CALVERT CLIFFS NUCLEAR POWER PLANT
TECHNICAL PROCEDURE

EMERGENCY RESPONSE PLAN
IMPLEMENTATION PROCEDURES

## ERPIP-611

# SEVERE ACCIDENT MANAGEMENT RESTORATIVE ACTIONS

REVISION 2

**Safety Related** √ **Non-Safety Related** ____

# REFERRAL USE

Periodically refer to procedure during use.

**APPROVAL AUTHORITY** D. Bauder

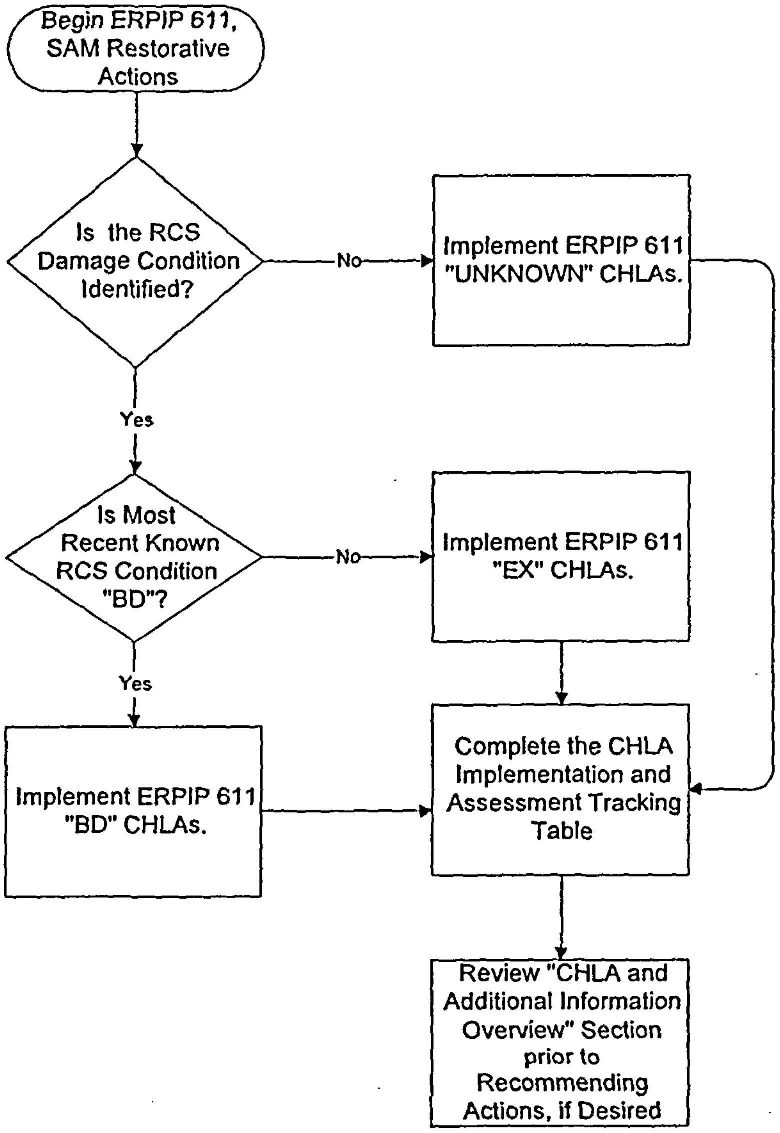
**EFFECTIVE DATE** 9/14/2005

# 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: Spray into the Containment

### 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: 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: 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: 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

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: 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 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.

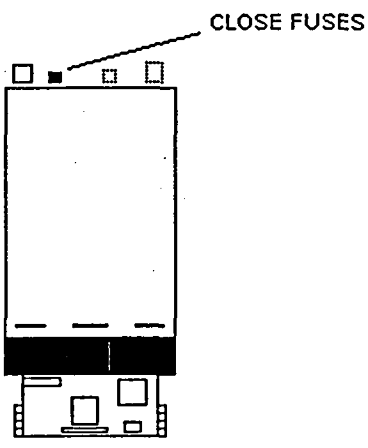
### C. Equipment Required to Implement CHLA:

> - 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: Flood the Reactor Cavity

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: 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 much water to the outside of the containment as possible. 0201

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: <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:**

> - <u>NOTE</u> -
> 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.

> - <u>NOTE</u> -
> 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: 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.

## 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.

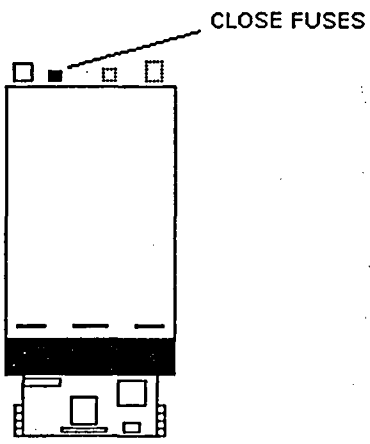
**C. Equipment Required to Implement CHLA:**

> - 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: Flood the Reactor Cavity

### 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: <u>Operate Hydrogen Recombiners</u>

**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: Spray into the Containment

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: Feed the Steam Generators

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: 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 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.

**Alternate Water Sources**

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 alternate 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.

| - NOTE - |
|---|
| The current AFW System drawing is to be used for actual valve alignments. |

1.F. The Plant Fire System can be used to provide water to the S/Gs through the AFW system via one of the following methods:

1. Use of the Fire System via a siamese hose connection at 13 (23) AFW Pump

   a. **ISOLATE** and **DRAIN** (depressurize) 13 (23) AFW Pump.

   b. **REMOVE** 13 (23) AFW Pump Auto Recirc Valve.

| - NOTE - |
|---|
| The AFW System Spool Piece is located in the Safe Shutdown Repair Locker in the Fire Pump House. |

   c. **INSTALL** the AFW System Spool Piece.

   d. **CONNECT** fire hoses to stations.

   e. **RUN** both hoses through the Service Water Pump Room watertight double doors.

   f. **CONNECT** the hoses to the siamese connection installed in the AFW System.

   g. **CLOSE** AFW Pump Drain Valves, **THEN PRESSURIZE** the fire hoses.

   h. **OPEN** ADVs to depressurize S/Gs and lower S/G level to approximately -350 inches,

   i. **USING** the AFW system, **THEN FEED** the S/G using the fire system.

2. Use of steam driven AFW pumps via a temporary fire hose connection. ***[B1168]**

   a. **ISOLATE** selected AFW pump (that is, 11, 12, 21 or 22) by shutting Pump Discharge, Mini- Flow and Suction Valves.

   b. **REMOVE** suction spool piece.

*[B1168] NRC Letter, R. W. Borchardt for J. E. Dyer to Holders of Licenses for Operating Power Reactors as listed in enclosure 1, NRC Staff Guidance for Use in Achieving Satisfactory Compliance with February 25, 2002, Order Section B.5.b, February 25, 2005.

| - NOTE - |
|---|
| The temporary fire hose flange is located in Warehouse 2; location number: 25-11-031-02-7, AFW Fire Hose Flange; Mech number: R3254. |

1.F.2.c. **INSTALL** temporary fire hose flange.

d. **ALIGN** the Fire system to both AFW suction hose connections.

e. **UNISOLATE** the selected AFW pump discharge **AND** mini-flow line.

f. **RUN** the selected AFW pump, as needed.

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

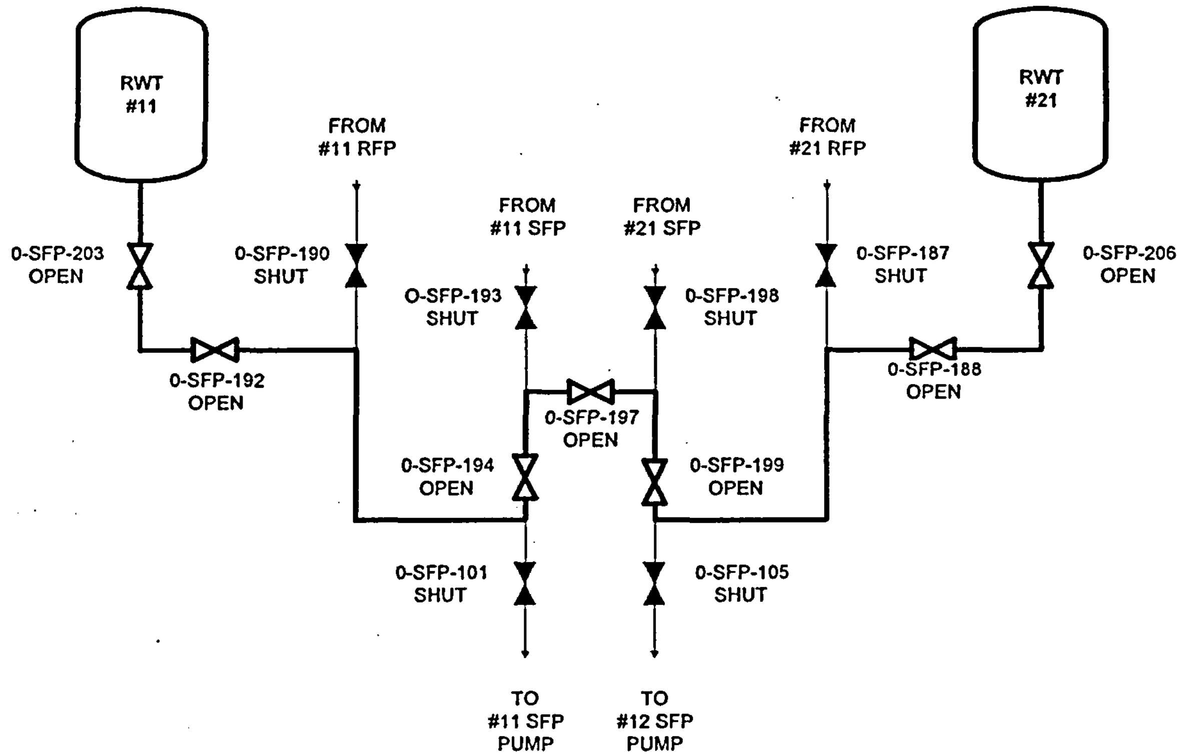
**Either Unit Affected**



**Unit - 1 Affected**



**Unit -2 Affected**




NOTE

This is an alternate lineup to OI-24 H

**FIGURE 1**
GRAVITY TRANSFER OF RWTs THROUGH SFP SYSTEM
(EITHER UNIT AFFECTED)

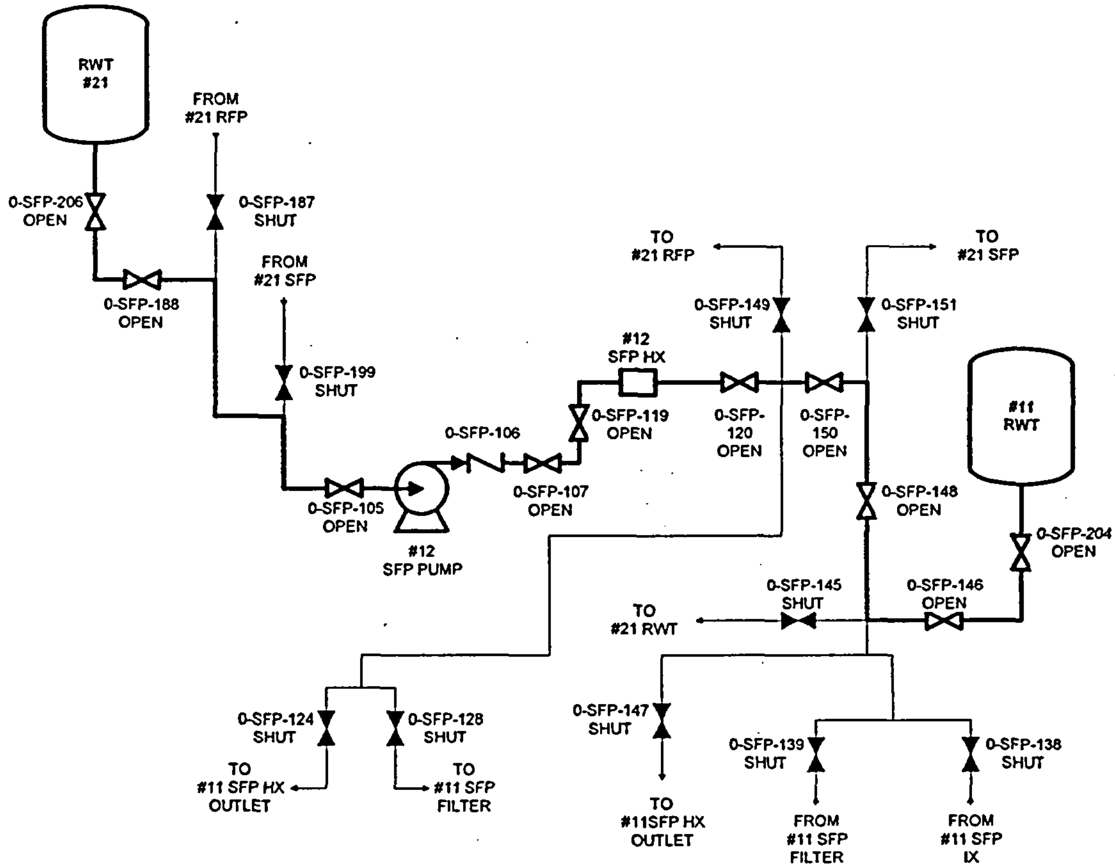



**FIGURE 2**
**PUMPING UNIT 2 RWT TO UNIT-1 RWT WITH #12 SFP PUMP**
**(UNIT-1 AFFECTED )**

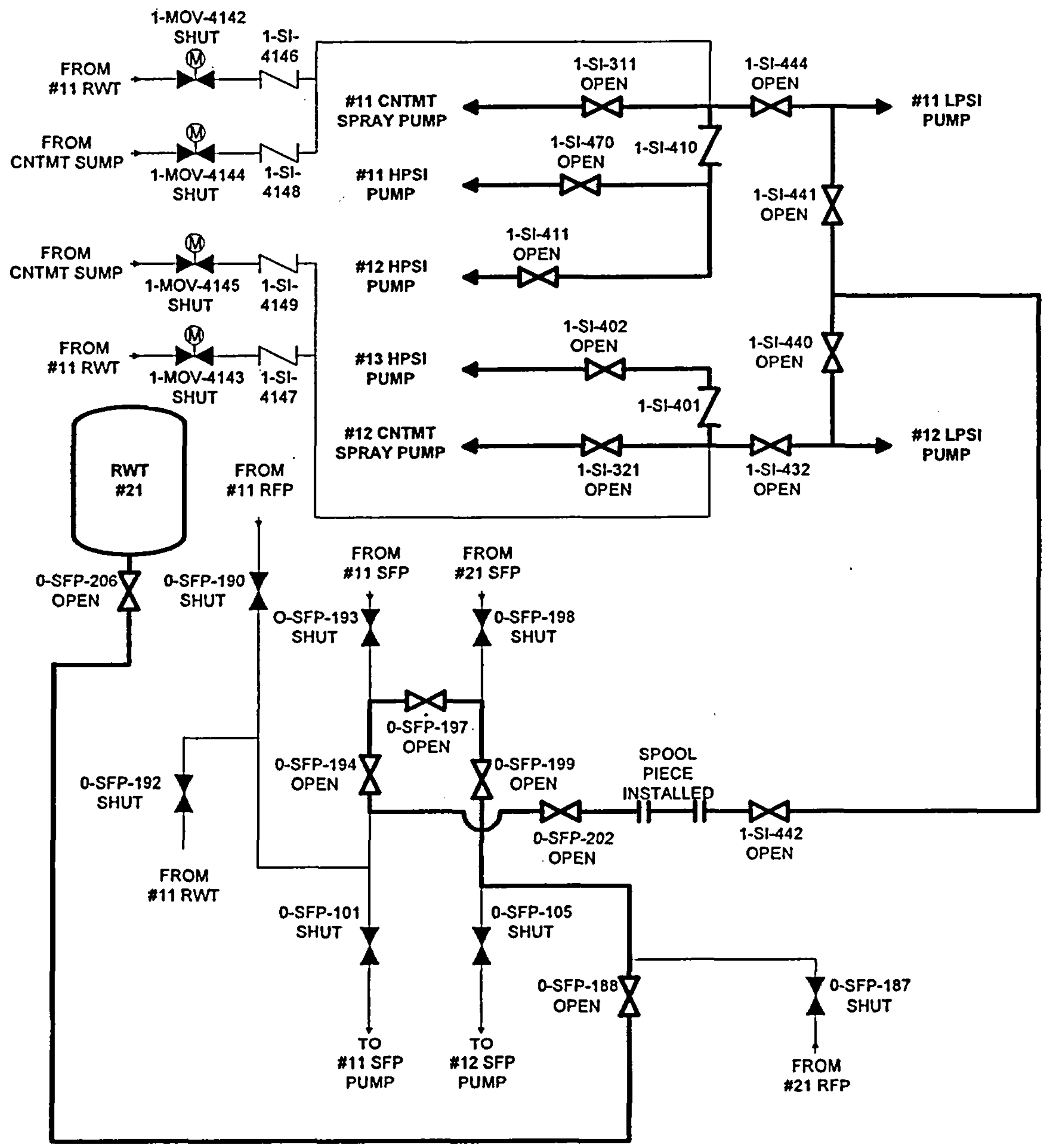



**FIGURE 3**
UNIT-2 RWT SUPPLYING UNIT-1 SI AND CS PUMPS
(UNIT-1 AFFECTED)

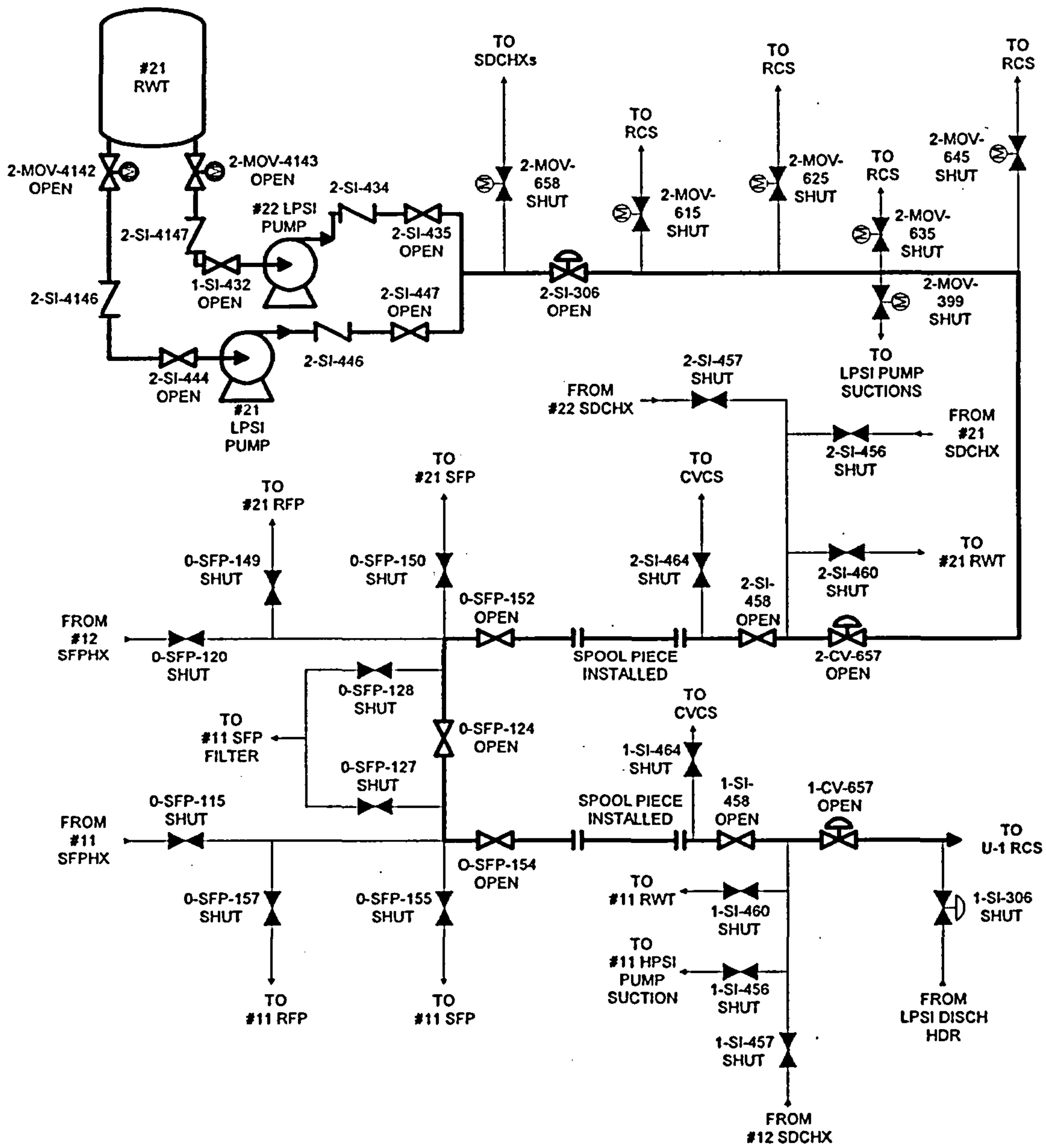



**FIGURE 4**
**#21 (22) LPSI PUMP SUPPLYING UNIT-1 RCS FROM #21 RWT**
**(UNIT-1 AFFECTED)**

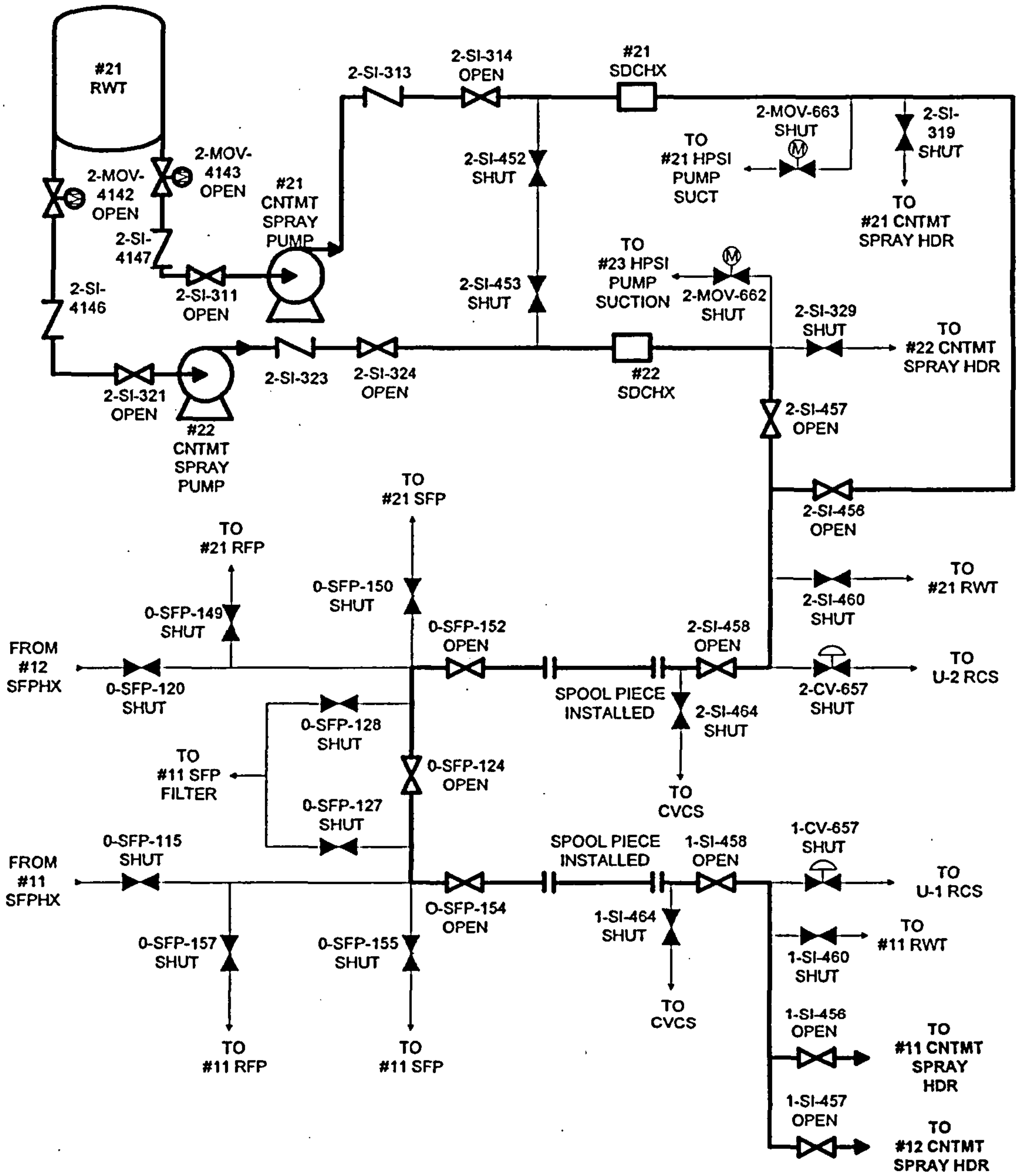



**FIGURE 5**
#21 (22) CS PUMP SUPPLYING UNIT-1 CNTMT FROM #21 RWT
(UNIT-1 AFFECTED)

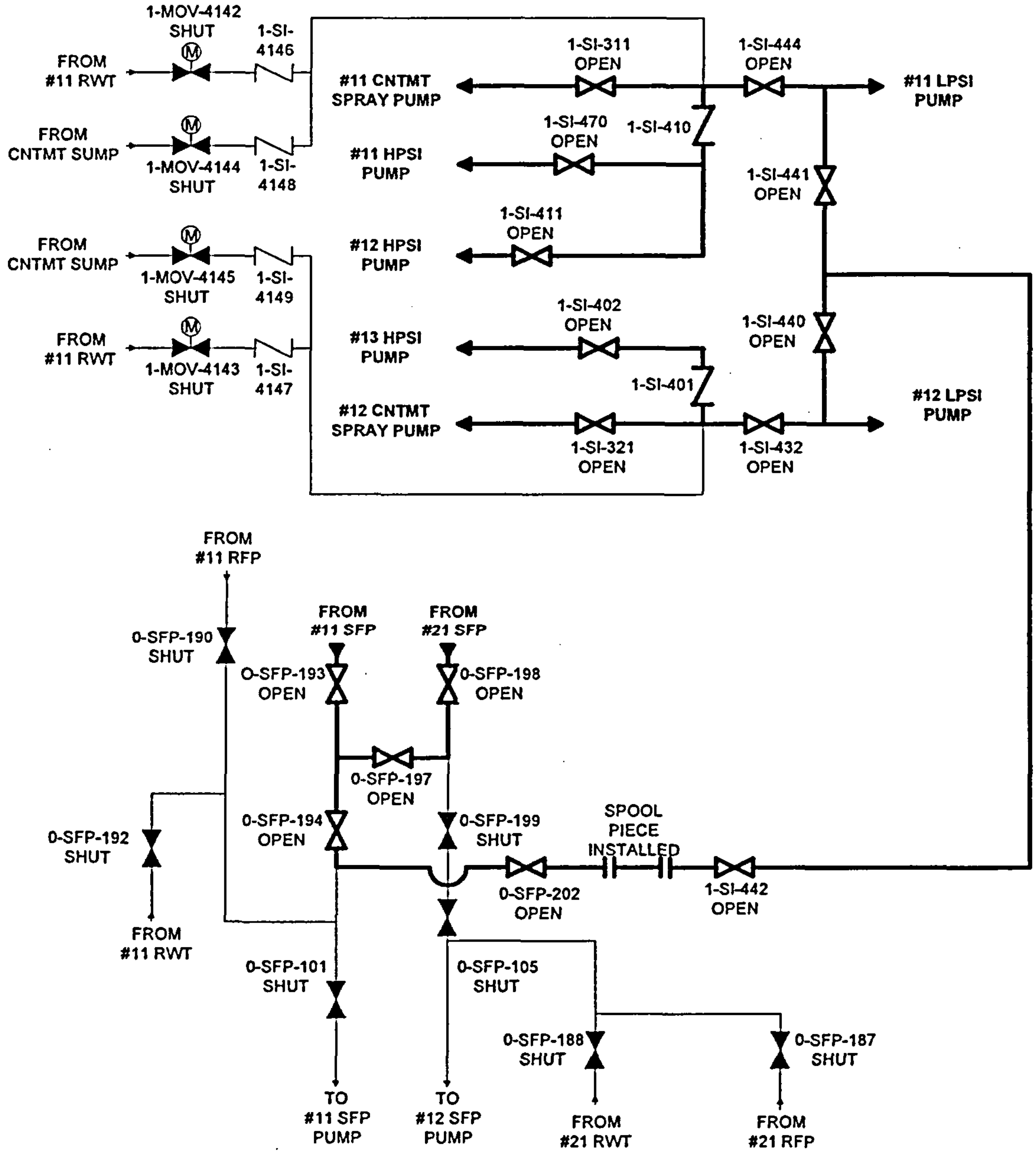



**FIGURE 6**
11 AND 21 SFPs SUPPLYING UNIT-1 SI AND CS PUMPS
(UNIT-1 AFFECTED)

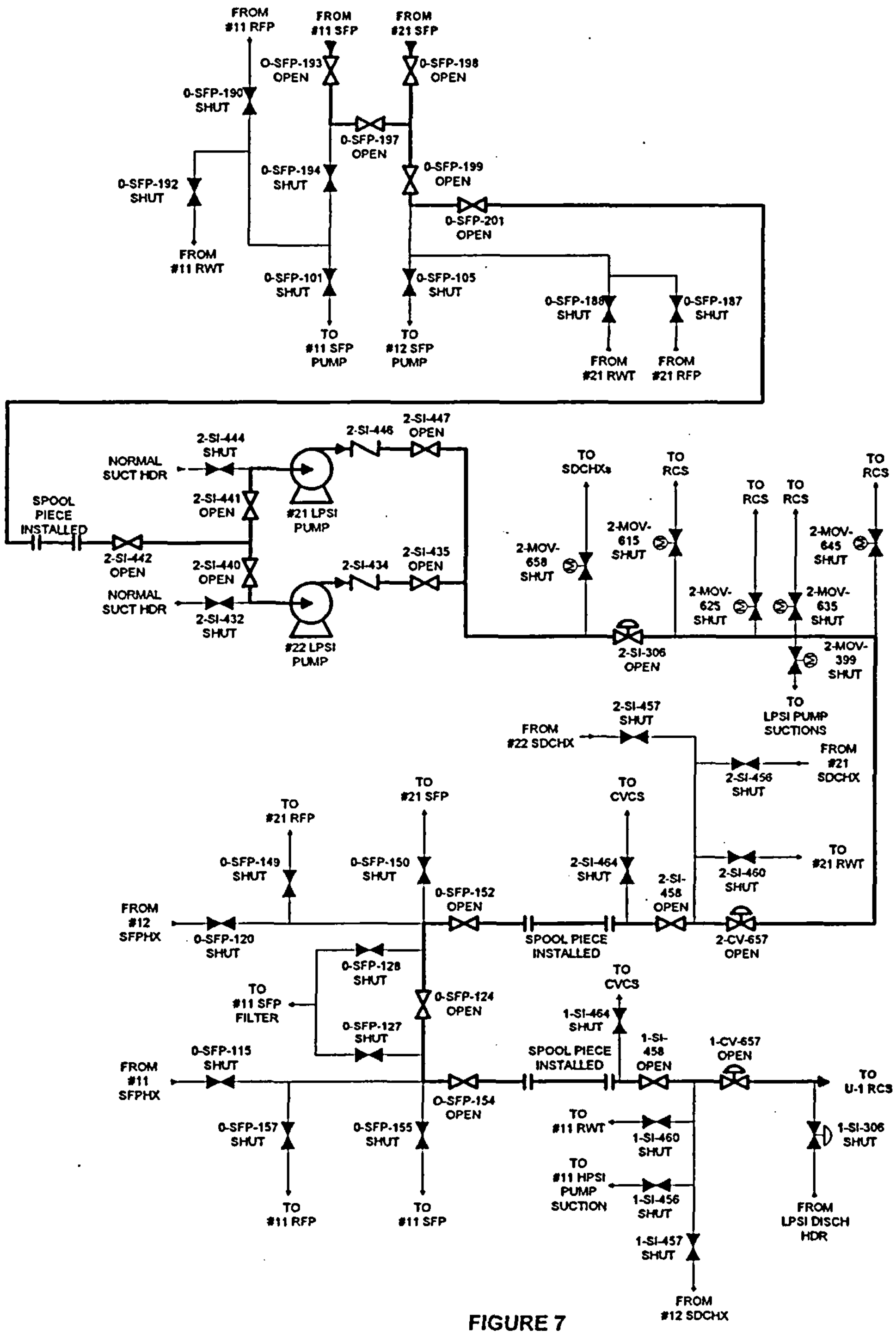



**FIGURE 7**
**#21 (22) LPSI PUMP SUPPLYING UNIT-1 RCS FROM 11/21 SFPs (UNIT-1 AFFECTED)**

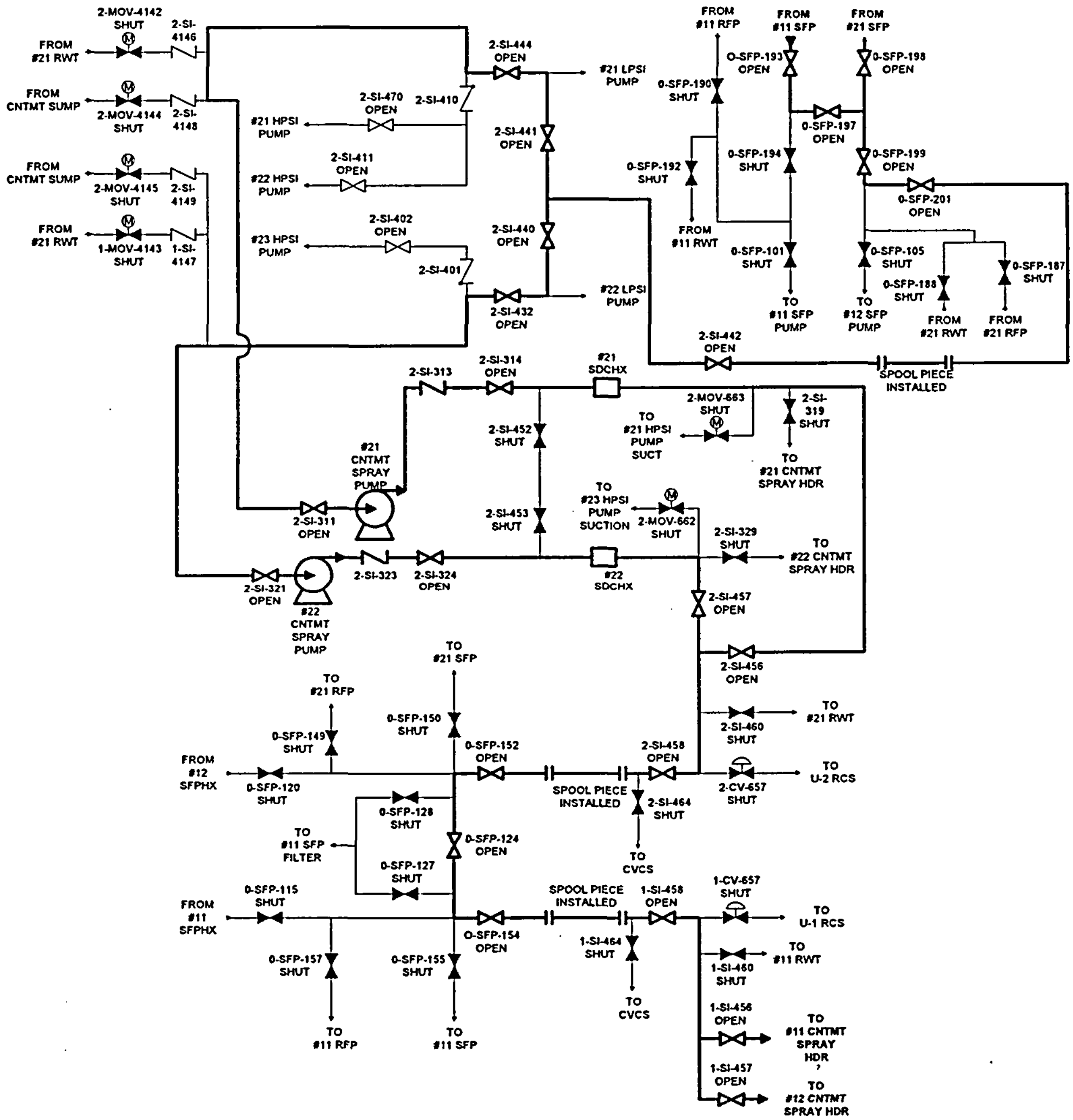
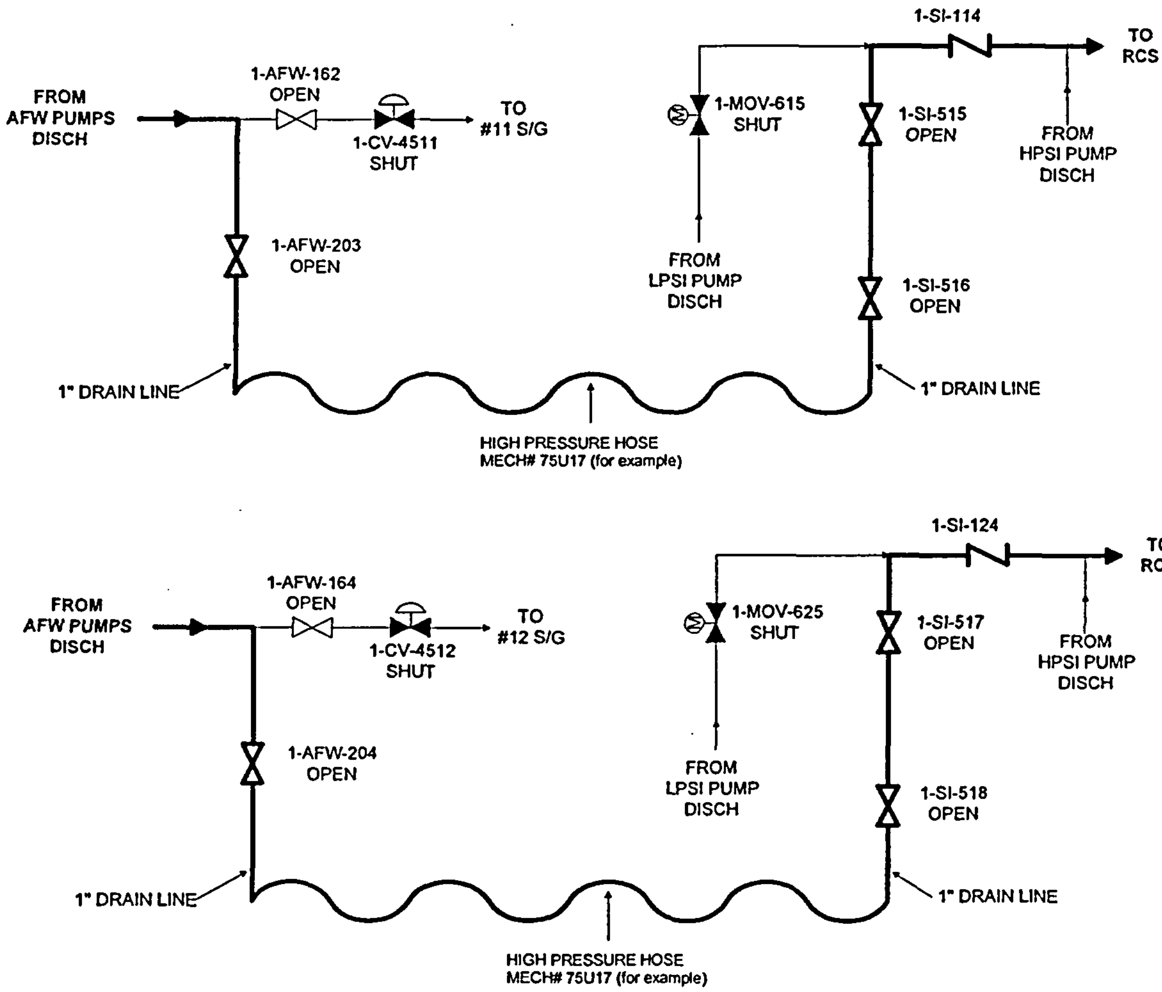



**FIGURE 8**
**#21 (22) CS PUMPS SUPPLYING UNIT-1 CONTAINMENT SPRAY FROM 11/21/SFPs (UNIT-1 AFFECTED)**

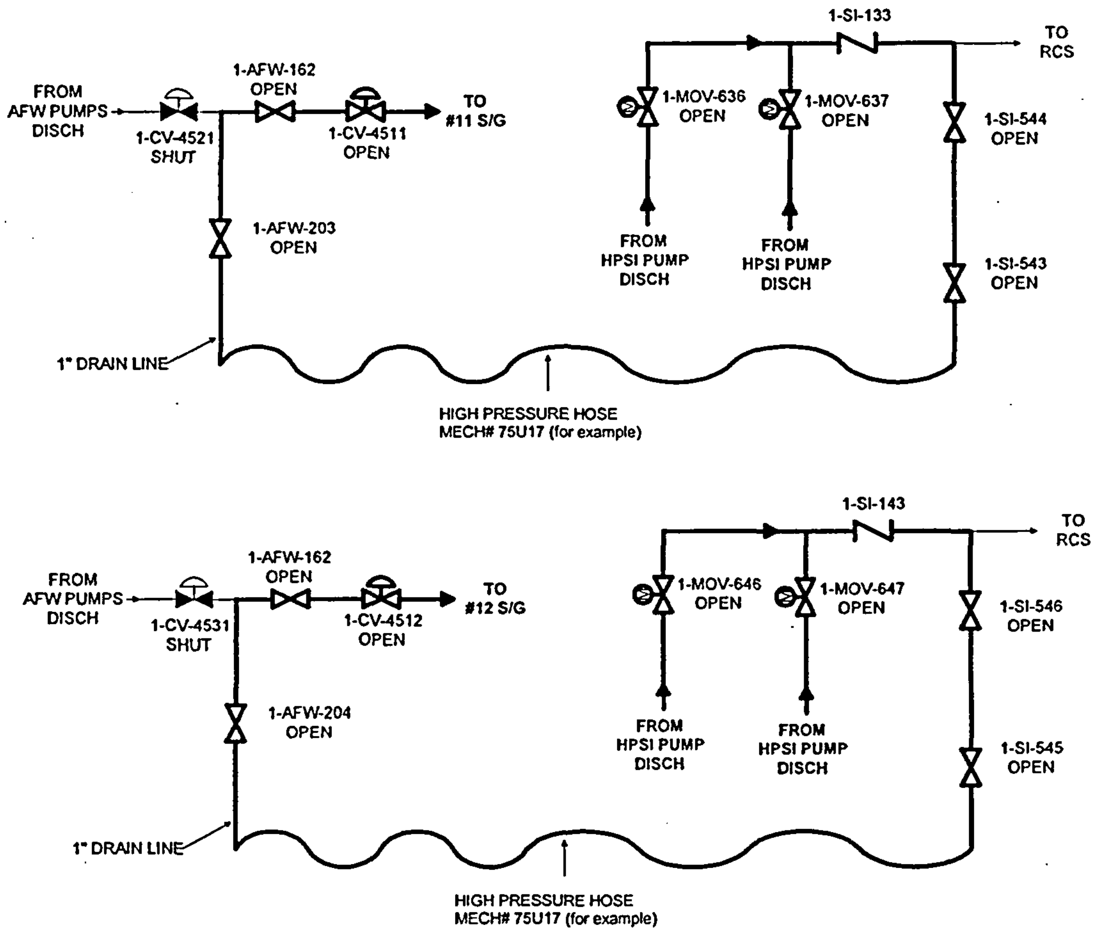



Notes

AFW drain valves are located in 5' East Pen. Room. SI drain valves are in the 27' East Pen Room.
The example hose is rated for 800 psi. Higher pressure hoses may be available.
Estimated flow with 300 psig 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 the 27' East Pen Room.
The example hose is rated for 800 psi. Higher pressure hoses may be available.
Estimated flow with 300 psig between AFW and RCS is 100 gpm

**FIGURE 10**

U-1 SI TO U-1 AFW X-CONNECT USING HP HOSES

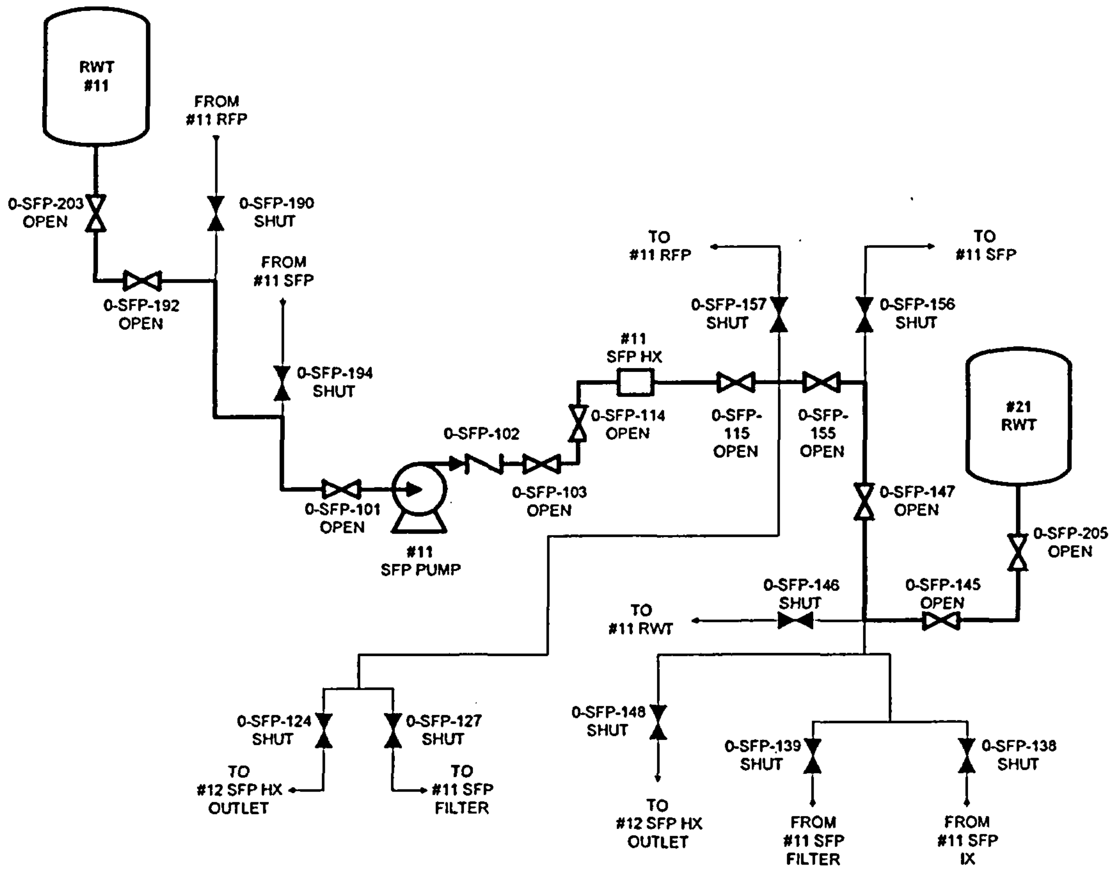



**FIGURE 11**
PUMPING UNIT 1 RWT TO UNIT-2 RWT WITH #11 SFP PUMP
(UNIT-2 AFFECTED )

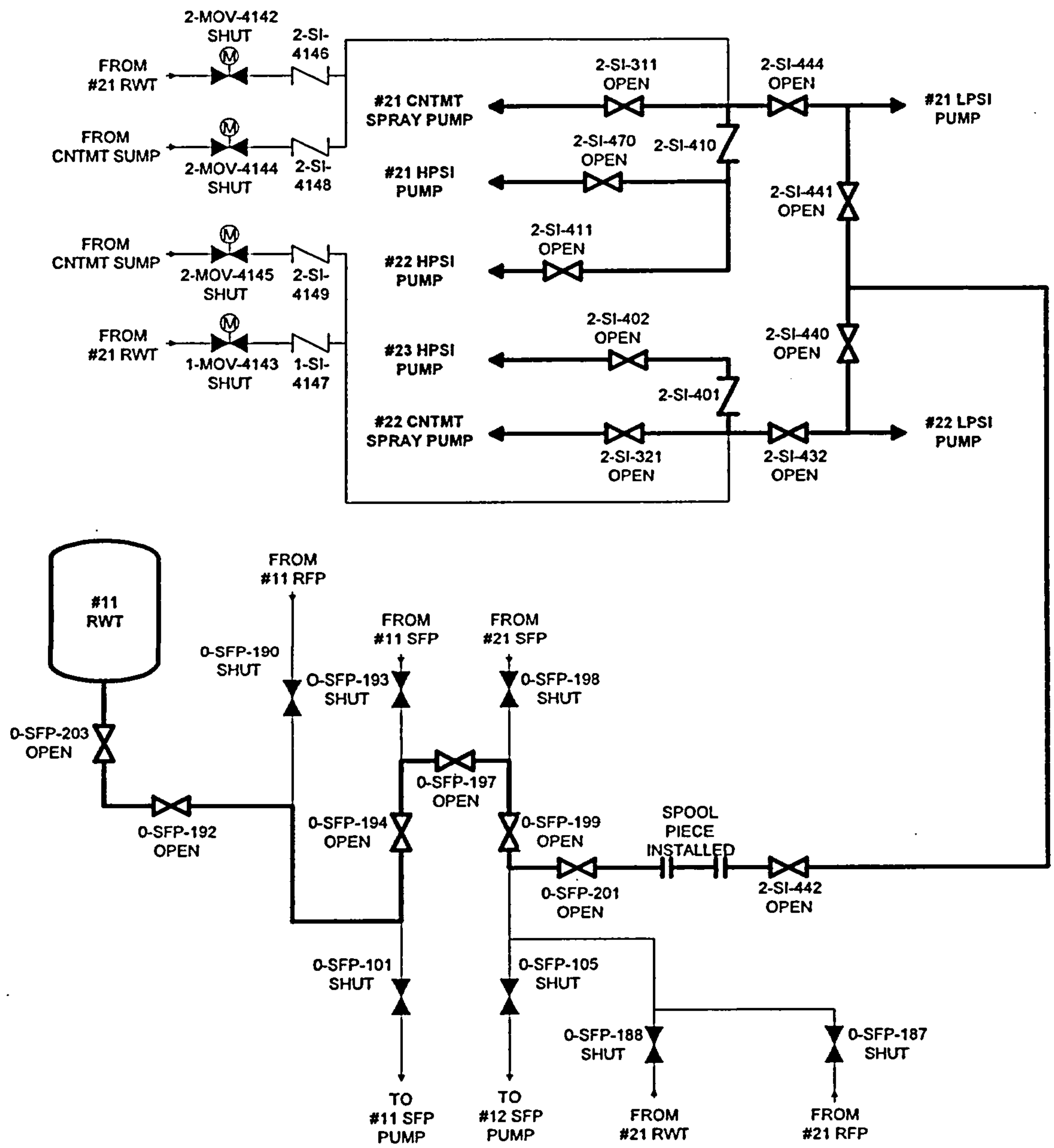



**FIGURE 12**
UNIT-1 RWT SUPPLYING UNIT-2 SI AND CS PUMPS
(UNIT-2 AFFECTED)

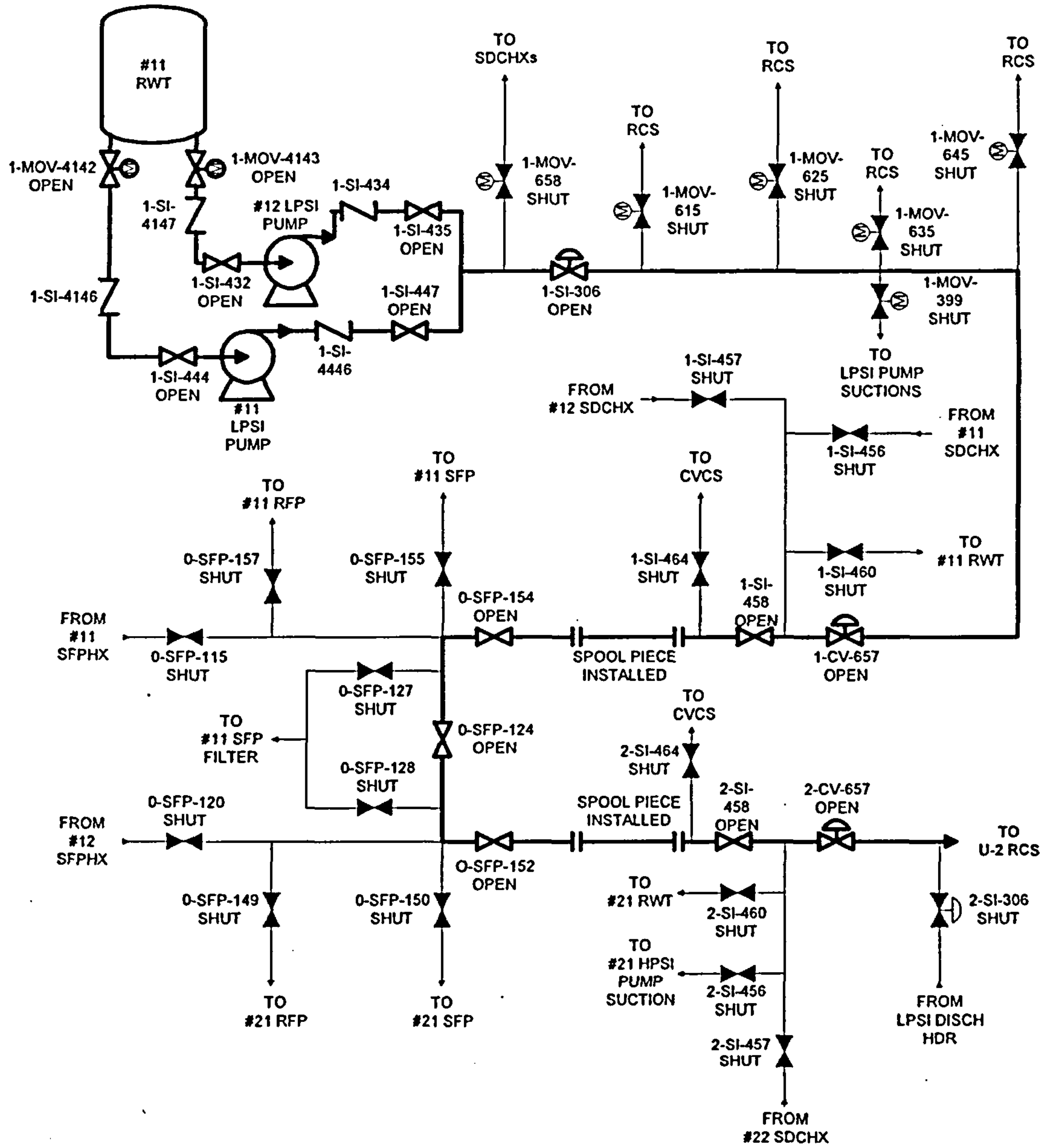



**FIGURE 13**
**#11 (12) LPSI PUMP SUPPLYING UNIT-2 RCS FROM #11 RWT**
**(UNIT-2 AFFECTED)**

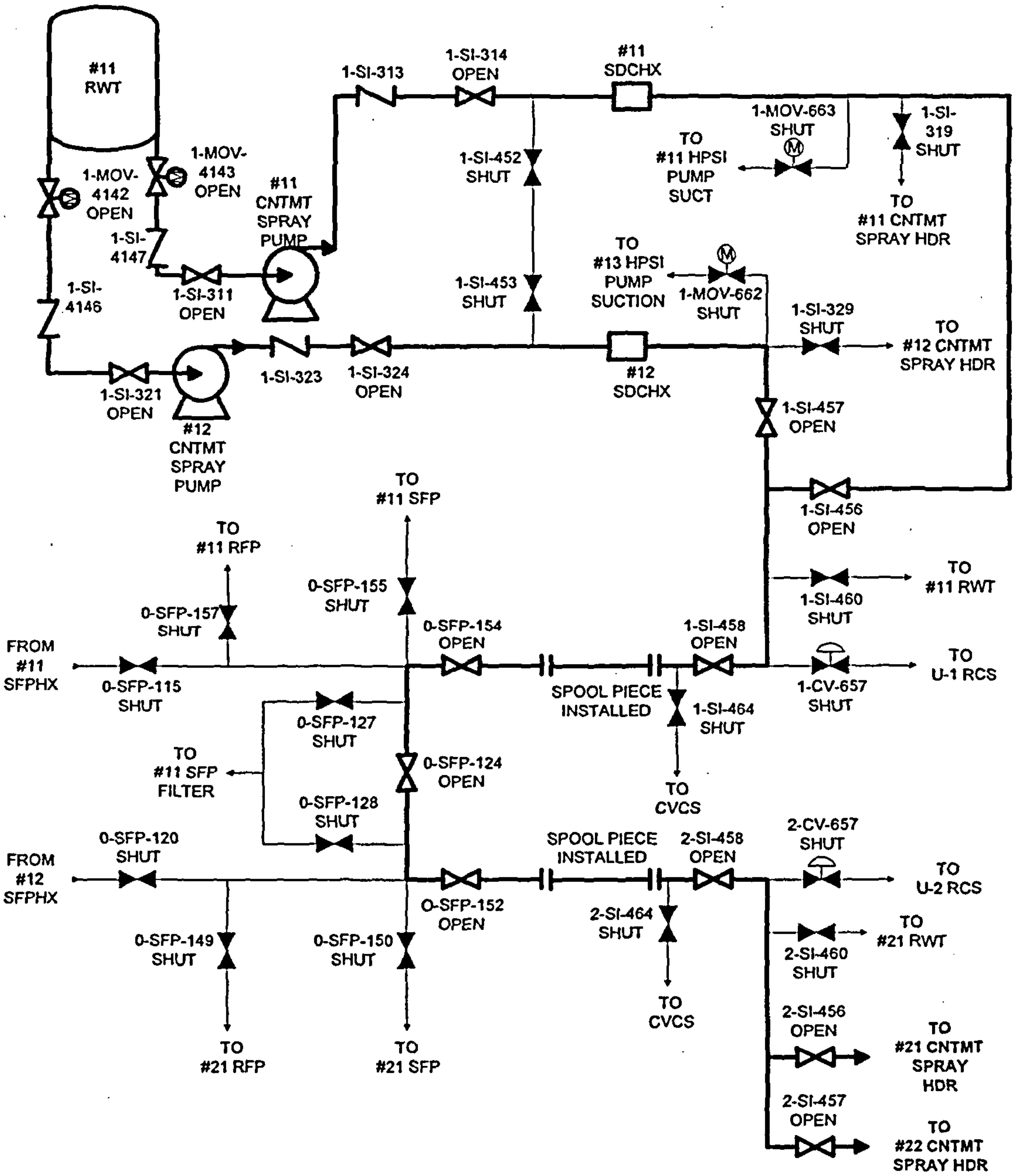



**FIGURE 14**
#11 (12) CS PUMP SUPPLYING UNIT-2 CNTMT FROM #11 RWT
(UNIT-2 AFFECTED)

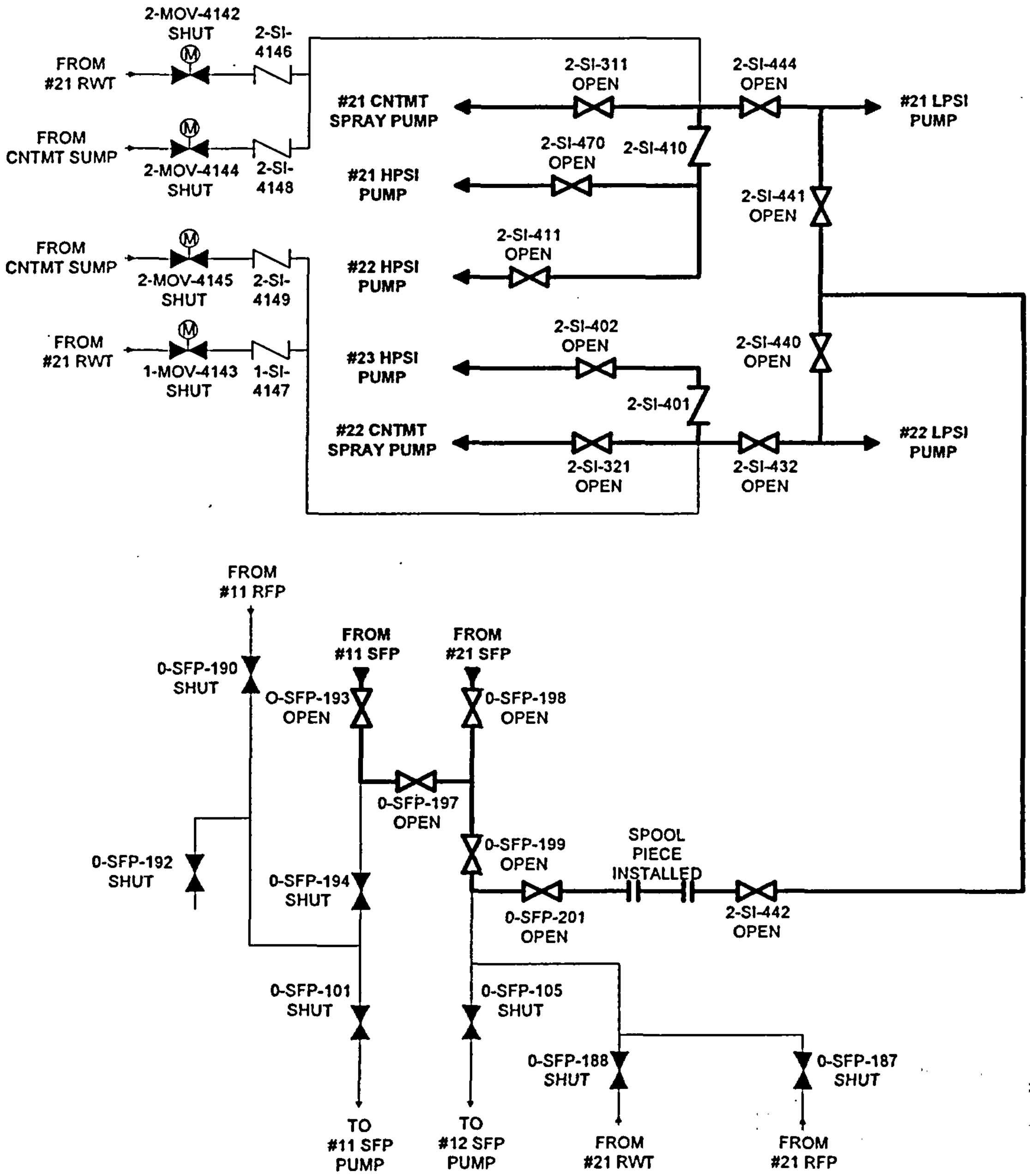



**FIGURE 15**
11 AND 21 SFPs SUPPLYING UNIT-2 SI AND CS PUMPS
(UNIT-2 AFFECTED)

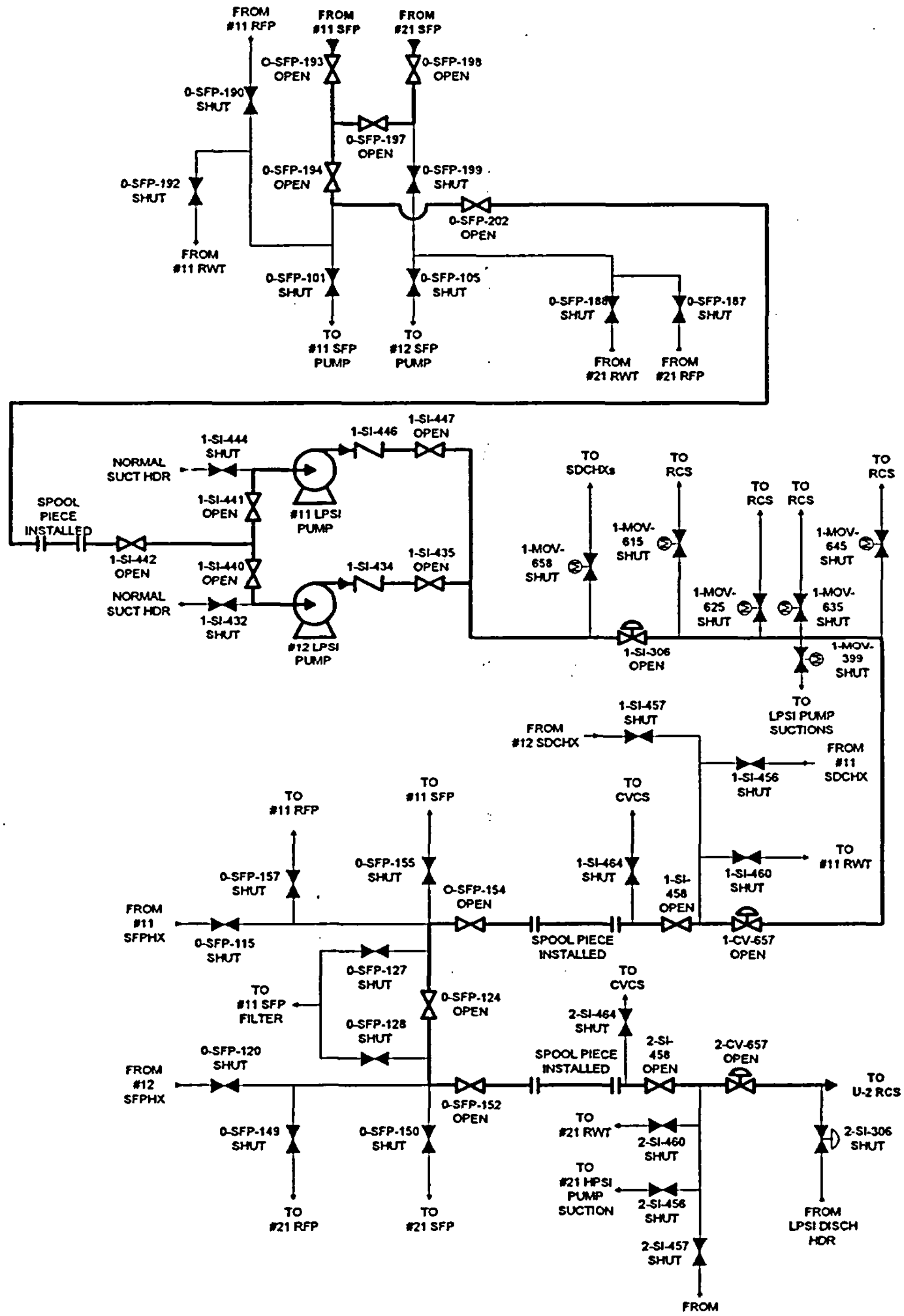



**FIGURE 16**
**#11 (12) LPSI PUMP SUPPLYING UNIT-2 RCS FROM 11/21 SFPs**
**(UNIT-2 AFFECTED)**

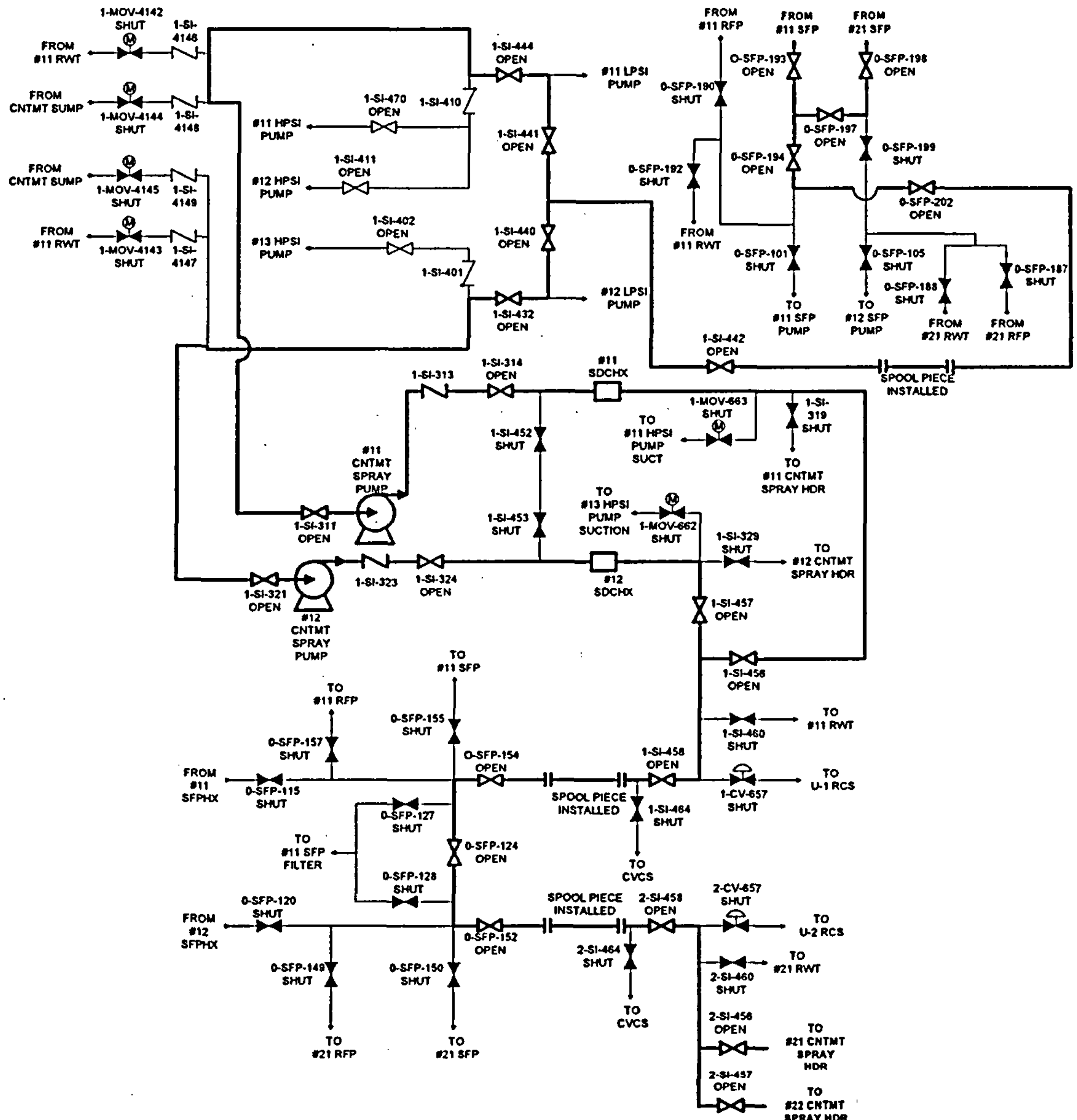
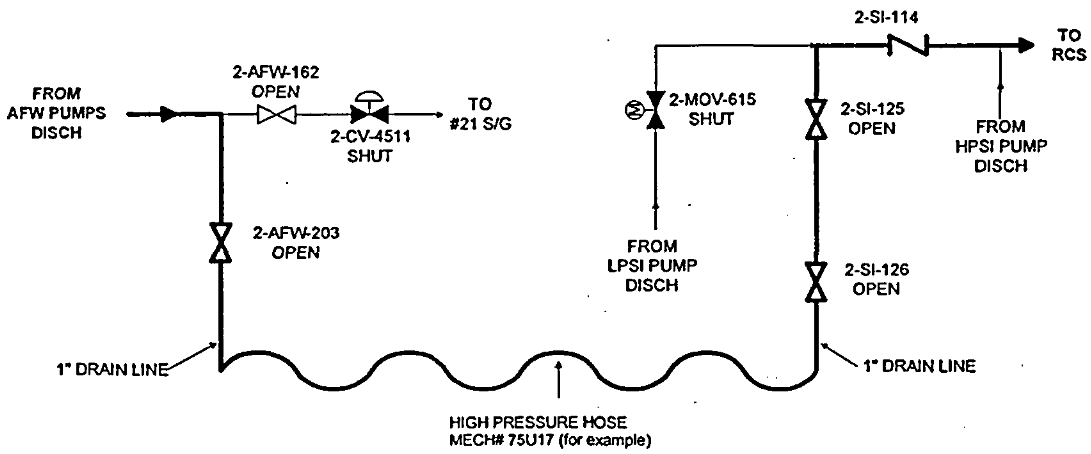
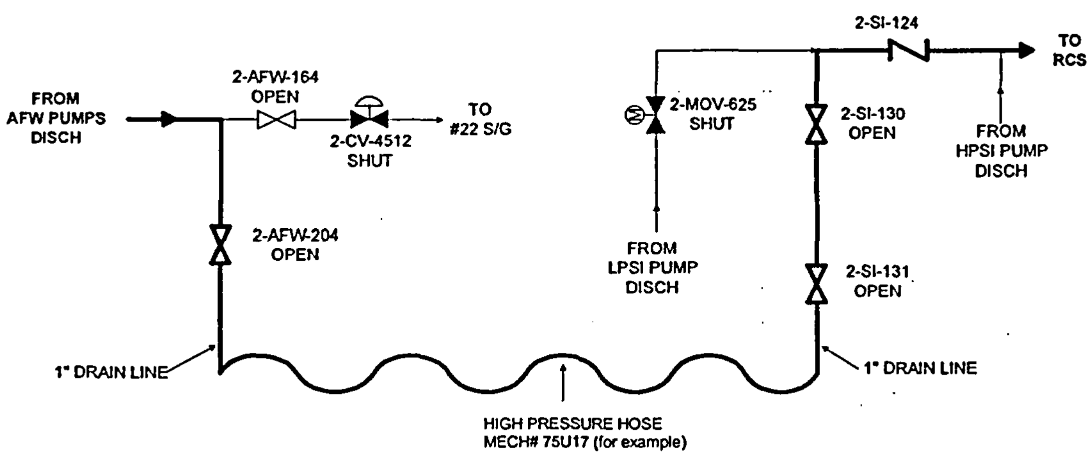



**FIGURE 17**
**#11 (12) CS PUMPS SUPPLYING UNIT-2 CONTAINMENT SPRAY FROM 11/21/SFPs**
**(UNIT-2 AFFECTED)**

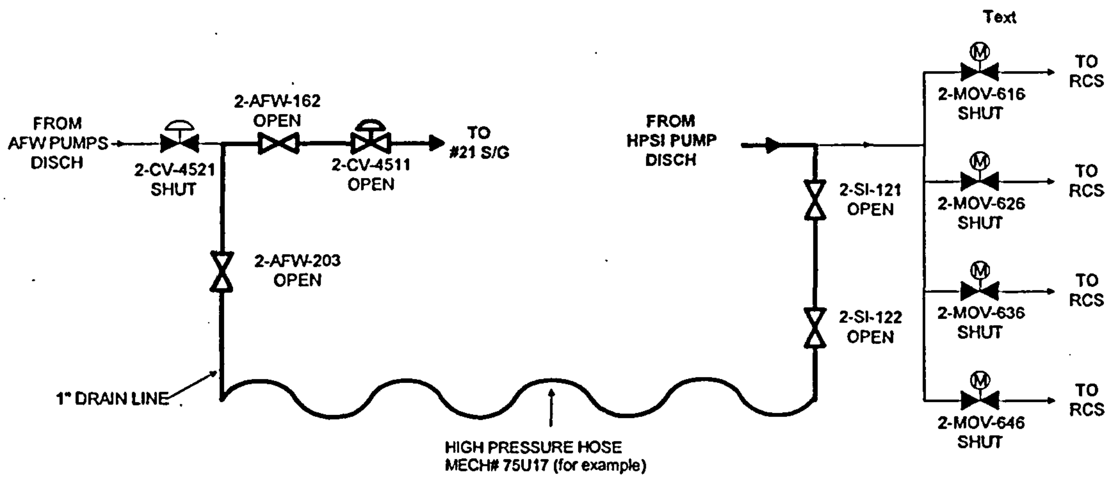


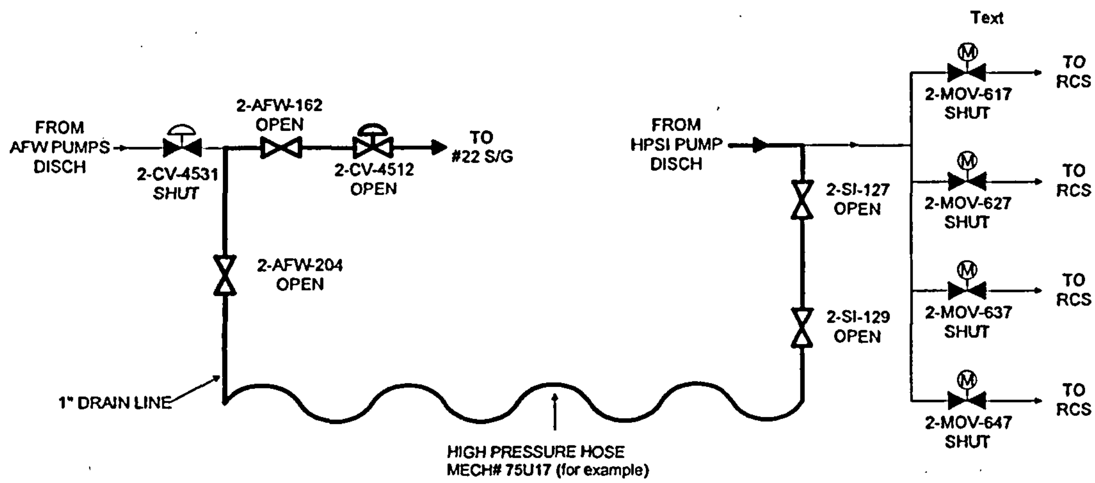




Notes

AFW drain valves are located in 5' East Pen. Room. SI drain valves are in the 27' East Pen Room.
The example hose is rated for 800 psi. Higher pressure hoses may be available.
Estimated flow with 300 psig between AFW and RCS is 100 gpm

**FIGURE 18**
U-2 AFW TO U-2 SI X-CONNECT USING HP HOSES




<u>Notes</u>

AFW drain valves are located in 5' East Pen. Room. SI drain valves are in the 27' East Pen Room.
The example hose is rated for 800 psi. Higher pressure hoses may be available.
Estimated flow with 300 psig between AFW and RCS is 100 gpm

**FIGURE 19**

U-2 SI TO U-2 AFW X-CONNECT USING HP HOSES

**Electrical Power Supplies**

A. The methods listed below are possible means to AC 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**


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.

B. The methods listed below are possible means to DC 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** a 250 V DC battery to replace a 125 V DC static battery. ***[B1168]**

    a. **OPEN** circuit the selected 125 V DC battery.

    b. **INSTALL** electrical jumper between the selected 250 V DC battery.

**- NOTE -**

The following is a list of possible parts that might be needed for use and can be found in Warehouse 2:

| Quantity Needed | Mech# | |
|---|---|---|
| 1000 | 88450 | 3/c 2/0 cable (2 runs 500') |
| 4 | 75E64 | 500 Raychem WCSF-500 |
| 86 | 96M96 | ½" Burndy flat washers |
| 48 | 96M99 | ½" Burndy lock washers |
| 48 | 96M93 | ½" Burndy nuts |
| 48 | 96M84 | ½" X 1 ½" Burndy bolts |
| 24 | 96M42 | 2/0 two hole ½" Burndy lugs |
| 4 | 96A43 | Scotch 33+ tape |

    (1). **REMOVE** 250 V DC battery cells from service (as needed) to supply 125 V DC battery.

    c. **ALIGN** the selected 250 V DC battery to take the place of the selected 125 V DC battery (approximately ½ of the battery cells may be needed).

    d. **ENERGIZE** 125 V bus as needed.

*[B1168] NRC Letter, R. W. Borchardt for J. E. Dyer to Holders of Licenses for Operating Power Reactors as listed in enclosure 1, NRC Staff Guidance for Use in Achieving Satisfactory Compliance with February 25, 2002, Order Section B.5.b, February 25, 2005.

**ATTACHMENT 2**
**Page 4 of 4**

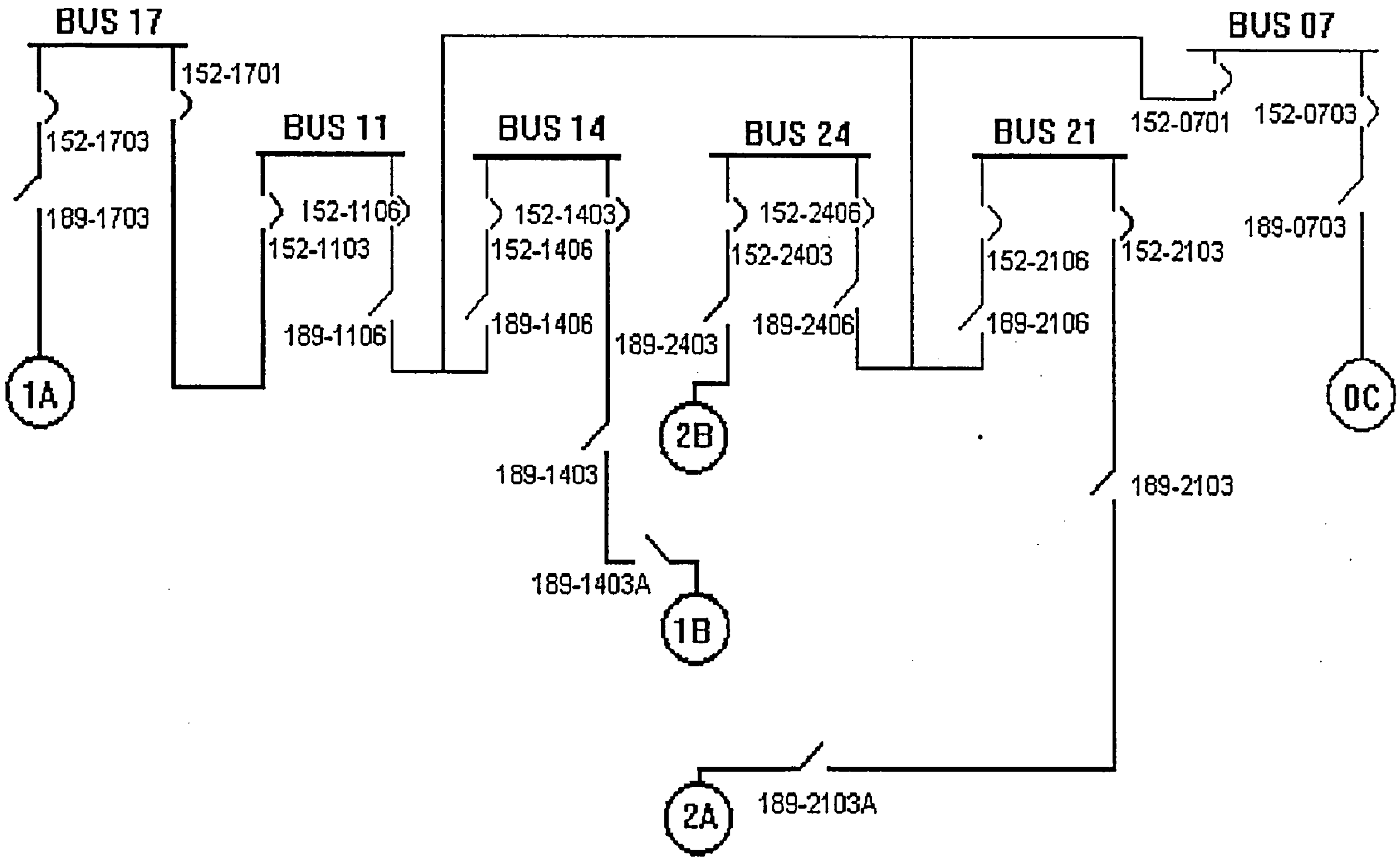



**FIGURE 1**
DIESEL GENERATOR LINEUPS

# 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)<br>*TI-131A-D, 132A-D | 1) EOP Att. 12<br>2) RVLMS<br>3) $T_h$ (up to 705°F) | Use RVLMS to determine if core covered<br>CETs can also be read from recorders or Subcooling Margin Monitor |
| RVLMS *<br>LI-20A, 20B | CETs | If CETs are not superheated then core is covered, also $T_h$/PZR Press<br>NI's can also be used to help determine if the core is covered. |
| RCS/PZR Press. *<br>PI-100A-D, PT-105B, PI-103, PR-100X,Y | 1)SIT level<br>LI-311,321,331,341 | If SIT level is normal then RCS press remains greater than 200 psi |
| CNMNT Press *<br>PI-5307, 5310, (WR)<br>PI-5308 (NR) | 1) RCS press<br>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 *<br>RI-5317A,B | Use ERPIP 800 series (core damage assessment) | |
| NIs *<br>WR (Gammametrics) | | |
| CNMNT Sump Level<br>LI-4146, 4147 (WR)<br>LI-4145, 4144 (NR) | | Use RCS state and RWT level to estimate |
| CNMNT $H_2$ *<br>0-AR-6519, 6527 | PASS, grab sample<br>Use ERPIP 800 series (core damage assessment) | |
| SI Flow<br>FI-351 (HPSI Total)<br>FI-311-341 (HPSI)<br>FI-312-342 (LPSI) | Pump amps | loop HPSI, loop LPSI, Total HPSI |
| RWT Level<br>LIA-4341, 4342 | Local indication | |
| Tail pipe Temperature<br>TI-106,108 | Acoustic Monitor<br>Quench Tank temp if intact | CNMNT temp if Quench tank ruptured |
| CNMNT Temperature<br>TI-5309 (dome)<br>TI-5311 (cavity) | Use Calc. Aid CA-10 | |
| Subcooling *<br>AI-11,12 | PZR temp minus CET temperature or $T_h$ | |

ATTACHMENT 4


| Instrument Used | Alternate Indication | Comments |
|---|---|---|
| PZR Level *<br>LT-110X,Y | | |
| CST Level *<br>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 *<br>LIC-1113A-D, 1123A-D (NR)<br>LIC-1114C, 1124D (WR) | | |
| S/G Press. *<br>PI-1013A-D, 1023A-D | $T_c$ and use steam tables | |
| AFW Flow<br>FIC-4511A, 4525A<br>FIC-4512A, 4535A | AFW Pump amps<br>II-4540 | |
| S/G Steam Flow<br>FI-1011, 1021 | | |
| $T_h$, $T_c$ *<br>TR-112, 122 | | |
| Instrument Air Pressure<br>PI-2079 | | |
| Condenser Vac.<br>PI-4404, 4407, 4410 | | |
| RCP Parameters | | |
| CNMNT Spray Flow<br>FI-4149, 4150 | Pump amps | |
| Feed Flow<br>FR-1111, 1121 | | |
| MWRT Level<br>LI-2195, 2197 | | |
| Aux. Bldg. Temperature<br>TI-5275, 5276, 5279, 5280 (pen rooms) | | |
| Aux. Bldg. Rad. Levels<br>RE-7004, 7005 (pen rooms) | | |
| SDC HX Out (TI-303X & 303Y) | | Use for estimate of reactor cavity sump water temp |
| Bast Level<br>LIA-206, 208 | | |

* denotes PAM instrument

# Figure 1-1a

Time to Uncover Top of Active Fuel
Condition 1: RVLMS 71° Light On

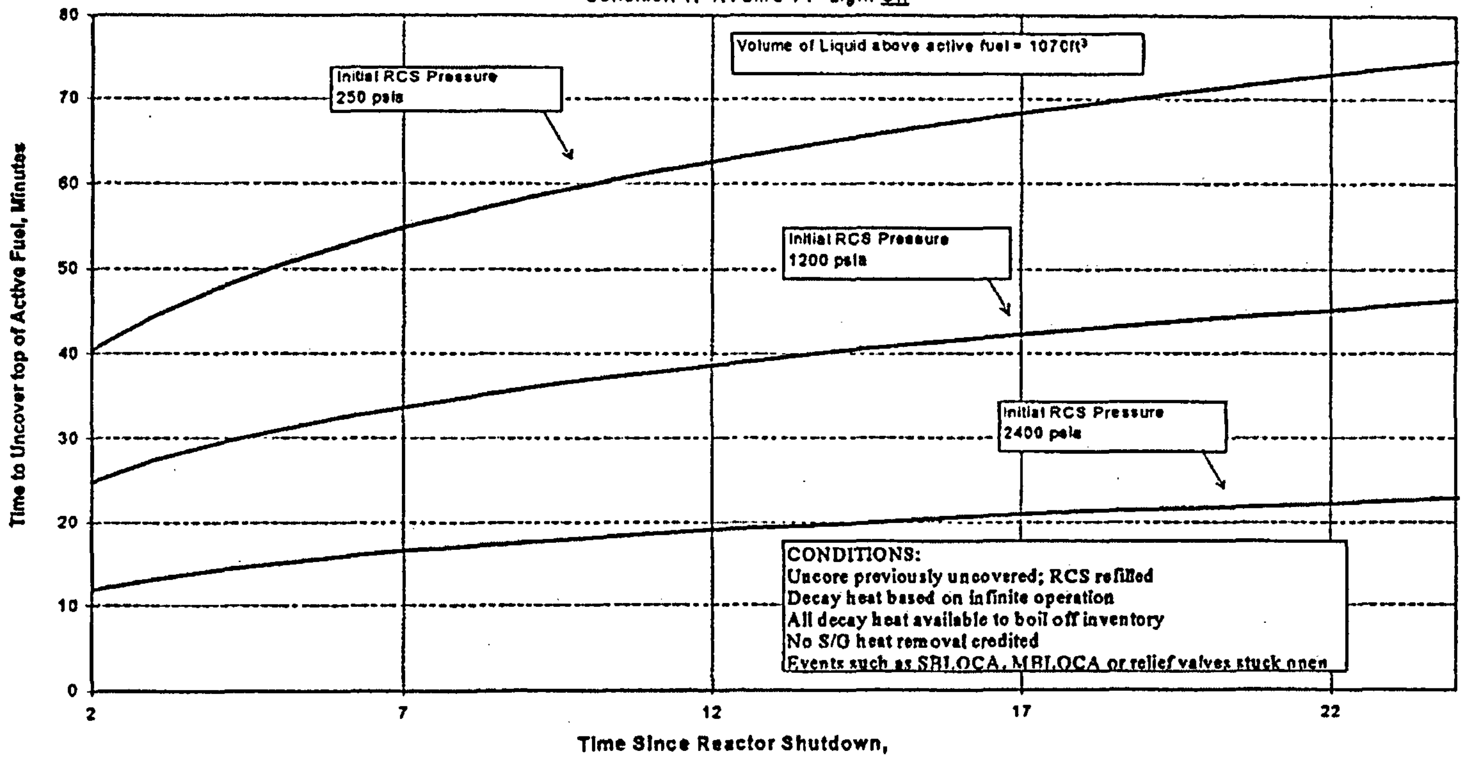
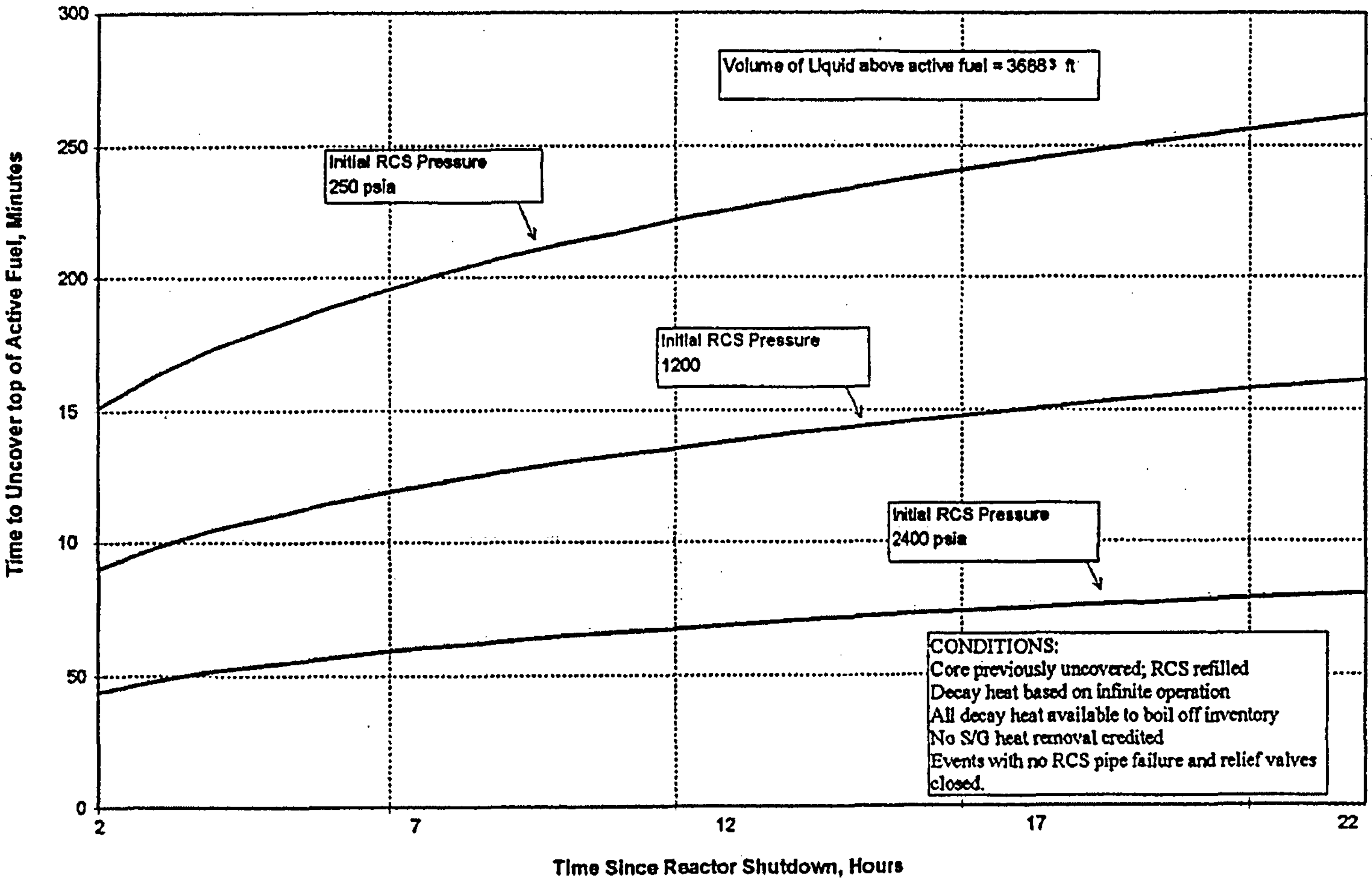


Figure 1-1b

Time to Uncover Top of Active Fuel

Condition 2: RLMS 160 "Lights ON"




ATTACHMENT 5
Page 2 of 45

**Figure 1-2**
**Coolant Level in Core Region vs. Time since Onset of Core Uncovery**
**RCS Pressure=2400 Psia**

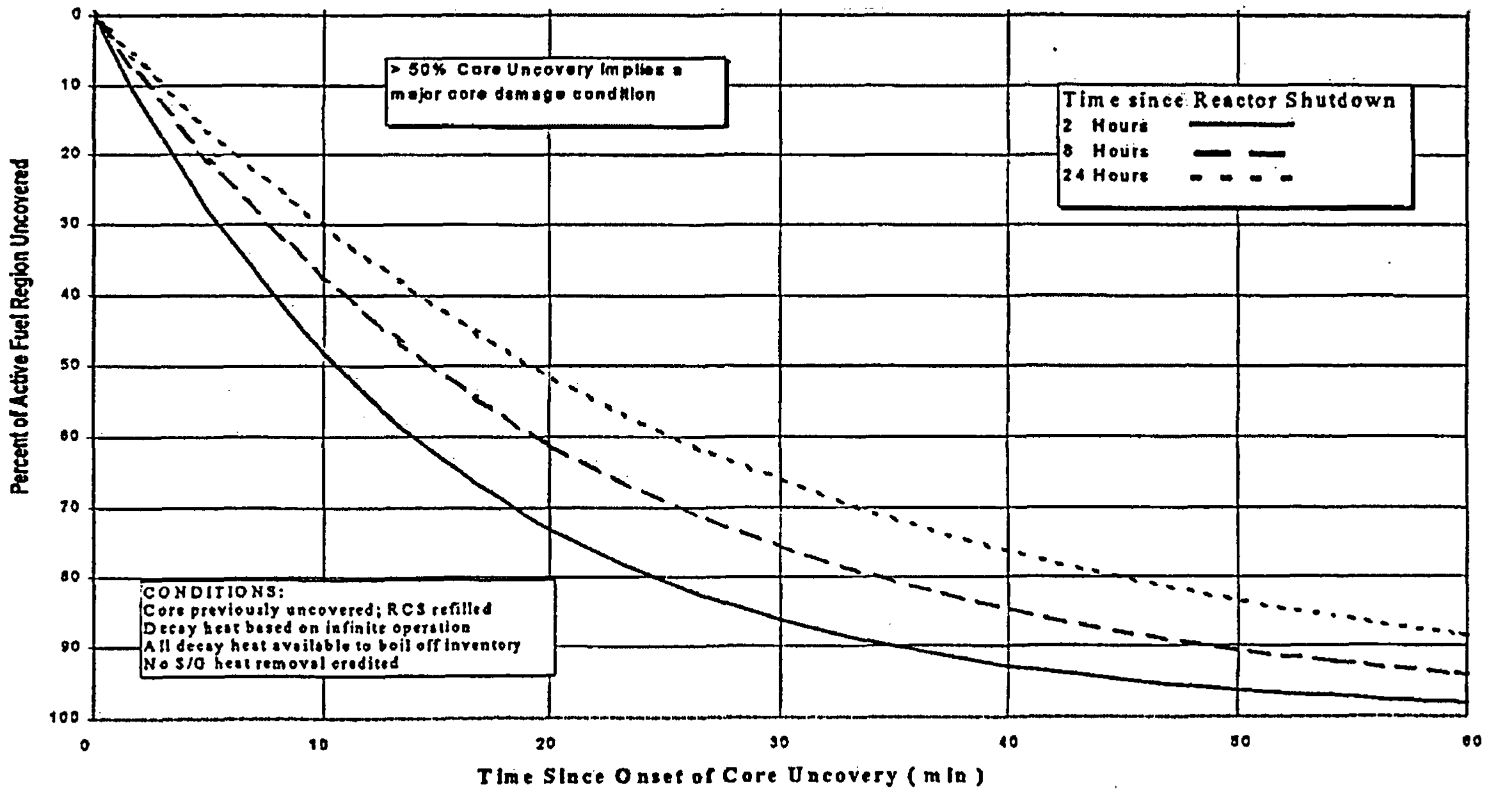


Figure 1-3
Coolant Level in Core Region vs. Time since Onset of Core Uncovery

RCS Pressure=1200 Psia

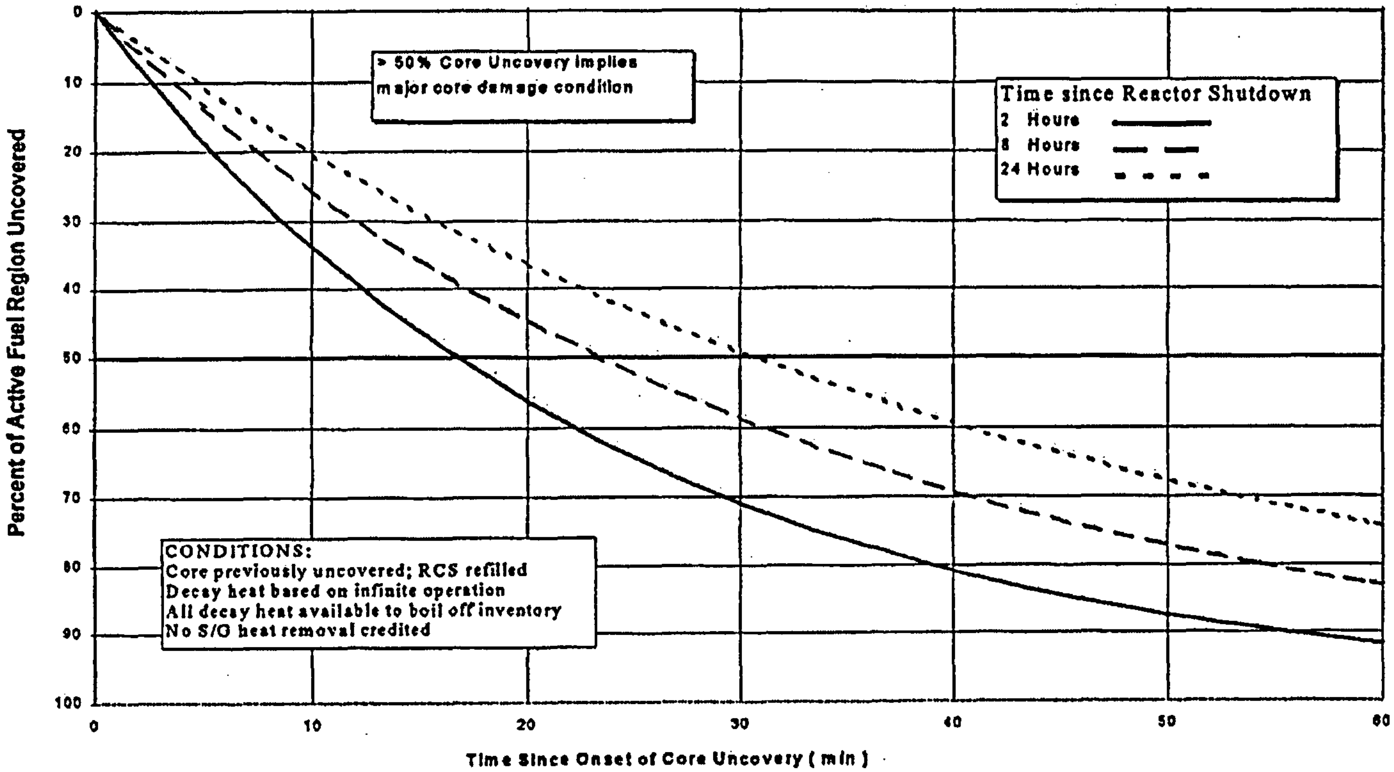


Figure 1-4

Coolant Level in Core Region vs. TIme since Onset of Core Uncovery
RCS Pressure=250 Psia

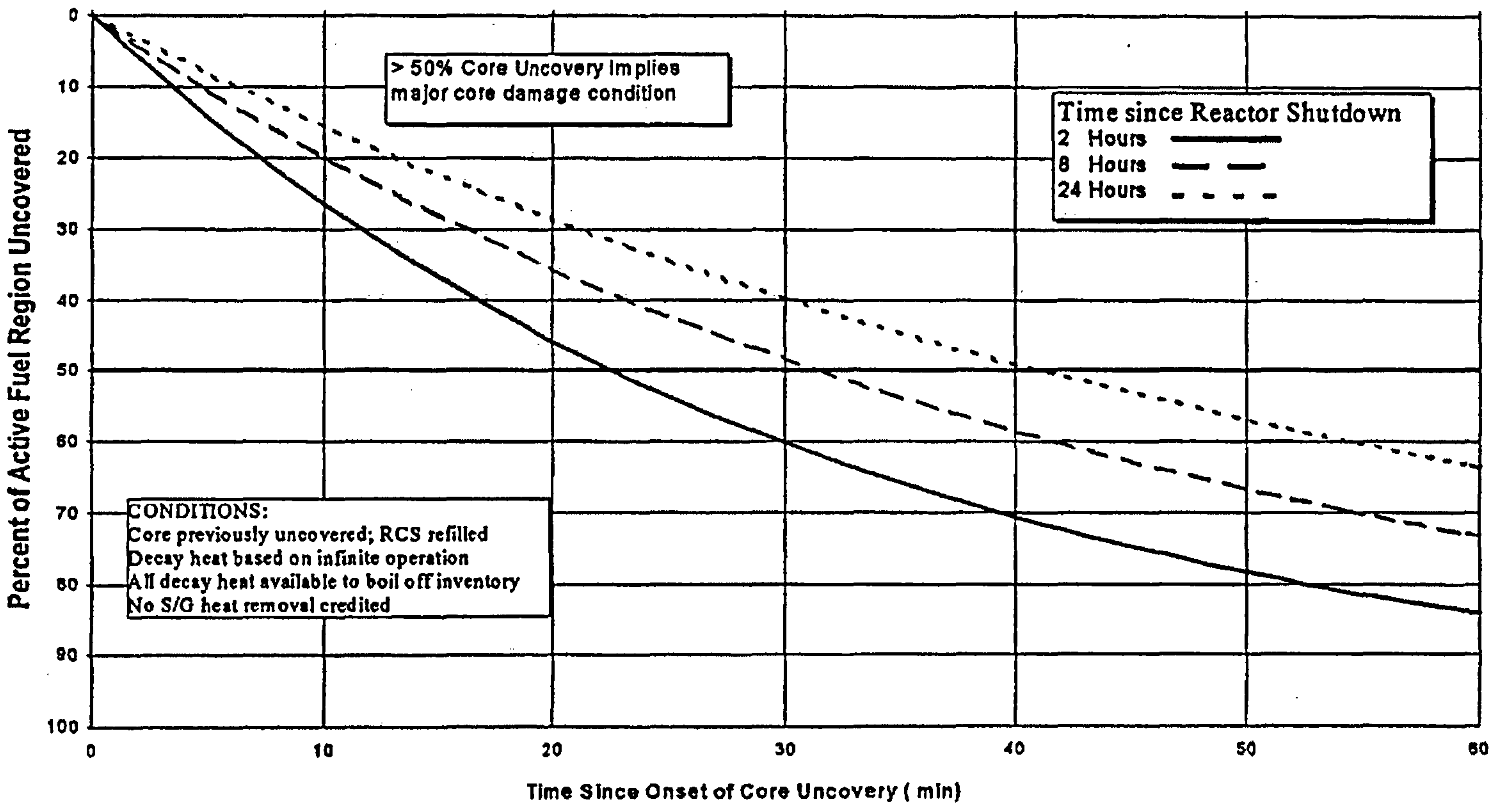


**Figure 1-5**
**Percent of Active Fuel Region Uncovered**
**Coolant Level in Core Region vs. Time since Onset of Core Uncovery**

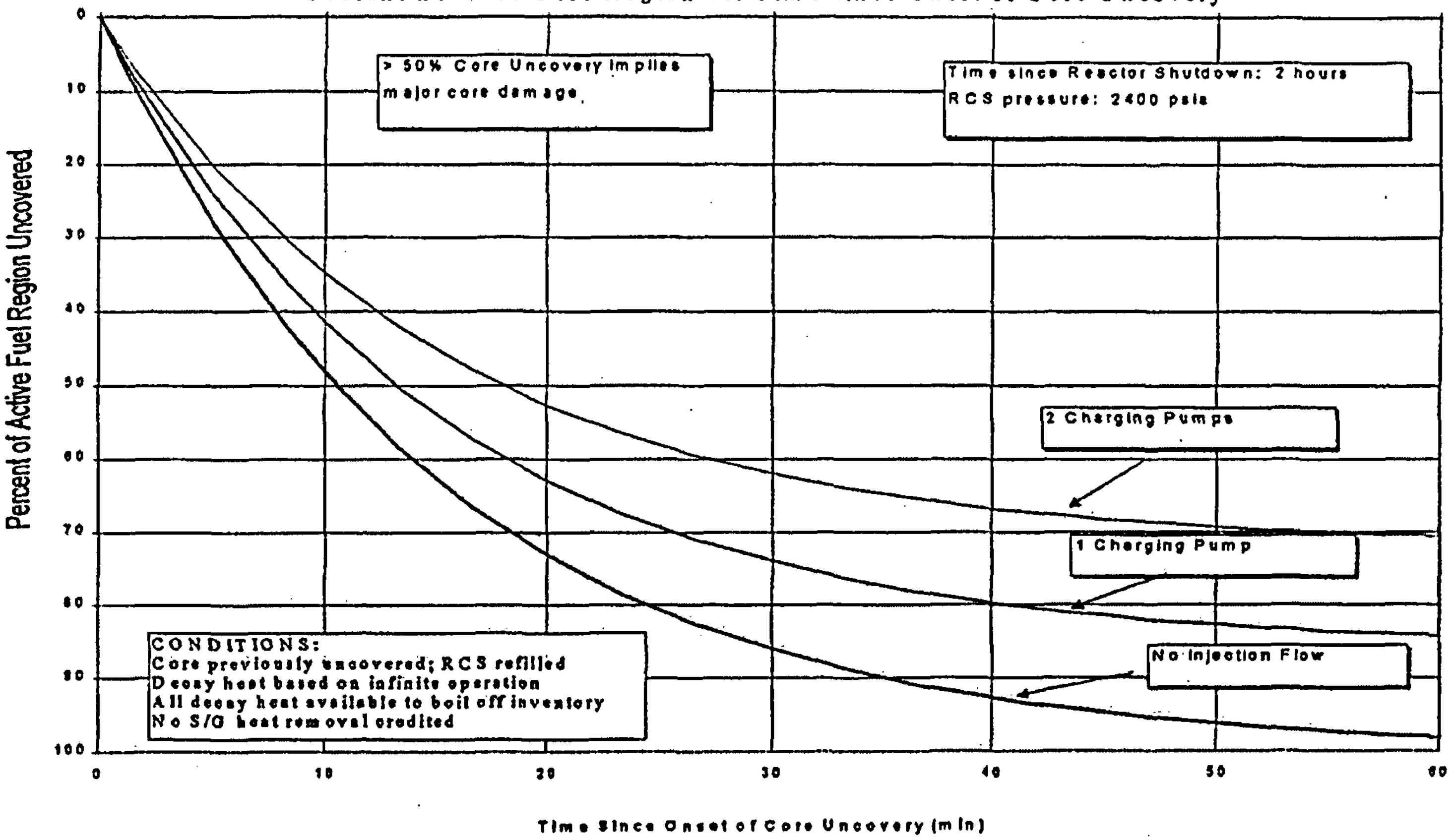


**Figure 1-6**

**Coolant Level in Core Region vs. Time since Onset of Core**

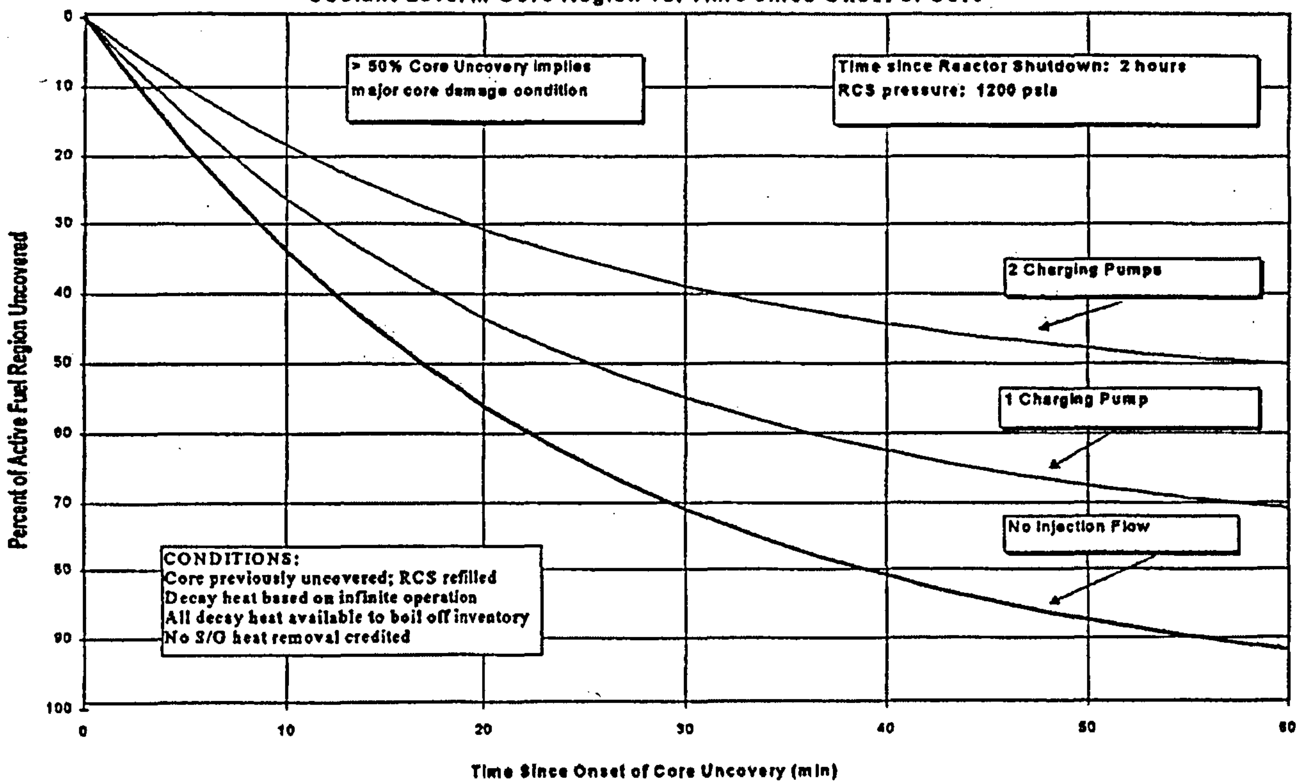


Figure 1-7
Coolant Level in Core Region vs. Time since Onset of Core Uncovery

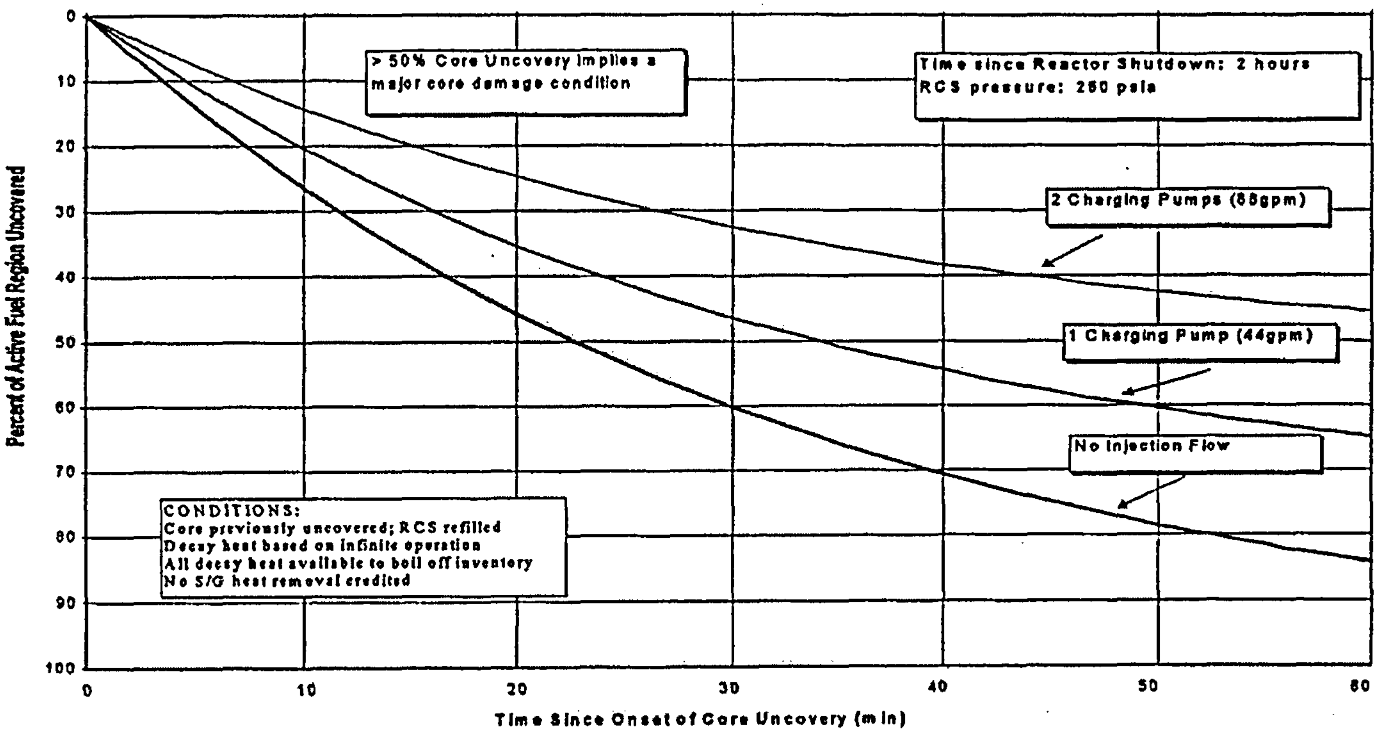


Figure 2a-1

Minimum Injection Flow Rate Required to Quench Molten Core (4000 deg. F)

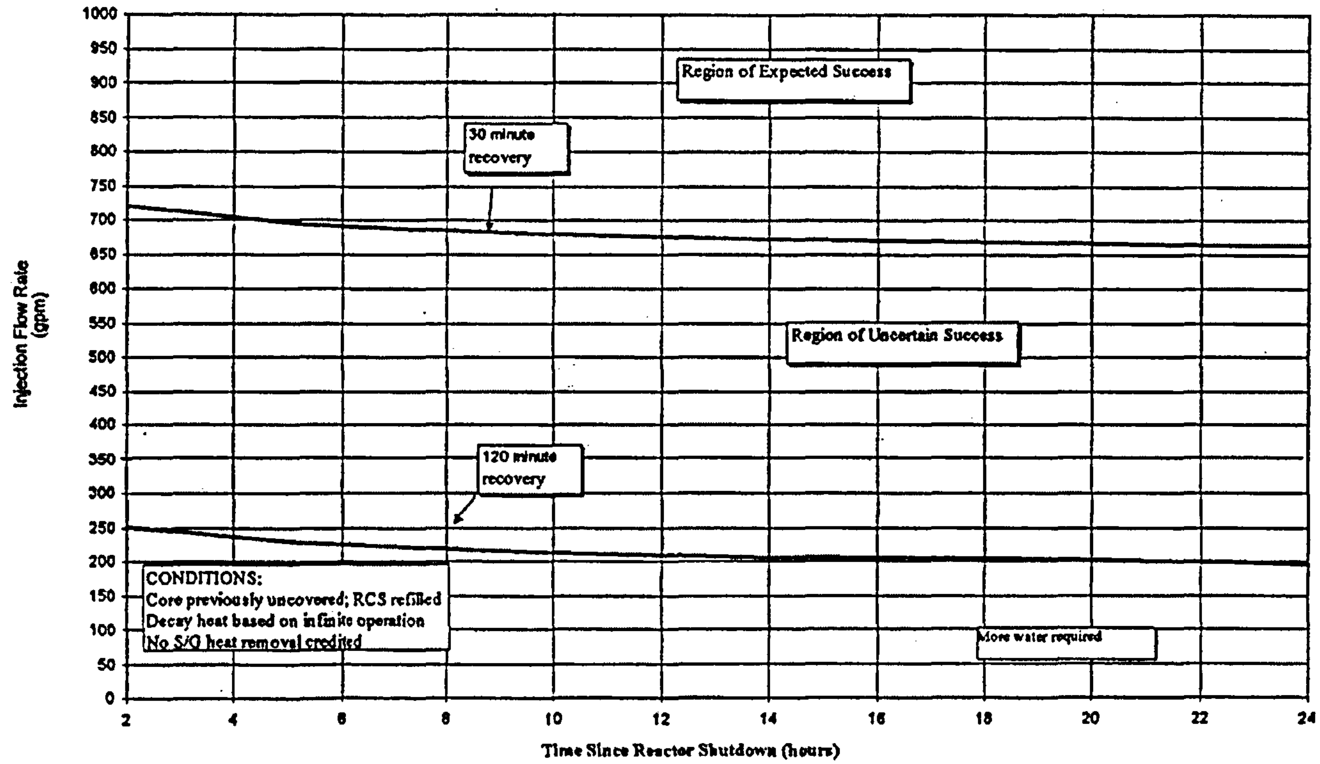


Figure 2b-1

Minimum Flowrate Required to Remove Decay Heat

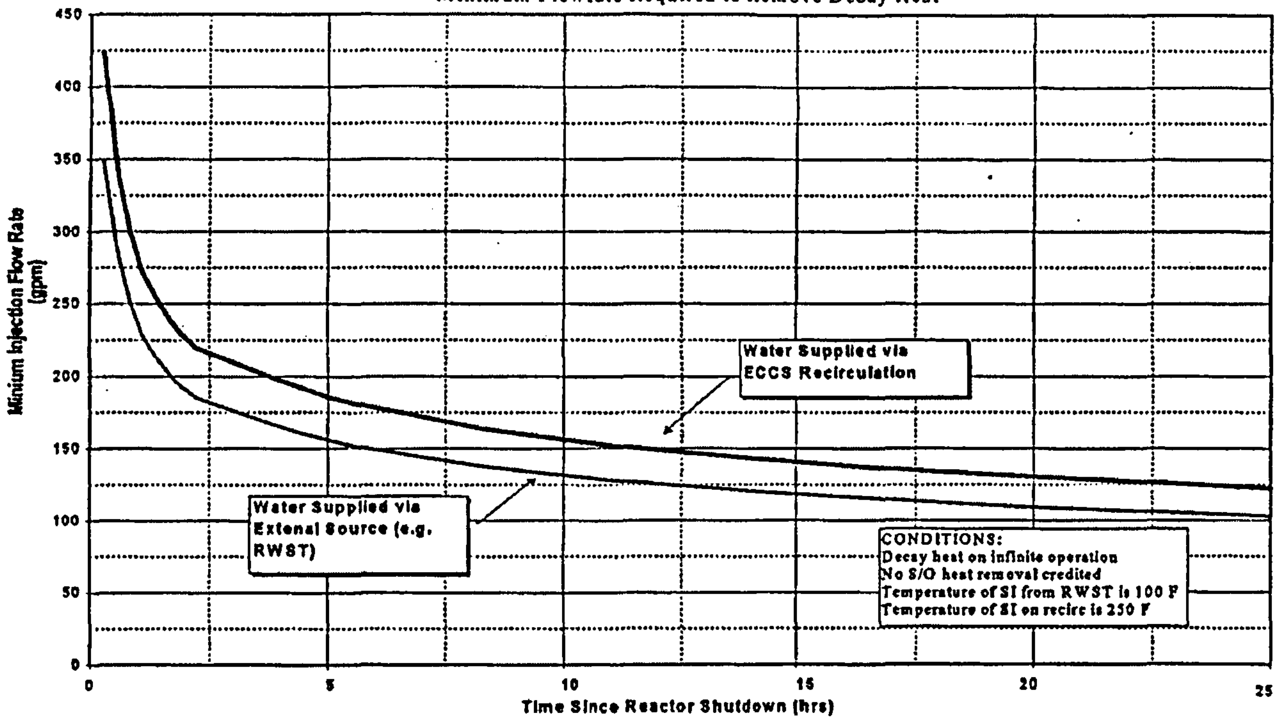


Figure 3a-1

**Pressure Increase Upon Injection of Loop Seal Water Into RV**
**(Superheated Conditions, T=1500F)**
***No RCS vents or SG heat removal considered**

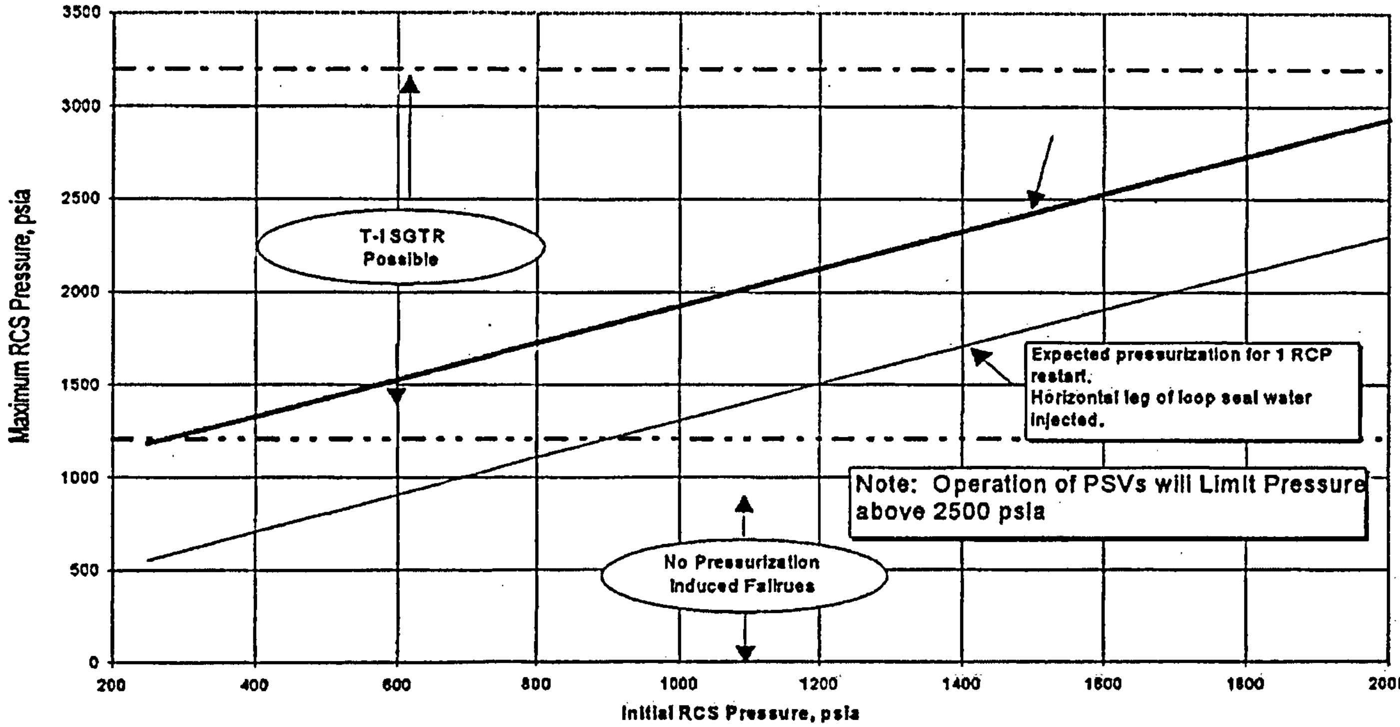
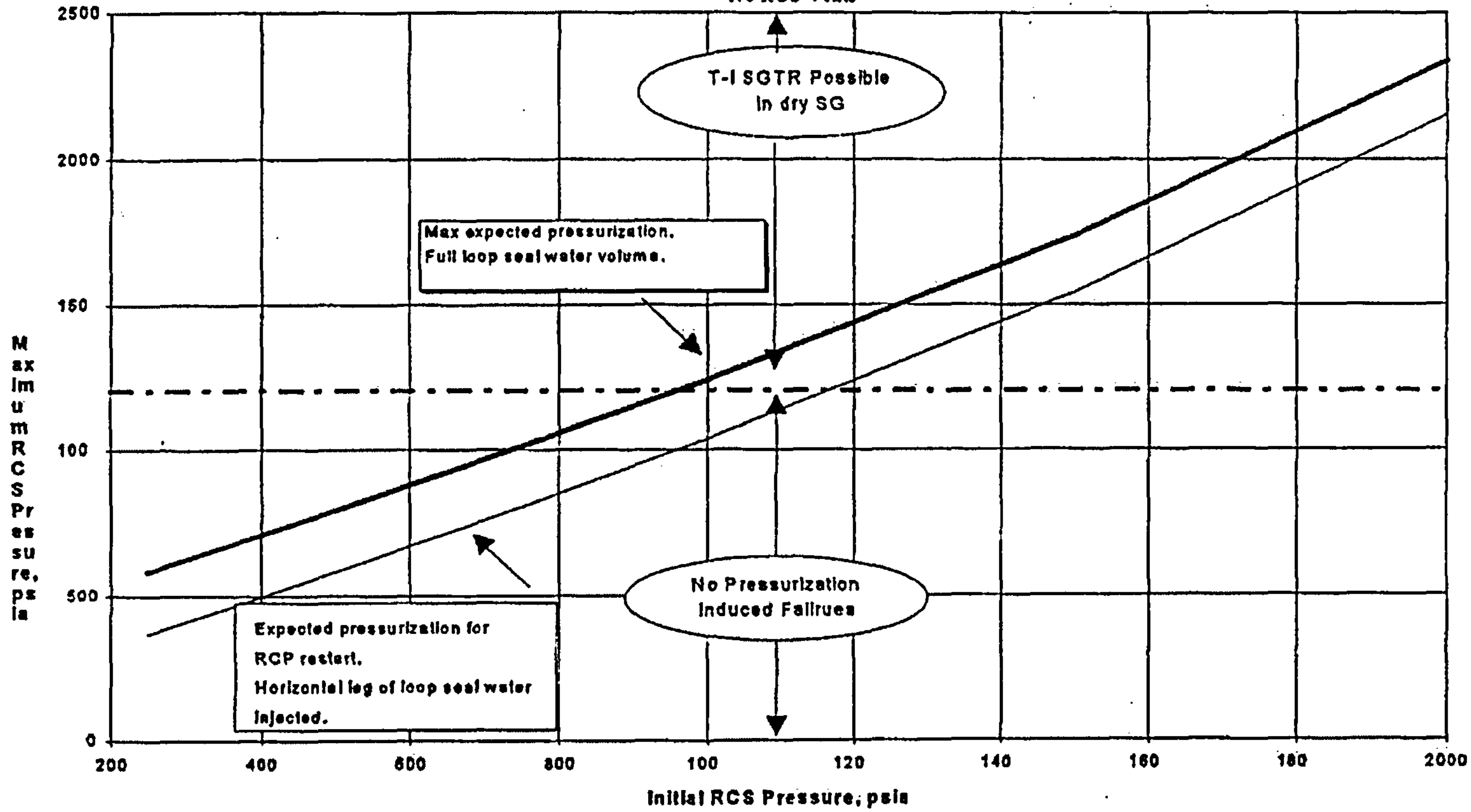


**Figure 3a-2**

**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<br>• 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

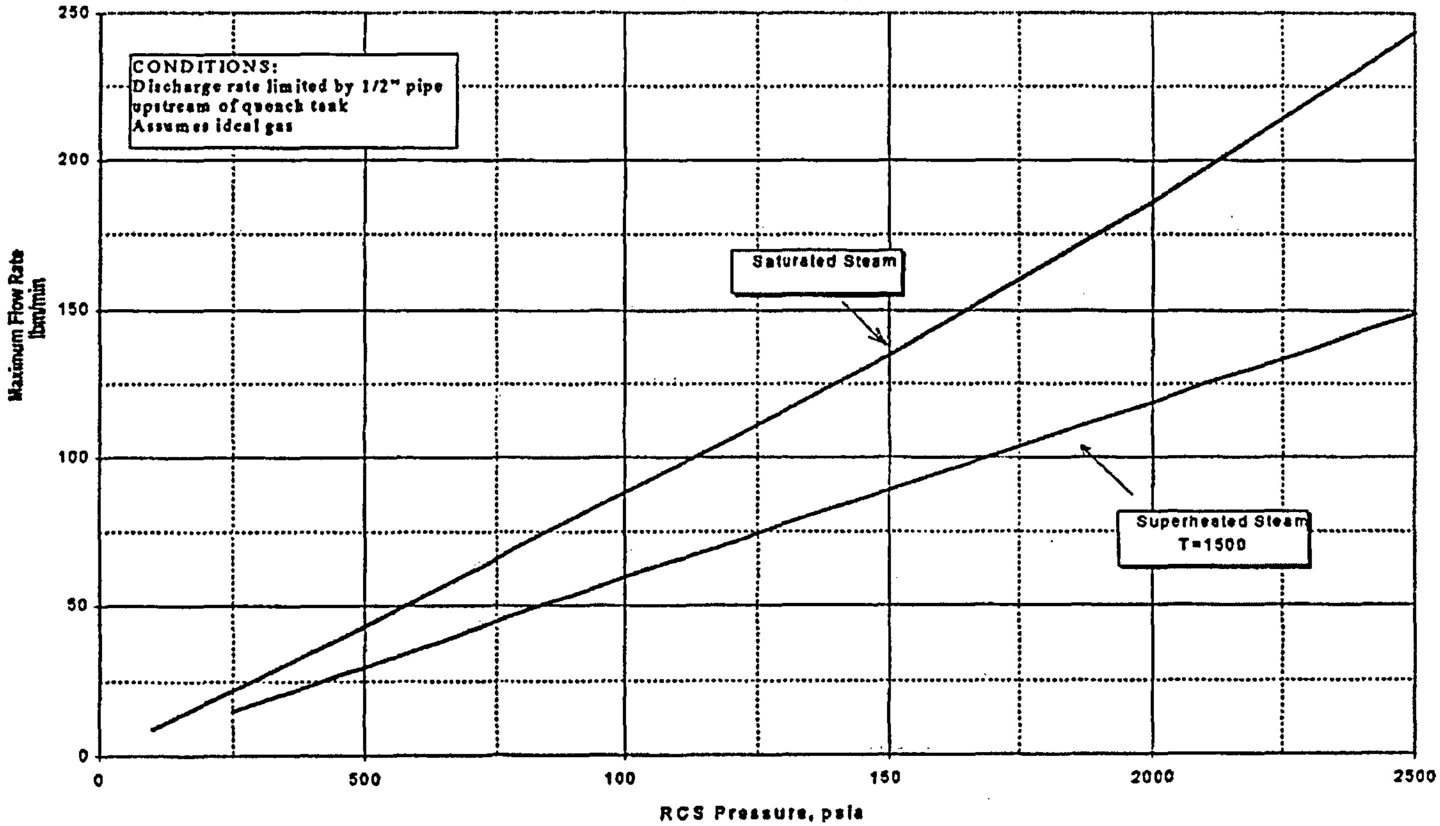


Figure 4a-2
Hydrogen Discharge Rate from RV/PZR Head Vent vs. RCS Pressure

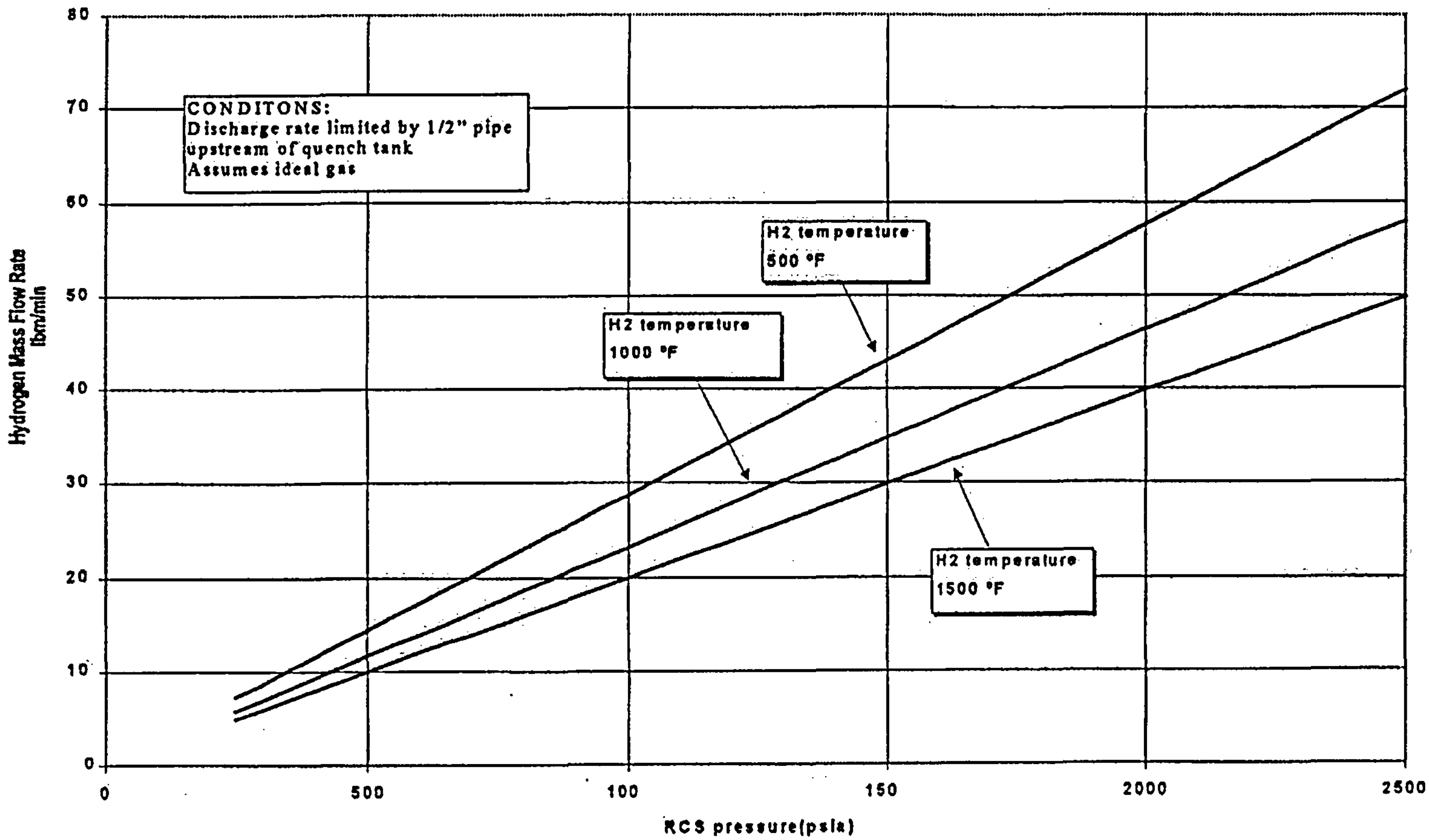


Figure 4a-3

Time Required to Vent Hydrogen From RCS as a Function of RCS Gas Temperature

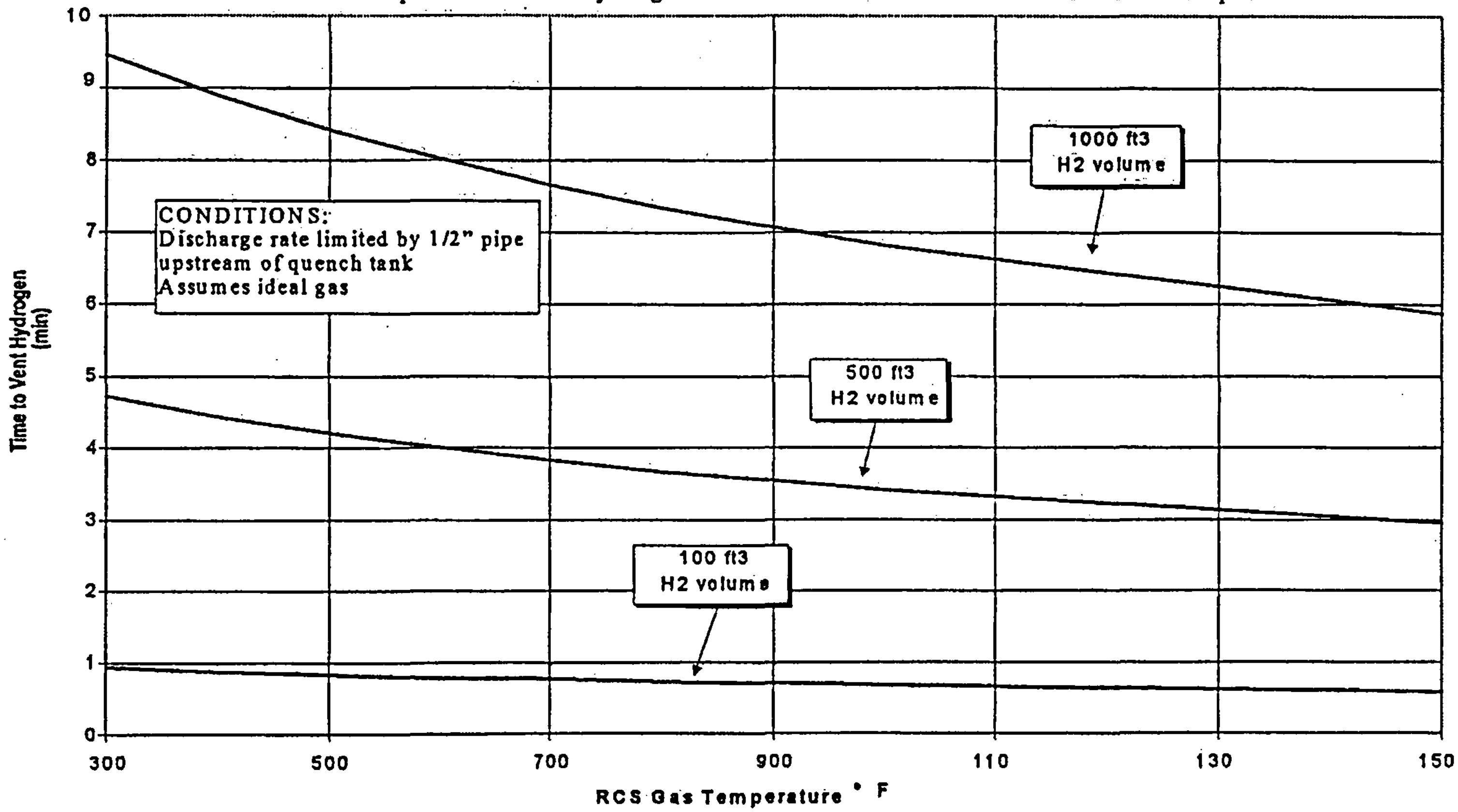


Figure 4b-1
PORV Mass Flow Rate as a
Function of RCS Pressure

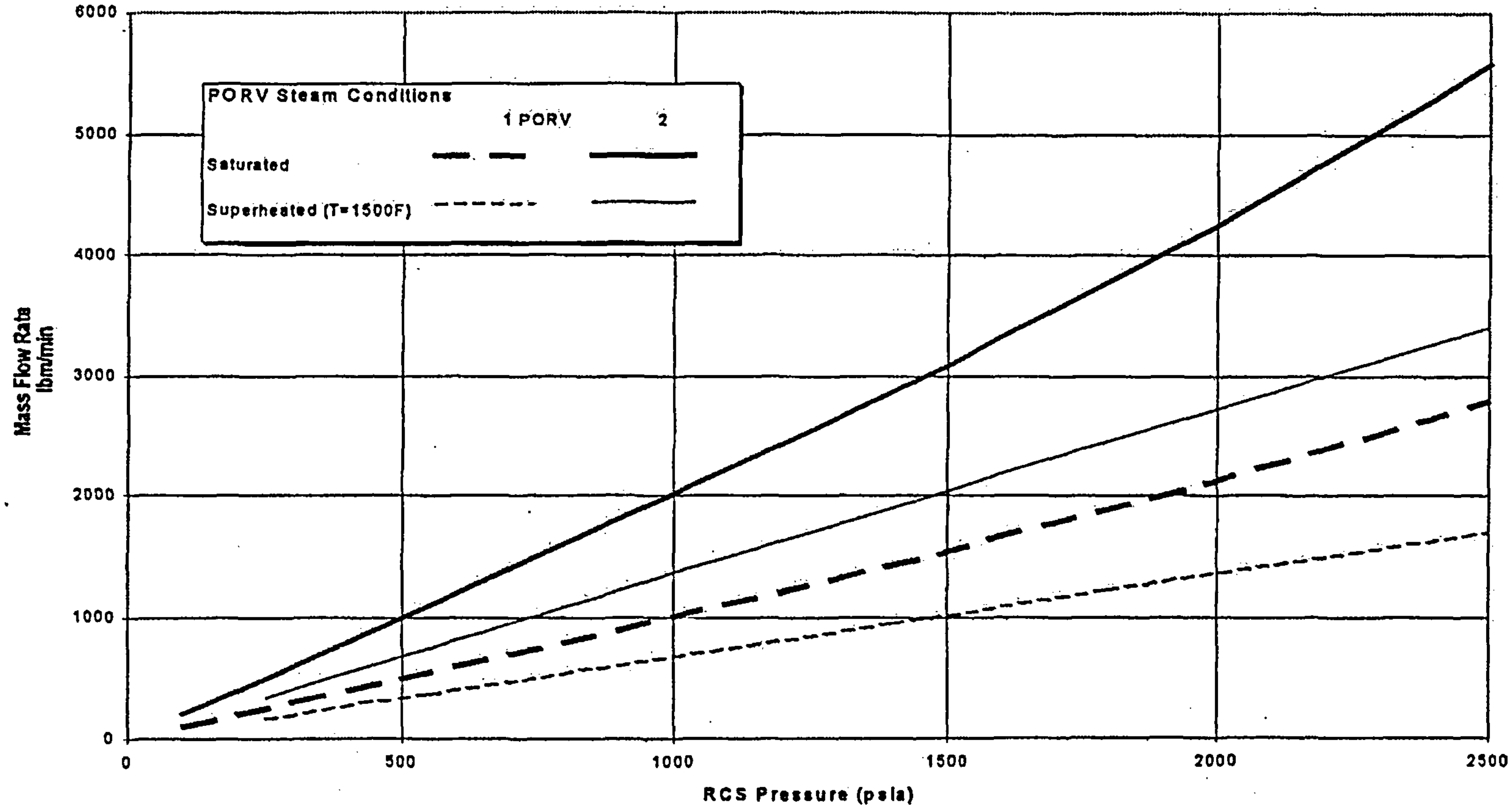


Figure 4b-2
PORV Energy Flow Rate as a
Function of RCS Pressure

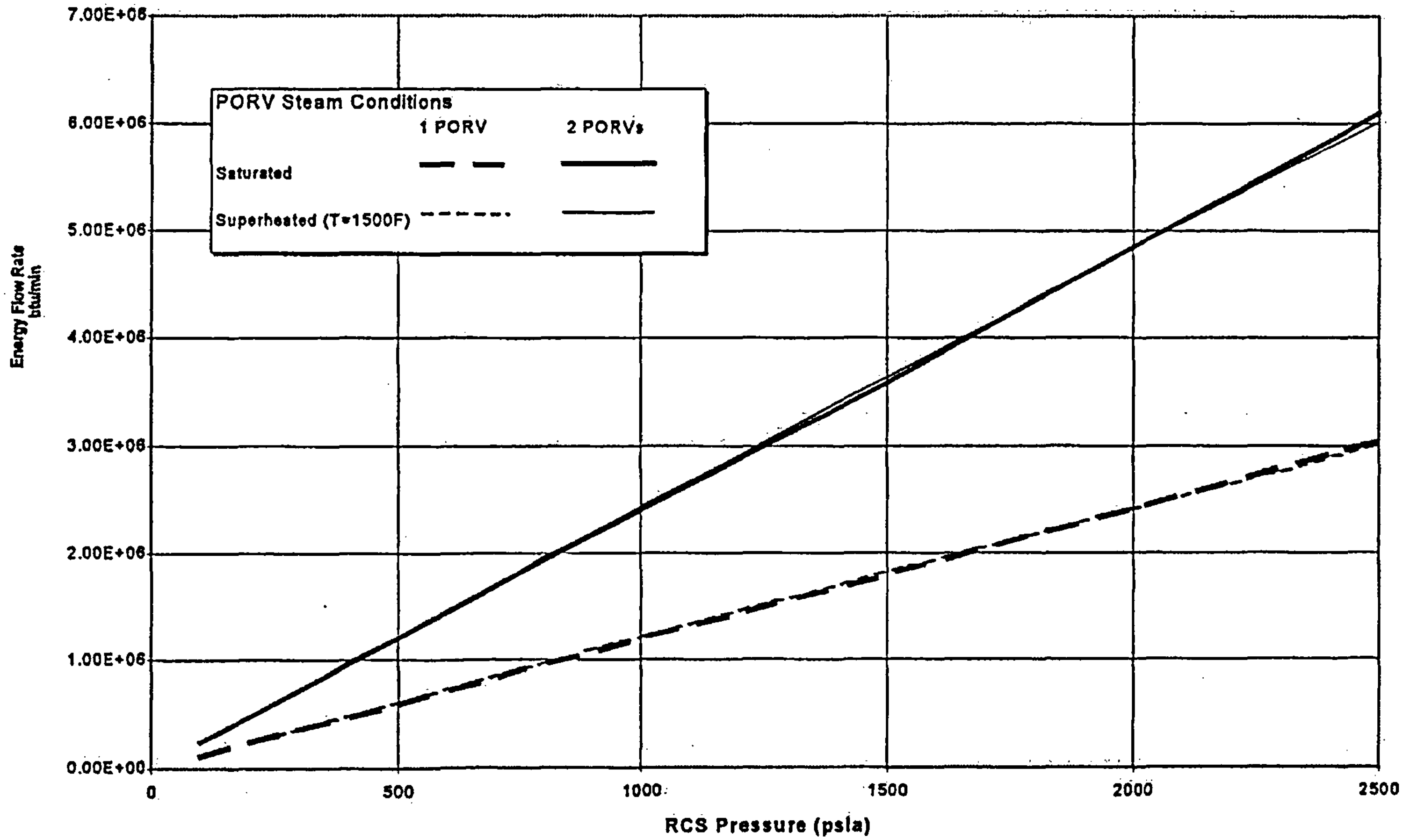


Figure 4b-3

**Available Resources For High Pressure Injection**

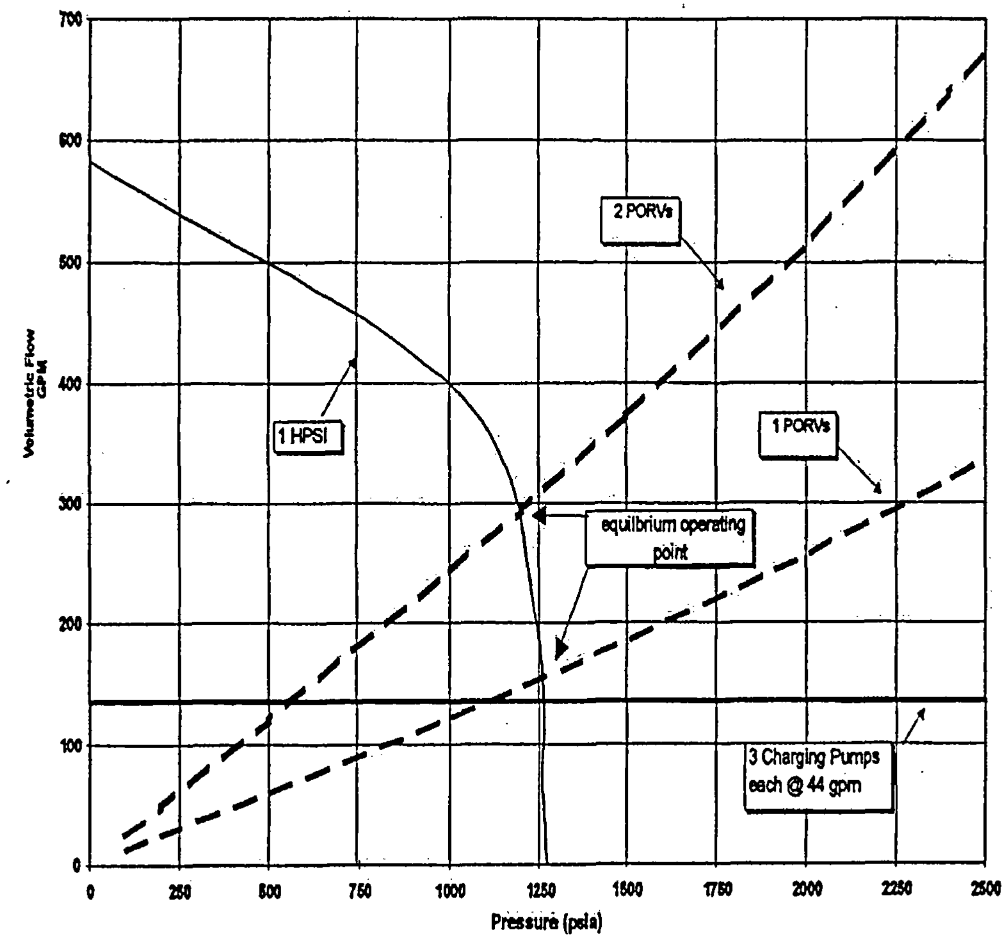


Figure 4c-1

RCS Depressurization Rate For Venting Saturated Steam

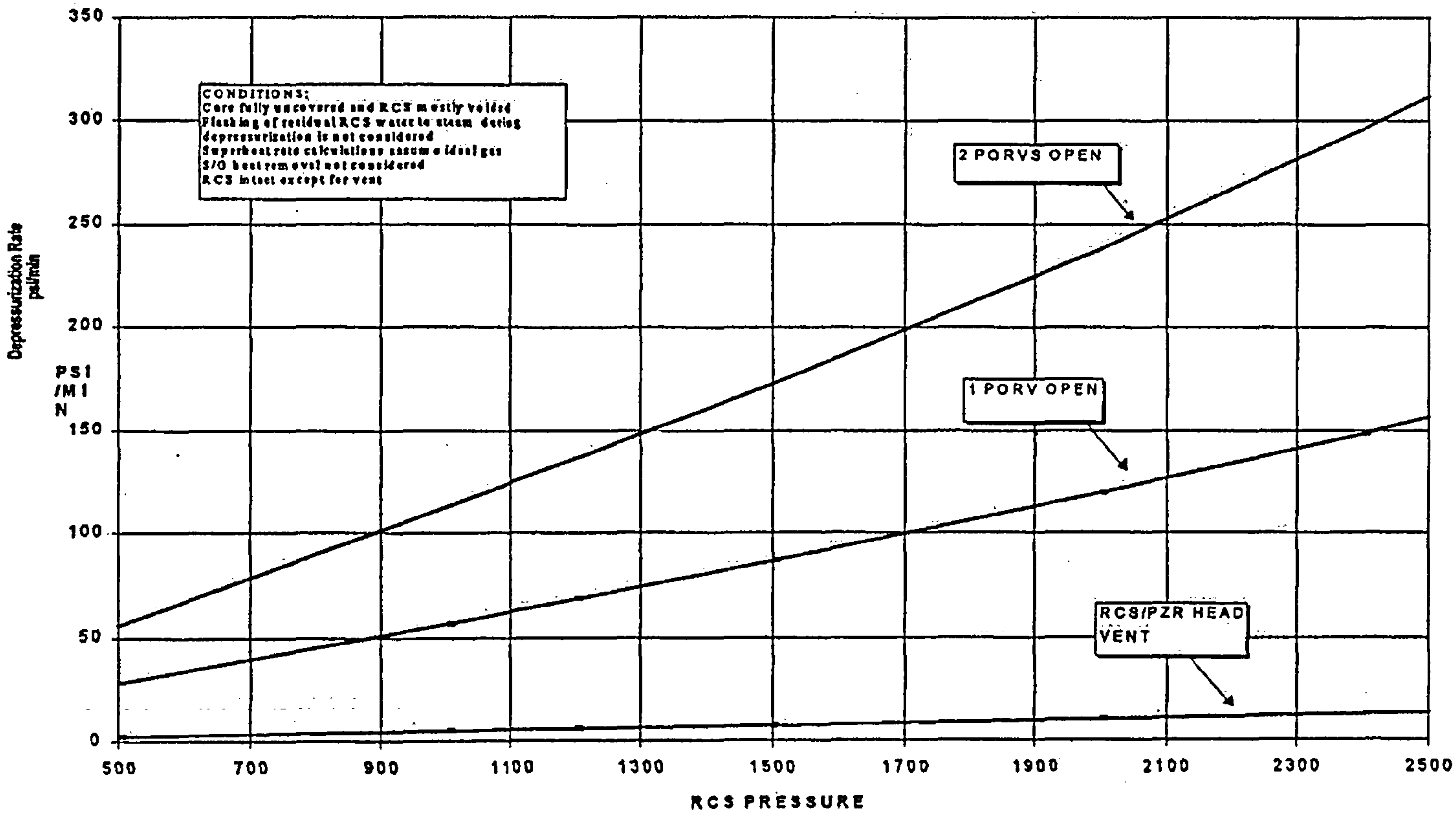


Figure 4c-2

RCS Depressurization Rate Venting Steam at 1500F

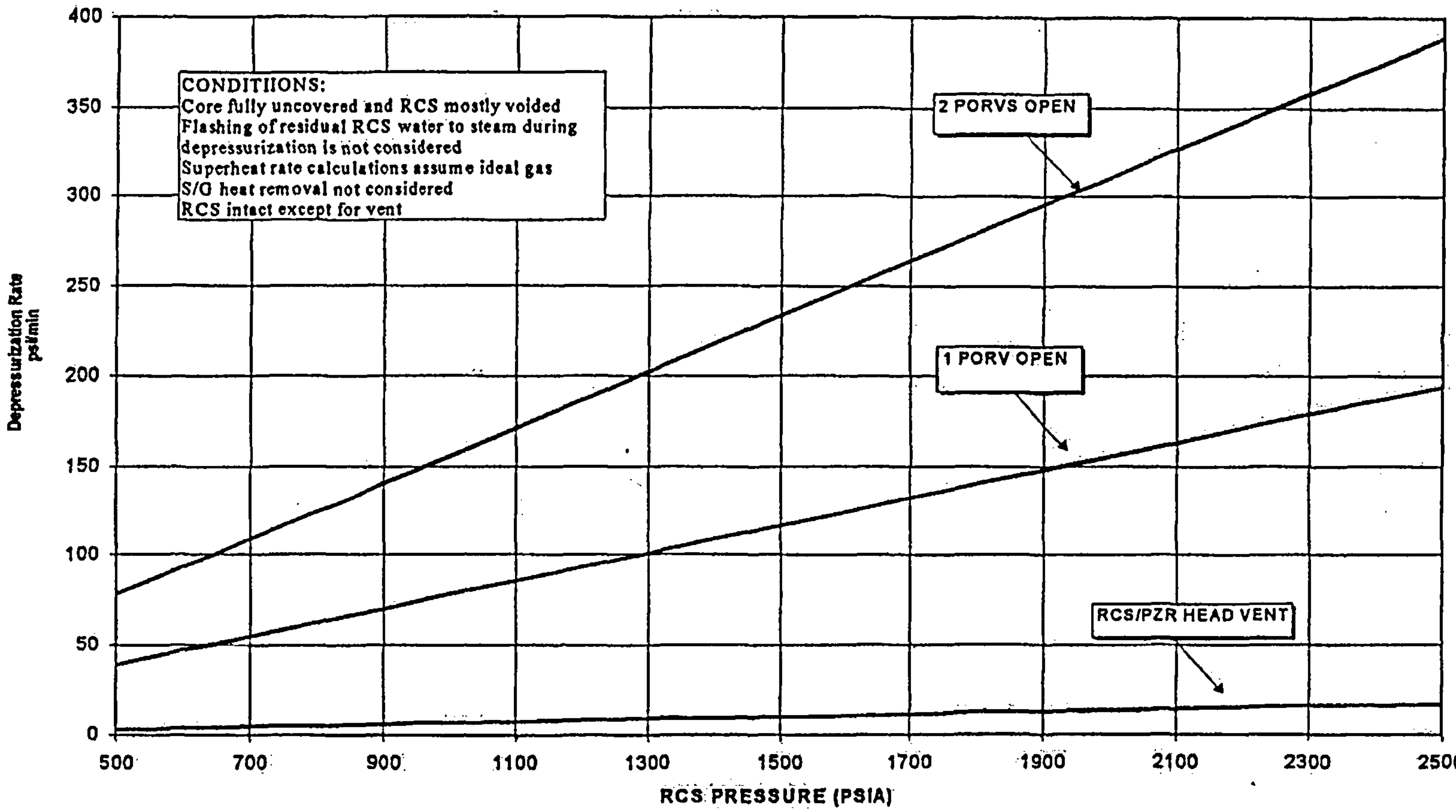


Table 5a-1

| 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**

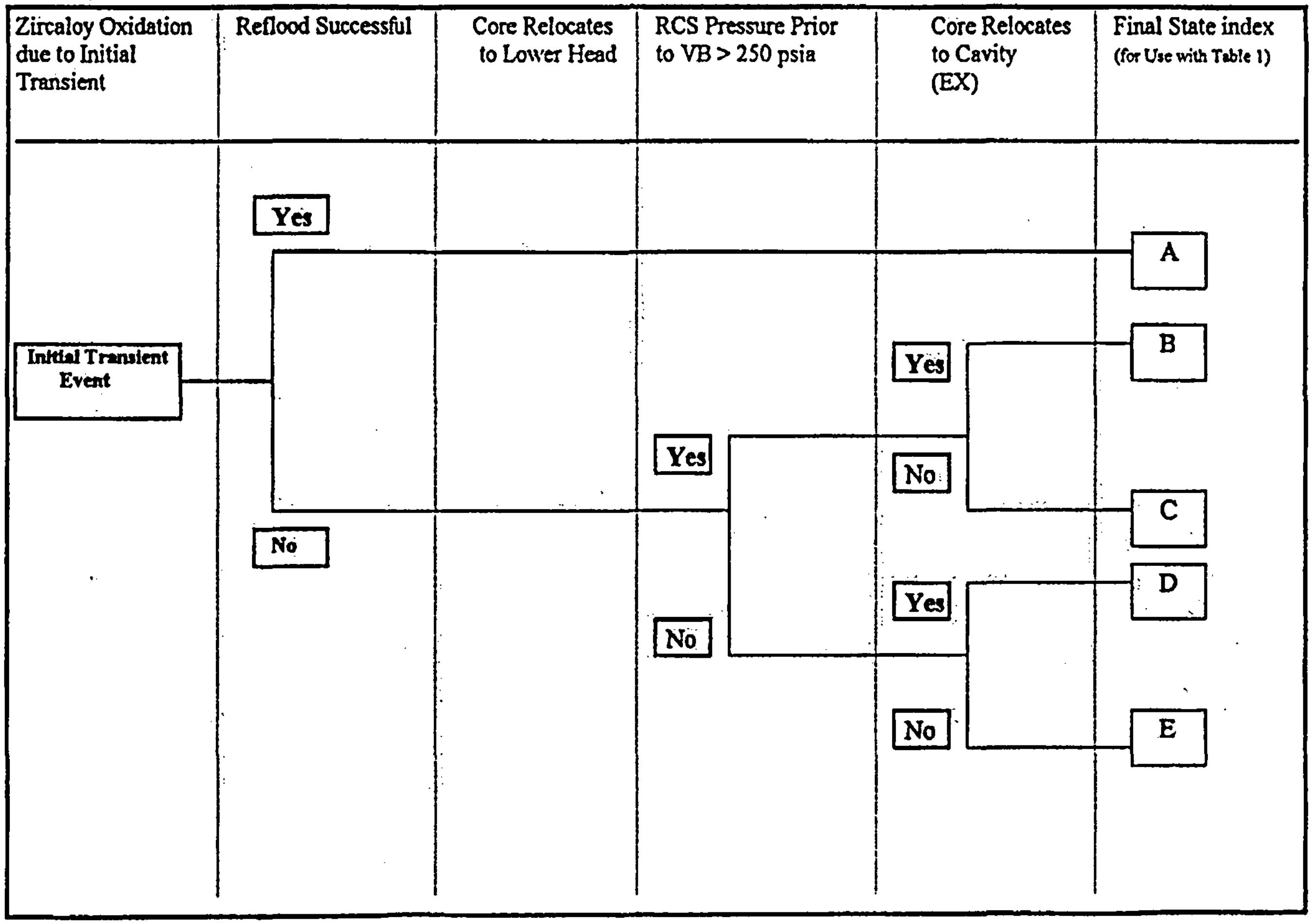


**Table 5b-1:**
**Fraction Zircaloy Oxidized and v/o Hydrogen in Containment (dry measurement)**

| Scenario / Event Description | Parameter | Final State Index A<br>Core Reflooded | Final State Index B<br>EX:HP-WETC | Final State Index C<br>EX:HP-DRYC | Final State Index D<br>EX:LP-WETC | Final State Index E<br>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**

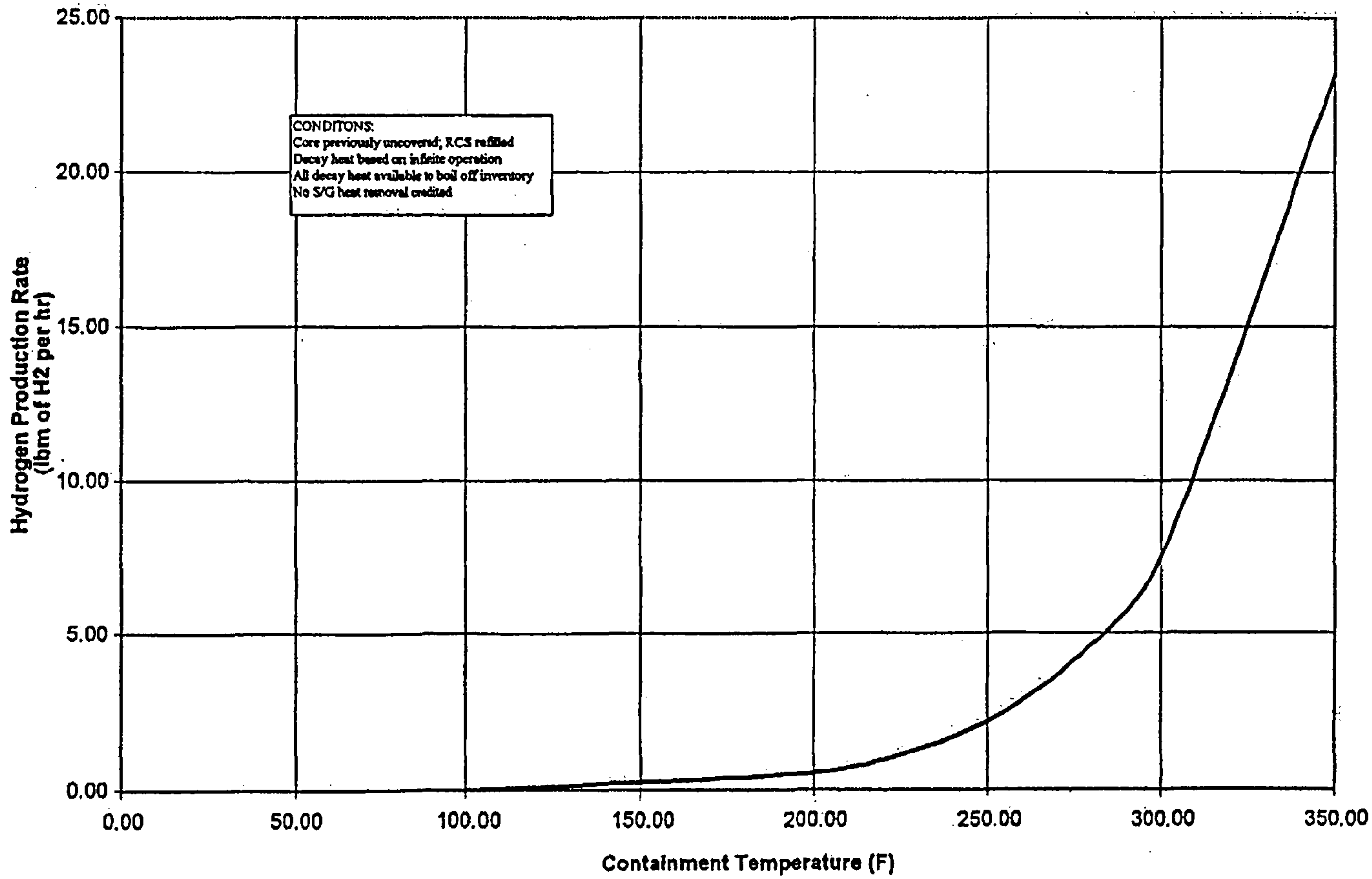
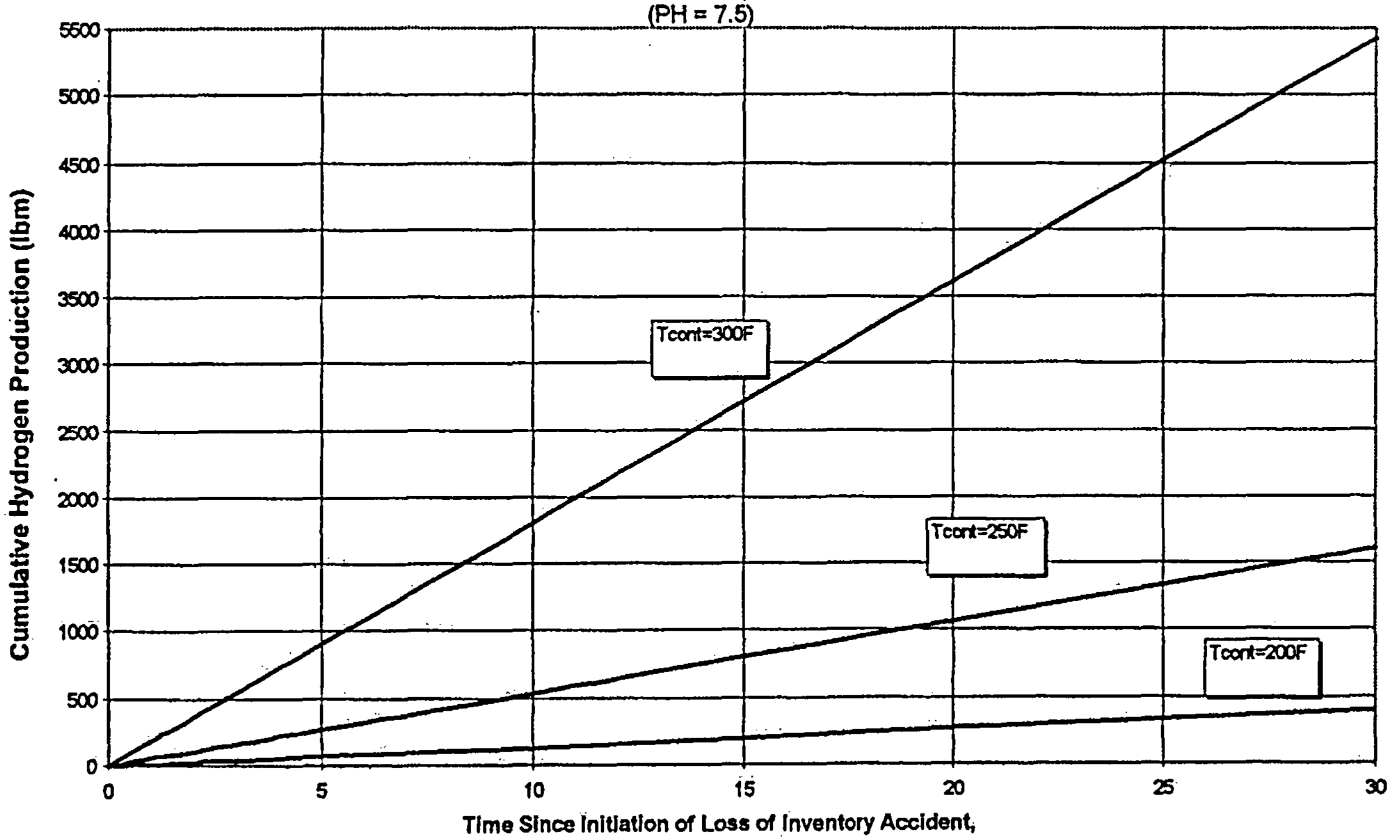


Figure 5c-2
Long Term Hydrogen Production
Due To Containment Metal Oxidation*
(PH = 7.5)



## Table 6-1
## USE OF EX-CORE NUCLEAR INSTRUMENTATION (NI) TO ASSESS CORE DAMAGE PROGRESSION

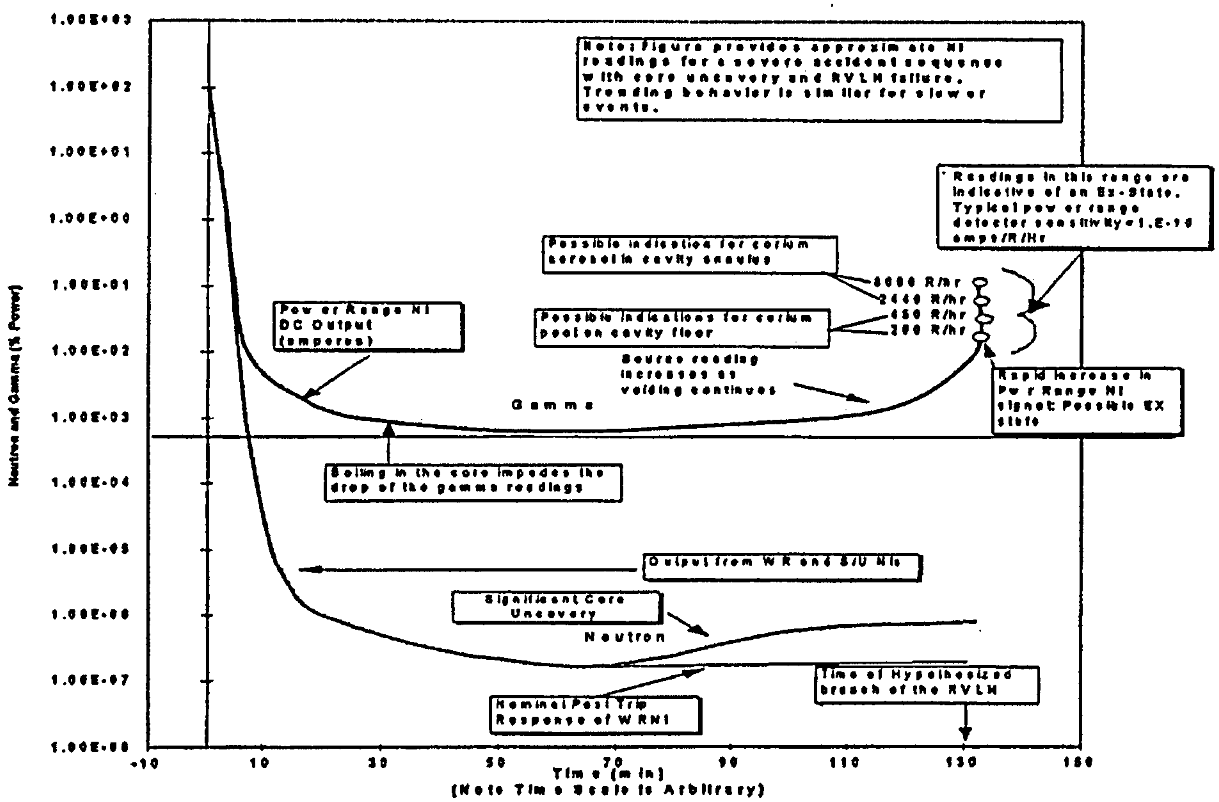
| INSTRUMENT | NORMAL OPERATION | SEVERE ACCIDENT RESPONSE |
|---|---|---|
| **STARTUP AND WIDE RANGE CHANNELS**<br><br>NI DEVICE USED AS A NEUTRON DETECTOR | DECREASING CPS AS $Br^{87}$ DECAYS AT A RATE OF 1/3 DECADE PER MINUTE.<br><br>FALL OFF RATE DECREASES IN 20 MINUTES AS NEUTRON SOURCE IS DOMINATED BY $D_2O$-GAMMA-NEUTRON REACTION. | AT INITIAL CORE UNCOVERY, CPS MAY STABILIZE<br><br>CPS INCREASES AS CORE UNCOVERY PROGRESSES (DUE TO INCREASE NEUTRON LEAKAGE)<br><br>UNCOVERY RESPONSE MAY BE INITIALLY MASKED BY CHANGES IN WATER AVAILABILITY EXTERNAL TO THE REACTOR VESSEL<br><br>Note:<br>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.<br><br>Caution:<br>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**<br><br>MAY BE USED AS GAMMA FLUX INDICATORS VIA DIRECT SENSING OF DETECTOR CURRENT<br><br>CURRENT MONITORS SENSE GAMMA FLUX FROM EXTERIOR CORE BUNDLES<br><br>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<br><br>CHANGING GAMMA FLUXES MORE INDICATIVE OF RELOCATION OF FISSION PRODUCTS<br><br>LARGE DOSE INCREASES (CURRENT) UPON RV FAILURE (TRANSITORY)<br><br>LARGE DOSE READINGS IF CORIUM BED FORMS IN CAVITY<br><br>Note:<br>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:<br>1. extent of cavity flooding<br>2. RCS pressure at VB. Low RCS pressures ($<250$ psia) are conducive to molten pool formation and lower aerosolization of fission products.<br><br>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



# Figure 7-2

## Hydrogen Combustibility Chart Based on Dry Hydrogen Measurement

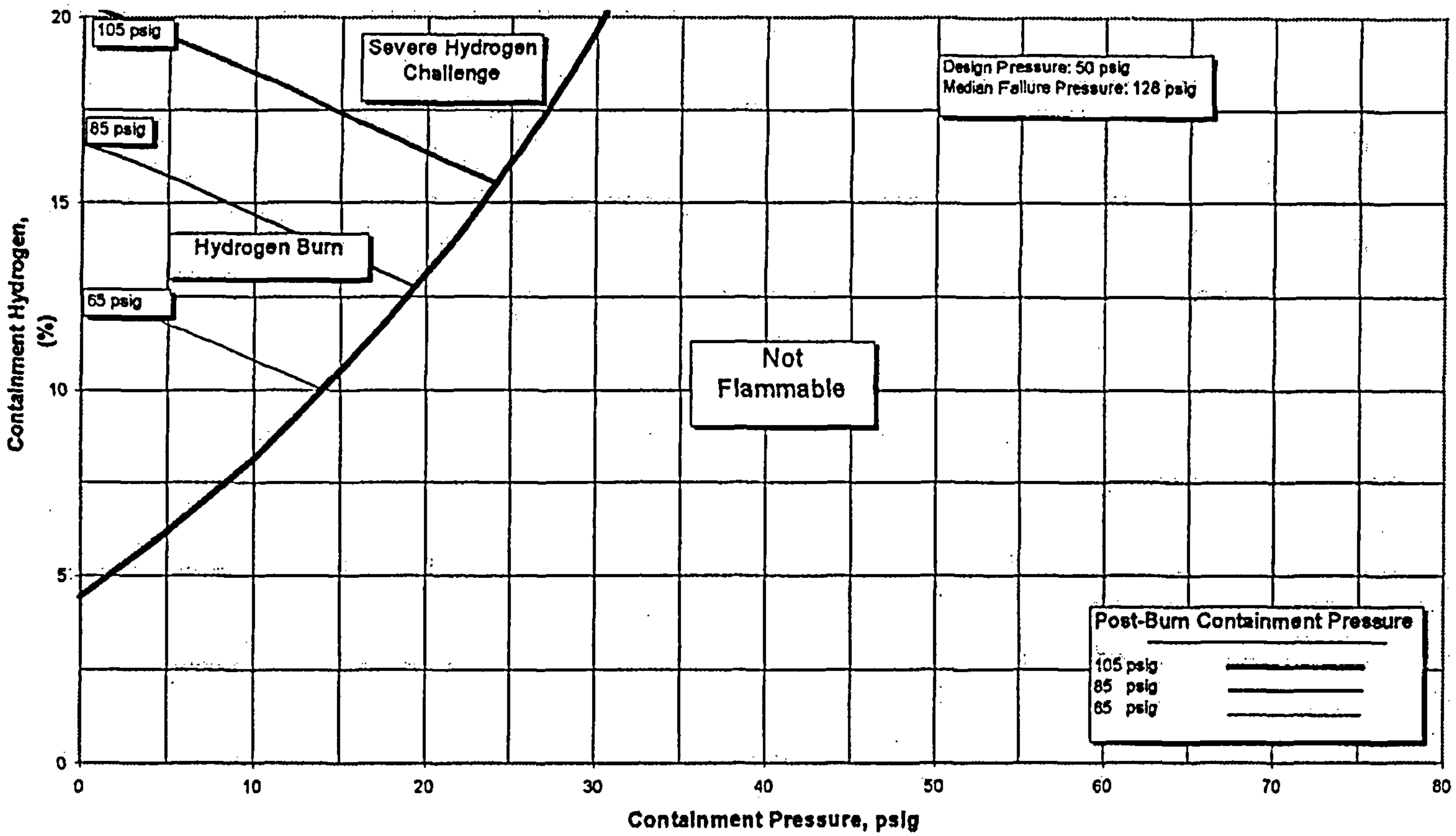
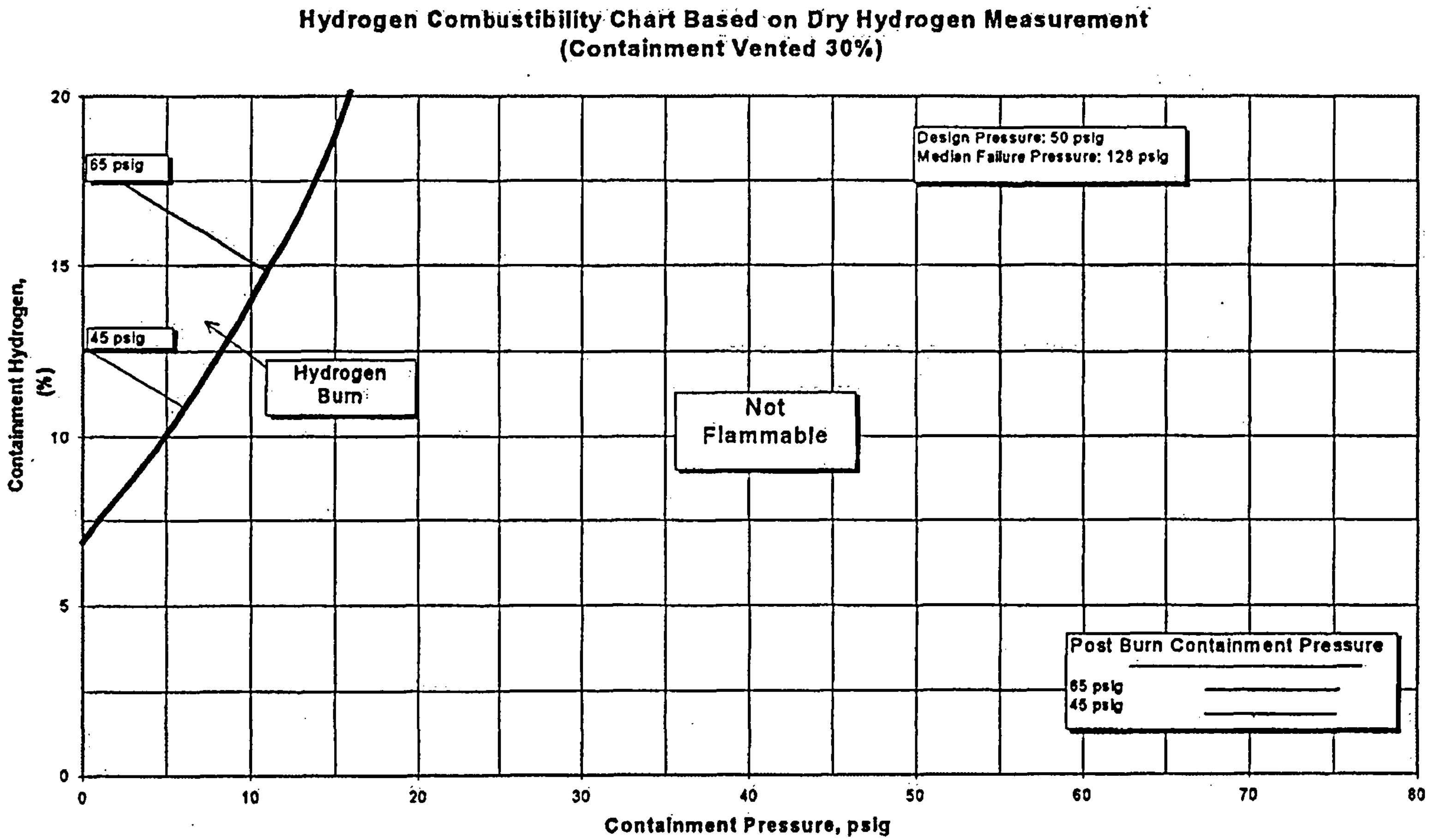


**Figure 7-4**


Hydrogen Combustibility Chart Based on Dry Hydrogen Measurement
(Containment Vented 30%)
Containment Hydrogen, (%)
Containment Pressure, psig
0
5
10
15
20
0
10
20
30
40
50
60
70
80
65 psig
45 psig
Hydrogen Burn
Not Flammable
Design Pressure: 50 psig
Median Failure Pressure: 128 psig
Post Burn Containment Pressure
65 psig
45 psig

## Figure 8-1

**Containment Pressure Following RCS Creep Failure or RV Lower Head Failure in the presence of a Dry Reactor Cavity**

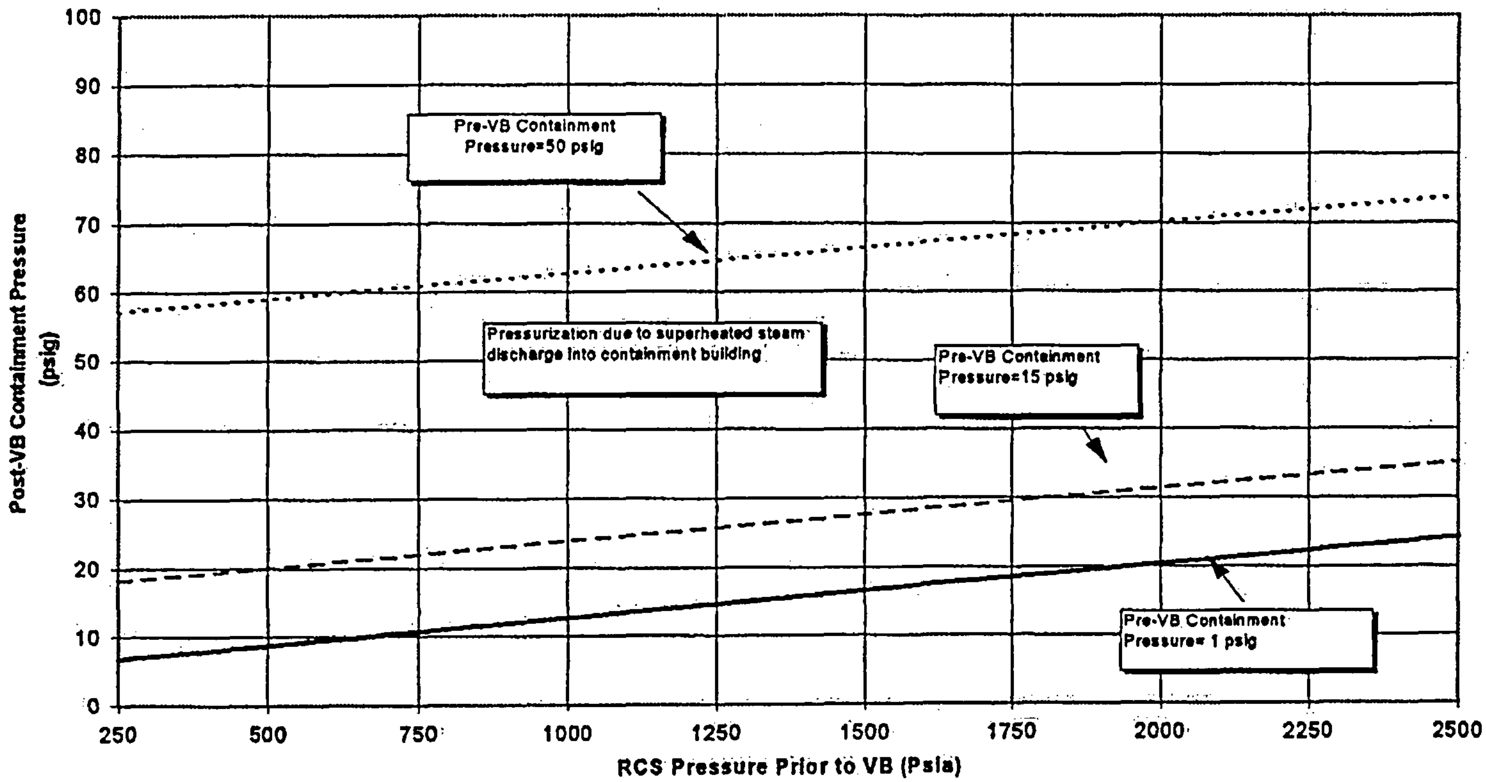


**Figure 8-2**

**Post VB Containment Pressure Following Corium discharge into a Wet Reactor Cavity**

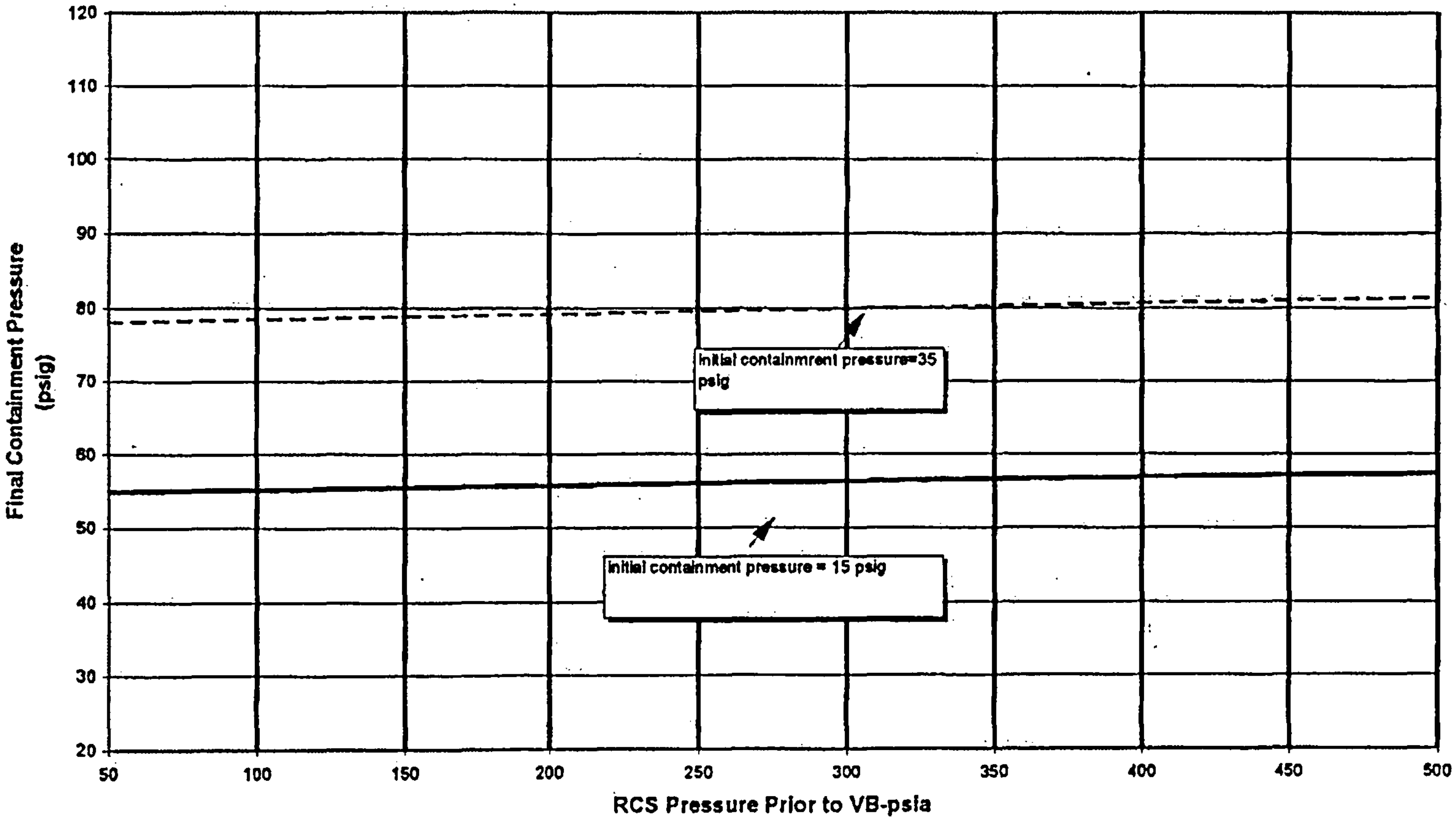
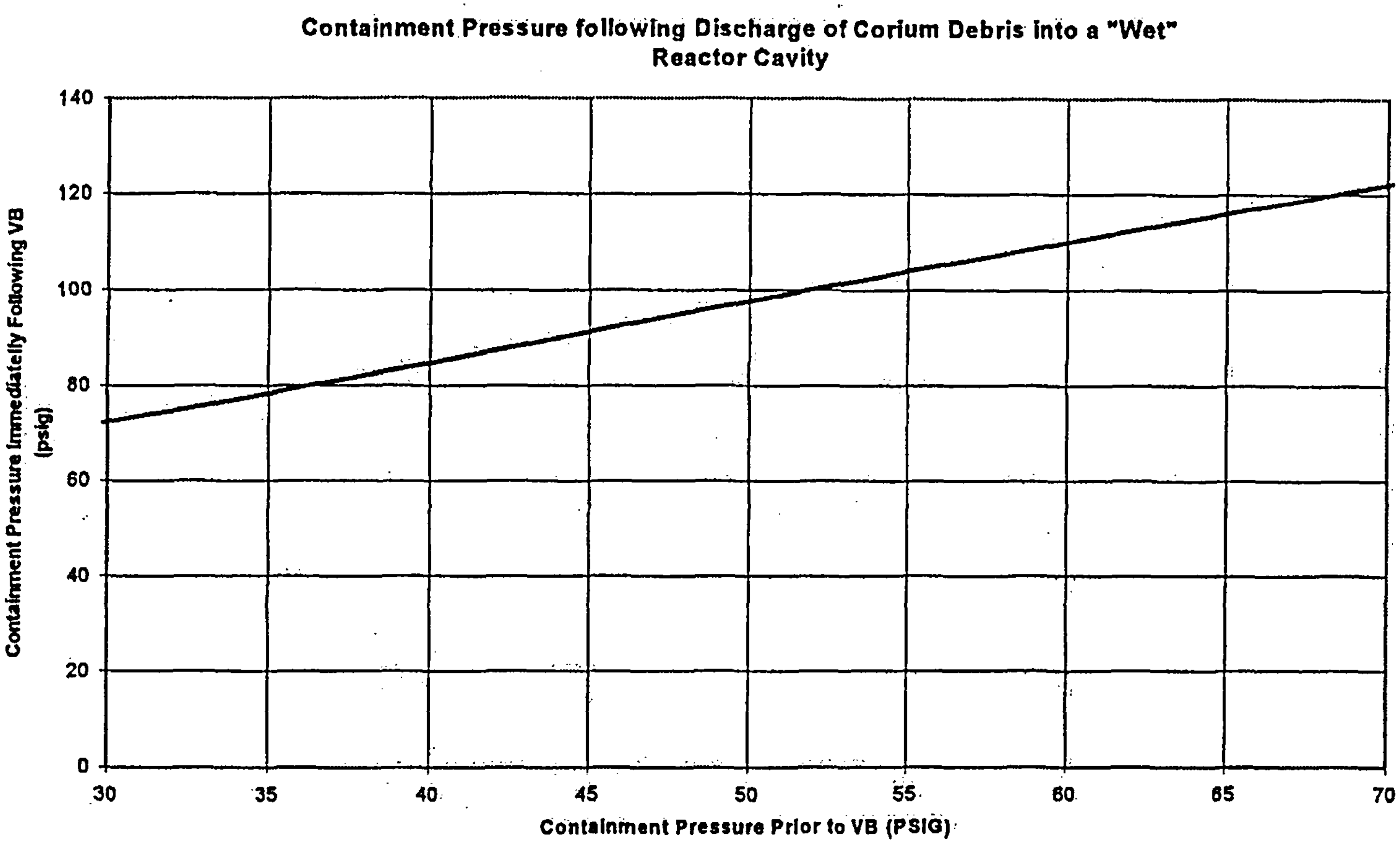


Figure 8-3
Containment Pressure following Discharge of Corium Debris into a "Wet" Reactivity Cavity



## 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**

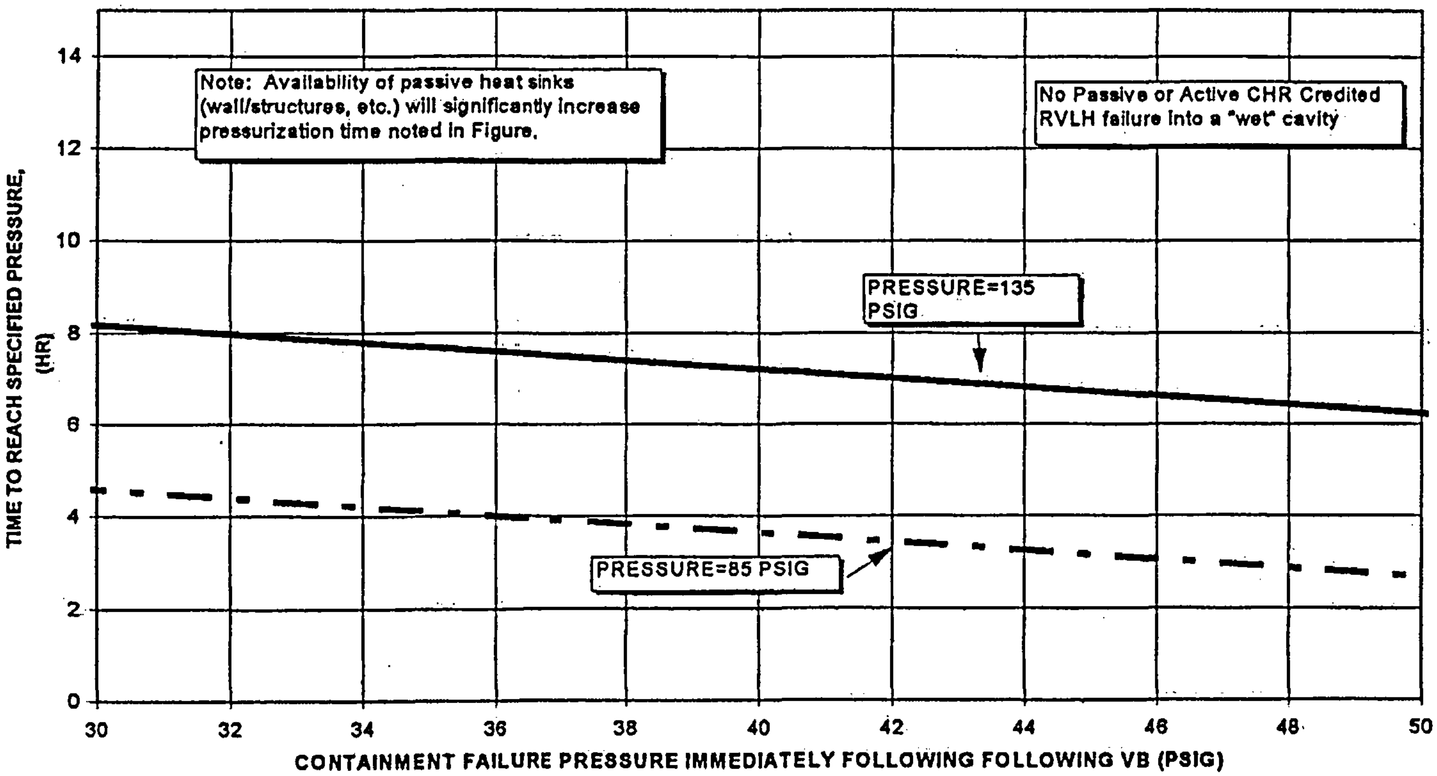


Figure 8-5

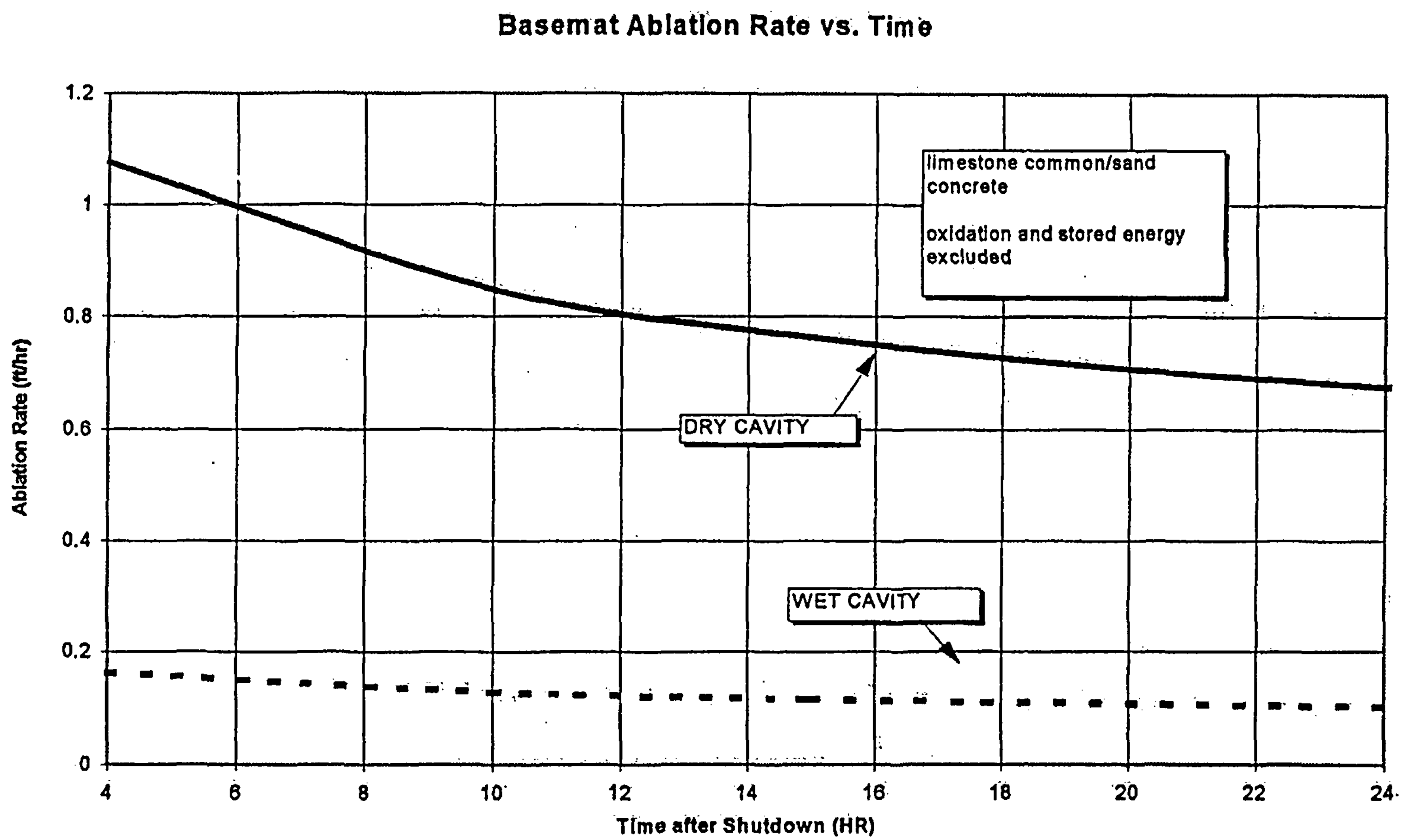

Basemat Ablation Rate vs. Time
1.2
1
0.8
0.6
0.4
0.2
0
Ablation Rate (ft/hr)
4
6
8
10
12
14
16
18
20
22
24
Time after Shutdown (HR)
limestone common/sand concrete
oxidation and stored energy excluded
DRY CAVITY
WET CAVITY

**Figure 9-1**
**Venting Mass Flow Rate vs. Containment Pressure**

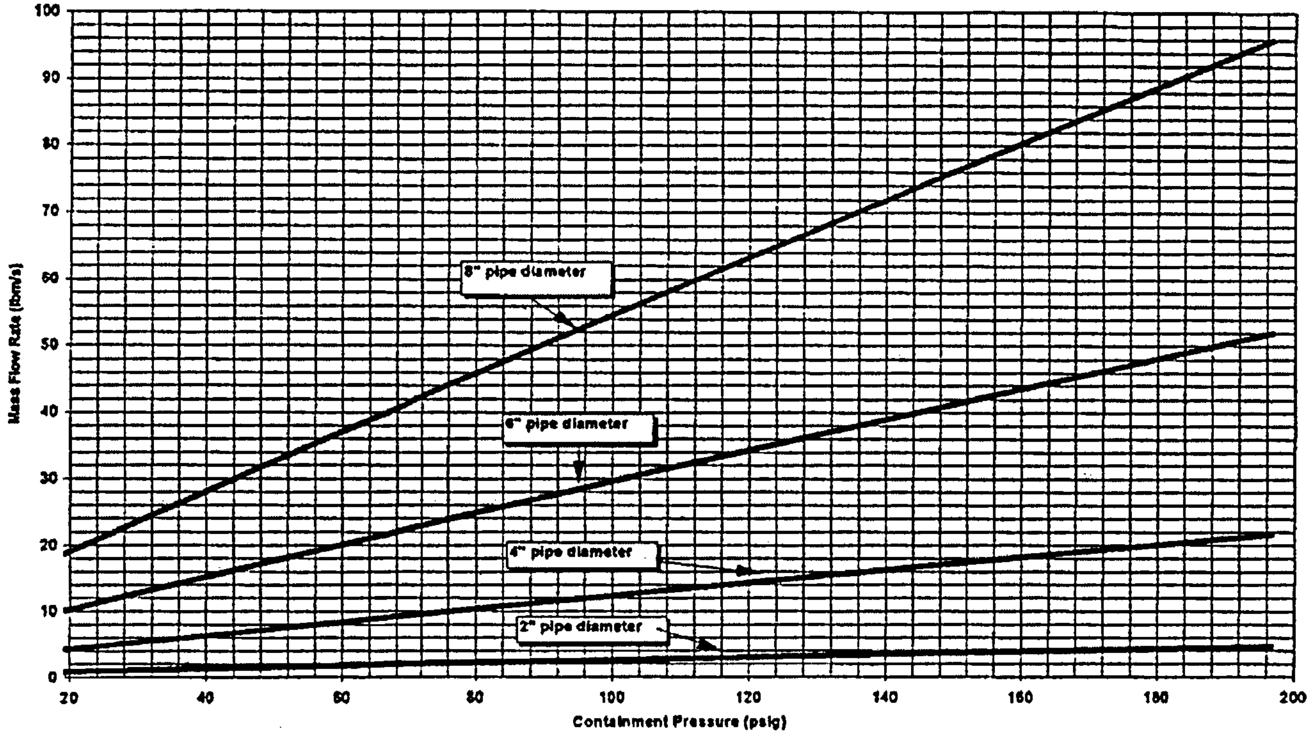
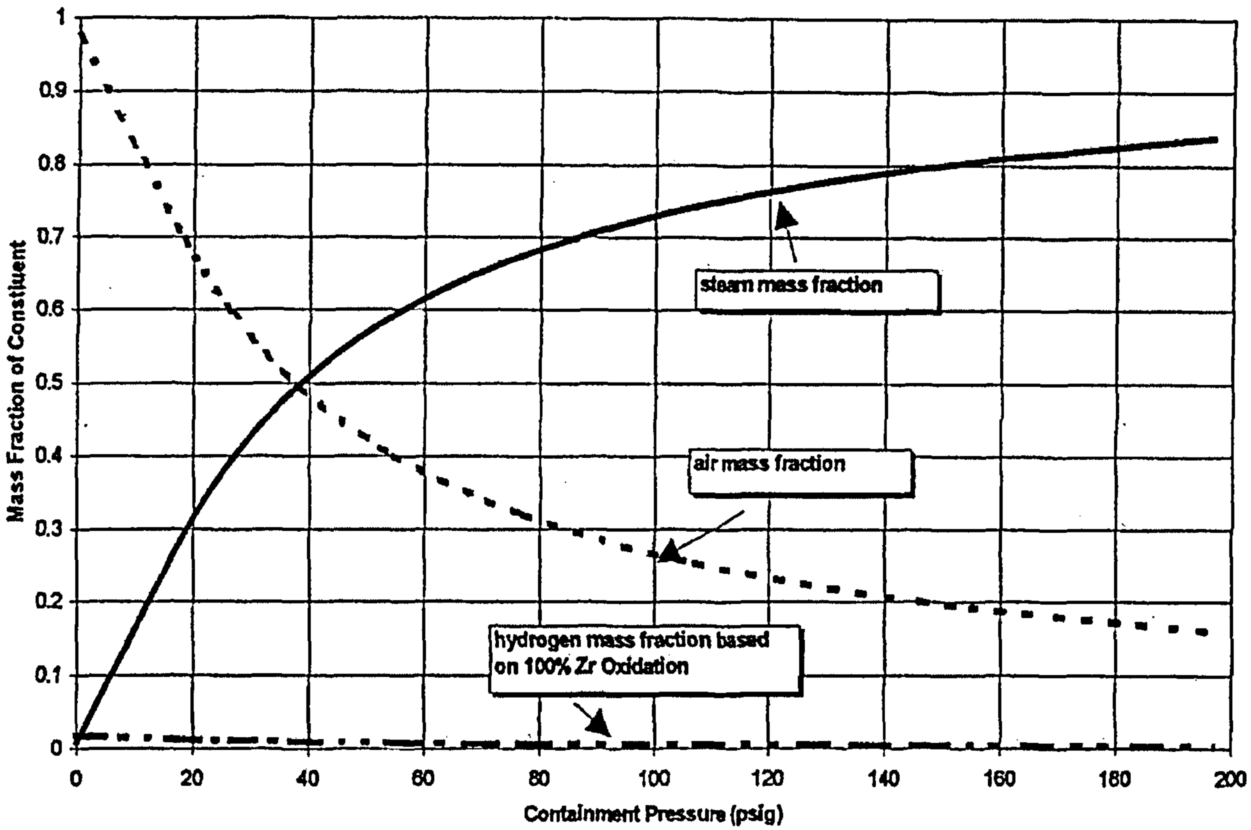


**Figure 9-2**
**Mass Fraction of Air, Steam and Hydrogen in Containment Atmosphere**



## Figure 9-3

**MAXIMUM EFFECTIVE DIAMETER OF VENT PATHWAY REQUIRED TO STABILIZE A LONG TERM CONTAINMENT PRESSURIZATION**

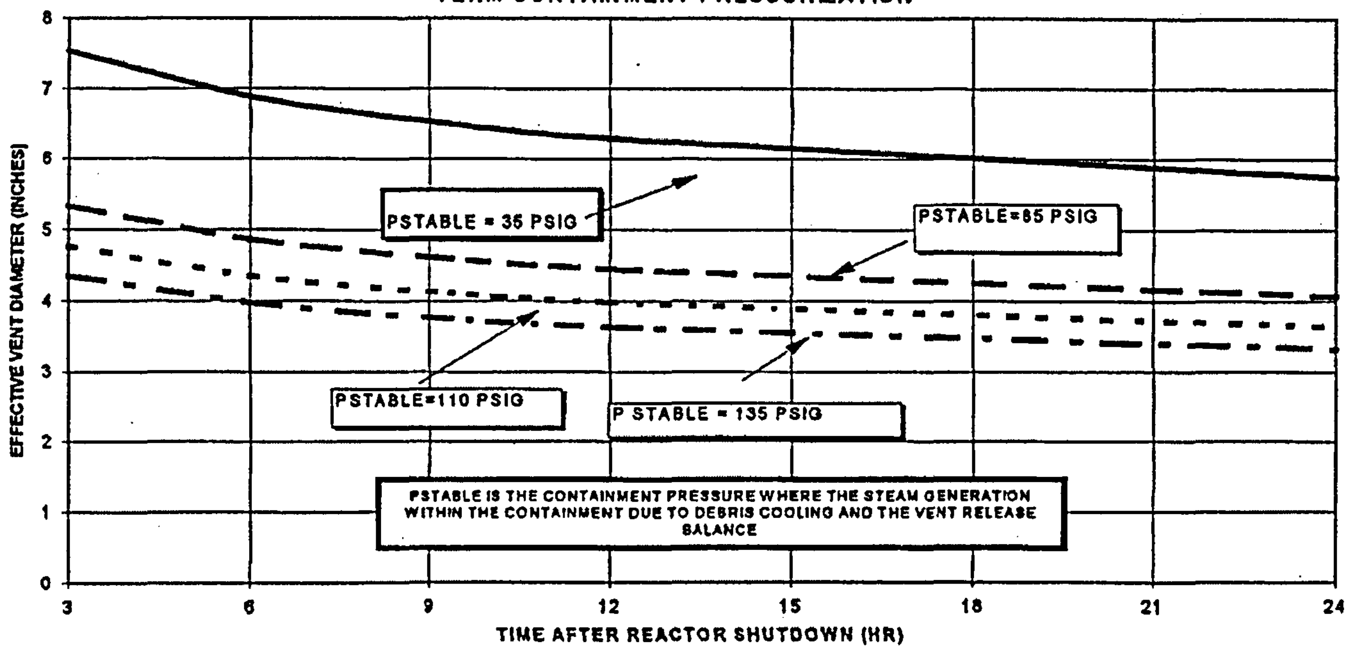


Figure 10-1

## Containment Temperature/Pressure Correlation

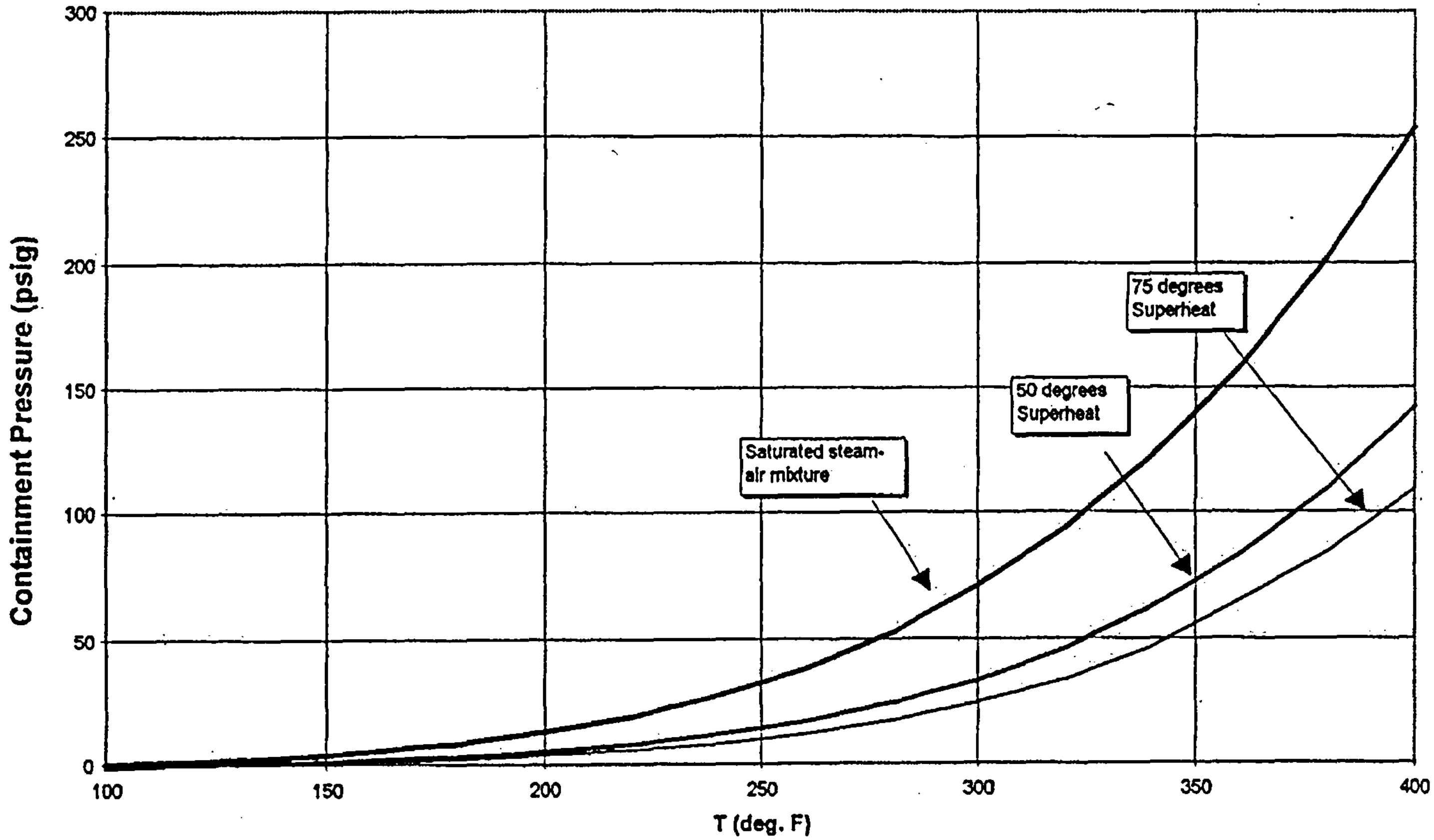
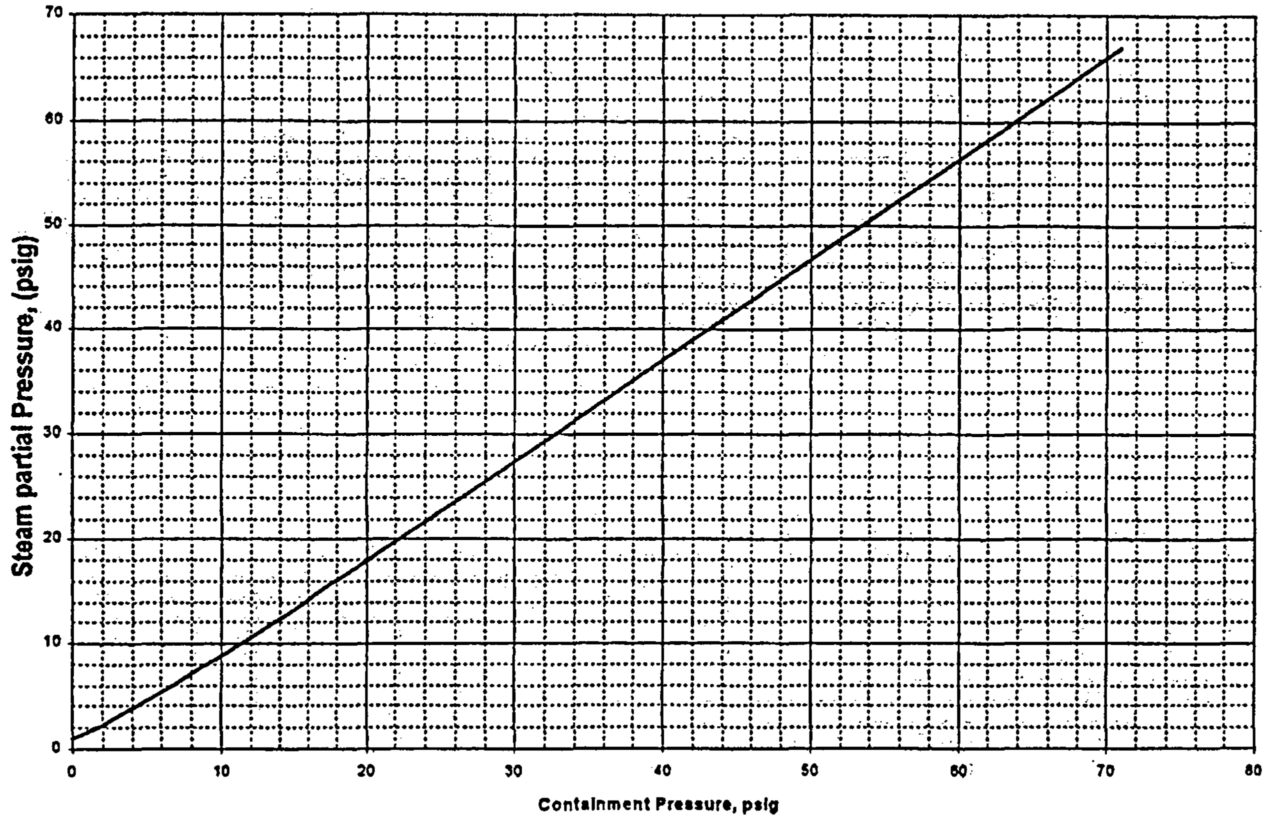


Figure 10-2
**Steam Partial Pressure vs. Containment Pressure (Saturated Steam/Air Mixture)**



# Figure 10-3

**Water Content of Containment Atmosphere (Saturated Steam/Air Mixture)**

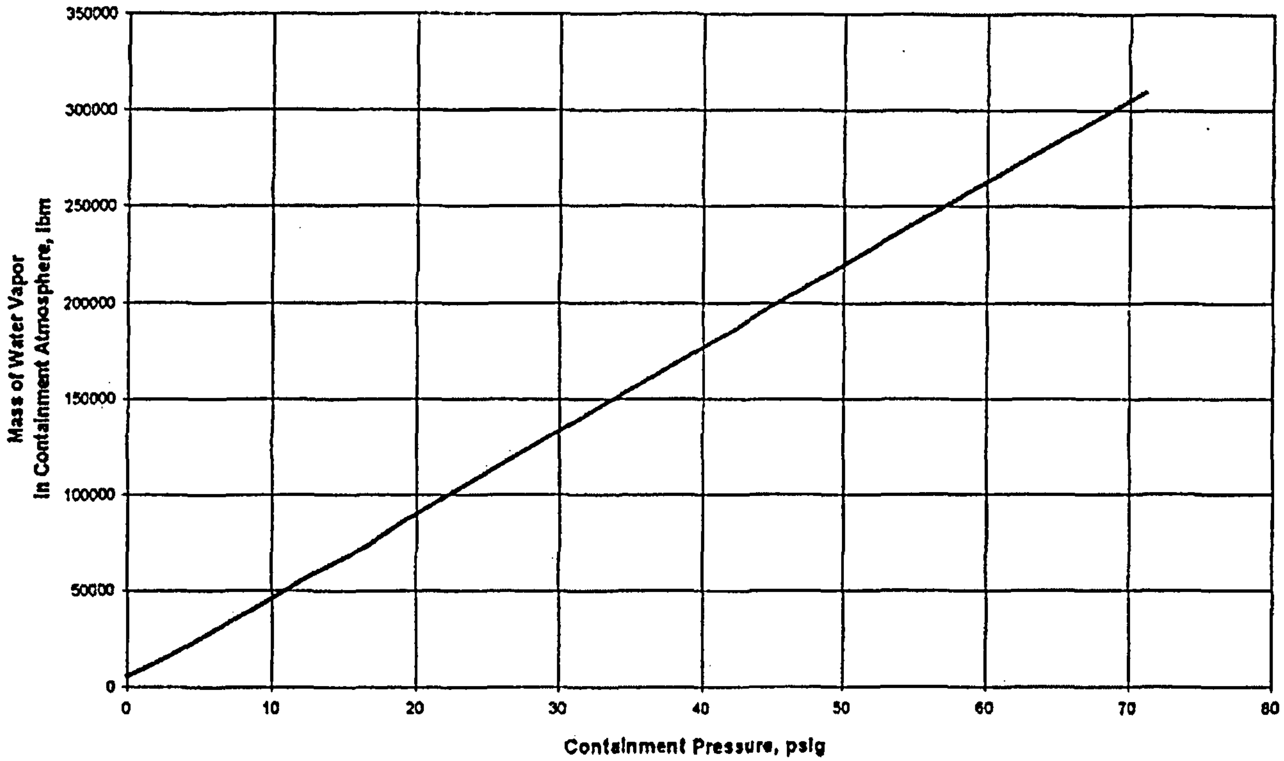
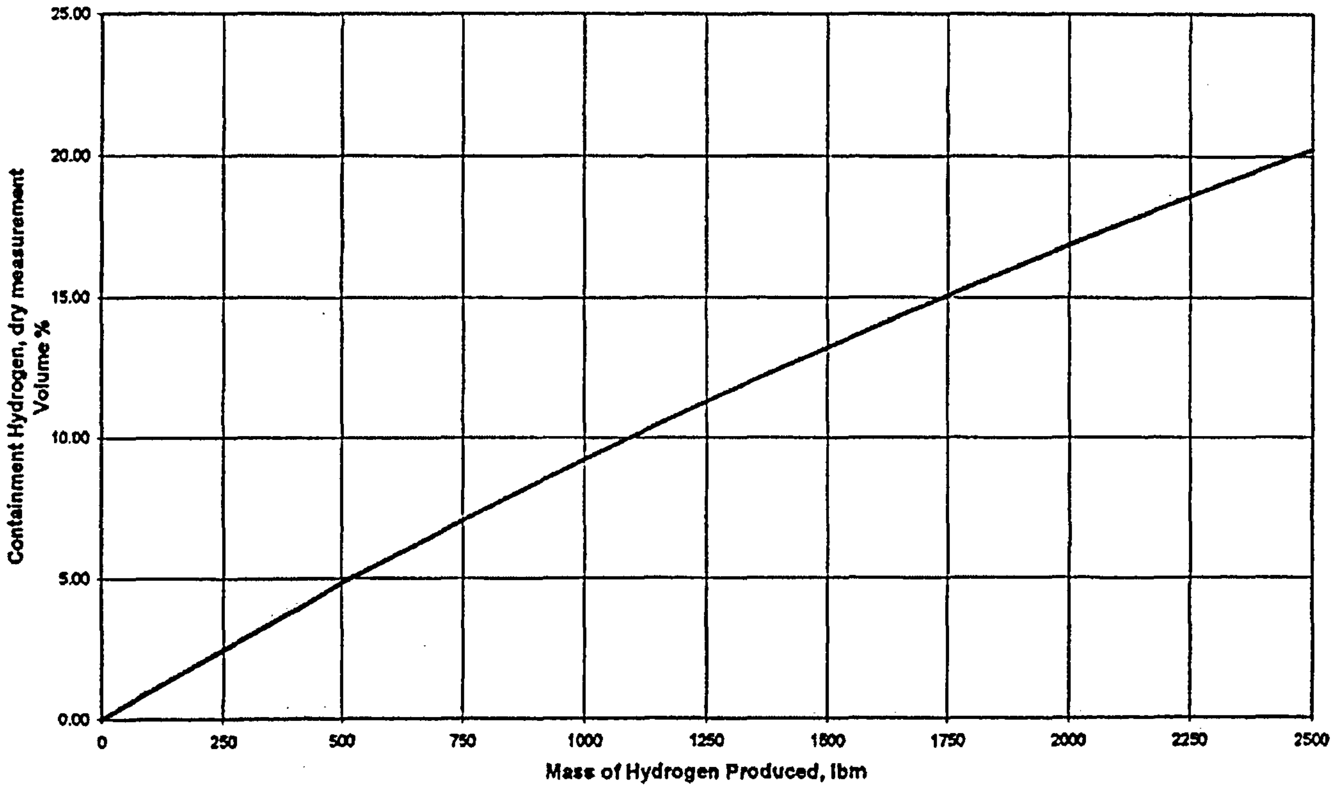


**Figure 10-4**
**Volume Percent Hydrogen (DRY)**
**Mass of Hydrogen in the Containment**



## LIST OF EFFECTIVE PAGES

Cumulative NORMs changes to this revision: 1

| PAGE | REVISION | EDITORIAL CORRECTION |
|---|---|---|
| 1 | 2 | |
| 2 | 2 | |
| 3 | 2 | |
| 4 | 2 | |
| 5 | 2 | |
| 6 | 2 | |
| 7 | 2 | |
| 8 | 2 | |
| 9 | 2 | |
| 10 | 2 | |
| 11 | 2 | |
| 12 | 2 | |
| 13 | 2 | |
| 14 | 2 | |
| 15 | 2 | |
| 16 | 2 | |
| 17 | 2 | |
| 18 | 2 | |
| 19 | 2 | 0201 |
| 20 | 2 | |
| 21 | 2 | |
| 22 | 2 | |
| 23 | 2 | |
| 24 | 2 | |
| 25 | 2 | |
| 26 | 2 | |
| 27 | 2 | |
| 28 | 2 | |
| 29 | 2 | |
| 30 thru 39 | 2 | |
| 40 thru 44 | 2 | |

| ATTACHMENT | REVISION | EDITORIAL CORRECTION |
|---|---|---|
| Attachment 1, Pages 1-22 | 2 | |
| Attachment 2, Pages 1-4 | 2 | |
| Attachment 3 | 2 | |
| Attachment 4, Pages 1-2 | 2 | |
| Attachment 5, Pages 1 - 45 | 2 | 0201 (page 2) |

## RECORD OF REVISIONS AND CHANGES

| Rev. | Chg. | Summary of Revision and Changes |
|---|---|---|
| 2 | | Added steps for alternate 125 V DC battery line-up and alternate steam driven AFW pump fire hose connection using readily available material as defined under B.5.b. These actions were bases captured under B1168. |
| | 0201 | Editorial correction to perform the following:<br>• Correct typo on page 19: "to apply as such water" should read "to apply as much water."<br>• Update RVLMS indication which has been changed from 185 to 160. |