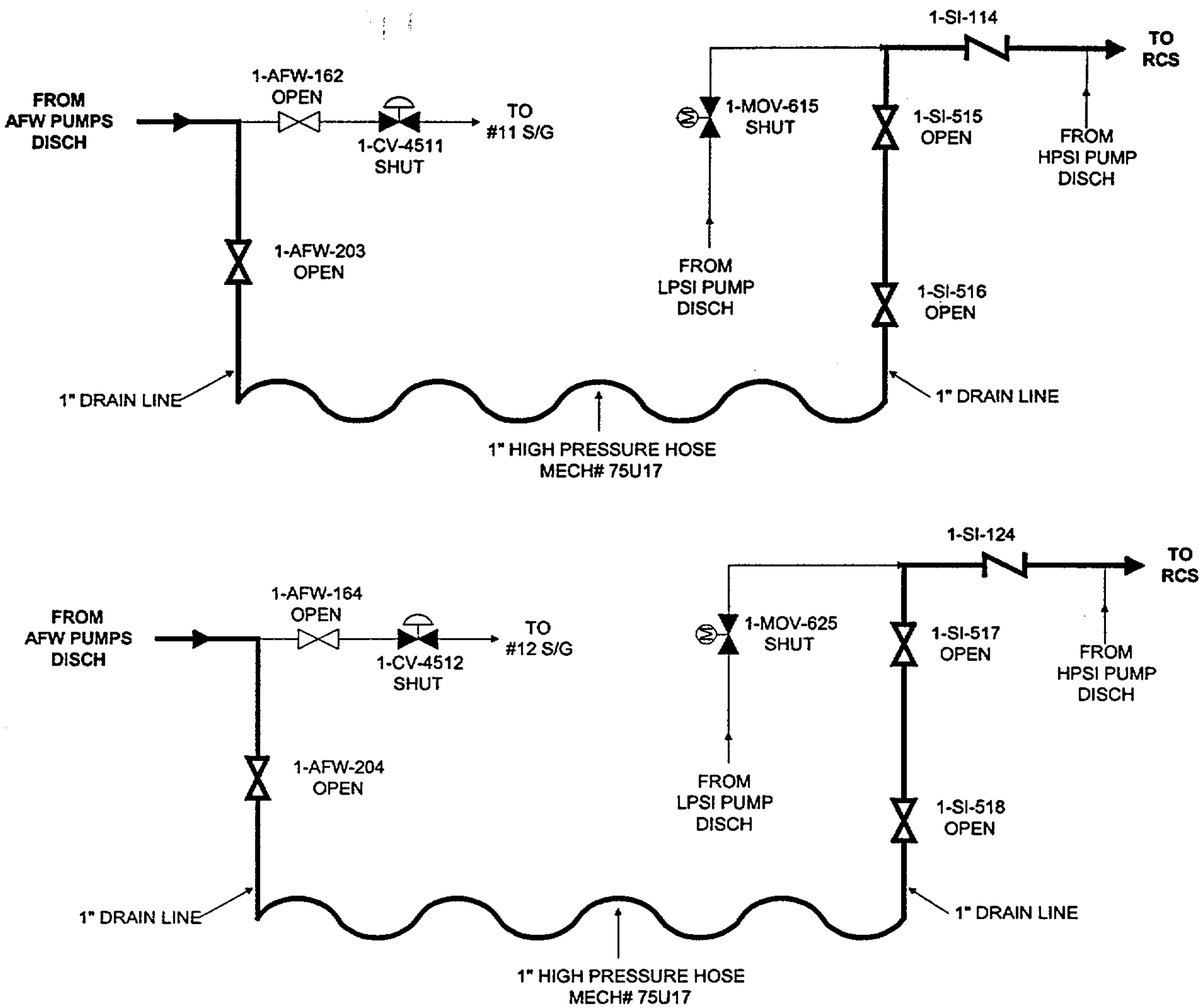


FIGURE 8
#21 (22) CS PUMPS SUPPLYING UNIT-1 CONTAINMENT SPRAY FROM 11/21/SFPs
(UNIT-1 AFFECTED)

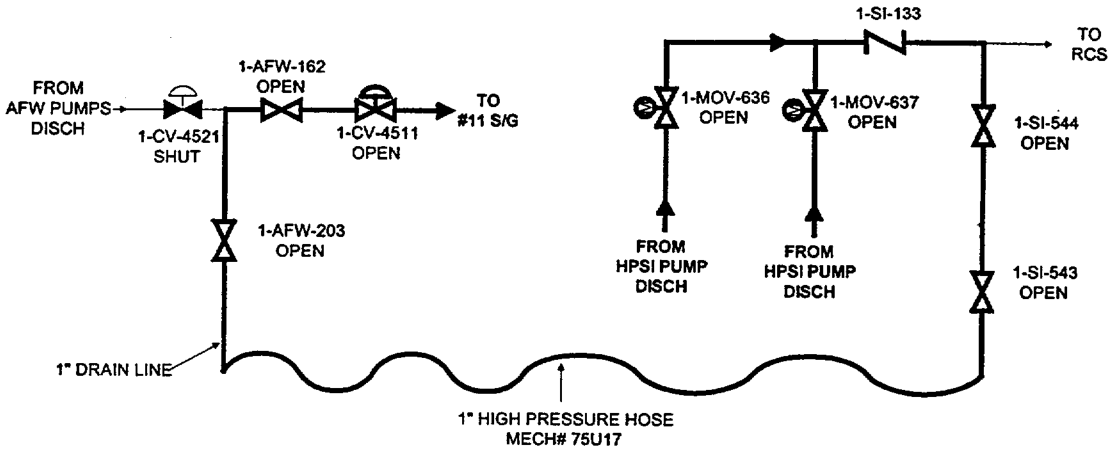


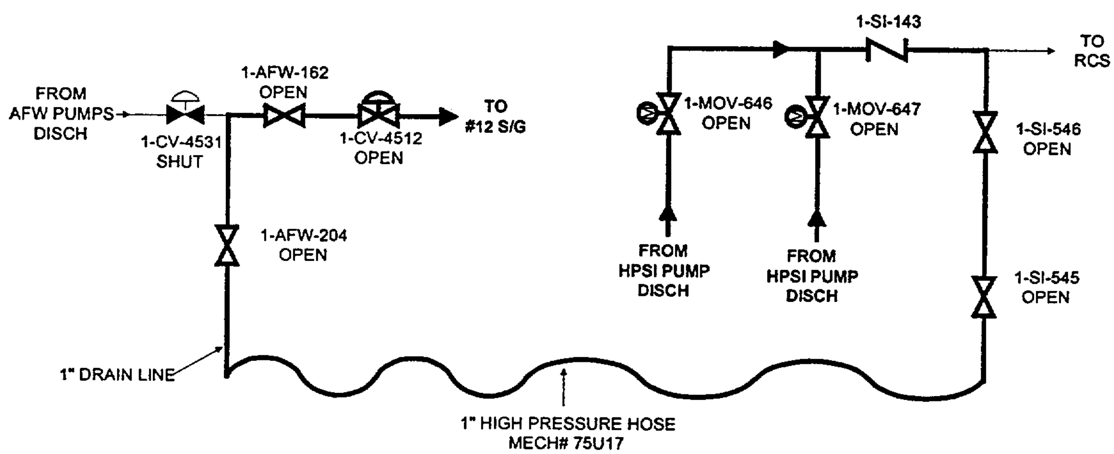
NOTES:

AFW drain valves are located in 5' East Pen Room. SI drain valves are in 27' East Pen Room.
The 1" hoses are rated for 800 psi. Higher pressure hoses may be available.
Estimated flow with 300 psid between AFW and RCS is 100 gpm.

FIGURE 9

U-1 AFW TO U-1 SI X-CONNECT USING HP HOSES





NOTES:
AFW drain valves are located in 5' East Pen Room. SI drain valves are in 27' East Pen Room.
The 1" hoses are rated for 800 psi. Higher pressure hoses may be available.
There are no isolations downstream of check valves 1-SI-133 and 1-SI-143, therefore RCS pressure must be greater than S/G pressure to allow flow to the S/Gs.

FIGURE 10

U-1 SI TO U-1 AFW X-CONNECT USING HP HOSES

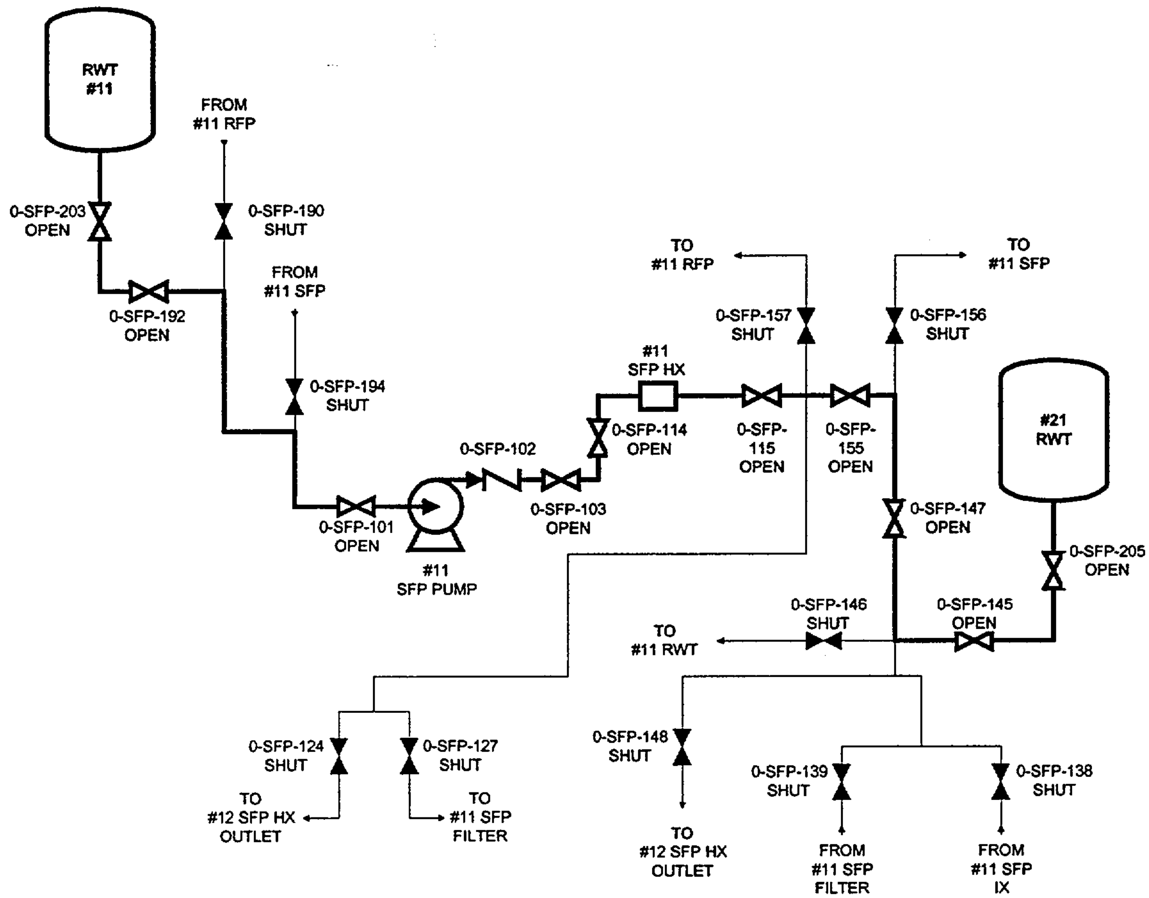


FIGURE 11
PUMPING UNIT 1 RWT TO UNIT-2 RWT WITH #11 SFP PUMP
(UNIT-2 AFFECTED)

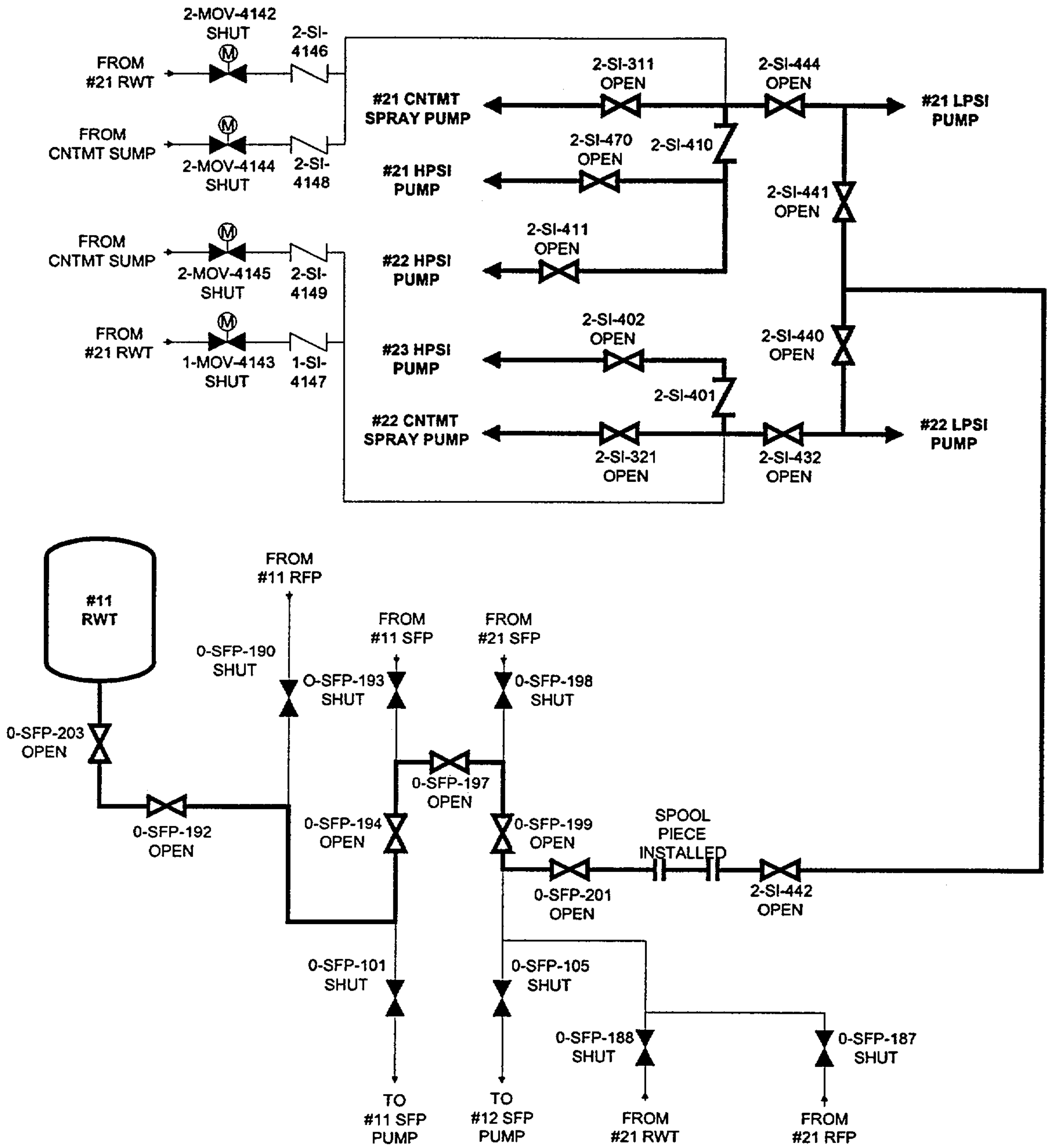


FIGURE 12
UNIT-1 RWT SUPPLYING UNIT-2 SI AND CS PUMPS
(UNIT-2 AFFECTED)

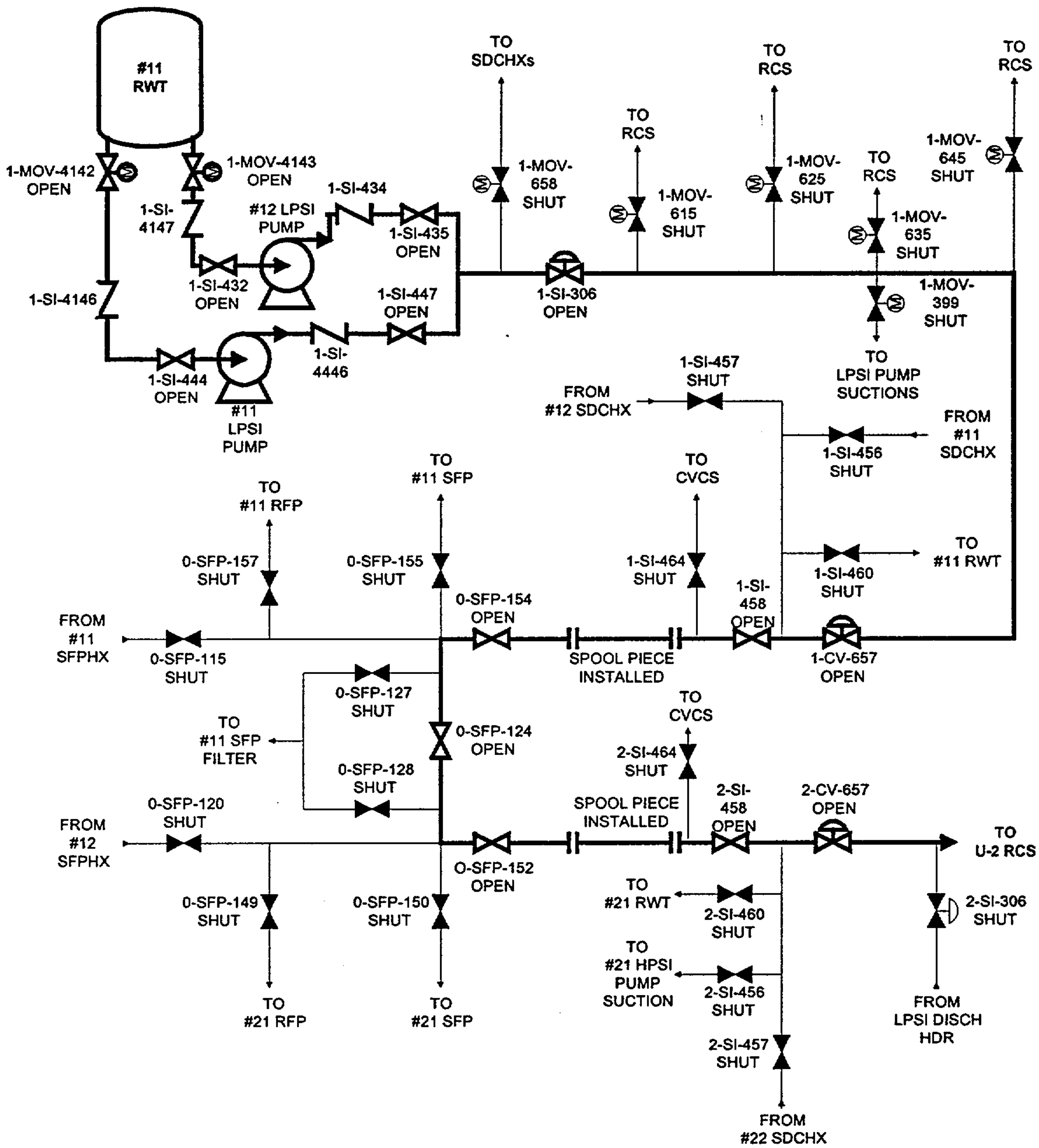


FIGURE 13
#11 (12) LPSI PUMP SUPPLYING UNIT-2 RCS FROM #11 RWT (UNIT-2 AFFECTED)

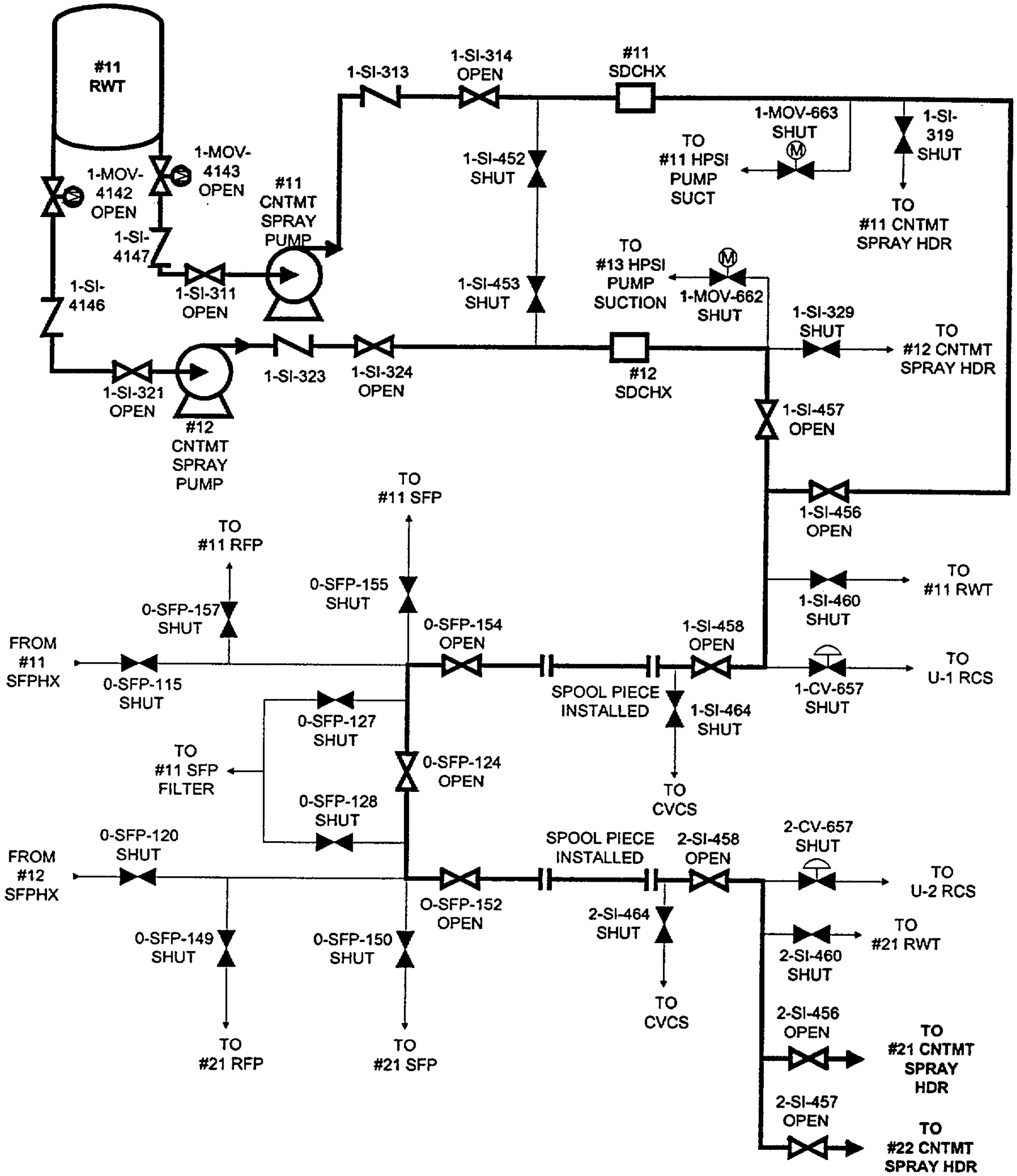


FIGURE 14
#11 (12) CS PUMP SUPPLYING UNIT-2 CNTMT FROM #11 RWT
(UNIT-2 AFFECTED)

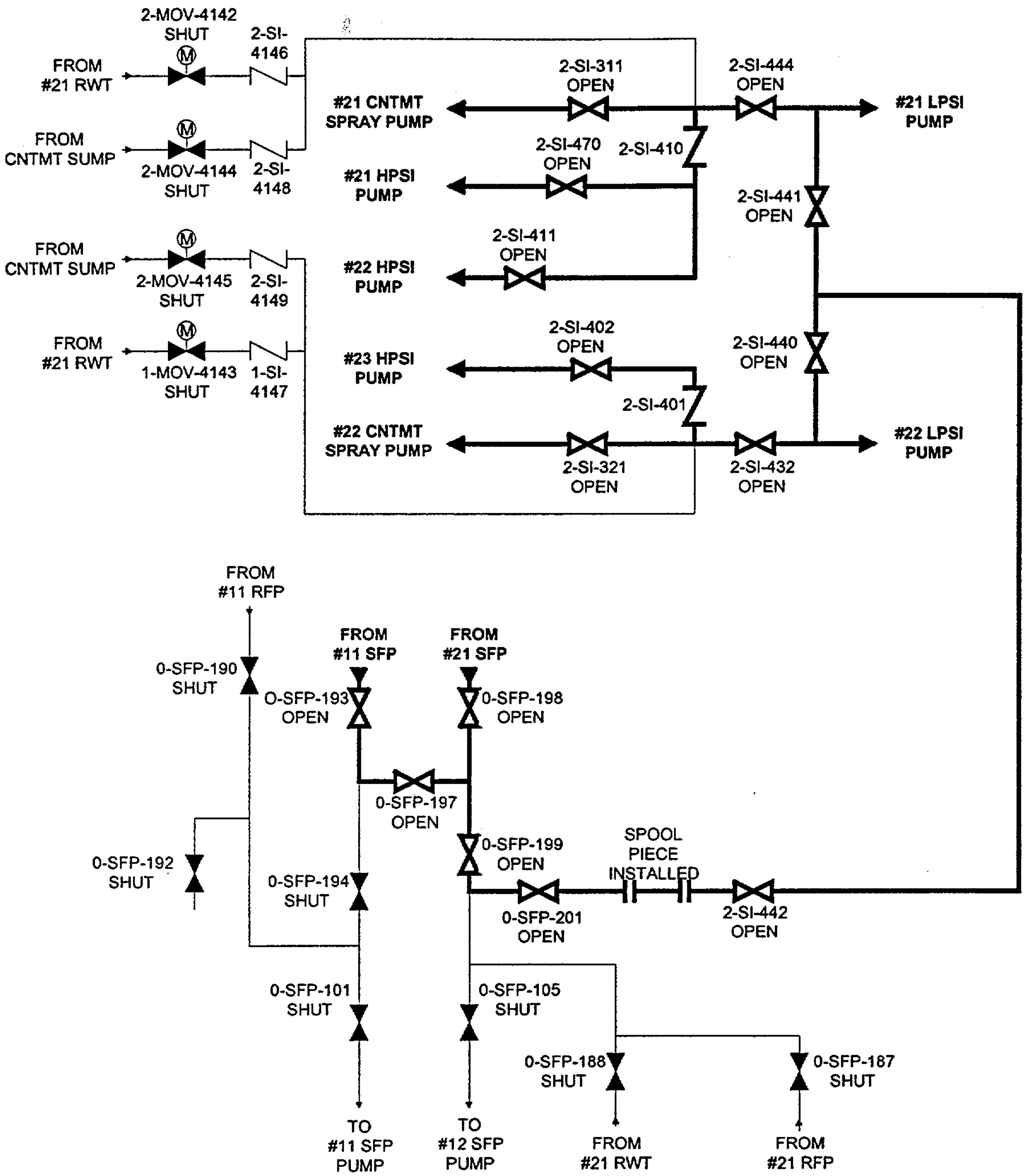


FIGURE 15
11 AND 21 SFPs SUPPLYING UNIT-2 SI AND CS PUMPS
(UNIT-2 AFFECTED)

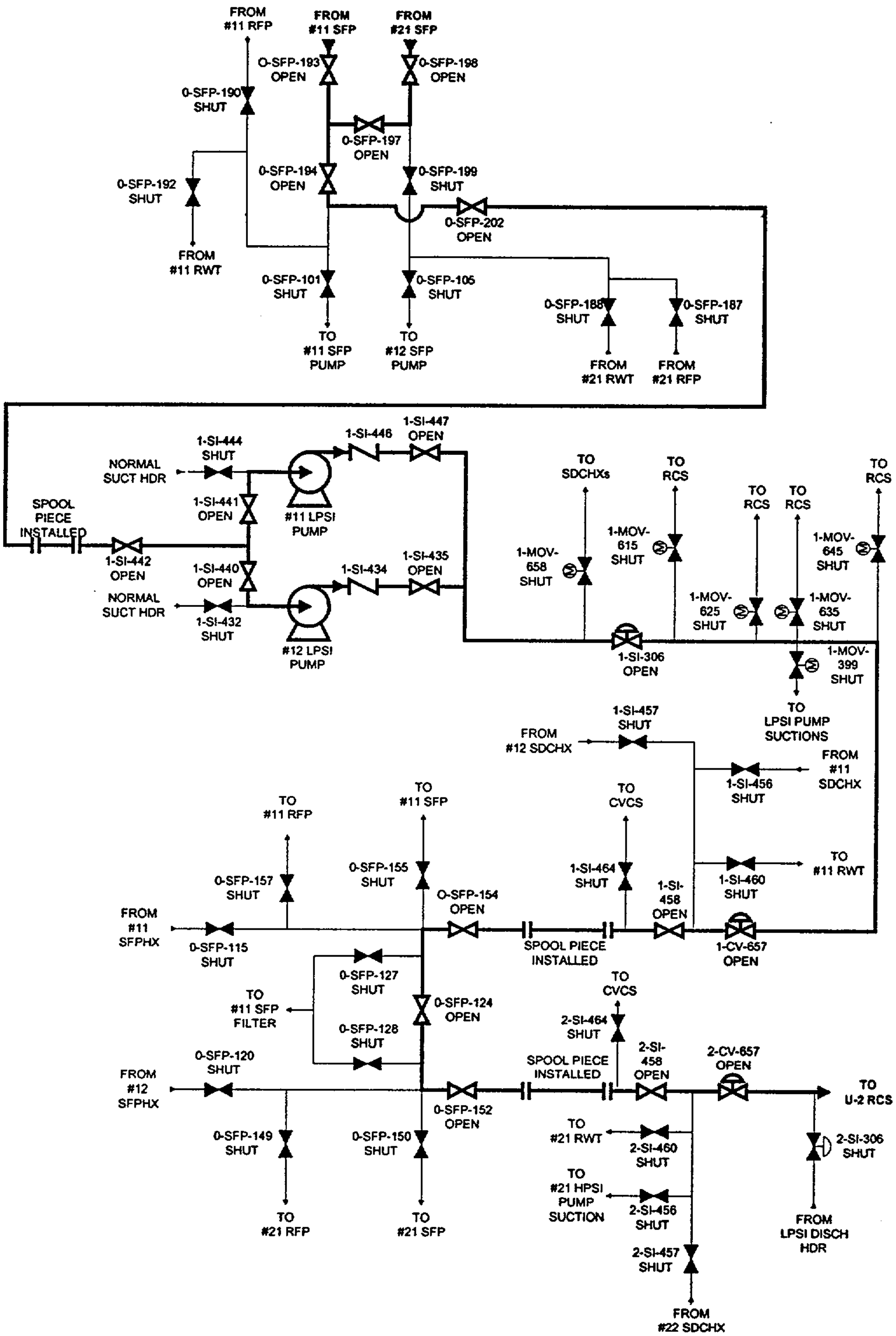


FIGURE 16
#11 (12) LPSI PUMP SUPPLYING UNIT-2 RCS FROM 11/21 SFPs (UNIT-2 AFFECTED)

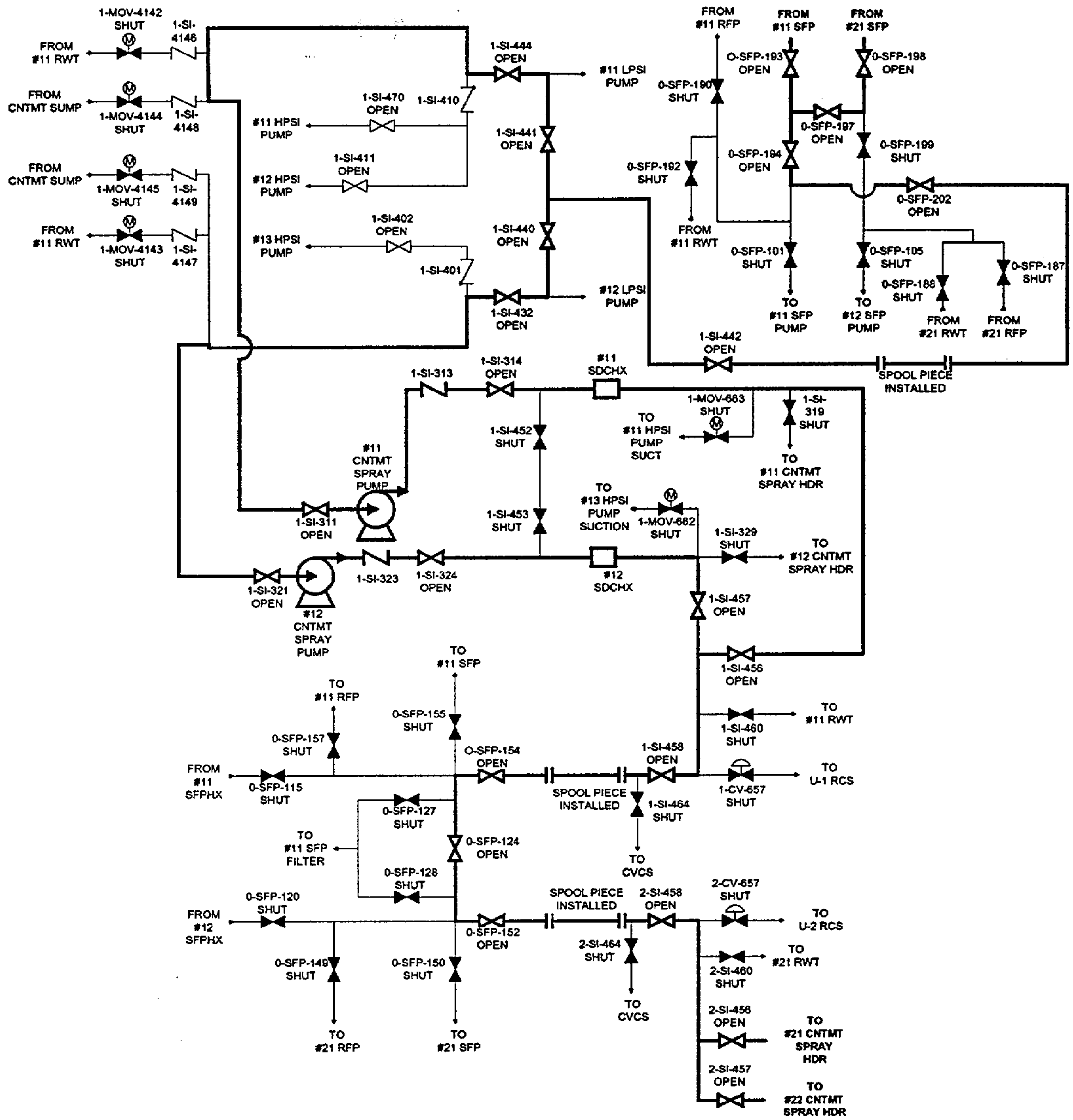
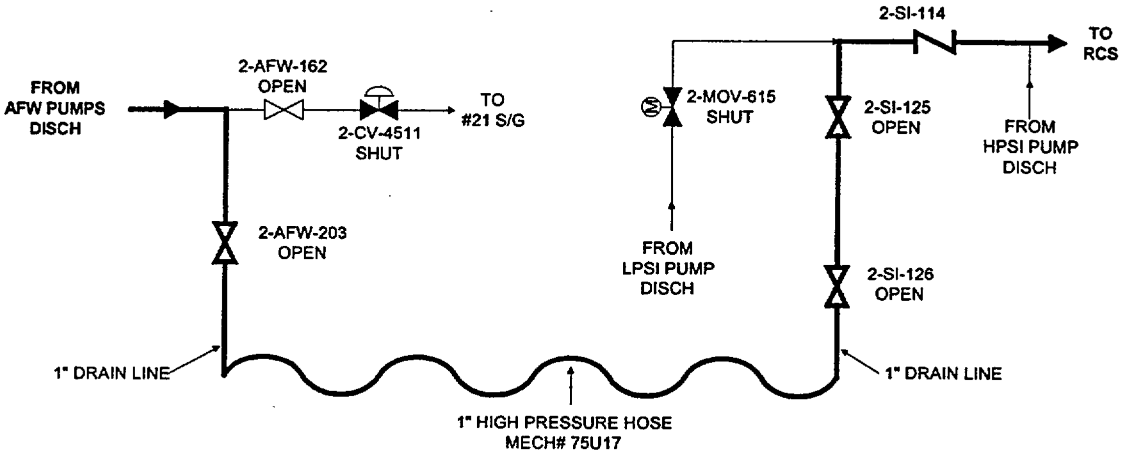
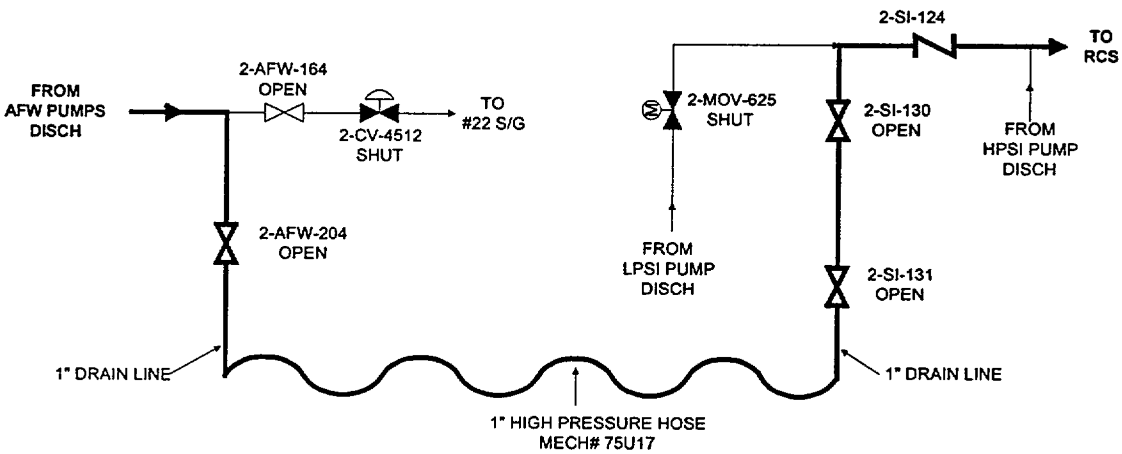


FIGURE 17
#11 (12) CS PUMPS SUPPLYING UNIT-2 CONTAINMENT SPRAY FROM 11/21/SFPs (UNIT-2 AFFECTED)



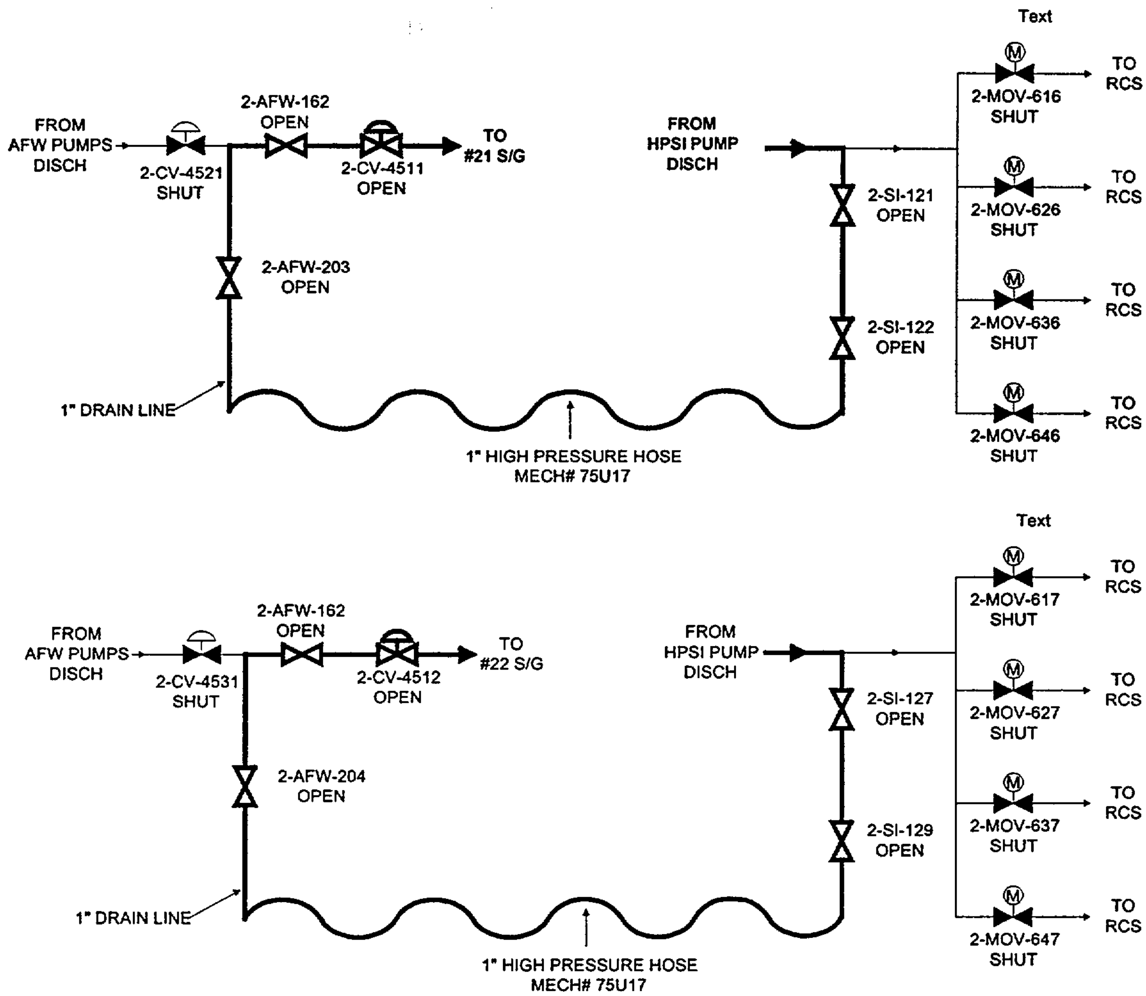


NOTES:

AFW and SI drain valves are located in 5' East Pen Room.
The 1" hoses are rated for 800 psi. Higher pressure hoses may be available.
Estimated flow with 300 psid between AFW and RCS is 100 gpm.

FIGURE 18

U-2 AFW TO U-2 SI X-CONNECT USING HP HOSES



NOTES:

AFW drain valves are located in 5' East Pen Room. SI drain valves are in 27' East Pen Room. The 1" hoses are rated for 800 psi. Higher pressure hoses may be available.

FIGURE 19

U-2 SI TO U-2 AFW X-CONNECT USING HP HOSES

ATTACHMENT 2
Page 1 of 3
Electrical Power Supplies

A. The methods listed below are possible means to supply power to an essential component that could be operated if power were available. The provisions of 10CFR50.54(x) and (y) likely apply to these actions and should be evaluated as such.

1. Align the 0C DG to more than one 4KV Vital Bus simultaneously.

   a. Get the EOP disconnect keys from the control room key locker for the desired "06" disconnect.

   b. Close the desired "06" disconnect then close the associated "06" breaker. (There are no interlocks to prevent closure of more than one "06" breaker at a time.)

2. Swap breakers between cubicles. (If a breaker problem is keeping an otherwise available component from service.)

3. Backfeed any 4KV Vital Bus with any Safety Related DG.

   a. Verify open 0C DG Output Breaker 152-0701.

   b. Strip the DGs normal bus except for Saltwater, Service Water and the associated reactor MCC, i.e.114R, 104R, 204R, or 214R.

   c. Strip the 4KV bus to be powered up.

   > - **NOTE** -
   > 1A DG requires 152-1703, 152-1701 and 152-1103 to be closed to feed another bus from 11 4KV Bus. The below operation pertaining to the "03" breakers will apply to 1703, 1701 and 1103 if 1A DG is used.

   d. Remove the trip power fuses (to defeat interlocks) from the "03" breaker for the bus normally supplied by the available DG.

   e. Remove the trip and control power fuses (to defeat interlocks) from the "06" breaker for the bus normally supplied by the available DG.

   f. Verify open, then remove the trip and control power fuses from the "06" breaker of the bus to be supplied.

   g. Get the EOP disconnect keys from the control room key locker and close both "06" disconnects associated with the "06" breakers from which the fuses have been removed.

   h. Locally close the "06" breaker for the normal bus.

   i. Locally close the "06" breaker for the other bus to be powered.

ATTACHMENT 2
Page 2 of 3

j. Start loads on either bus as desired (monitor DG loading limits).

4. If a DG is available and it is desired to energize another 4KV bus to power an essential component, but the DG cannot be realigned to a another 4KV bus as per 3. above of this attachment, then consider backfeeding the DG up through the 13KV transformer and back down to the desired bus.

5. Single engine operation of the SACM DGs. (If an engine has a rotational problem, i.e., bearing seizure, then the engine will have to be uncoupled.)

   a. Select the engine to be used with the engine selector keyswitch on the local control panel. (Along with Emergency Start, this overrides the damaged engine's trips. There will be a significant differential between the fuel rack settings.)

   b. Open the cylinder vents on the damaged engine to allow the engine to windmill, **or**

   c. Uncouple the damaged engine from the generator.

   d. Emergency Start the SACM DG and energize the desired bus.

6. Fuel can be supplied to the diesels without a Fuel Oil Transfer Pump using the head of the Day Tank by connecting a hose at the "Y" strainer at the Fuel Oil Transfer Pump from the Day Tank.

7. Tie a temporary generator into a selected 480V cubicle and backfeed power to an essential component.

8. Tie a temporary generator into a OC DG Building breaker cubicle (Bus 07) and backfeed to energize the 07 Bus as follows:

   a. Verify OC DG Output Breaker 152-0703 open.

   b. Tie the temporary generator into a breaker cubicle on Bus 07.

   c. Energize Bus 07 via backfeed from the temporary generator.

   d. Close OC DG Tie Breaker 152-0701.

   e. Energize the selected 4KV vital bus by closing the "06" breaker for the bus to be energized.

9. An additional potential source is to use the SBO transformer from SMECO, 0X01, (1500KVA). Remove trip and control power fuses to defeat interlock then close 152-0704 and 152-0701 to energize a 4KV Bus via an "06" breaker.

ATTACHMENT 2

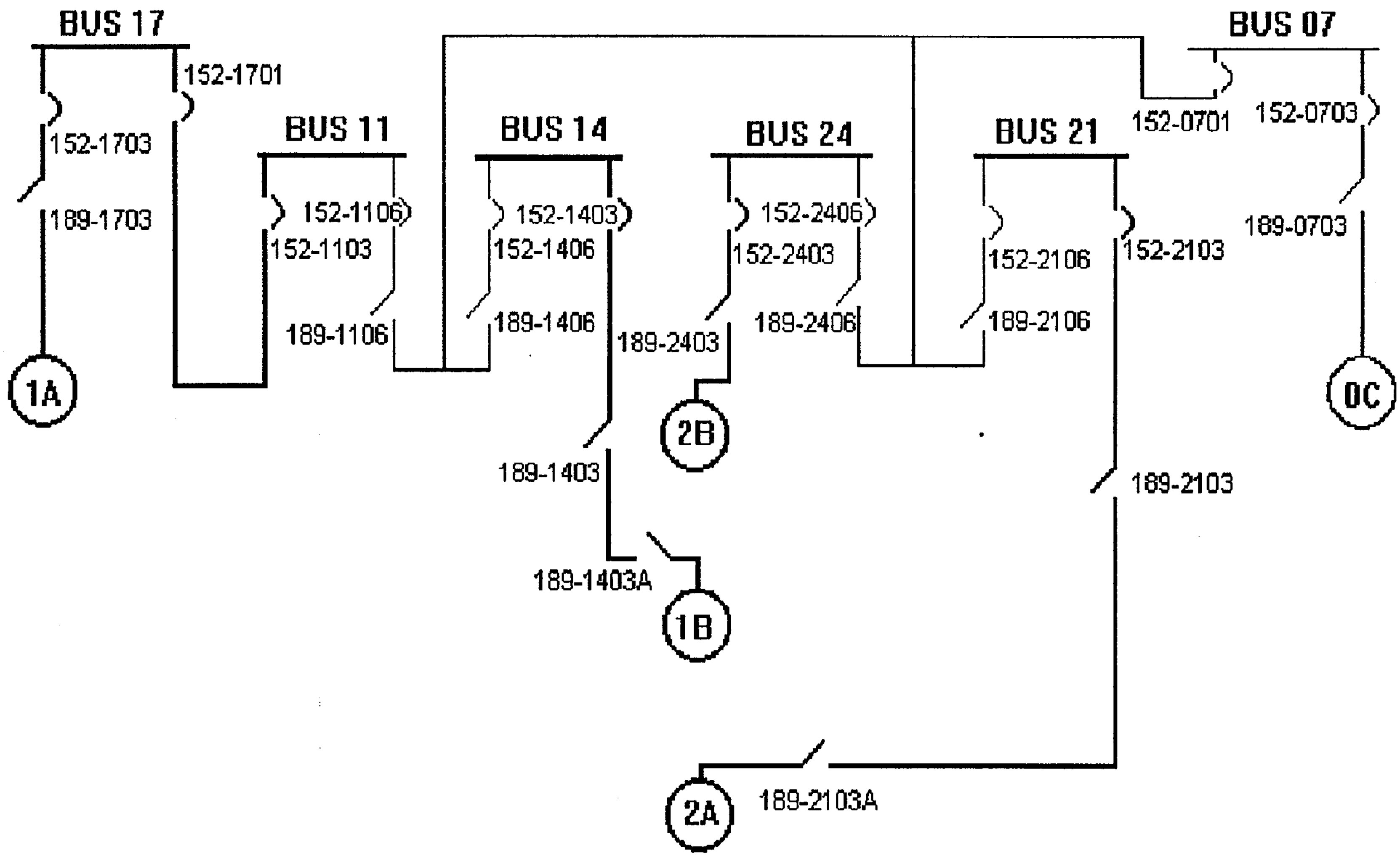


FIGURE 1
DIESEL GENERATOR LINEUPS

ATTACHMENT 3
Overriding Interlocks/Trips

A. The items listed below are suggested as possible methods that can be used to restore a particular component or system to useable status by overriding interlocks and/or trips that otherwise would prevent the system or component from operating. The provisions of 10CFR50.54(x) and (y) likely apply to these actions and should be evaluated as such.

1. RCP's (remove close fuses on breakers to override interlocks).

2. Pull ESFAS modules at the logic cabinets for ESFAS function desired to be overridden (i.e., SIAS, CSAS, etc.).

3. Pull individual component ESFAS relays to remove ESFAS signals.

4. Reset ESFAS signals at cabinets to override handswitch position interlock.

5. Remove the 35 amp control fuses from needed component's breaker (i.e., HPSI, LPSI, CNMNT Spray) to override interlocks/trips then close breaker locally.

ATTACHMENT 4

Instrument Used	Alternate Indication	Comments
Core Exit Temperature (CETs) *TI-131A-D, 132A-D	1) EOP Att. 12 2) RVLMS 3) T_h (up to 705°F)	Use RVLMS to determine if core covered CETs can also be read from recorders or Subcooling Margin Monitor
RVLMS * LI-20A, 20B	CETs	If CETs are not superheated then core is covered, also T_h/PZR Press NI's can also be used to help determine if the core is covered.
RCS/PZR Press. * PI-100A-D, PT-105B, PI-103, PR-100X,Y	1)SIT level LI-311,321,331,341	If SIT level is normal then RCS press remains greater than 200 psi
CNMNT Press * PI-5307, 5310, (WR) PI-5308 (NR)	1) RCS press 2) Assume saturated and use steam tables with CNMNT temperature	1) If large break LOCA Possibly use disch. press on idle SI/CS pump with CNMNT recirc valve open and RWT Out Shut
CNMNT HI Range RMS * RI-5317A,B	Use ERPIP 800 series (core damage assessment)	
NIs * WR (Gammametrics)		
CNMNT Sump Level LI-4146, 4147 (WR) LI-4145, 4144 (NR)		Use RCS state and RWT level to estimate
CNMNT H_2 * 0-AR-6519, 6527	PASS, grab sample Use ERPIP 800 series (core damage assessment)	
SI Flow FI-351 (HPSI Total) FI-311-341 (HPSI) FI-312-342 (LPSI)	Pump amps	loop HPSI, loop LPSI, Total HPSI
RWT Level LIA-4341, 4342	Local indication	
Tail pipe Temperature TI-106,108	Acoustic Monitor Quench Tank temp if intact	CNMNT temp if Quench tank ruptured
CNMNT Temperature TI-5309 (dome) TI-5311 (cavity)	Use Calc. Aid CA-10	
Subcooling * AI-11,12	PZR temp minus CET temperature or T_h	

ATTACHMENT 4
Page 2 of 2

Instrument Used	Alternate Indication	Comments
PZR Level * LT-110X,Y		
CST Level * LIA-5610, 5611, 5603	1/2-LI-5609	located on AFW suction line in Unit-1 27' CNMNT Purge Air Supply Room
S/G Level * LIC-1113A-D, 1123A-D (NR) LIC-1114C, 1124D (WR)		
S/G Press. * PI-1013A-D, 1023A-D	T_c and use steam tables	
AFW Flow FIC-4511A, 4525A FIC-4512A, 4535A	AFW Pump amps II-4540	
S/G Steam Flow FI-1011, 1021		
T_h, T_c * TR-112, 122		
Instrument Air Pressure PI-2079		
Condenser Vac. PI-4404, 4407, 4410		
RCP Parameters		
CNMNT Spray Flow FI-4149, 4150	Pump amps	
Feed Flow FR-1111, 1121		
MWRT Level LI-2195, 2197		
Aux. Bldg. Temperature TI-5275, 5276, 5279, 5280 (pen rooms)		
Aux. Bldg. Rad. Levels RE-7004, 7005 (pen rooms)		
SDC HX Out (TI-303X & 303Y)		Use for estimate of reactor cavity sump water temp
Bast Level LIA-206, 208		

* denotes PAM instrument

Figure 1-1a

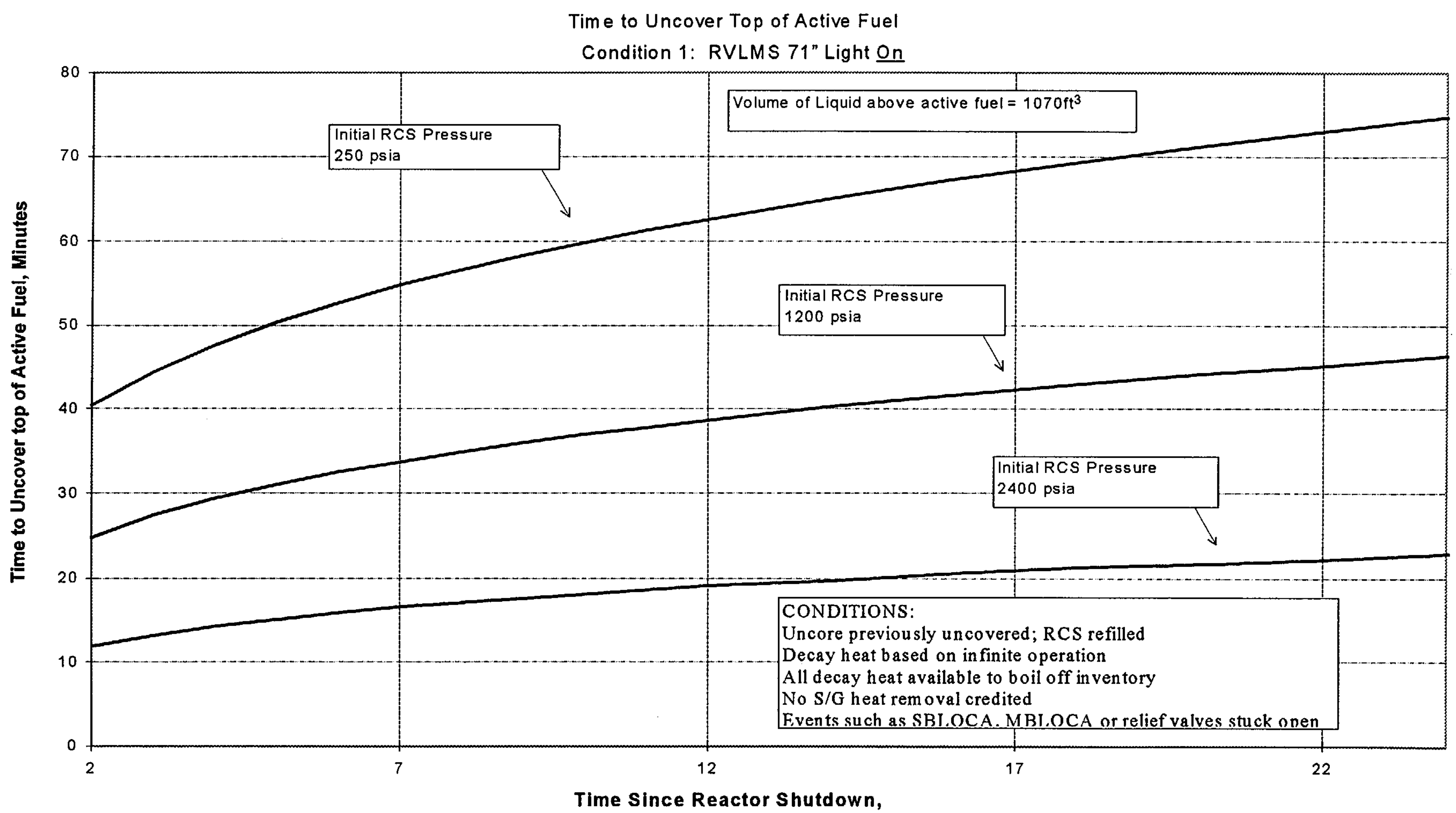

Time to Uncover Top of Active Fuel
Condition 1: RVLMS 71" Light On
Volume of Liquid above active fuel = 1070ft3
Initial RCS Pressure
250 psia
Initial RCS Pressure
1200 psia
Initial RCS Pressure
2400 psia
CONDITIONS:
Uncore previously uncovered; RCS refilled
Decay heat based on infinite operation
All decay heat available to boil off inventory
No S/G heat removal credited
Events such as SBLOCA, MBLOCA or relief valves stuck open
Time to Uncover top of Active Fuel, Minutes
80
70
60
50
40
30
20
10
0
2
7
12
17
22
Time Since Reactor Shutdown,

Figure 1-1b

Time to Uncover Top of Active Fuel

Condition 2: RLMS 185 "Lights On"

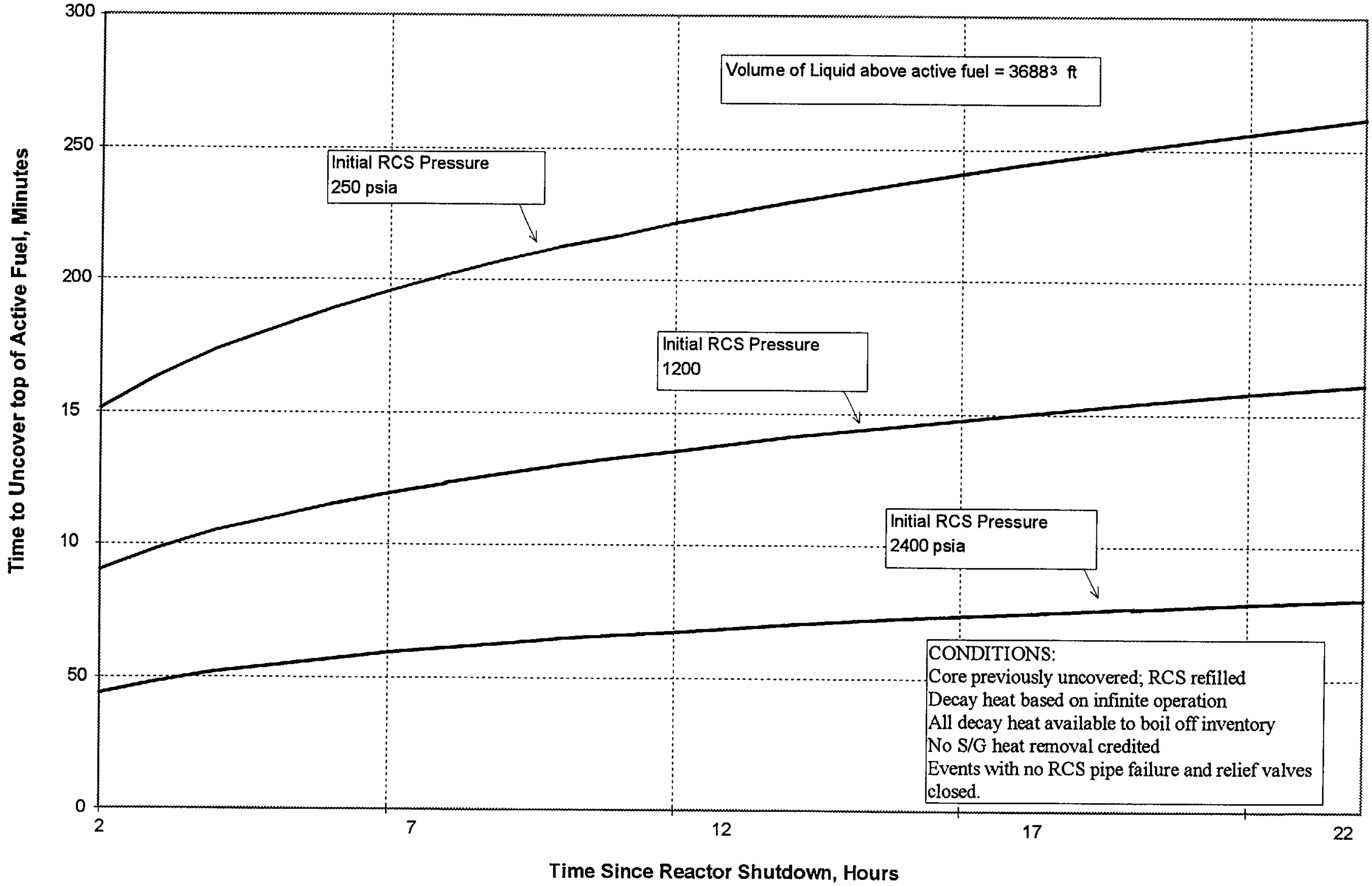


Figure 1-2
Coolant Level in Core Region vs. Time since Onset of Core Uncovery
RCS Pressure=2400 Psia

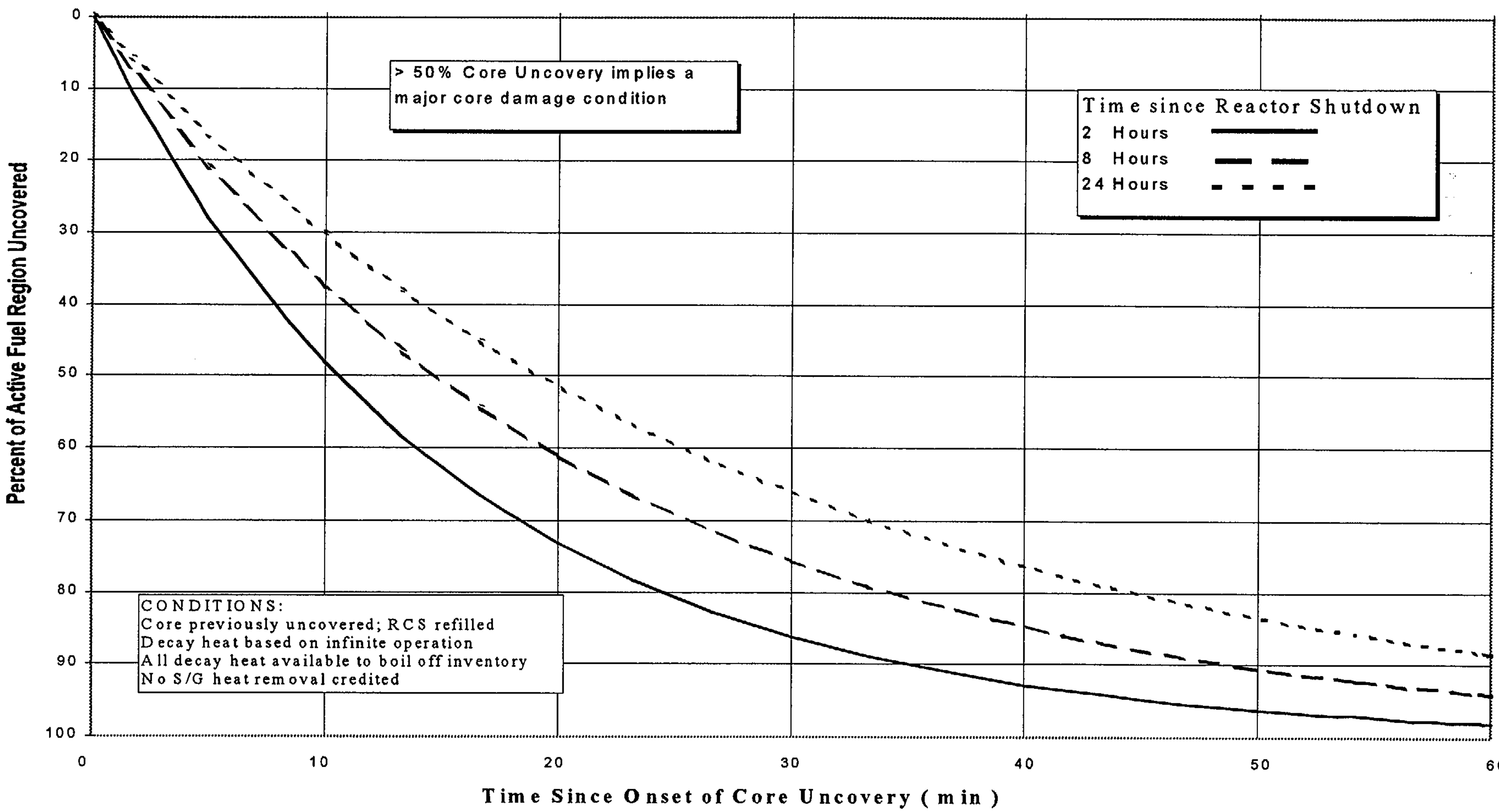


Figure 1-3
Coolant Level in Core Region vs. TIme since Onset of Core Uncovery

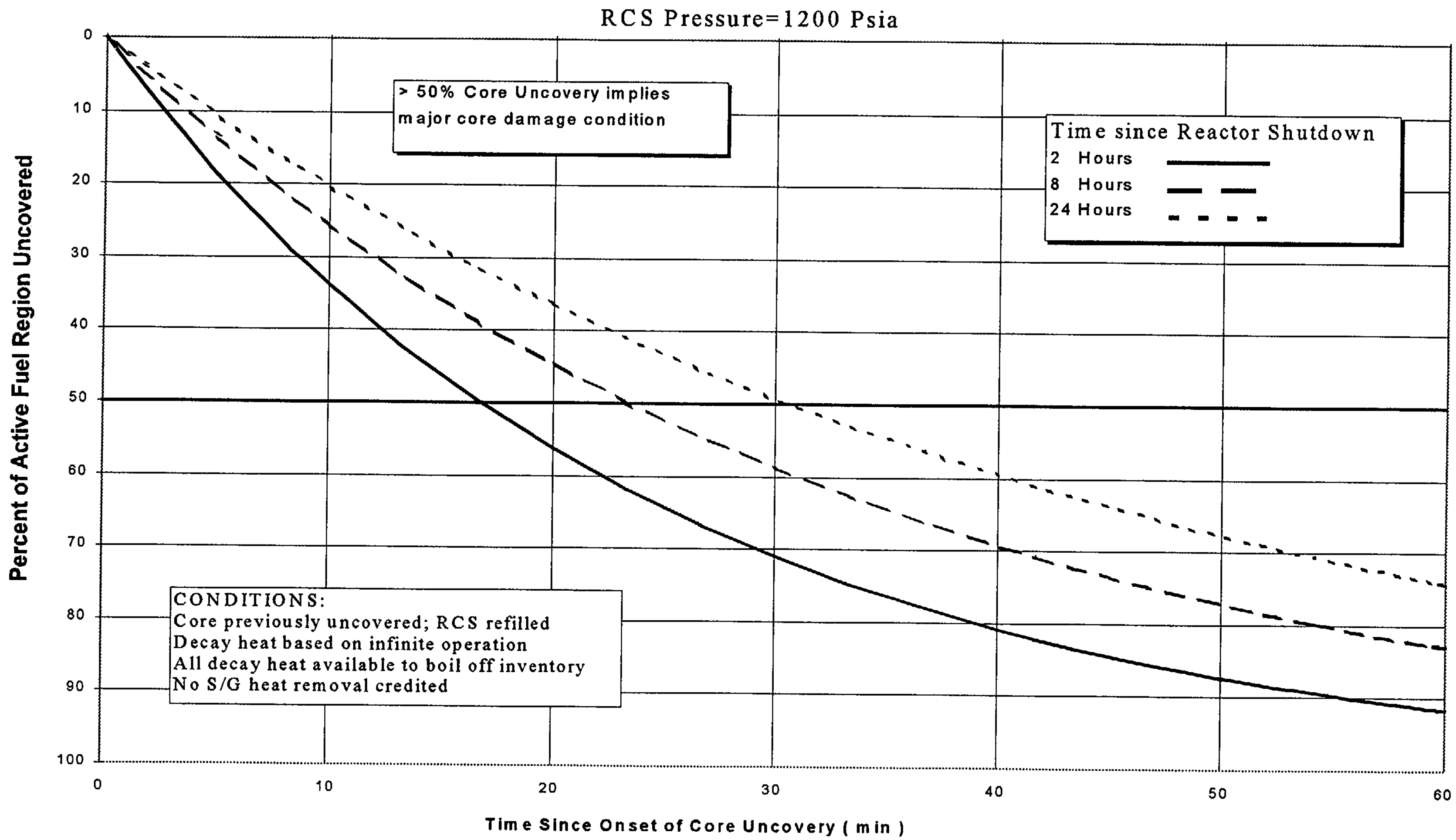


Figure 1-4

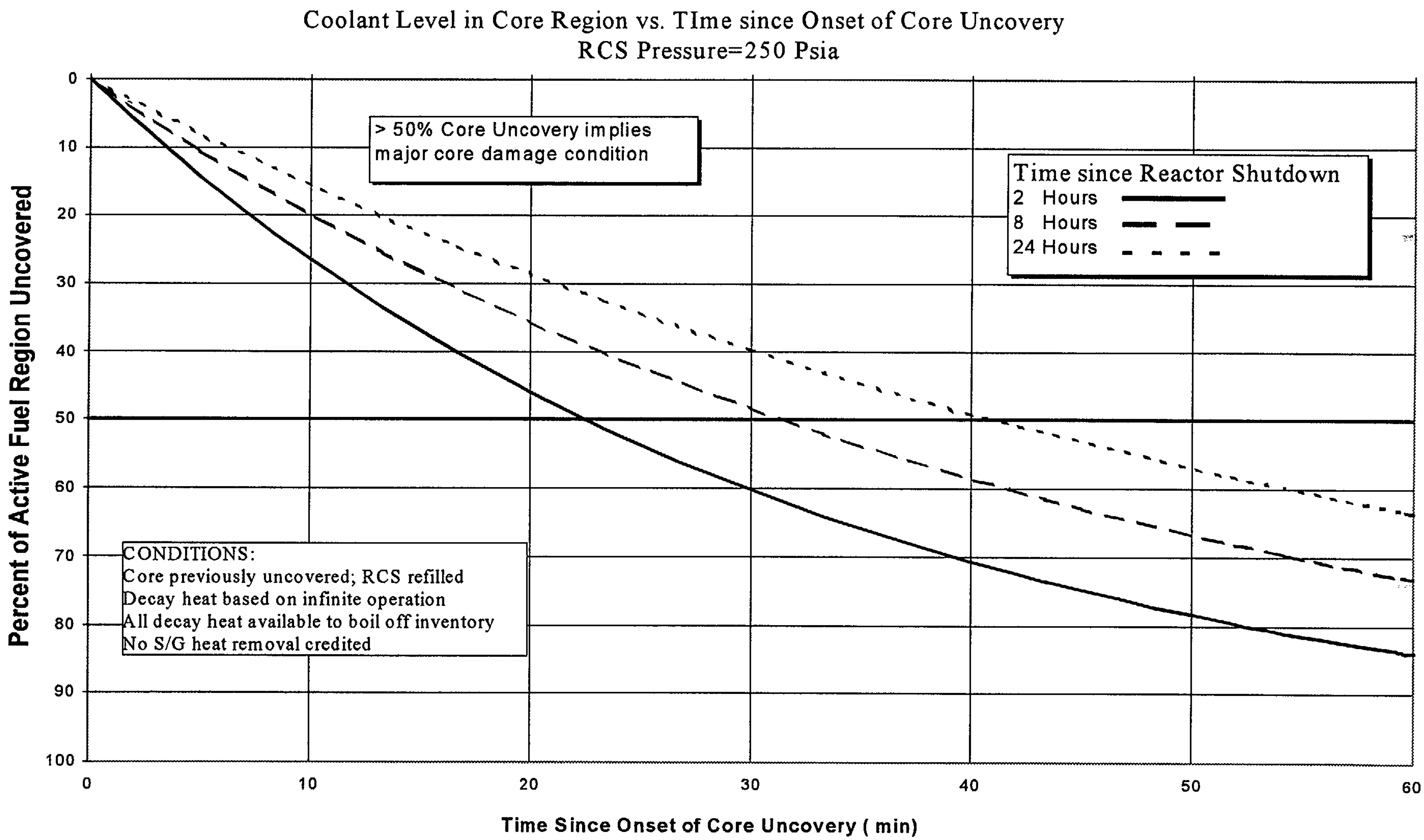

Coolant Level in Core Region vs. TIme since Onset of Core Uncovery
RCS Pressure=250 Psia
> 50% Core Uncovery implies major core damage condition
Time since Reactor Shutdown
2 Hours
8 Hours
24 Hours
CONDITIONS:
Core previously uncovered; RCS refilled
Decay heat based on infinite operation
All decay heat available to boil off inventory
No S/G heat removal credited
Percent of Active Fuel Region Uncovered
0
10
20
30
40
50
60
70
80
90
100
0
10
20
30
40
50
60
Time Since Onset of Core Uncovery (min)

Figure 1-5
Percent of Active Fuel Region Uncovered
Coolant Level in Core Region vs. Time since Onset of Core Uncovery

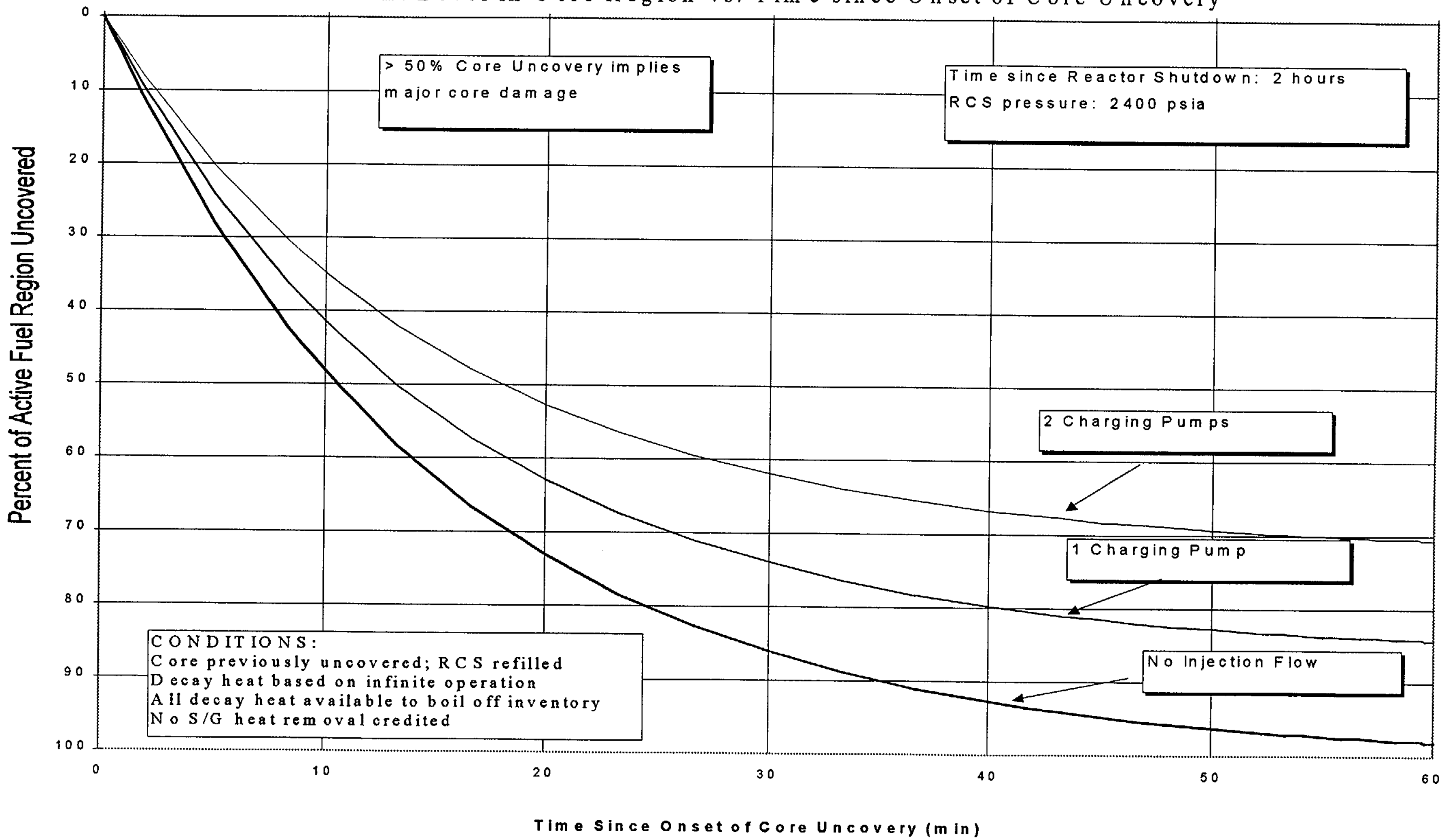


Figure 1-6

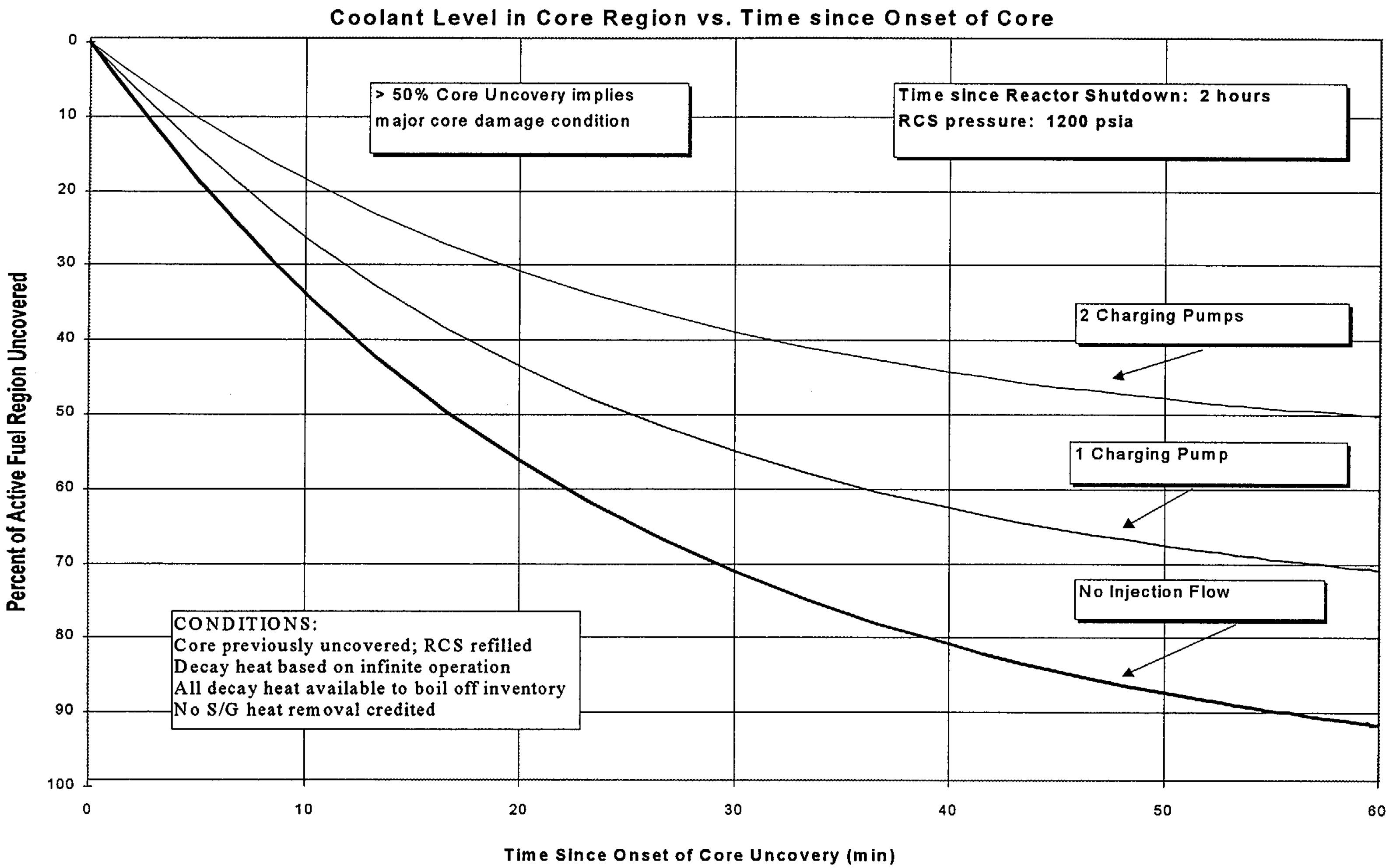

Coolant Level in Core Region vs. Time since Onset of Core
> 50% Core Uncovery implies
major core damage condition
Time since Reactor Shutdown: 2 hours
RCS pressure: 1200 psia
2 Charging Pumps
1 Charging Pump
No Injection Flow
CONDITIONS:
Core previously uncovered; RCS refilled
Decay heat based on infinite operation
All decay heat available to boil off inventory
No S/G heat removal credited
Percent of Active Fuel Region Uncovered
0
10
20
30
40
50
60
70
80
90
100
0
10
20
30
40
50
60
Time Since Onset of Core Uncovery (min)

Figure 1-7
Coolant Level in Core Region vs. Time since Onset of Core Uncovery

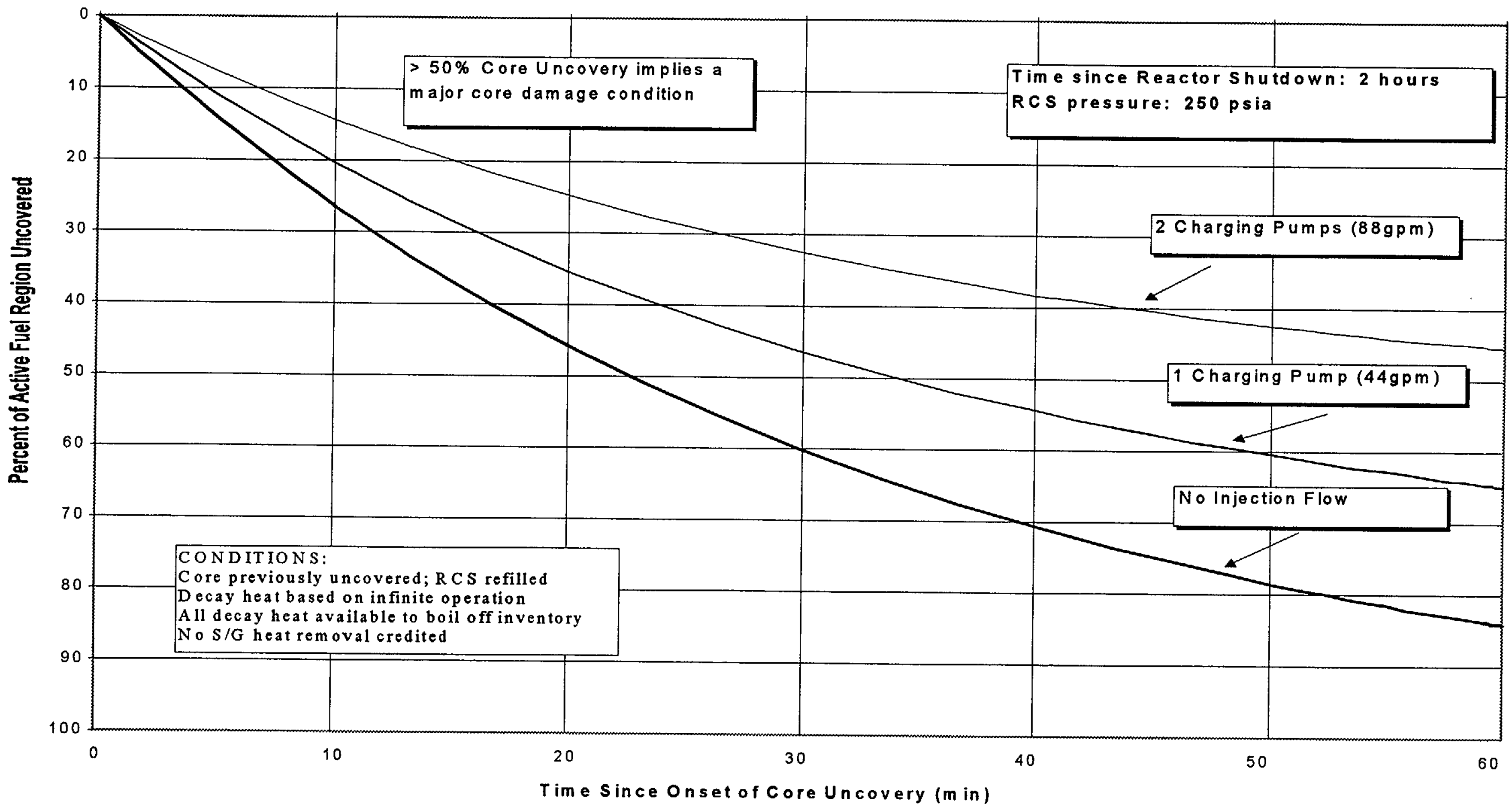


Figure 2a-1

Minimum Injection Flow Rate Required to Quench Molten Core (4000 deg. F)

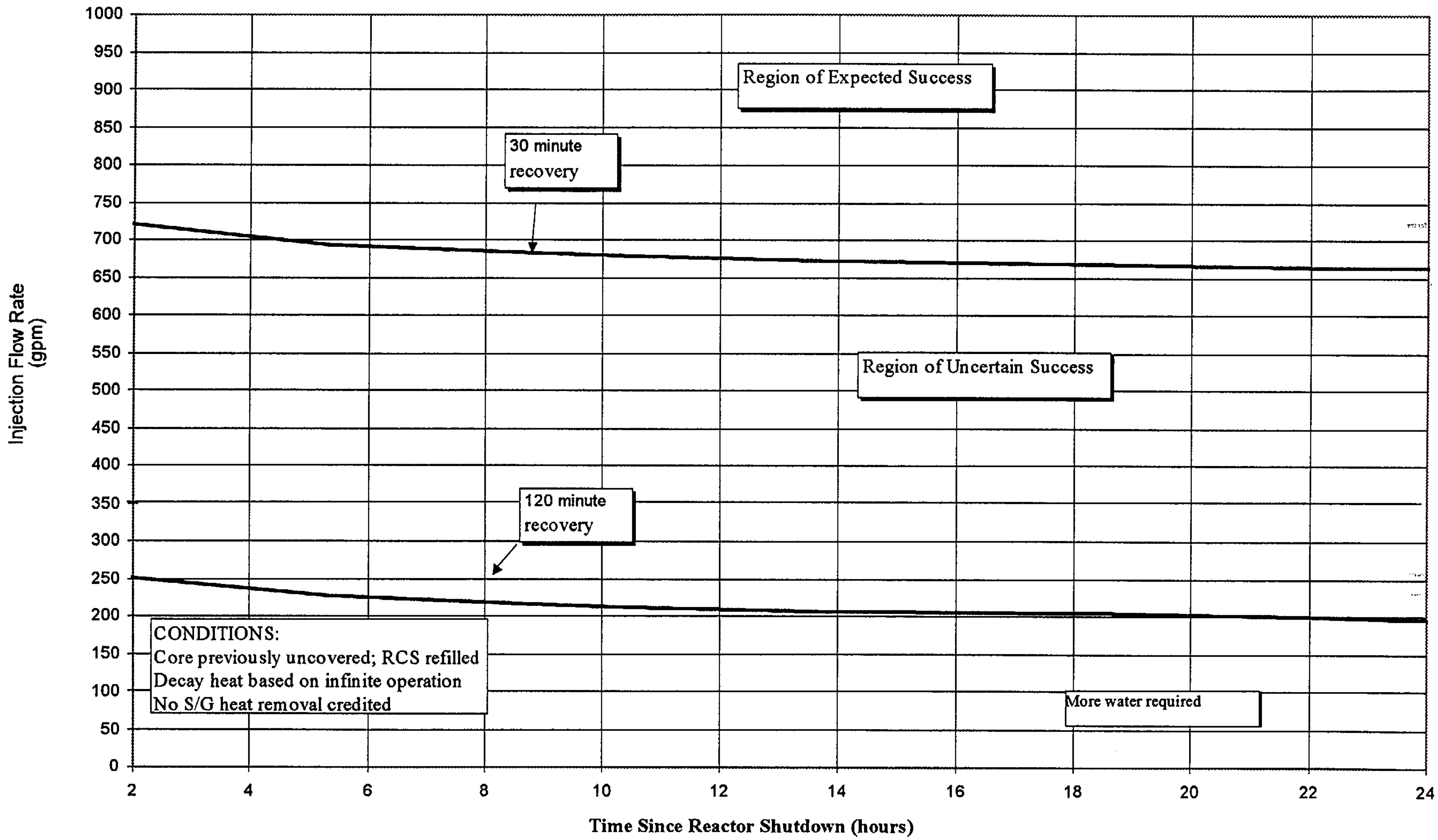


Figure 2b-1

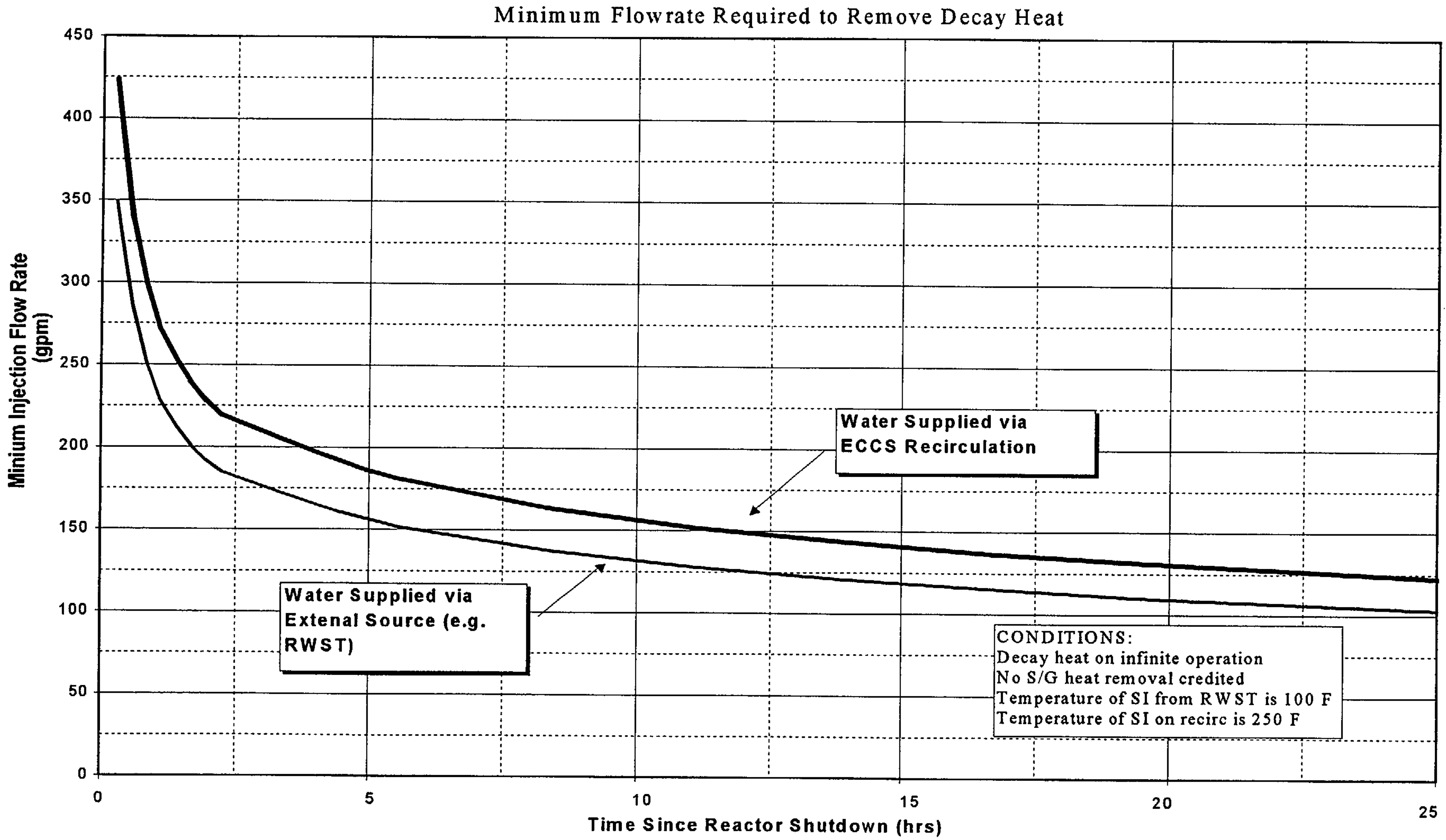

Minimum Flowrate Required to Remove Decay Heat
450
400
350
300
250
200
150
100
50
0
Minium Injection Flow Rate (gpm)
0
5
10
15
20
25
Time Since Reactor Shutdown (hrs)
Water Supplied via ECCS Recirculation
Water Supplied via Extenal Source (e.g. RWST)
CONDITIONS:
Decay heat on infinite operation
No S/G heat removal credited
Temperature of SI from RWST is 100 F
Temperature of SI on recirc is 250 F

Figure 3a-1

Pressure Increase Upon Injection of Loop Seal Water into RV

(Superheated Conditions, T=1500F)

***No RCS vents or SG heat removal considered**

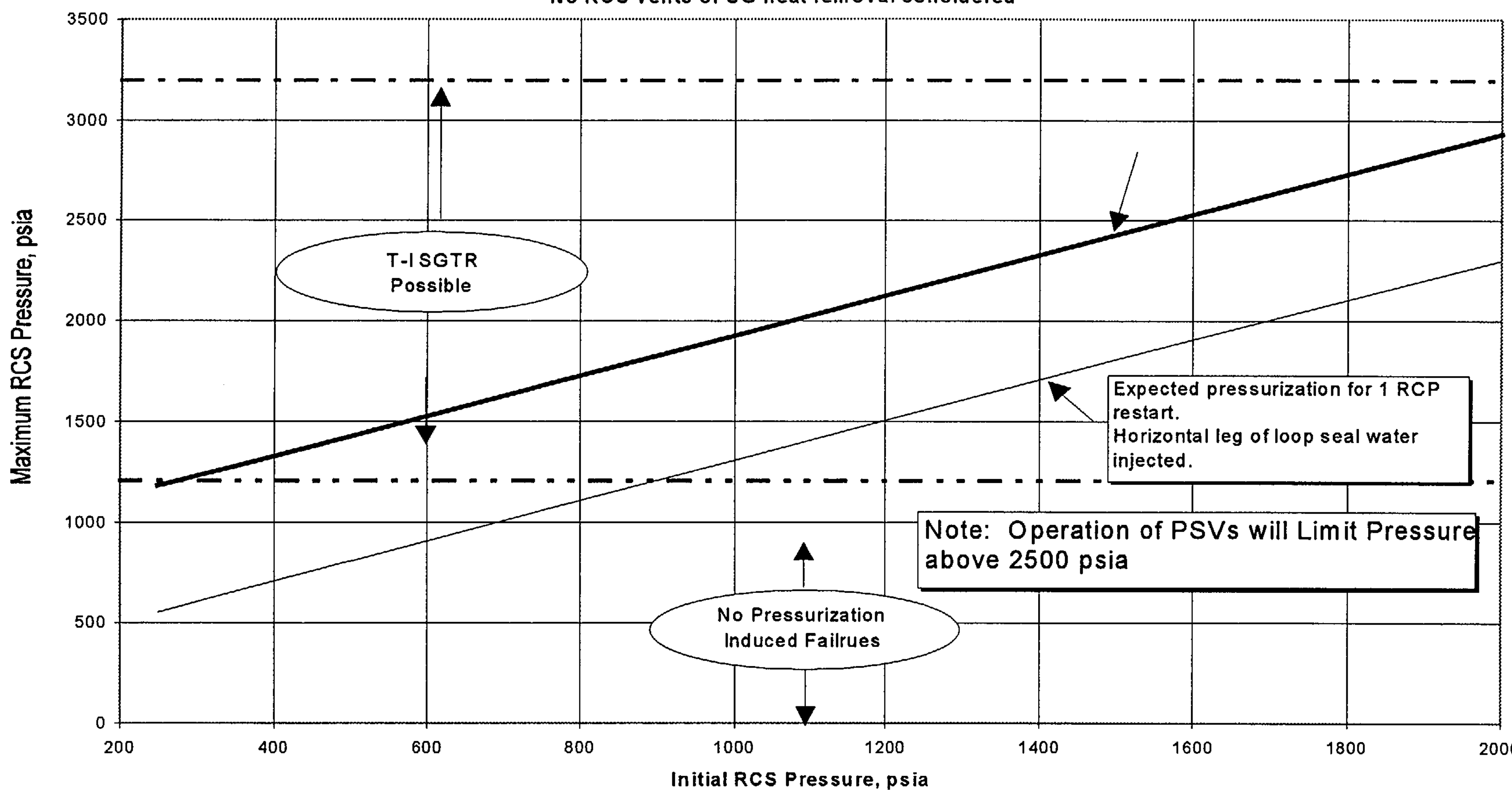


Figure 3a-2
Pressure Increase Upon Injection of Loop Seal Water into RV
(Saturated Conditions, SG Heat Removal Considered)
* No RCS Vents

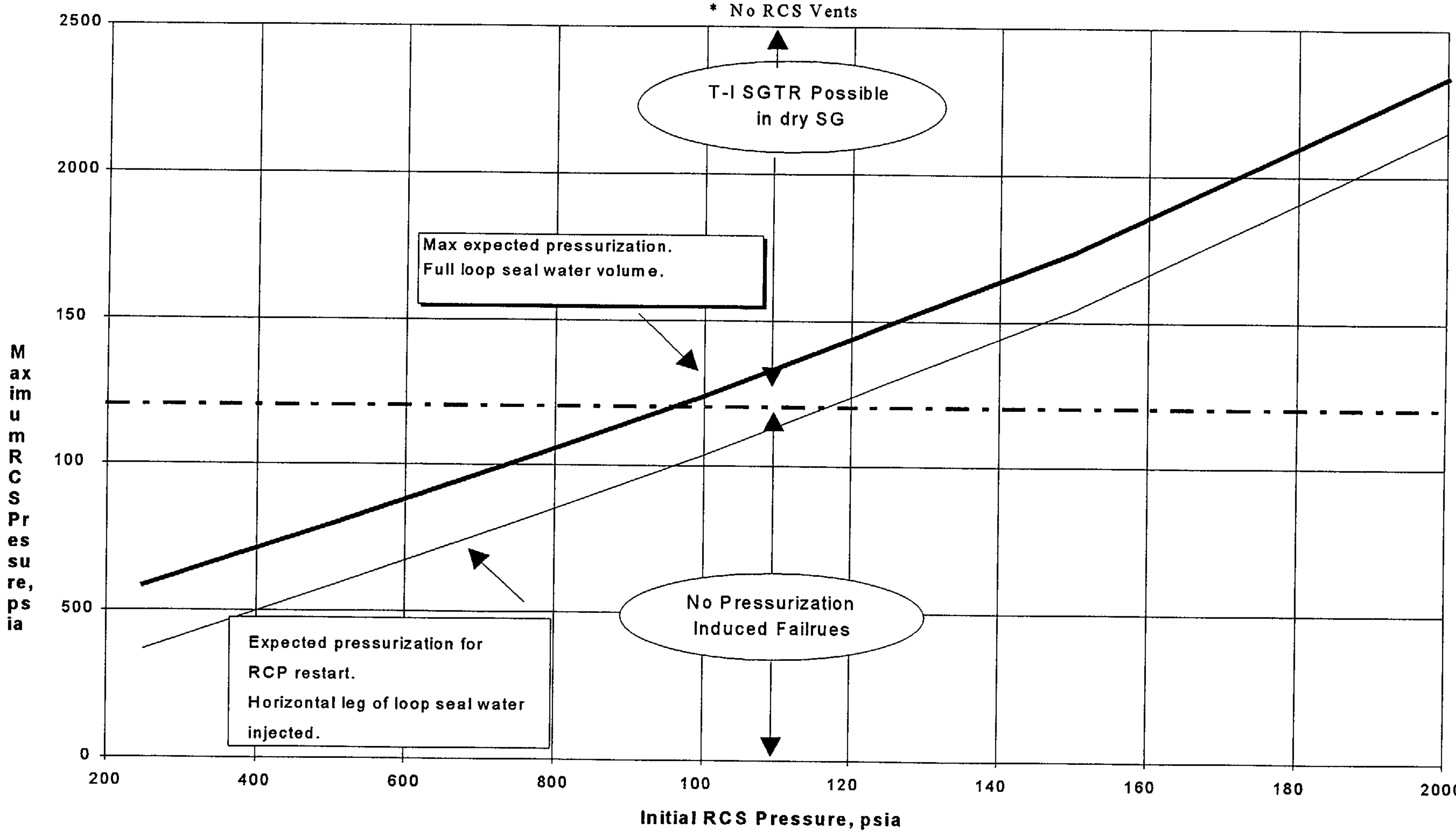


TABLE 3a-1: *CONSEQUENCES OF RCP RESTART* FOR VARIOUS PLANT ACCIDENT STATES

PLANT STATE PRIOR TO RCP RESTART						
CASE	PRE-EXISTING UNISOLATED LOCA	PORV(S) OPEN	SG AVAILABLE FOR HEAT REMOVAL	PSVs OPEN WHEN CHALLENGED	RCS PRESSURES FOLLOWING RCP RESTART	PRESSURE RELATED CONSEQUENCES OF RCP RESTART
1A	NO	NONE	NO	NO	SEE FIGURE 3a-1	• RCS PRESSURIZATION MAY CHALLENGE OPERABILITY SI INJECTION VALVES • TI-SGTR IS POSSIBLE
1B	NO	NONE	NO	YES	SEE FIGURE 3a-1. NOTE THAT IF PRESSURE > 2500 PSIA THE MAXIMUM SYSTEM PRESSURE IS EXPECTED TO BE LESS THAN 3000 PSIA	• TI-SGTR IS POSSIBLE
2	NO	1	NO	NO CHALLENGE EXPECTED	PEAK PRESSURE IN THE RANGE OF 1900 TO 2500 PSIA	• TI-SGTR IS POSSIBLE
3	NO	2	NO	NO CHALLENGE EXPECTED	PEAK PRESSURE IN THE RANGE OF 300 TO 2000 PSIA	• TI-SGTR IS POSSIBLE BUT LESS LIKELY THAN FOR CASE 2
4	YES	0	NO	NO CHALLENGE EXPECTED	PEAK PRESSURE IN THE RANGE OF 300 TO 2000 PSIA	• TI-SGTR IS POSSIBLE
5	YES	1 OR 2	NO	NO CHALLENGE EXPECTED	VARIES FROM NEGLIGIBLE TO UP TO 2500 PSIA DEPENDING UPON BREAK SIZE AND LOOP SEAL DISCHARGE	• TI-SGTR UNLIKELY DUE TO LOW INITIAL RCS PRESSURE AND PORVS WHICH DIRECT STEAM FLOW AWAY FROM DRY SGs.
6	YES	ANY COMBINATION	YES[1,2]	NO CHALLENGE EXPECTED	RCS PRESSURE NEAR MSSV SETPOINT	• TI SGTR THREAT IS VERY UNLIKELY AND IS ONLY POSSIBLE IF ONE SG IS DRY
7	NO	0	YES[1,2]	NO CHALLENGE EXPECTED	SEE FIGURE 3a-2	
8	NO	1 OR 2	YES[1,2]	NO CHALLENGE EXPECTED	RCS PRESSURE NEAR MSSV SETPOINT	

1. Steam generators with a water level on the secondary side greater than 10 feet above the tubesheet may be considered sufficiently wetted that TI-SGTR will not occur.
2. It is important that both SGs contain inventory to assure TI-SGTR can be avoided

TABLE 3b-1: *CONSEQUENCES OF CORE DEBRIS REFLOOD* FOR VARIOUS PLANT ACCIDENT STATES

PLANT STATE PRIOR TO CORE DEBRIS REFLOOD*,**						
CASE	PRE-EXISTING UNISOLATED LOCA	PORV(S) OPEN	SG AVAILABLE FOR HEAT REMOVAL	PSVs OPEN WHEN CHALLENGED	RCS PRESSURES FOLLOWING REFLOOD	PRESSURE RELATED CONSEQUENCES OF REFLOOD
1A	NO	NONE	NO	NO	RCS PRESSURE WILL EXCEED 2500 PSIA. MUCH GREATER PRESSURIZATION UNLIKELY DUE TO LIMITATIONS IN THE ABILITY TO INJECT INTO A HIGH PRESSURE RCS. NOTE FIGURE 3a-1/3a-2 MAY BE USED TO ESTIMATE PRESSURIZATION. FOR THIS APPLICATION THE LOWER BOUND LINE REPRESENTS THE EQUIVALENT INJECTION OF ABOUT 250 GALLONS OF WATER, WHILE THE UPPER BOUND LINE CORRESPONDS TO THE INJECTION AND VAPORIZATION OF 800 GALLONS OF WATER	• TI-SGTR IS POSSIBLE
1B	NO	NONE	NO	YES	PEAK PRESSURE IN VICINITY OF 2500 PSIA	• TI-SGTR IS POSSIBLE
2	NO	1	NO	CHALLENGE POSSIBLE	PEAK PRESSURE IN THE RANGE OF 1900 TO 2500 PSIA	• TI-SGTR IS POSSIBLE
3	NO	2	NO	NO CHALLENGE EXPECTED	PEAK PRESSURE IN THE RANGE OF 300 TO 2000 PSIA	• TI-SGTR IS POSSIBLE BUT LESS LIKELY THAN FOR CASE 2
4	YES	0	NO	NO CHALLENGE EXPECTED	PEAK PRESSURE IN THE RANGE OF 2000 PSIA	• TI-SGTR IS POSSIBLE
5	YES	1 OR 2	NO	NO CHALLENGE EXPECTED	VARIES FROM NEGLIGIBLE TO UP TO 2500 PSIA DEPENDING UPON BREAK SIZE AND LOOP SEAL DISCHARGE	• TI-SGTR UNLIKELY DUE TO LOW INITIAL RCS PRESSURE AND PORVS WHICH DIRECT STEAM FLOW AWAY FROM DRY SGs.
6	YES	ANY COMBINATION	YES[1,2]	NO CHALLENGE EXPECTED	RCS PRESSURE NEAR MSSV SETPOINT	• TI SGTR THREAT IS VERY UNLIKELY AND IS ONLY POSSIBLE IF ONE SG IS DRY
7	NO	0	YES[1,2]	NO CHALLENGE EXPECTED	PEAK RCS PRESSURE BELOW 2000 PSIA	
8	NO	1 OR 2	YES[1,2]	NO CHALLENGE EXPECTED	RCS PRESSURE NEAR MSSV SETPOINT	

1. Steam generators with a water level on the secondary side greater than 10 feet above the tubesheet may be considered sufficiently wetted that TI-SGTR will not occur.
2. Note, it is important that both SGs contain inventory to assure TI-SGTR can be avoided.
* RCS pressures following reflood are approximate
** Note pressure spike will also be limited by the capability and delivery of the injection source

Figure 4a-1
RV Head/Pressurizer Vent Steam Flow Rate as a
Function of RCS Pressure

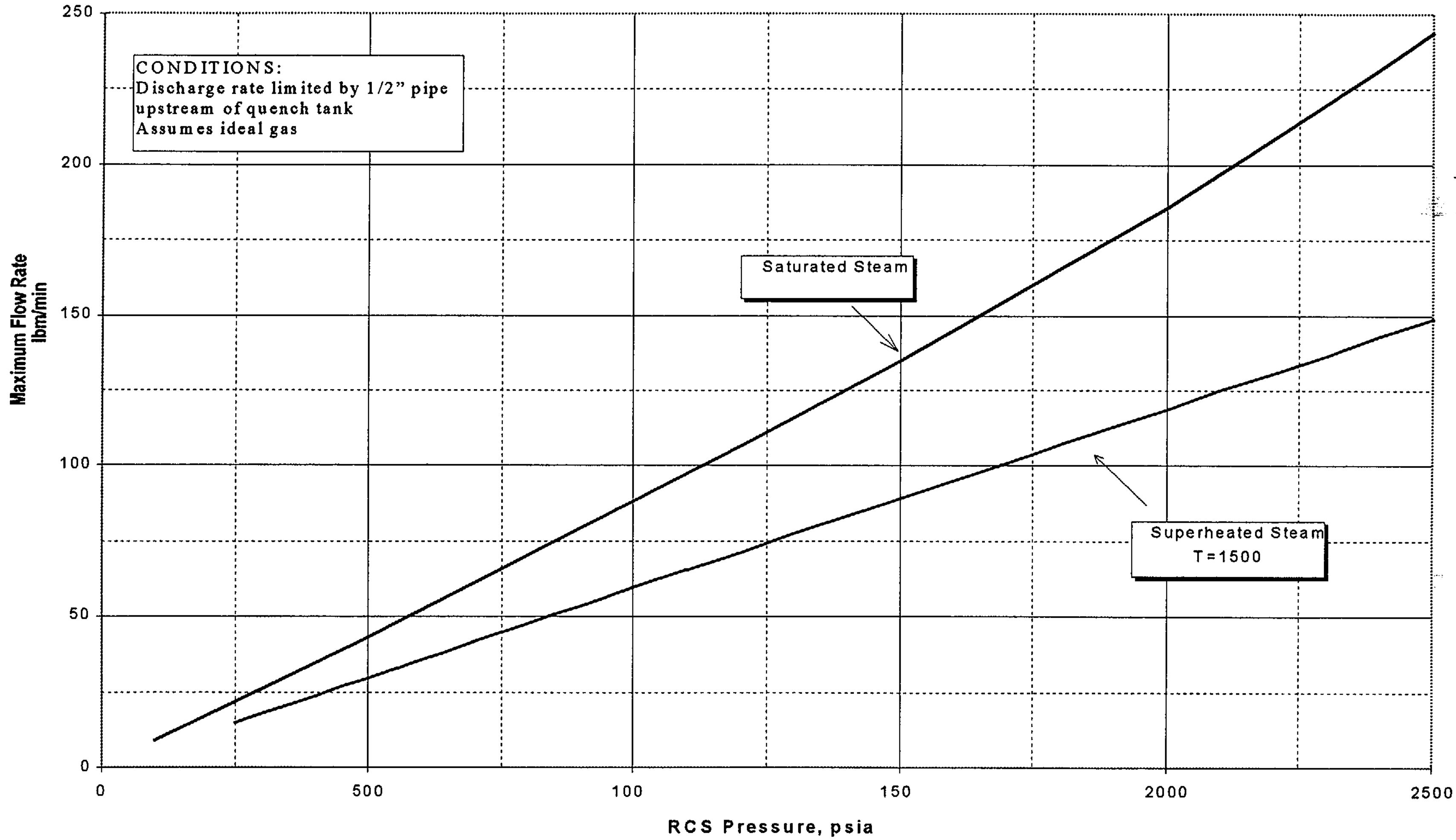


Figure 4a-2
Hydrogen Discharge Rate from RV/PZR Head Vent vs. RCS Pressure

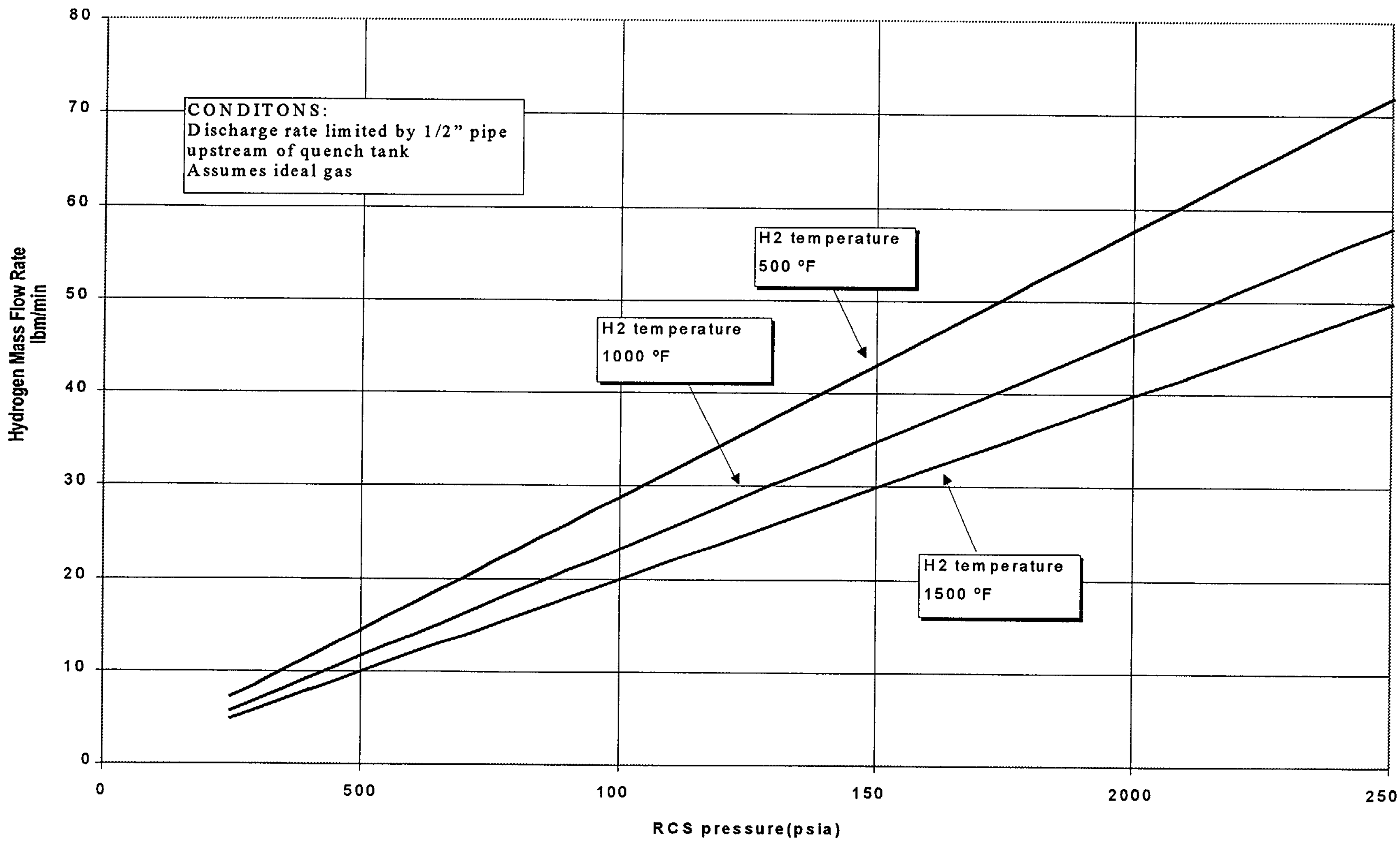


Figure 4a-3

Time Required to Vent Hydrogen From RCS as a Function of RCS Gas Temperature

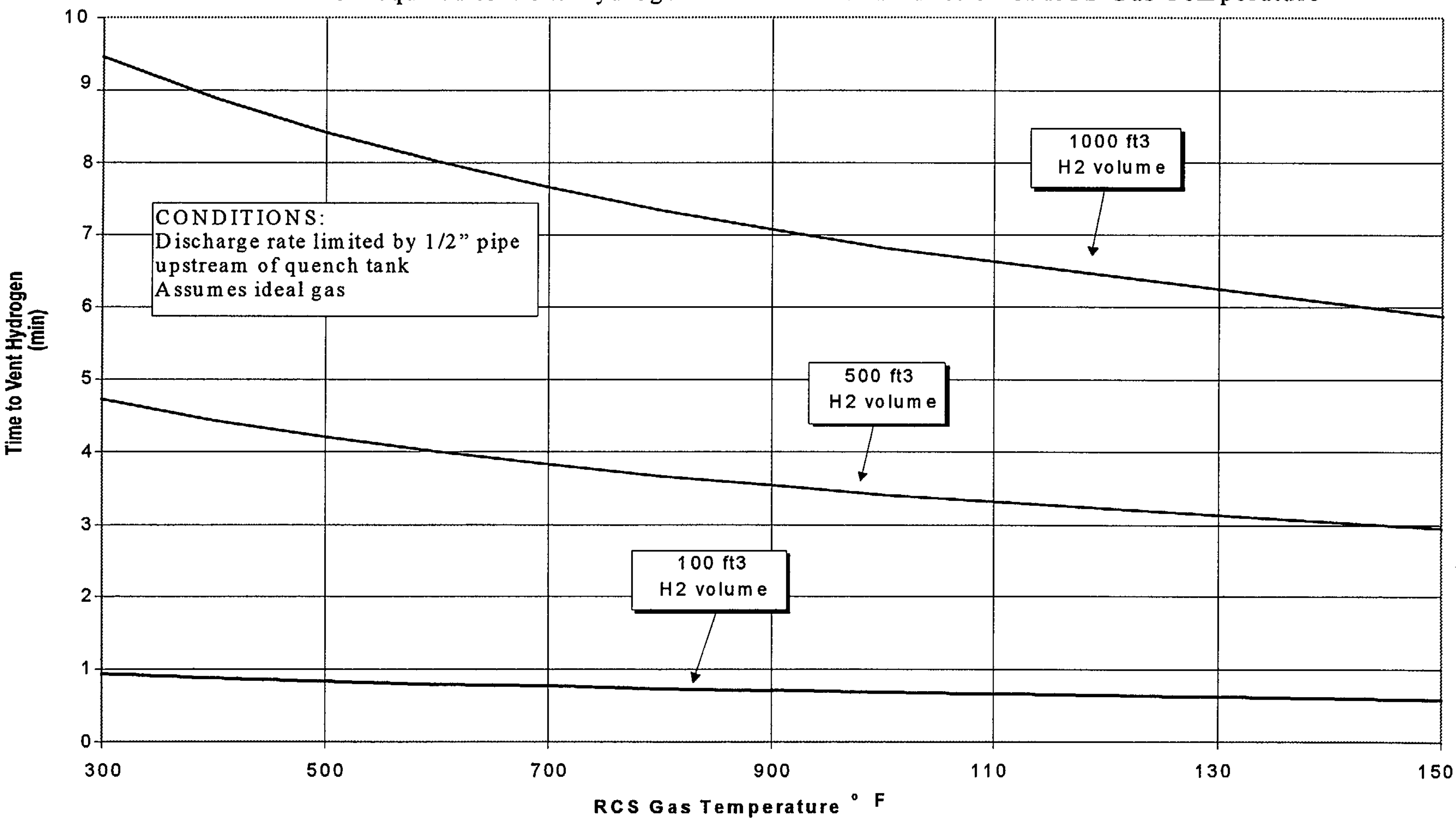


Figure 4b-1
PORV Mass Flow Rate as a
Function of RCS Pressure

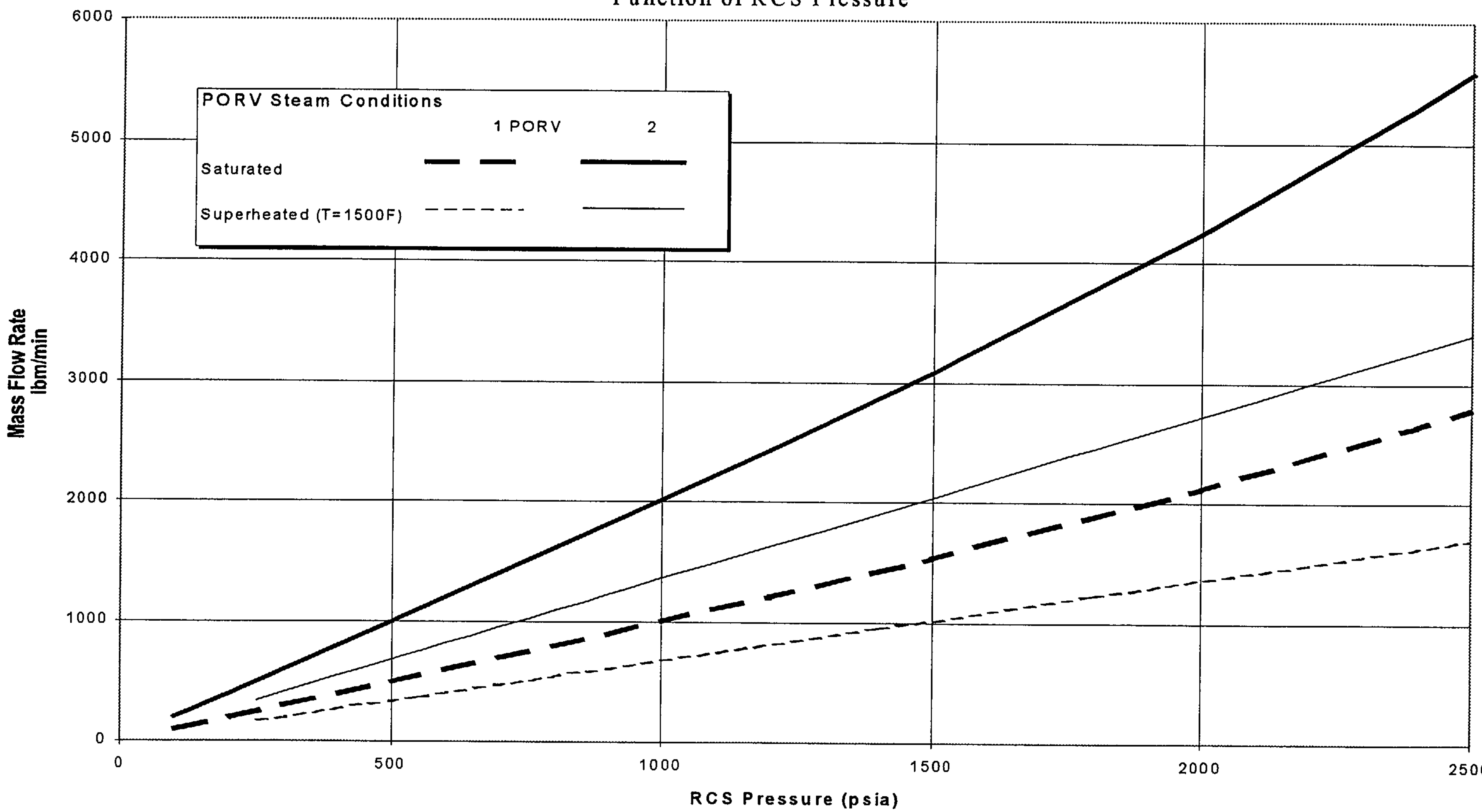


Figure 4b-2
PORV Energy Flow Rate as a
Function of RCS Pressure

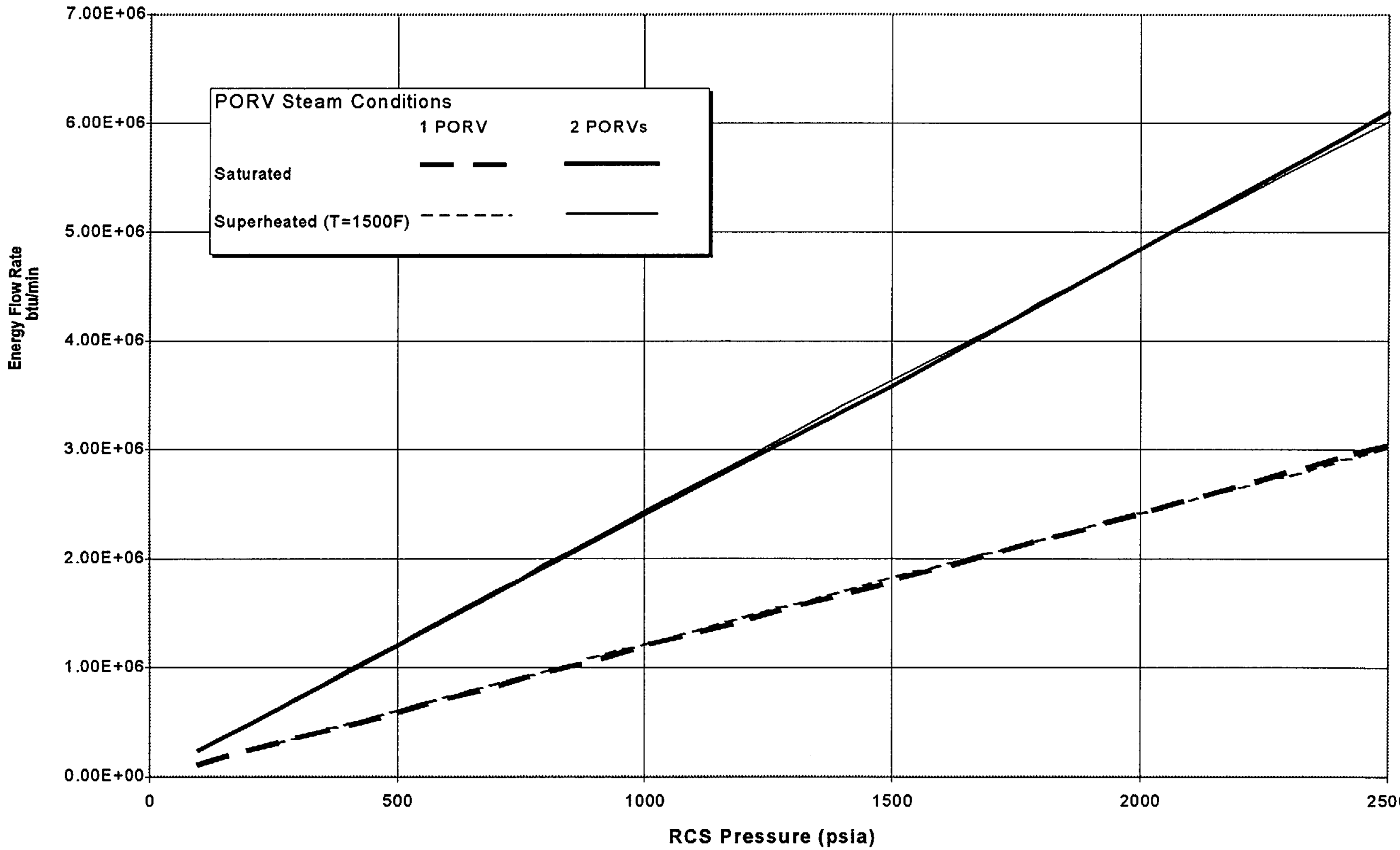


Figure 4b-3

Available Resources For High Pressure Injection

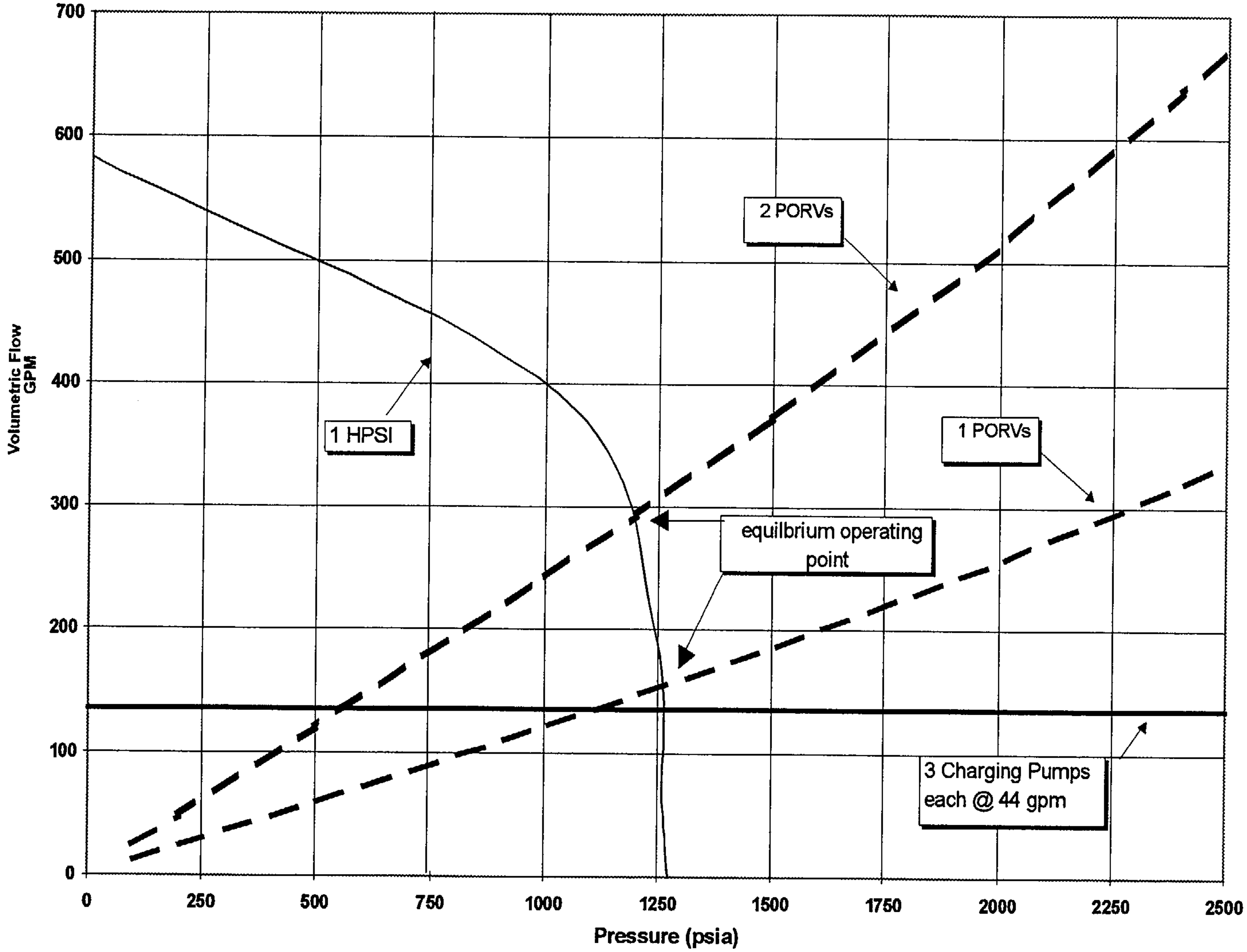


Figure 4c-1

RCS Depressurization Rate For Venting Saturated Steam

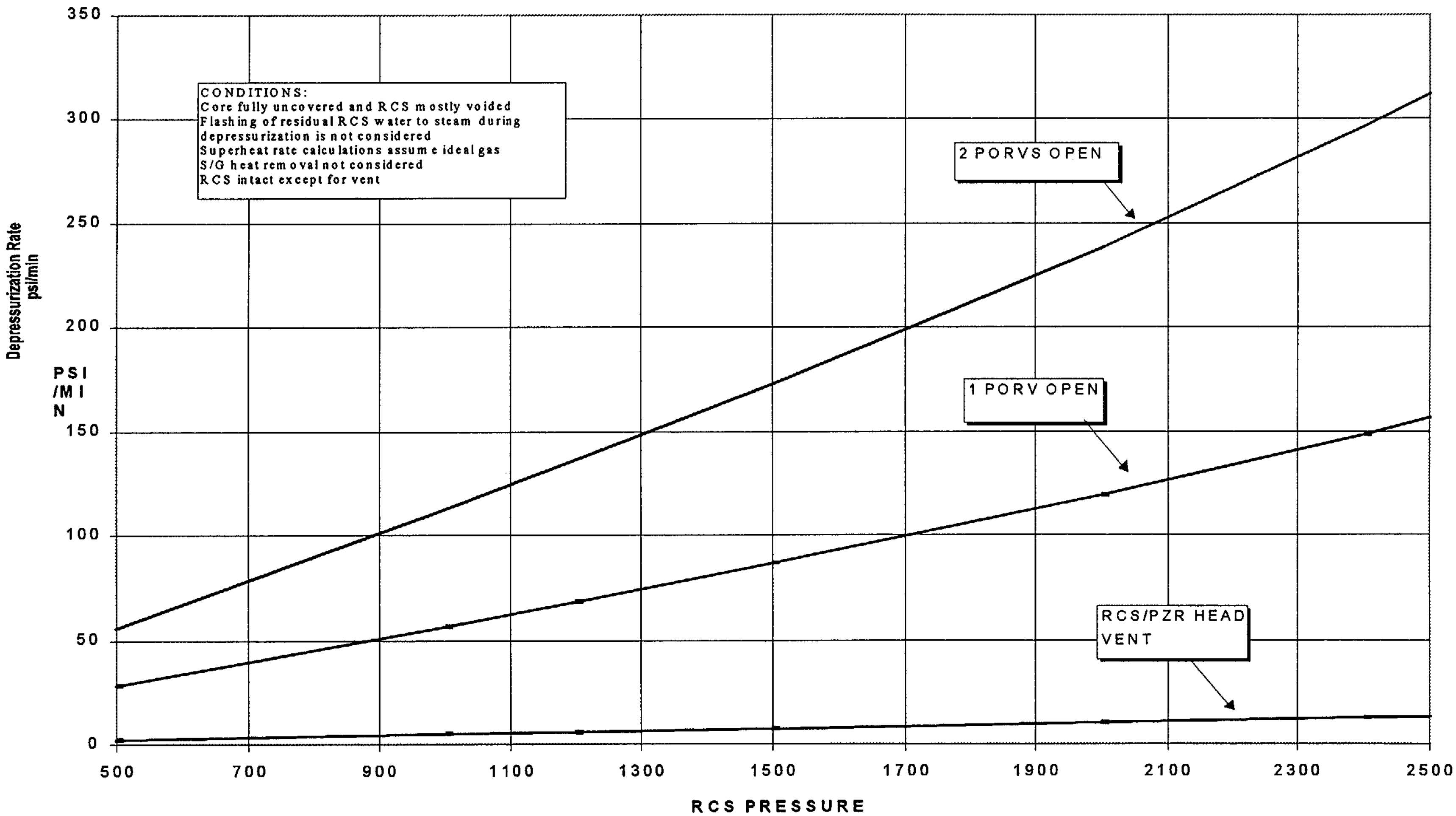


Figure 4c-2

RCS Depressurization Rate Venting Steam at 1500F

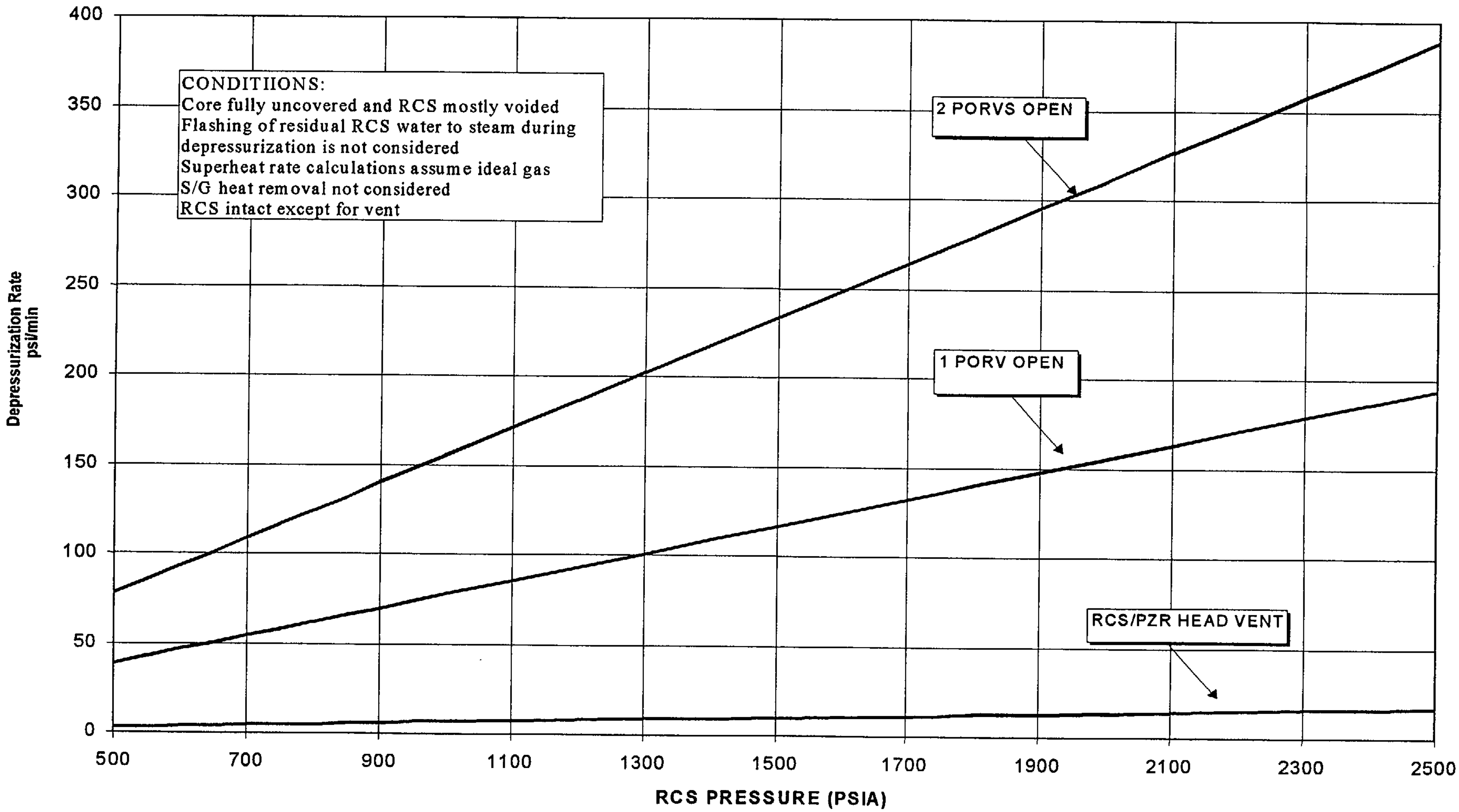


Table 5a-1

Fraction Zircaloy Oxidized and Containment Hydrogen (v/o dry measurement) No Core Recovery			
Scenario/ Event	**Fraction of Zircaloy Oxidized (no Reflood)**	**Equivalent Mass of Hydrogen Generated**	**Hydrogen Concentration (dry)**
	--	(lbm)	volume %
Station Blackout with stuck open PORV or Extended total loss of feedwater	**0.50**	**1250**	**11.4**
Large LOCA w/o SI -initial core uncovery	**0.40**	**1000**	**9.3**
Small LOCA w/o SI - initial core uncovery	**0.35**	**875**	**8.3**

* H2 concentrations are referenced to a dry containment atmosphere (no steam) at 100 F.
Radiolytic H2 production is comparatively small and is neglected.
For SBO, H2 mostly trapped in RCS until vessel breach.
For LOCAs, H2 mostly distributed in containment.

Table 5a-2

Fraction Zircaloy Oxidized and Containment Hydrogen (v/o dry measurement) Core Reflooded			
Scenario/ Event	Fraction of Zircaloy Oxidized (w/reflood) *	Equivalent Mass of Hydrogen Generated*	Hydrogen Concentration, Dry
	--	(lbm)	volume %
Station Blackout with stuck open PORV or Extended total loss of feedwater	**0.75**	**1875**	**16.2**
Large LOCA w/o SI -initial core uncovery	**0.65**	**1625**	**14.3**
Small LOCA w/o SI - initial core uncovery	**0.6**	**1500**	**13.4**

* H2 concentrations are referenced to a dry containment atmosphere (no steam) at 100 F.
Radiolytic H2 production is comparatively small and is neglected.
For SBO, H2 mostly trapped in RCS until vessel breach.
For LOCAs, H2 mostly distributed in containment.

Figure 5b-1: Hydrogen Production Event and Progression Decision Tree

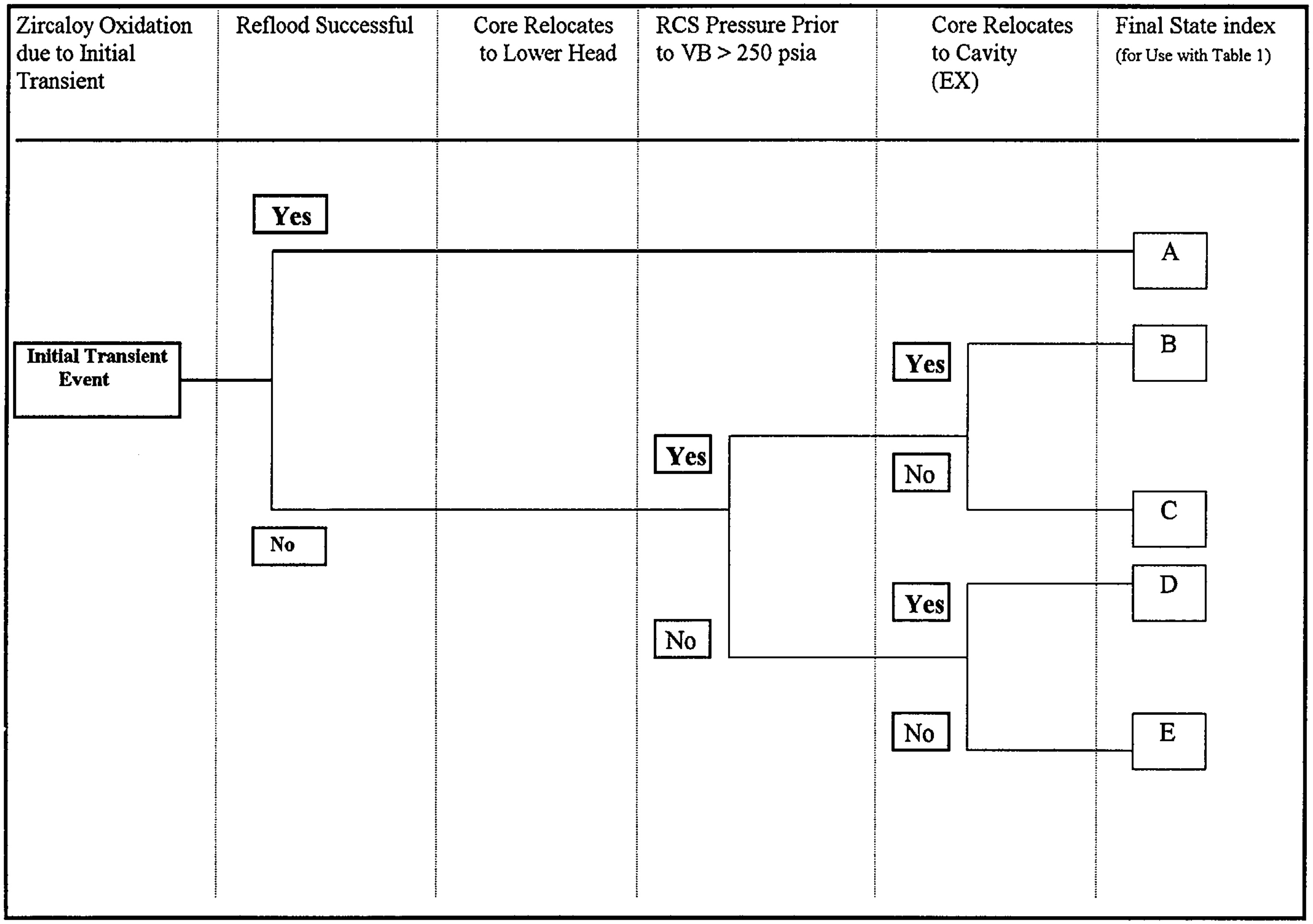


Table 5b-1:
Fraction Zircaloy Oxidized and v/o Hydrogen in Containment (dry measurement)

Scenario / Event Description	Parameter	Final State Index A Core Reflooded	Final State Index B EX:HP-WETC	Final State Index C EX:HP-DRYC	Final State Index D EX:LP-WETC	Final State Index E EX:LP-DRYC
Station Blackout with stuck open PORV or Extended total loss of feedwater	Fraction of Zr Oxidized	0.75	0.78	0.73	0.77	>1.0
	Mass of H2 produced (lbm)	1875	1950	1825	1940	>2500
	Volume % H2 (Dry)	16.2	16.7	15.8	16.6	>20.5
Large LOCA w/o SI -initial core uncovery	Fraction of Zr Oxidized	0.65	0.74	0.68	.73	>1
	Mass of H2 produced (lbm)	1625	1840	1690	1830	>2500
	Volume % H2 (Dry)	14.3	15.9	14.8	15.8	>20.5
Small LOCA w/o SI - initial core	Fraction of Zr Oxidized	0.60	0.71	0.65	.70	>1
	Mass of H2 produced (lbm)	1500	1785	1622	1770	>2500
	Volume % H2 (Dry)	13.4	15.5	14.3	15.4	>20.5

Figure 5c-1
Hydrogen Generation Rate due to Corrosion of Containment Materials

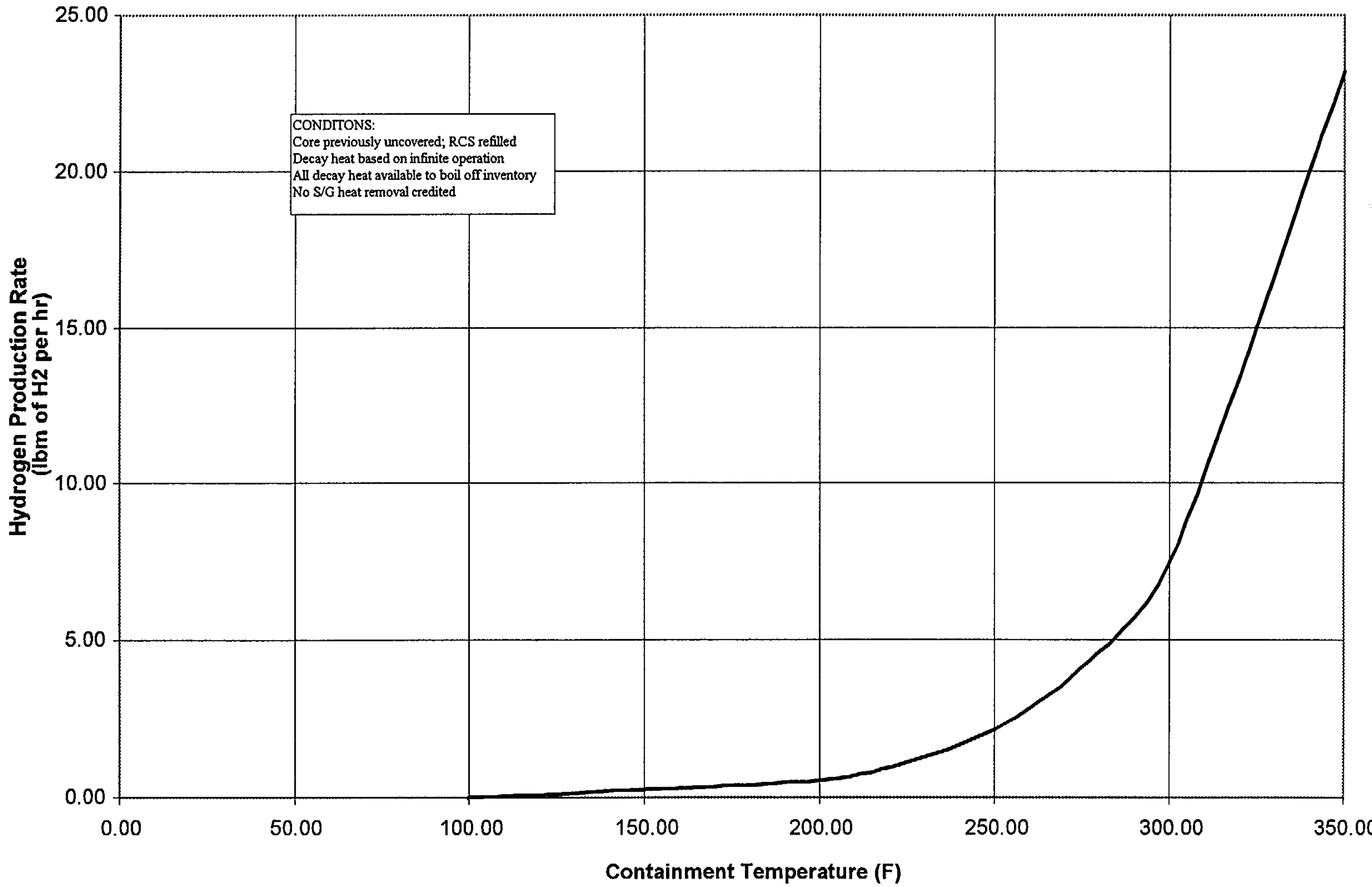


Figure 5c-2
Long Term Hydrogen Production
Due To Containment Metal Oxidation*
(PH = 7.5)

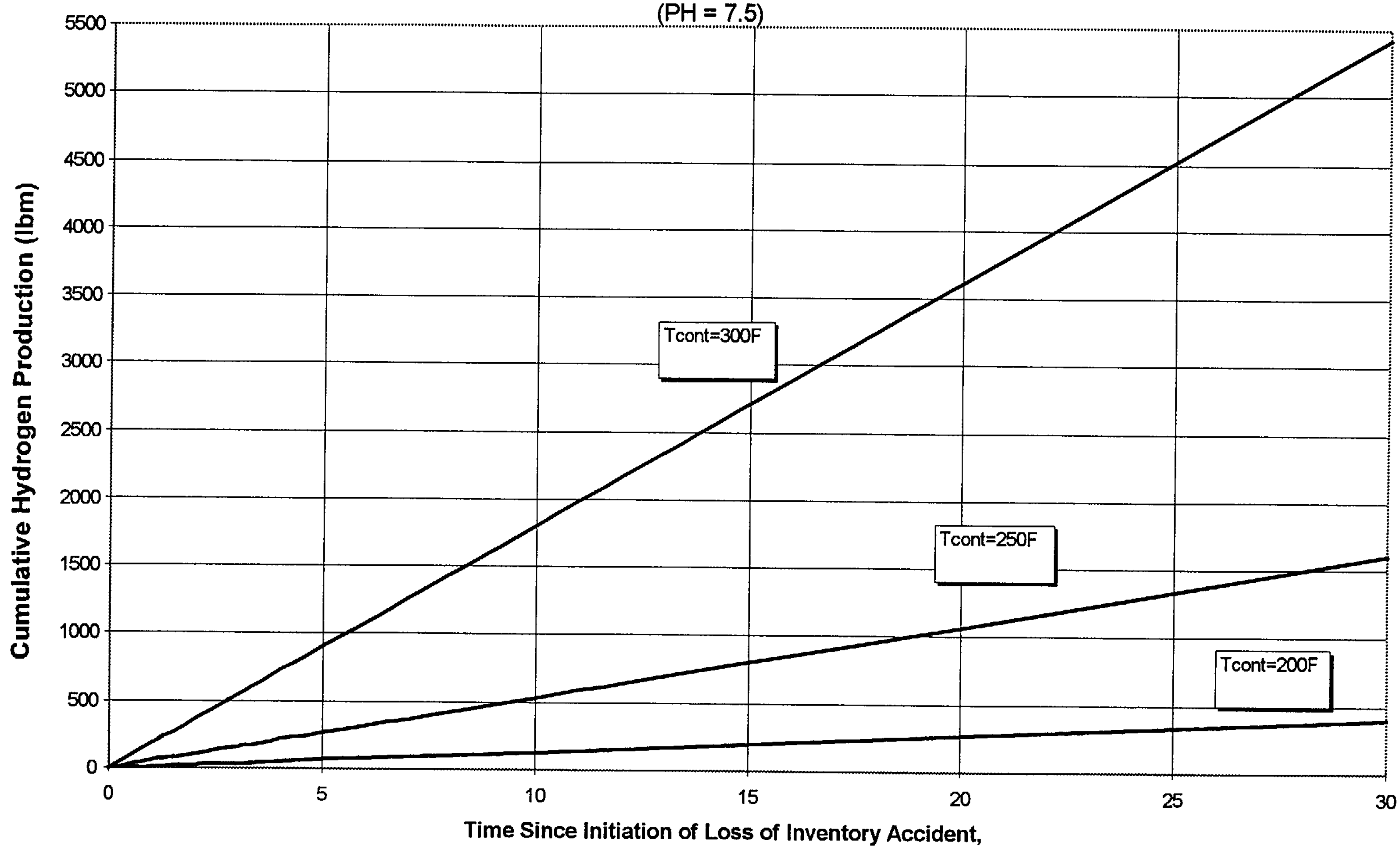


Table 6-1
USE OF EX-CORE NUCLEAR INSTRUMENTATION (NI) TO ASSESS CORE DAMAGE PROGRESSION

INSTRUMENT	NORMAL OPERATION	SEVERE ACCIDENT RESPONSE
STARTUP AND WIDE RANGE CHANNELS NI DEVICE USED AS A NEUTRON DETECTOR	DECREASING CPS AS Br^{87} DECAYS AT A RATE OF 1/3 DECADE PER MINUTE. FALL OFF RATE DECREASES IN 20 MINUTES AS NEUTRON SOURCE IS DOMINATED BY D_2O-GAMMA-NEUTRON REACTION.	AT INITIAL CORE UNCOVERY, CPS MAY STABILIZE CPS INCREASES AS CORE UNCOVERY PROGRESSES (DUE TO INCREASE NEUTRON LEAKAGE) UNCOVERY RESPONSE MAY BE INITIALLY MASKED BY CHANGES IN WATER AVAILABILITY EXTERNAL TO THE REACTOR VESSEL Note: Activities contributing to: (a) RV Refill, (b) cavity flooding, (c) temporary relocation of water into the core or (d) relocation of core material to the lower plenum will be evident by a decrease in neutron count rate. Caution: Once significant core uncovery has occurred, the decrease in water availability will cause the neutron production rate to drop (decrease in D_2O reaction). Care should be taken not to interpret this signal as an indication of core recovery.

Table 6-1
USE OF EX-CORE NUCLEAR INSTRUMENTATION (NI) TO ASSESS CORE DAMAGE PROGRESSION

INSTRUMENT	NORMAL OPERATION	SEVERE ACCIDENT RESPONSE
POWER RANGE DETECTORS MAY BE USED AS GAMMA FLUX INDICATORS VIA DIRECT SENSING OF DETECTOR CURRENT CURRENT MONITORS SENSE GAMMA FLUX FROM EXTERIOR CORE BUNDLES DC OUTPUT OF THE POWER RANGE NI MUST BE READ MANUALLY USING A PICO-AMMETER	DATA SHOULD BE INTERPRETED BASED ON CURRENT TYPICAL OF STARTUP AND REACTOR SHUTDOWN.	INCREASING GAMMA FLUXES MAY INDICATE UNCOVERY, HOWEVER, GAMMA FLUXES ARE NOT VERY SENSITIVE TO WATER LOSS CHANGING GAMMA FLUXES MORE INDICATIVE OF RELOCATION OF FISSION PRODUCTS LARGE DOSE INCREASES (CURRENT) UPON RV FAILURE (TRANSITORY) LARGE DOSE READINGS IF CORIUM BED FORMS IN CAVITY Note: Typical detector currents during core uncovery are on the order of 10^{-9} amps. Following a scenario including a lower head vessel breach (VB), this current will abruptly rise. The magnitude of the rise will depend upon: 1. extent of cavity flooding 2. RCS pressure at VB. Low RCS pressures (<250 psia) are conducive to molten pool formation and lower aerosolization of fission products. Current increases may vary from a factor of 2 to up to 3 orders of magnitude for high pressure melt ejection conditions. (See Figure 6-1)

Figure 6-1

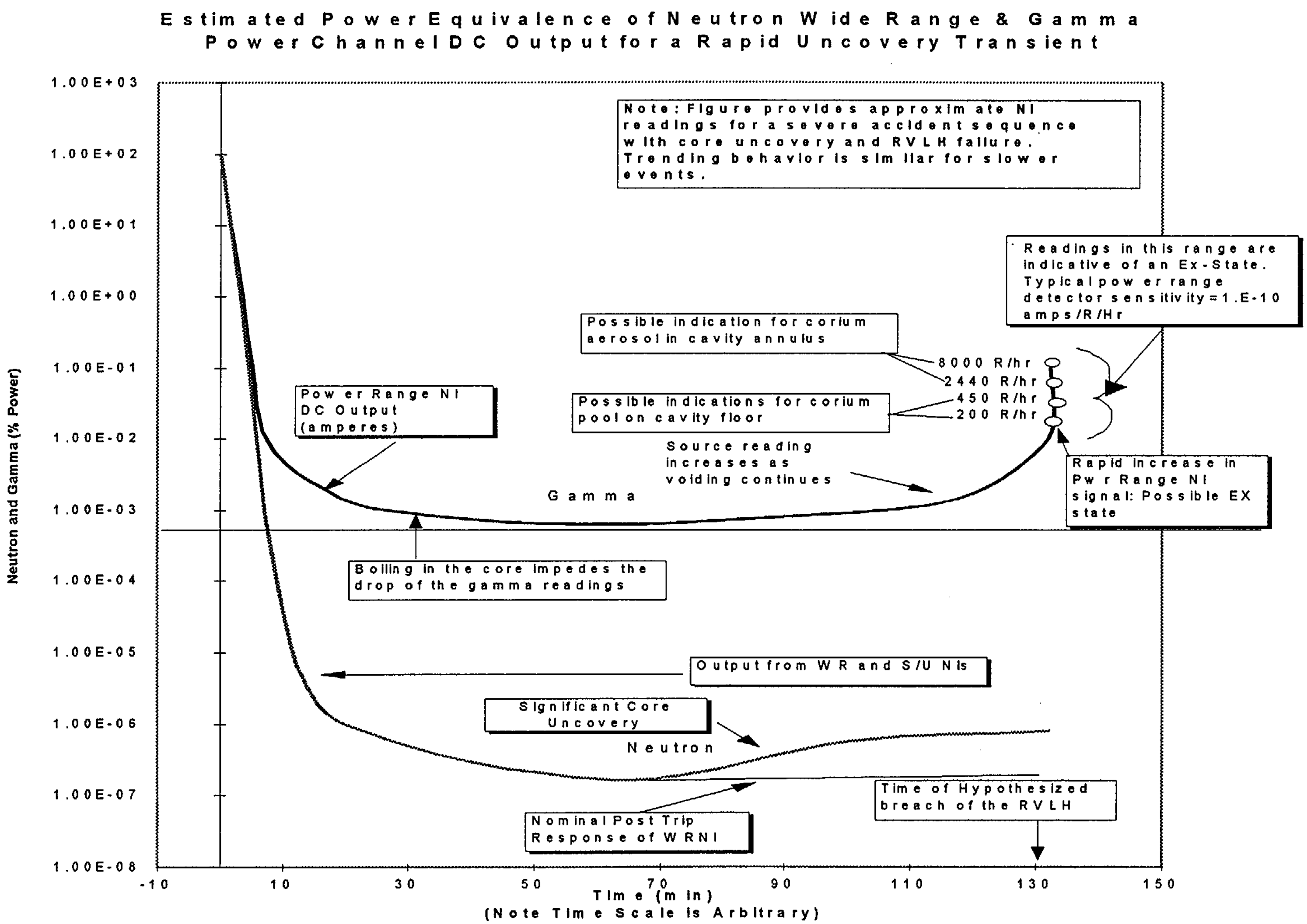

Estimated Power Equivalence of Neutron Wide Range & Gamma Power Channel DC Output for a Rapid Uncovery Transient
Note: Figure provides approximate NI readings for a severe accident sequence with core uncovery and RVLH failure. Trending behavior is similar for slower events.
Readings in this range are indicative of an Ex-State. Typical power range detector sensitivity = 1.E-10 amps/R/Hr
Possible indication for corium aerosol in cavity annulus
8000 R/hr
2440 R/hr
450 R/hr
200 R/hr
Possible indications for corium pool on cavity floor
Power Range NI DC Output (amperes)
Source reading increases as voiding continues
Gamma
Rapid increase in Pwr Range NI signal: Possible EX state
Boiling in the core impedes the drop of the gamma readings
Output from WR and S/U NIs
Significant Core Uncovery
Neutron
Time of Hypothesized breach of the RVLH
Nominal Post Trip Response of WRNI
Neutron and Gamma (% Power)
1.00E+03
1.00E+02
1.00E+01
1.00E+00
1.00E-01
1.00E-02
1.00E-03
1.00E-04
1.00E-05
1.00E-06
1.00E-07
1.00E-08
-10
10
30
50
70
90
110
130
150
Time (min)
(Note Time Scale is Arbitrary)

Figure 7-2

Hydrogen Combustibility Chart Based on Dry Hydrogen Measurement

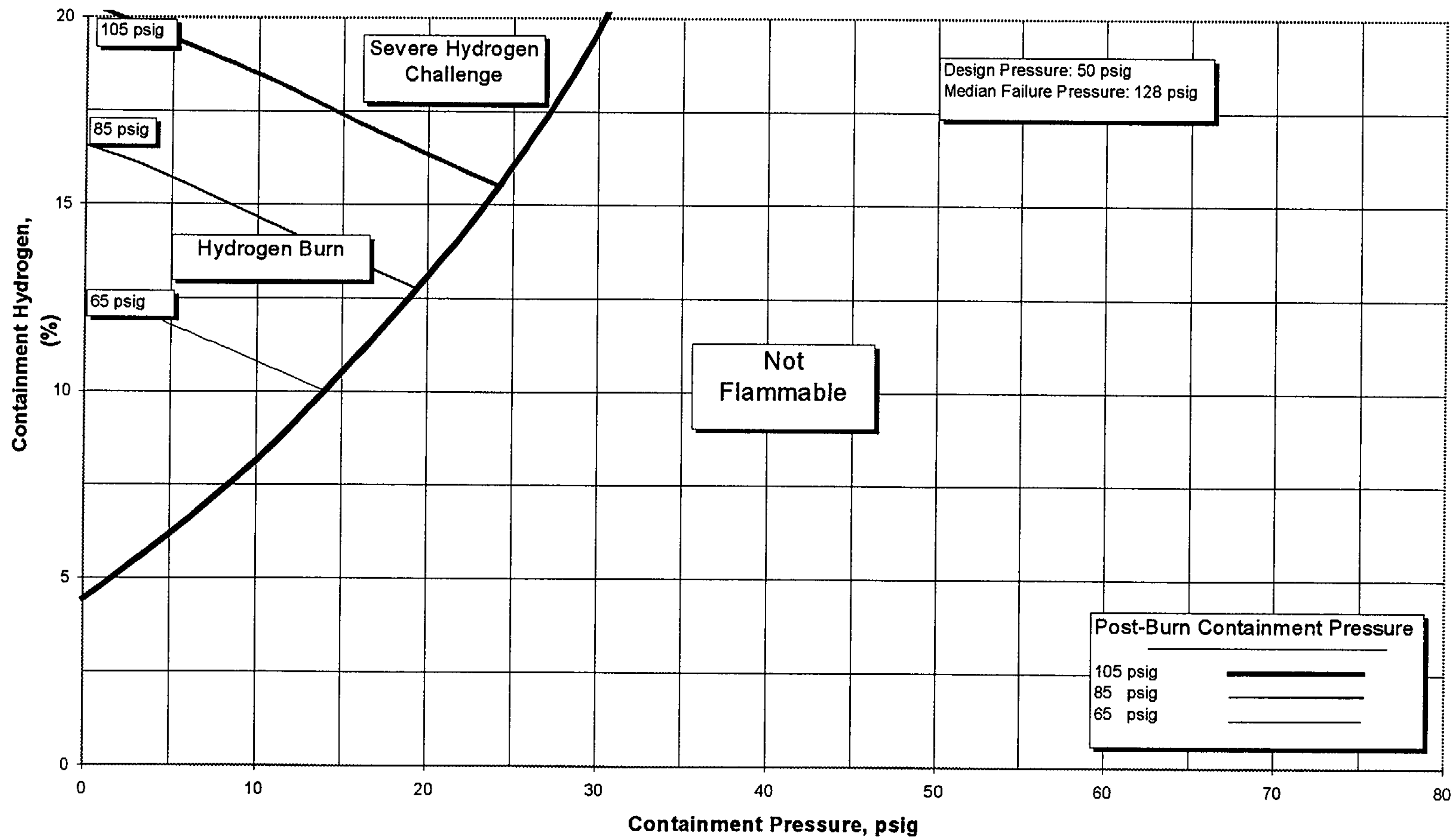


Figure 7-4

Hydrogen Combustibility Chart Based on Dry Hydrogen Measurement (Containment Vented 30%)

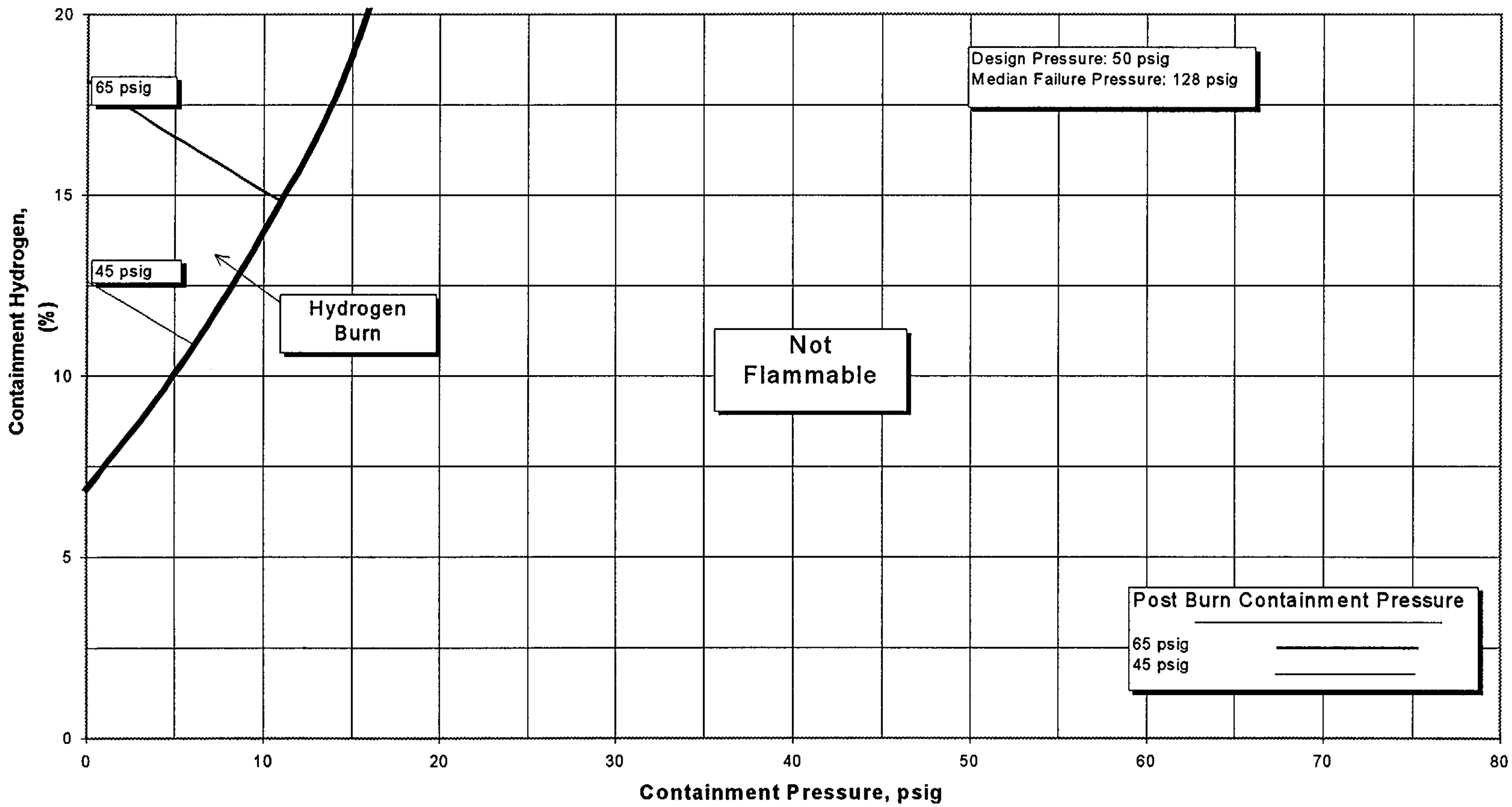


Figure 8-1

Containment Pressure Following RCS Creep Failure or RV Lower Head Failure in the presence of a Dry Reactor Cavity

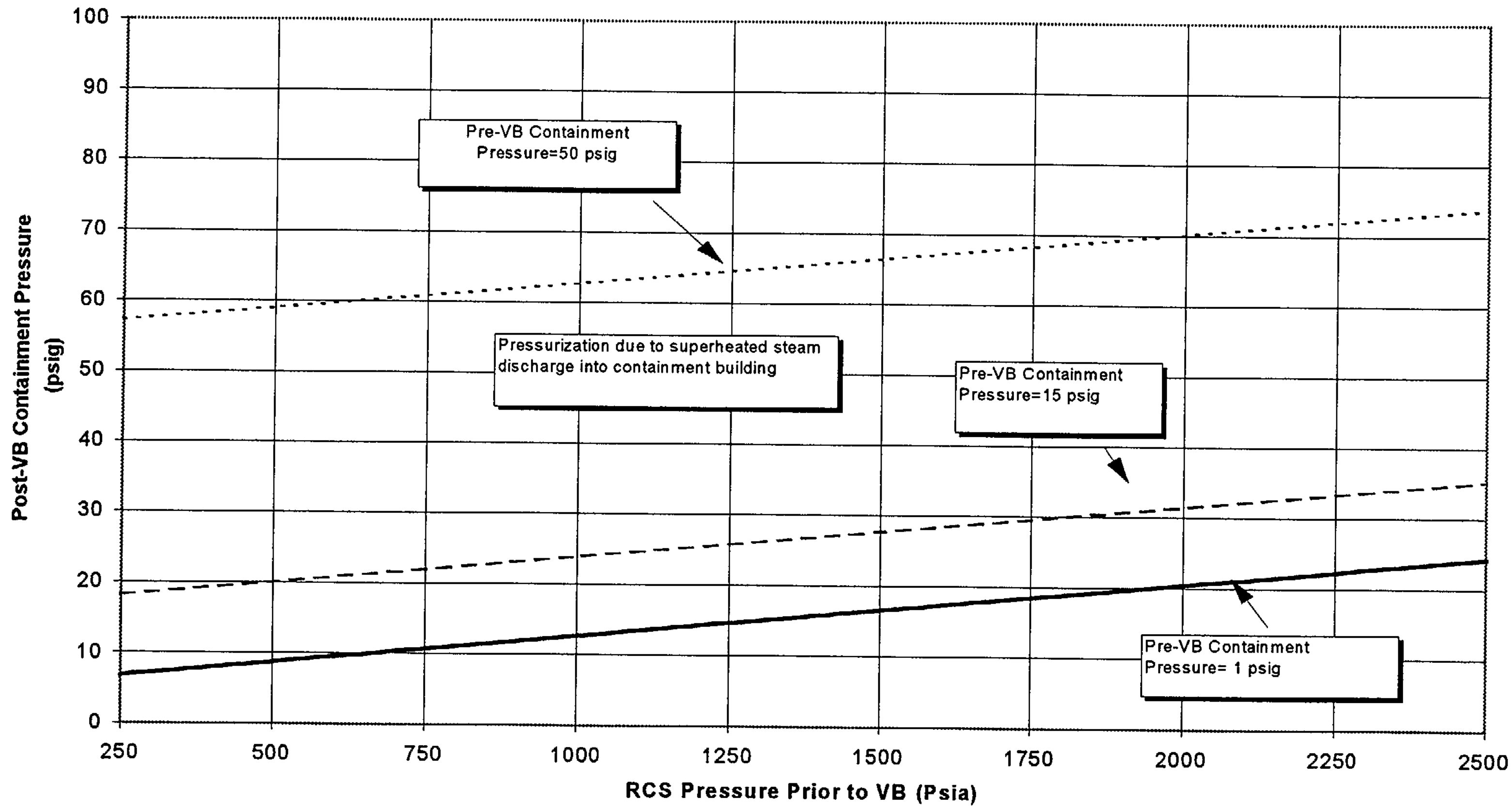


Figure 8-2

Post VB Containment Pressure Following Corium discharge into a Wet Reactor Cavity

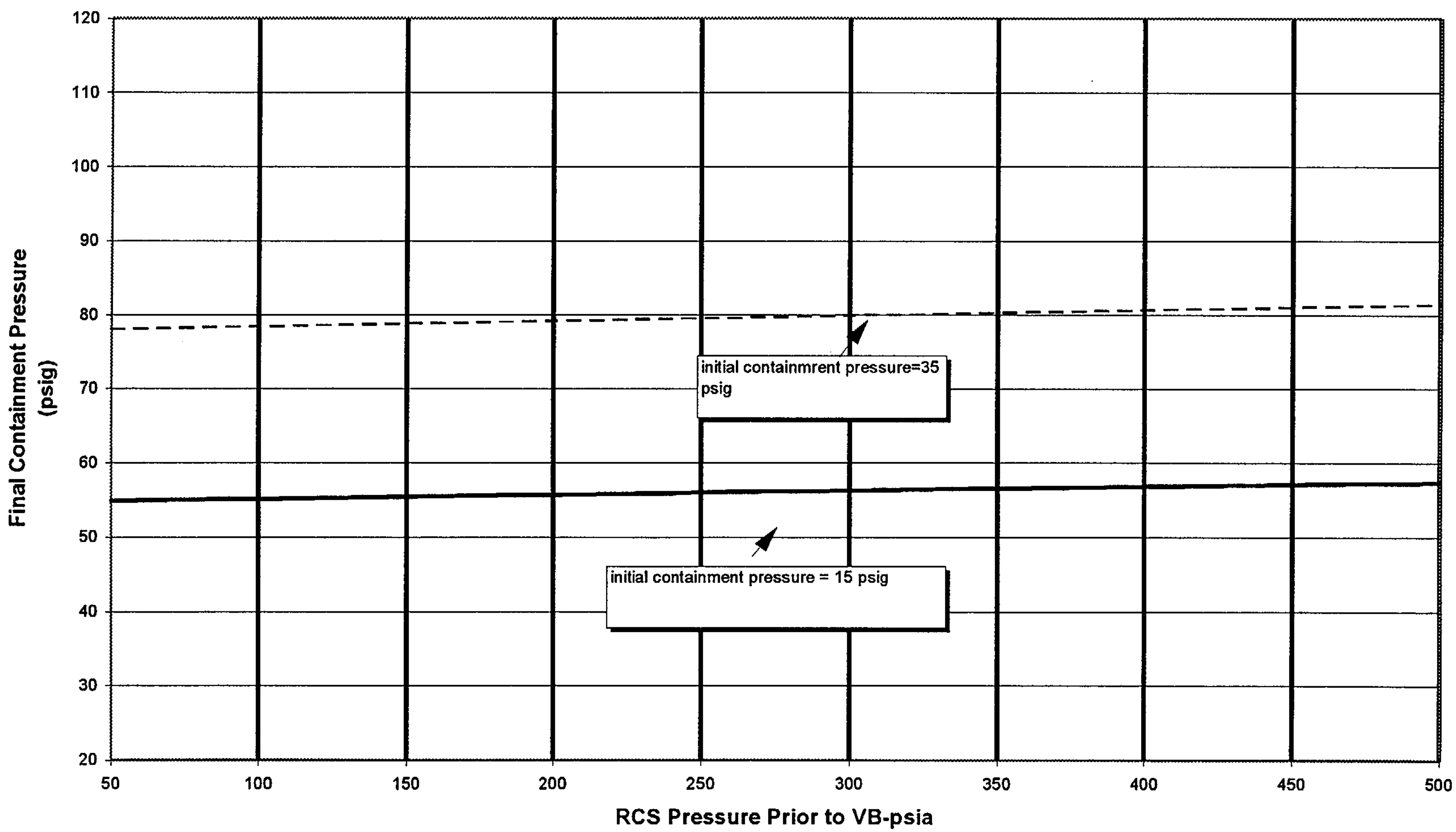


Figure 8-3
Containment Pressure following Discharge of Corium Debris into a "Wet" Reactivity Cavity

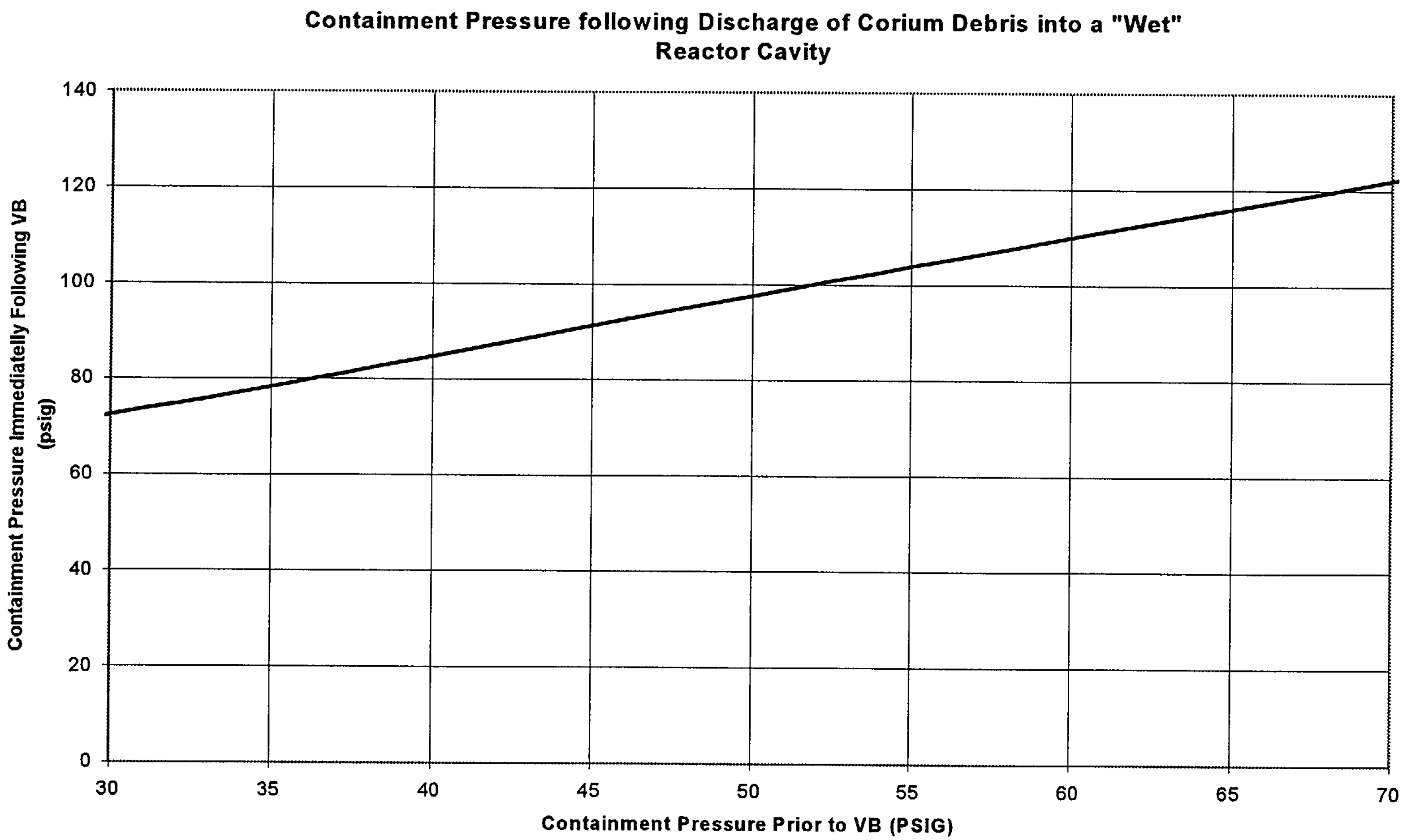


Figure 8-4

Minimum Expected Time to Pressurize the Containment to Various Pressure Levels following RVLH failure in the presence of a "Wet" reactor cavity

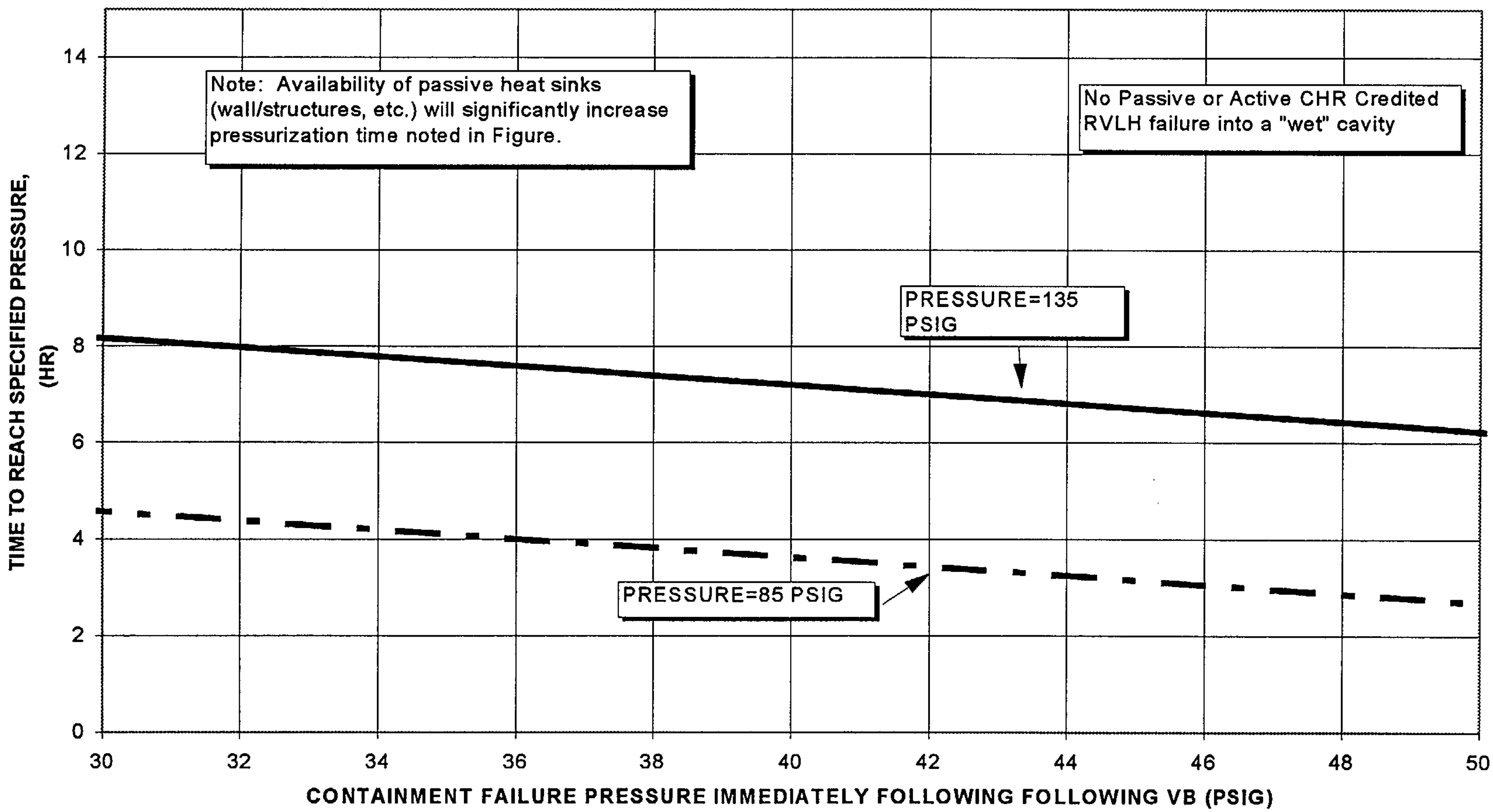


Figure 8-5

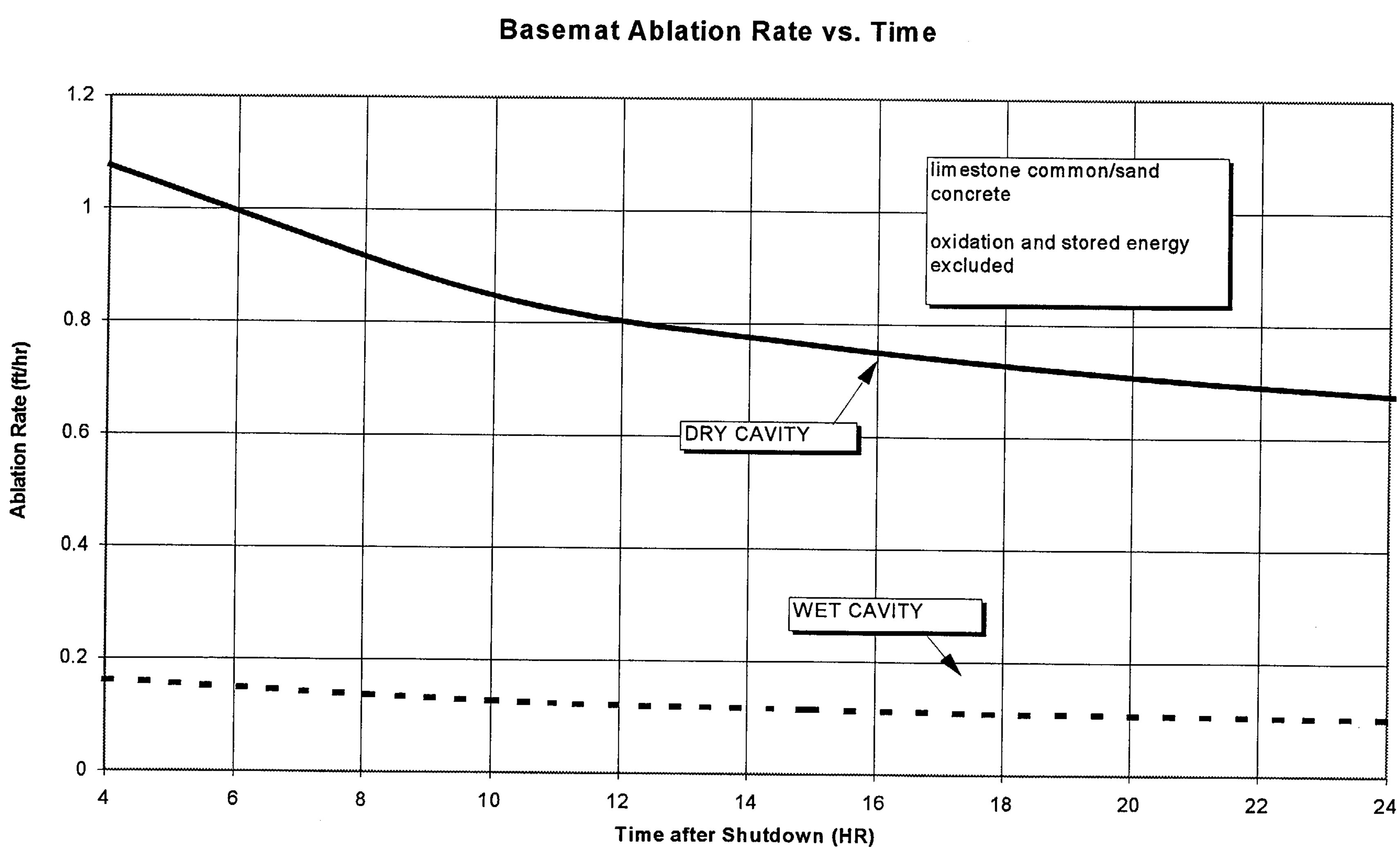

Basemat Ablation Rate vs. Time
1.2
1
0.8
0.6
0.4
0.2
0
Ablation Rate (ft/hr)
4
6
8
10
12
14
16
18
20
22
24
Time after Shutdown (HR)
limestone common/sand concrete
oxidation and stored energy excluded
DRY CAVITY
WET CAVITY

Figure 9-1
Venting Mass Flow Rate vs. Containment Pressure

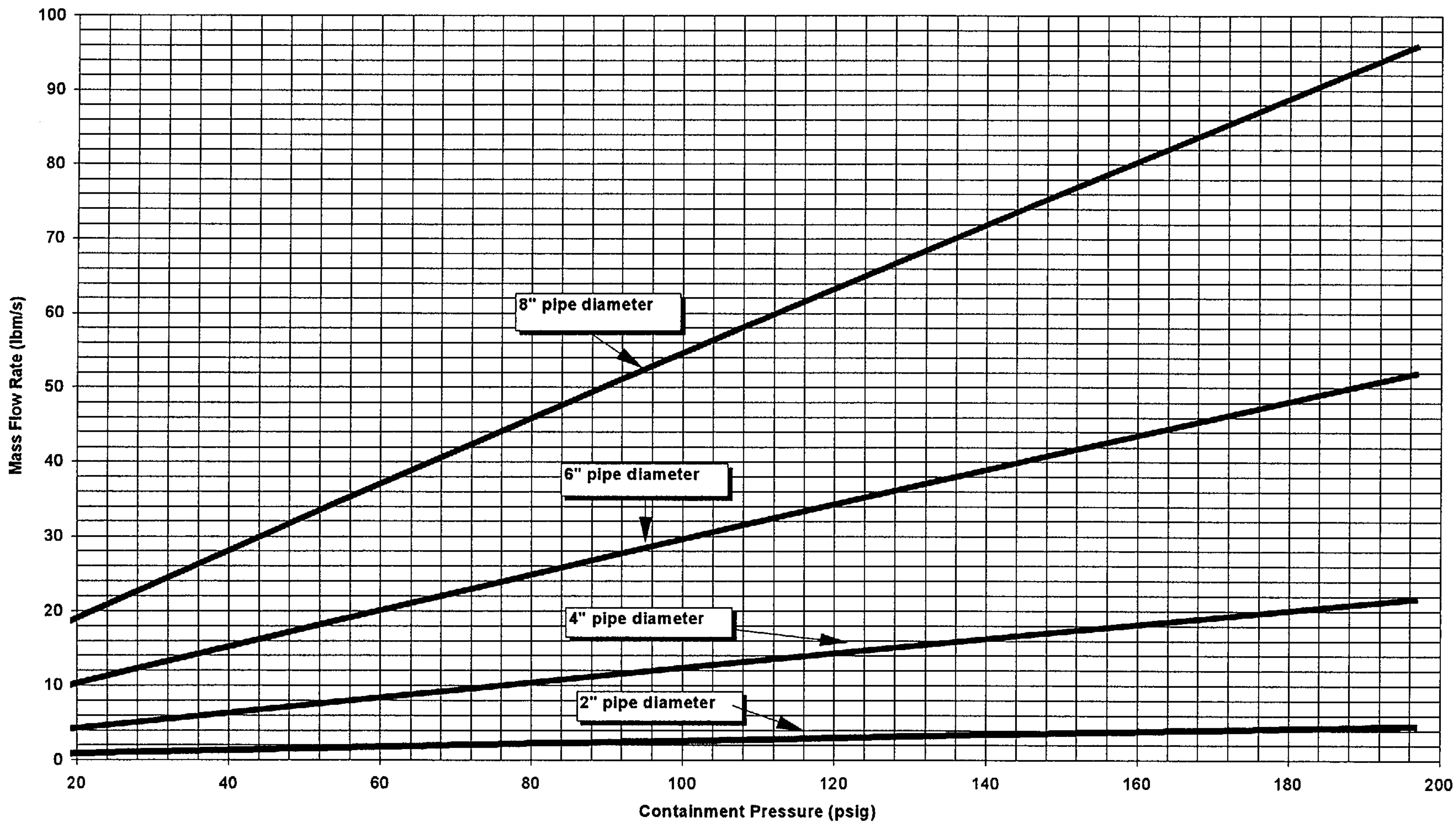


Figure 9-2
Mass Fraction of Air, Steam and Hydrogen in Containment Atmosphere

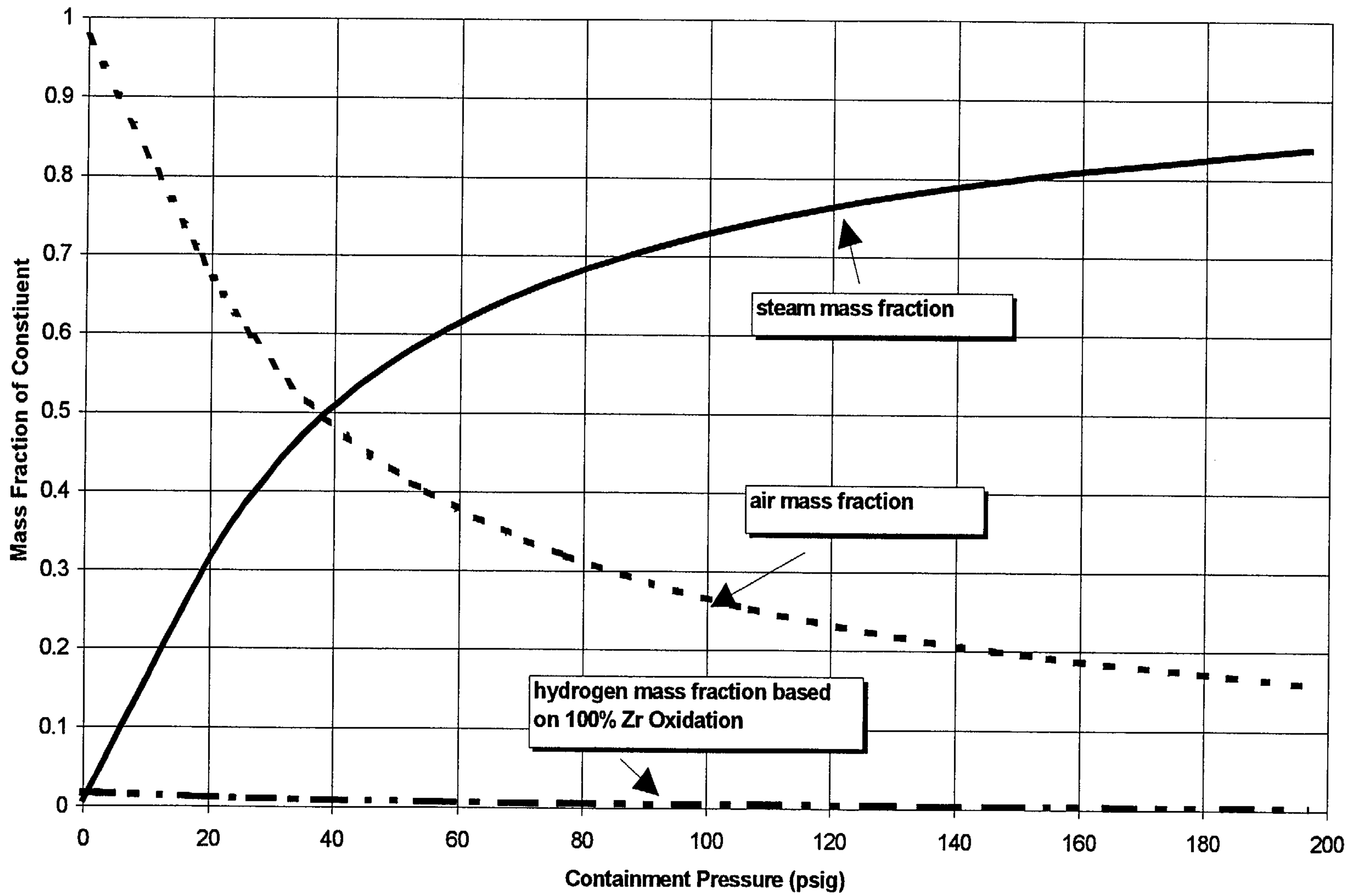


Figure 9-3

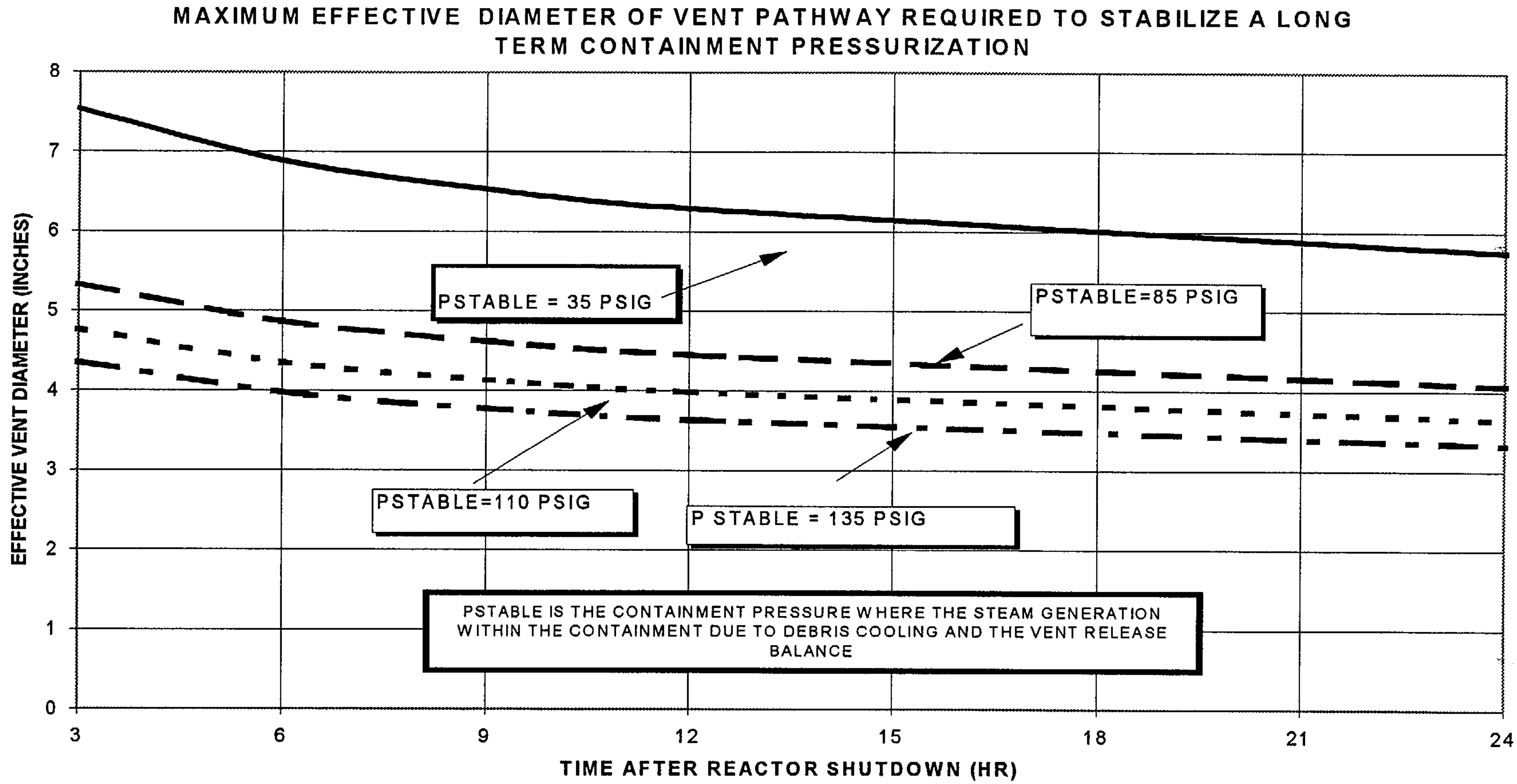

MAXIMUM EFFECTIVE DIAMETER OF VENT PATHWAY REQUIRED TO STABILIZE A LONG TERM CONTAINMENT PRESSURIZATION
EFFECTIVE VENT DIAMETER (INCHES)
0
1
2
3
4
5
6
7
8
PSTABLE = 35 PSIG
PSTABLE=85 PSIG
PSTABLE=110 PSIG
P STABLE = 135 PSIG
PSTABLE IS THE CONTAINMENT PRESSURE WHERE THE STEAM GENERATION WITHIN THE CONTAINMENT DUE TO DEBRIS COOLING AND THE VENT RELEASE BALANCE
3
6
9
12
15
18
21
24
TIME AFTER REACTOR SHUTDOWN (HR)

Figure 10-1

Containment Temperature/Pressure Correlation

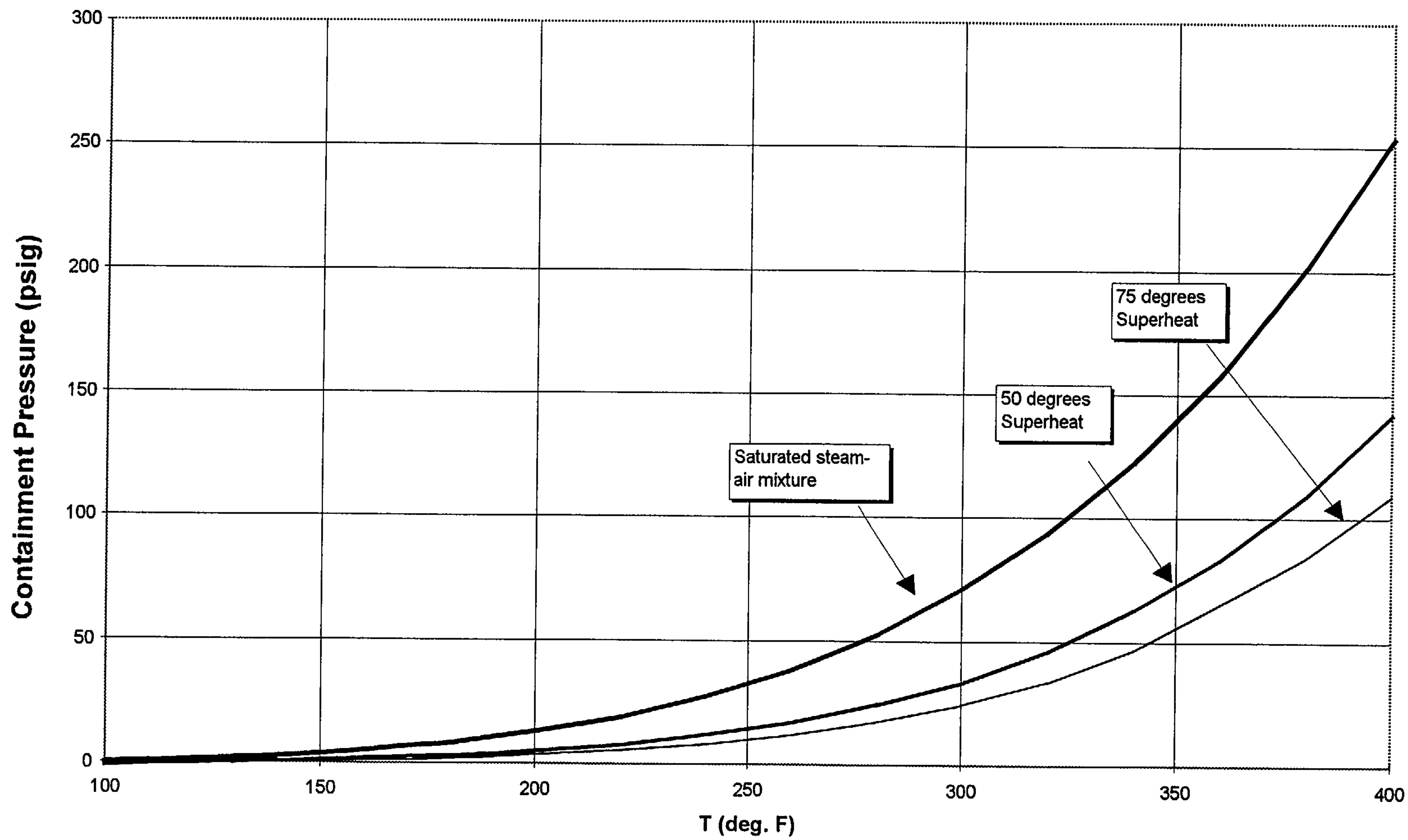


Figure 10-2
Steam Partial Pressure vs. Containment Pressure (Saturated Steam/Air Mixture)

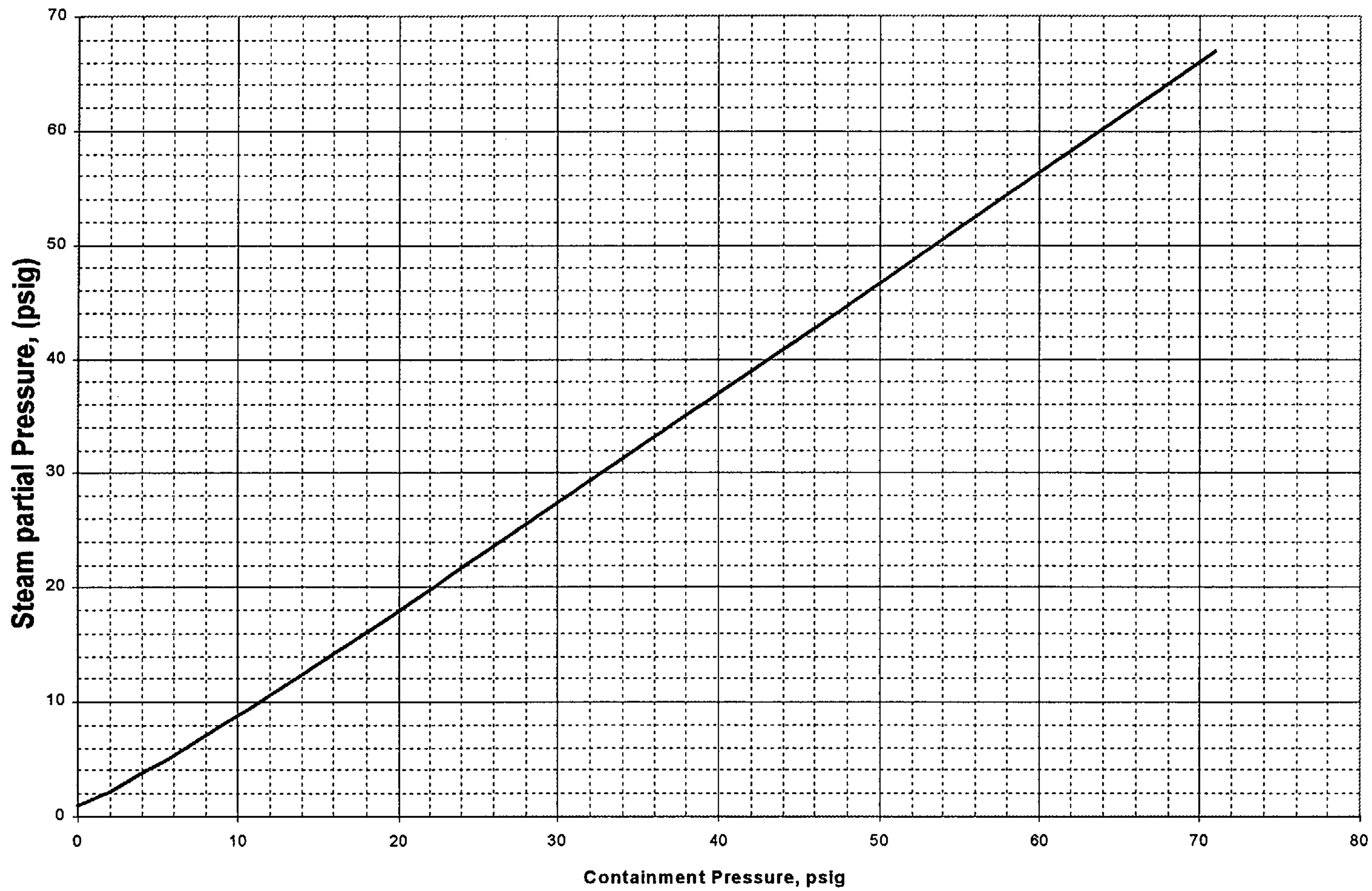


Figure 10-3

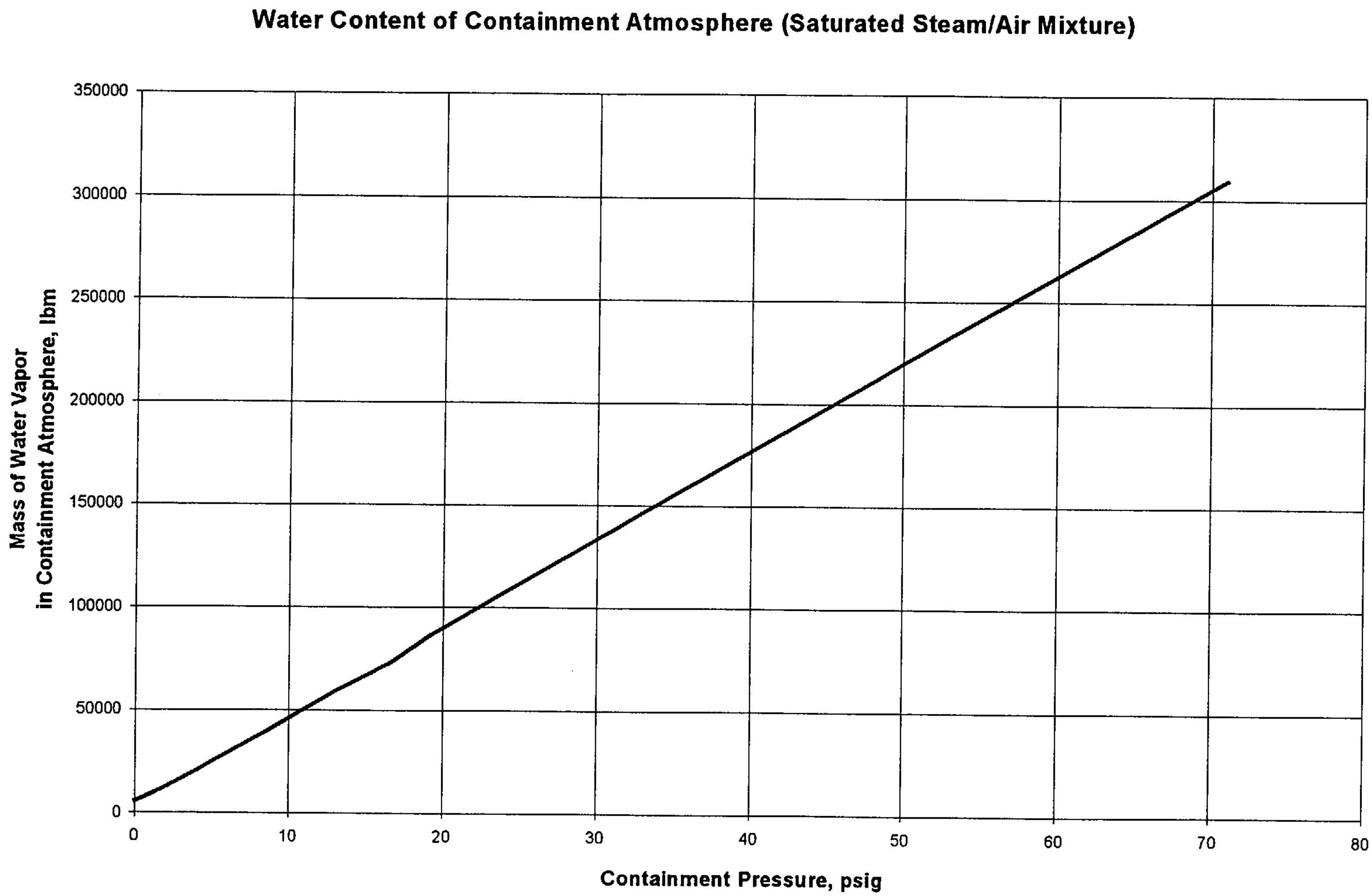
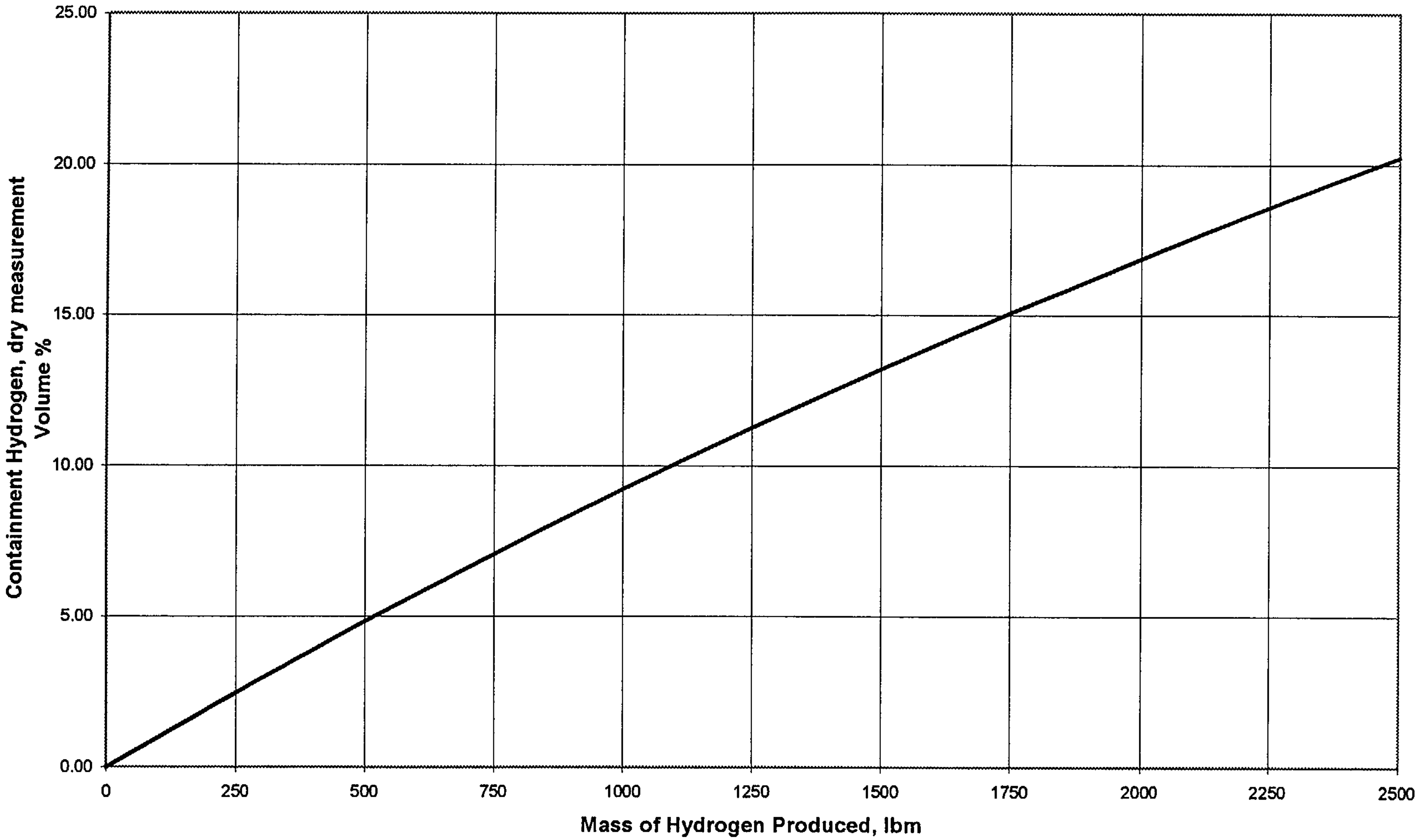

Water Content of Containment Atmosphere (Saturated Steam/Air Mixture)
Mass of Water Vapor
in Containment Atmosphere, lbm
350000
300000
250000
200000
150000
100000
50000
0
0
10
20
30
40
50
60
70
80
Containment Pressure, psig

Figure 10-4
Volume Percent Hydrogen (DRY)
Mass of Hydrogen in the Containment



LIST OF EFFECTIVE PAGES

Cumulative NORMs changes to this revision: 0

PAGE	REVISION	EDITORIAL CORRECTION
1	1	
2	1	
3	1	
4	1	
5	1	
6	1	
7	1	
8	1	
9	1	
10	1	
11	1	
12	1	
13	1	
14	1	
15	1	
16	1	
17	1	
18	1	
19	1	
20	1	
21	1	
22	1	
23	1	
24	1	
25	1	
26	1	
27	1	
28	1	
29	1	
30 thru 39	1	
40 thru 44	1	

ATTACHMENT	REVISION	EDITORIAL CORRECTION
Attachment 1, Pages 1-21	1	
Attachment 2, Pages 1-3	1	
Attachment 3	1	
Attachment 4, Pages 1-2	1	
Attachment 5, Pages 1 - 45	1	