Florida Power
CORPORATION

October 22,1984
3F1084-11

Director of Nuclear Reactor Regulation
Attention: Mr. John F. Stolz, Chief
Operating Reactors Branch #4
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Subject: Crystal River Unit 3
Docket No. 50-302
Operating License No. DPR-72
Request for Permanent Exemption from Installation of a Reactor Vessel Head Vent

Dear Sir:

On July 21, 1983, the Nuclear Regulatory Commission (NRC) issued a temporary exemption to Florida Power Corporation (FPC) for the installation of a reactor vessel head vent in Crystal River Unit 3 (CR-3). The exemption was based on information presented to the NRC by FPC's letters of October 12, 1982 and April 29, 1983, and on a requirement that confirming integral system tests would be conducted.

During the Fall of 1983, the NRC (Dr. Brian Sheron) suggested that FPC and Sacramento Municipal Utility District (SMUD) consider use of the Once Through Integral System (OTIS) facility to perform the tests which could confirm that a reactor vessel head vent exemption could be technically justified. The use of the OTIS facility was suggested so that supporting data would be obtained sooner than from the planned use of the Multi-Loop Integrated System Test (MIST) facility.

After meeting with NRC representatives to discuss test plans on March 14 and April 5, 1984, FPC and SMUD decided that useful tests could be conducted in OTIS. Two tests were conducted by Babcock & Wilcox (B&W) in OTIS during April and May 1984. The tests were fully funded by FPC and SMUD.

A001
1/20 Limited Dist

GENERAL OFFICE 3201 Thirty-fourth Street South • P.O. Box 14042, St. Petersburg, Florida 33733 • 813—866-5151

The results of the two tests were presented to NRC by FPC on July 20, 1984. The first test provided convincing evidence that a reactor vessel (RV) head vent is not needed at CR-3 to assure the ability to depressurize and cooldown without interrupting natural circulation following an inadequate core cooling (ICC) event. Results from the second OTIS test indicated that even if natural circulation were allowed to be interrupted, it could be restored after long periods of time had elapsed that were sufficient to decouple the primary and secondary cooling systems.

Both tests demonstrated that the presence of a non-condensable bubble remaining in the reactor vessel head during and after depressurization following an ICC event has no adverse effect on reactor core cooling. Also, the second test demonstrated that feed/bleed cooling using high pressure injection (HPI)/pilot operated relief valve (PORV) cooling operation is an alternate and effective method, which can be interchanged with natural circulation to keep the reactor core cooled when required.

The tests were conducted to demonstrate applicability to both CR-3 and Rancho Seco (177 fuel assembly plants) although the OTIS facility scaling was based on a plant design using 205 fuel assemblies and raised coolant loop configuration. Principal emphasis on the test planning and conduct was the application of fundamental "proof of principle" concepts related to physical properties of non-condensable gasses in a PWR depressurization and cooldown environment.

For the reasons stated above, FPC remains convinced that a reactor vessel head vent is an unnecessary penetration of the reactor primary coolant system at CR-3 when hot leg high point vents can be utilized with appropriate operator procedures to assure core cooling during system depressurization and cooldown in the presence of noncondensables .

Additional information is supplied for NRC review in the Attachments identified below.

We request expedited review by NRC of this submittal, leading to an early and permanent exemption from installation of a reactor vessel head vent in CR-3.

This exemption would assure substantial savings (on the order of one million dollars) to FPC and its customers, without detriment to the health and safety of the general public or to the plant operators.

Sincerely,

G. R. Westafer
Manager, Nuclear Operations
Licensing and Fuel Management

EHD/feb

Att: (1) Items to be addressed by Florida Power Corporation arising from meeting with NRC on July 20, 1984.
(2) FPC's responses to items listed in Attachment 1.
(3) Slides used in FPC presentation to NRC on July 20, 1984.
(4) Reports:
a. Babcock & Wilcox Report 12-1152307-00, "OTIS Hot Leg High Point Vent Test #240100" for Florida Power Corporation and Sacramento Municipal Utility District, July, 1984.
b. Babcock & Wilcox Report 12-1152308-00, "OTIS Hot Leg High Point Vent Test #2040200" for Florida Power Corporation and Sacramento Municipal Utility District, July, 1984.
c. Babcock & Wilcox Report RDD:84:4091-24-01:01, "Once Through Integral System Test Program, OTIS Loop Functional Specification", issued for review 9/13/84.

ATTACHMENT I

ITEMS TO BE ADDRESSED BY FLORIDA POWER CORPORATION ARISING FROM MEETING WITH NRC ON JULY 20, 1984

1. Furnish writeup of OTIS tests.

2. Provide responses to the NRC memo of April 16, 1984.

3. Furnish methods for removing the non-condensable gas remaining in the RV head after cooldown.

4. Provide a discussion of how the OTIS test facility is applicable to CR-3.

5. Demonstrate how CR-3 operators have been trained on reactor coolant pressurizer control effects with a non-condensable bubble in the RV head.

6. Provide information on how the operators limit the depressurization rate following an ICC event to assure that natural circulation is not interrupted with the present size hot leg vents.

7. Indicate whether FPC procedures will be revised so that a distinction is made between "hard" (non-condensables) and "soft" (steam) bubbles.

8. Provide the slides used during the July 20, 1984 presentation by FPC.

9. Indicate what training the operators have received in ICC and handling non-condensables in the reactor cooling system (RCS).

ATTACHMENT 2

FLORIDA POWER CORPORATION'S RESPONSES TO ITEMS LISTED IN ATTACHMENT 1

1. **Request:**

Furnish writeup of OTIS tests.

Response:

Summary of OTIS Tests Performed in Support of Requests for Reactor Vessel Head Vent Exemption for CR-3

Results

Two tests were performed in the OTIS facility simulating recovery from an ICC event without the use of a RV head vent. The tests demonstrated that:

- Two mechanisms, natural circulation and feed/bleed, were available for core cooldown recovery and could be interchanged when desired.
- The evolution rate of noncondensable gasses, from the reactor vessel head and from the gas-saturated coolant, did not interfere with natural circulation when the hot leg high point vent (HLHPV) was continuously kept open during cooldown.
- When natural circulation was interrupted by closure of the HLHPV, core cooling was transferred to feed/bleed.
- A quasi-equilibrium in core cooling was reached during feed/bleed cooldown which was not observed during natural circulation cooldown.
- Natural circulation, when interrupted by non-condensables, was restorable hours after interruption, even with adverse temperature distributions between the secondary and primary cooling systems.
- Absence of the RV head vent did not interfere with core cooldown.
- Non-condensables which remained in the RV head for the duration of both tests had no adverse effect on core cooldown.

Facility Description*

The OTIS (formerly GERDA) facility was designed to evaluate the thermal/hydraulic conditions in the reactor coolant system and steam generator of a raised-loop B&W reactor during the natural circulation cooling phase. The facility is a scaled 1 x 1 (one hot leg, one cold leg) electrically heated loop simulating the important features of the plant at scaled power levels of 1 to 5%.

The loop consists of one 19-tube Once-Through Steam Generator (OTSG), a simulated reactor, a pressurizer, a single hot leg, and a single cold leg. Reactor decay heat following a scram is simulated by electrical heaters in the reactor vessel. No pump is included in the basic system, but a multipurpose pump in an isolatable cold leg bypass line may be used to provide forced primary flow. The test loop is full raised-loop plant elevation, approximately 95 feet high, and is shortened in the horizontal plane (to approximately 6 feet) to maintain approximate volumetric scaling.

Other primary loop components include an internal reactor vessel vent valve, pressurizer power-operated relief valve (PORV), and hot leg and reactor vessel high point vents. Auxiliary systems are available for scaled high pressure injection (HPI), controlled primary leaks in both the two-phase and single-phase regions, a secondary forced circulation system for providing auxiliary feedwater to the OTSG, steam piping and pressure control, a cleanup system for the secondary loop, gas addition, and gas sampling.

Test Descriptions

Initial conditions for each test included:

- System at ~1700 psig, 580°F.
- Coolant saturated with non-condensable gas.
- Reactor vessel head filled with non-condensable gas.
- Reactor vessel head vent not available.
- Core decay heat at constant 1% of operating power.
- Reactor coolant system boundary intact.
- Auxiliary feedwater available to OTSG.
- High pressure injection coolant system available.
- Reactor coolant pumps unavailable.

---

* Excerpted from NRC-04-83-168, RP 2399-1, "OTIS Initial Report 2: Test 220100, Nominal, B&W Document No. 12-1152282-00", April 24, 1984.

- Natural circulation cooling temporarily interrupted by injection of non-condensible gas at HLHPV.

- Natural circulation cooling restored by opening of HLHPV.

In the first test, the HLHPV remained open throughout the test until cooldown to decay heat removal system conditions (284 psig, 280°F) was attained.

In the second test, the HLHPV was closed. The evolution of non-condensables during depressurization and cooldown caused interruption of natural circulation. The core was then cooled by the feed/bleed technique in which the PORV on the pressurizer was opened and HPI was injected. Cooldown continued until a quasi-equilibrium between heat generation and heat removal occurred at approximately 1100 psig and 475°F. After reopening the HLHPV, system cooldown by feed/bleed was continued to 700 psig and 425°F. At this time, natural circulation was re-initiated until test completion at 284 psig and 280°F.

2. **Request:**

Provide responses to the NRC memo of April 16, 1984.

Response:

On April 16, 1984, a Request for Additional Information was sent to Florida Power Corporation (FPC) concerning the Reactor Vessel Head Vent schedular exemption for Crystal River Unit 3 (CR-3). The meeting between FPC and the NRC on July 20, 1984 included discussions of the requested information. Those discussions are summarized as below. Emphasis, as requested by NRC at the meeting, is placed on current status rather than historical review.

i) Revisions to procedures (EP-290 and AP-530) that instruct the operator in maintaining natural circulation after an inadequate core cooling event by keeping the hot leg high point vents open were discussed at the meeting of July 20, 1984. These revisions will be completed by December 1, 1984.

ii) To assure that natural circulation is maintained during depressurization/cooldown subsequent to an inadequate core cooling event, the depressurization will be performed utilizing the pressurizer high point vent. Graph 1 shows that the size of this vent is insufficient to allow a depressurization rate that will interrupt natural circulation provided the hot leg high point vents are maintained open. Modified procedures will be in place by December 1, 1984.

iii) Upon review and approval of these modified procedures, the CR-3 operators will review the procedure changes and the procedures will automatically become a part of the requalification and replacement training programs. The initial review of these procedures will be completed by January 1, 1985.

iv) The OTIS test procedure and OTIS test methodologies are addressed in Attachment 4, Reports a and b.

v) The feed and bleed (or HPI/PORV) method of cooling was reviewed at the meeting vis-a-vis Abnormal Procedure 530, "Natural Circulation", Step 6. The scenario in question is that adequate subcooling margin does not exist. The proper operator response to that symptom is to initiate HPI cooling and observe the RC system pressure and temperature response. A pressure rise coupled with inadequate subcooled margin in the RC system would indicate that more flow is needed through the core. More flow can be created by opening one or more of the pressurizer vents. The vent(s) should not be opened if flow through a small primary system break, coupled with HPI to maintain the coolant inventory, is sufficient to keep an adequate subcooled margin. FPC agrees with NRC that the operator should not always open the PORV at the time of HPI injection since this might create an unnecessary additional "hole" in the system. The operator will also open the PORV as necessary to prevent challenging the pressurizer code safety valves or to avoid exceeding PTS limits, as specifically instructed by procedural steps.

vi) Initiation of HPI/PORV cooling is included in other emergency abnormal procedures. As explained in v) above, the way in which HPI/PORV cooling is initiated does not automatically establish another "hole" in the reactor coolant system based on inadequate subcooling margin. Thus, our ECCS analyses continue to comply with 10 CFR 50.46.

vii) Abnormal Procedure AP-530, "Natural Circulation", has been revised to close the PORV (if it is open) prior to starting a reactor coolant pump, when subcooled natural circulation is providing core cooling.

As discussed in Item 7, AP-530 has also been revised to clarify that the steps which address "voids" refer to steam voids not noncondensables.

In addition to the above referenced April 16, 1984 Request for Additional Information, FPC responded to another Request for Additional Information (dated January 19, 1982) on March 9, 1982. Those fifteen responses have been reviewed and only Response 4 needs to be re-addressed as the CR-3 hot leg high point vents will now be maintained open from the onset of inadequate core cooling through refill and natural circulation until cooldown is complete.

The possibility of a water slug and its effects on the hot leg high point vents is being evaluated and any corrective action necessary will be taken to assure the operation of the hot leg high point vent.

3. **Request:**

Furnish methods for removing non-condensable gas remaining in the RV head after cooldown.

Response:

Methods for Removal of Non-condensable Bubble from Reactor Vessel Head Following ICC Event

The following methods for removing a non-condensable bubble from the reactor head following inadequate core cooling all assume the following common conditions:

- Reactor coolant system (RCS) saturated with non-condensables.
- Reactor head completely filled with noncondensables.
- RCS pressure boundary intact.

No time estimates are available concerning the time required to remove a non-condensable bubble from the reactor. FPC is not convinced that moving the bubble from an oxygen-deficient atmosphere (inside the RV head) to an oxygen-rich atmosphere outside the primary system is necessarily desirable. If, however, an appraisal of the situation by operators, management, and NRC leads to a decision to move the bubble, two principal options exist: use of RC pumps, and dissolution into coolant. The methodology is outlined below:

Method 1

Initial Conditions:

- One or more RC pumps running.
- RCS temperature and pressure just above the NPSH curve for the existing pump combination.
- Steam bubble in the pressurizer.
- Pressurizer heaters and spray available.

Procedure

1. Turn on all pressurizer heaters (use spray to control pressure).
2. Increase pressure to about 100 PSI above RC pump NPSH curve.
3. Operate at this point for a time (to be determined later).
4. Turn off spray.
5. Use pressurizer vent or PORV to reduce pressure to NPSH limit.
6. Repeat steps 1 - 5 until RCS temperature pressure response indicates bubble has been removed.

Method 2

Initial Conditions:

- RC pumps not available.
- Cooling core by natural circulation or decay heat removal system.
- RCS Temperature about 250°F.

Procedure

1. Turn on all pressurizer heaters (use auxiliary spray to control pressure).

2. Establish 100°F subcooling margin.

3. Operate at this point for a time to be determined later.

4. Use PORV or pressurizer vent to reduce pressure to 50°F subcooling margin.

5. Repeat steps 1 - 5 until RCS temperature pressure response indicates bubble has been removed.

Method 3

Initial Conditions:

- RCP's unavailable.
- DH system unavailable.
- Core cooling by natural circulation.
- Incore temperature about 250°F, subcooling margin about 50°F.

Procedure

1. Turn on all pressurizer heaters.

2. Increase pressure to reach 100°F subcooled margin.

3. Use PORV or high point vent to reduce pressure until subcooled margin is about 50°F.

4. Use makeup and letdown or RCS temperature changes to outsurge then insurge the pressurizer.

5. Repeat steps 1 - 5 until RCS temperature pressure response indicates bubble has been removed.

Method 4

Initial Conditions:

- Core cooling by natural circulation.
- Makeup and purification system available.
- RCS temperature and pressure are not important.
- Subcooling margin 50°F to 100°F.

Procedure

1. Establish letdown to makeup tank (use block orifice bypass valve, monitor makeup tank level to estimate flow).

2. Establish makeup to RCS.

3. Maintain makeup tank pressure as low as possible by venting.

4. Maintain letdown temperature as high as possible without exceeding 135°F interlock until RCS temperature pressure response indicates bubble has been removed.

4. **Request:**

Provide a discussion of how the OTIS test facility is applicable to CR-3.

Response:

A brief discussion of OTIS applicability is given below. Additional discussion on OTIS scaling is provided in the Attachment 4 documents. The principal reasons for applying OTIS results to the likely behavior of CR-3 hot leg high point vents are:

a) The rate of evolution of gasses from the RV head and from the coolant depends primarily on head volume and on rates of system pressure and temperature reductions. The rate of venting depends on the vent orifice areas and on system conditions. Geometrical scaling (except for vent orifice areas) is less significant than system fluid conditions.

b) The single OTIS hot leg vent orifice area was approximately scaled to represent the two CR-3 hot leg high point vent orifice areas. (in OTIS, one hot leg represents 2 plant hot legs.) The power and volume ratios between CR-3 and OTIS were also taken into account in scaling the OTIS orifice area. For idealized scaling, each of the important variables in OTIS (for a B&W 205 fuel assembly plant) would be scaled by a factor of 1686:1, which represents the ratio of tubes in the 205 plant steam generators (32,026) to the number of tubes in the OTIS steam generator (19). Both CR-3 and Rancho Seco contain 177 fuel assemblies but different operating power levels. Adjustments were made in the idealized scaling parameters to obtain a single orifice area for OTIS which would be suitable for representing the fundamental physical phenomena which would likely govern the system response of both CR-3 and Rancho Seco. In arriving at the OTIS orifice area, the idealized scaling factor of 1686:1 was adjusted by the ratio of plant power to OTIS power to obtain a power adjusted scaling factor. This adjusted factor was then applied to the actual plant HPV orifice area to obtain desired scaled areas for OTIS if representing each of the two plants. A scaled orifice area was then chosen which was intermediate between those of the two plants. These considerations are summarized in Table 1.

c) A constant (conservative) power generation rate was utilized in OTIS.

d) RCS cooldown in CR-3 is limited by current procedures to 10°F/hr. The RCS depressurization rate for CR-3 following an ICC event will be limited by revised procedures to the use of only the pressurizer high point vent. The hot leg high point vents will remain open, also by revised procedures.

e) Under the conditions stated in 4d, above, the maximum calculated RCS depressurization rate for CR-3 is about 1150 psi/hr.

f) Assuming depressurization of CR-3 from an initial value of 2200 psia (conservatively high) to a final value of about 400 psia, the rates of non-condensable gas evolution were calculated from the upper head and from the gas-saturated coolant. These combined evolution rates were compared to the rates which would be vented through the two hot leg high point vents. The calculated vent rates far exceed the calculated evolution rates as shown in Figure 1.

g) The peak pressure and temperature reduction rates used in the OTIS tests were about 2500 psi/hr. and about 100°F/hr. for small periods of time. Under these conditions, the gas evolution rates observed in OTIS far exceed those calculated for CR-3 in Step 4f, above. Even so, no interruption of natural circulation was observed in the first OTIS test (in which the HLHPV remained open). Therefore, no interruption of natural circulation would be expected in CR-3 when using more restrictive conditions to control gas evolution rate than were used in the first OTIS test.

TABLE 1

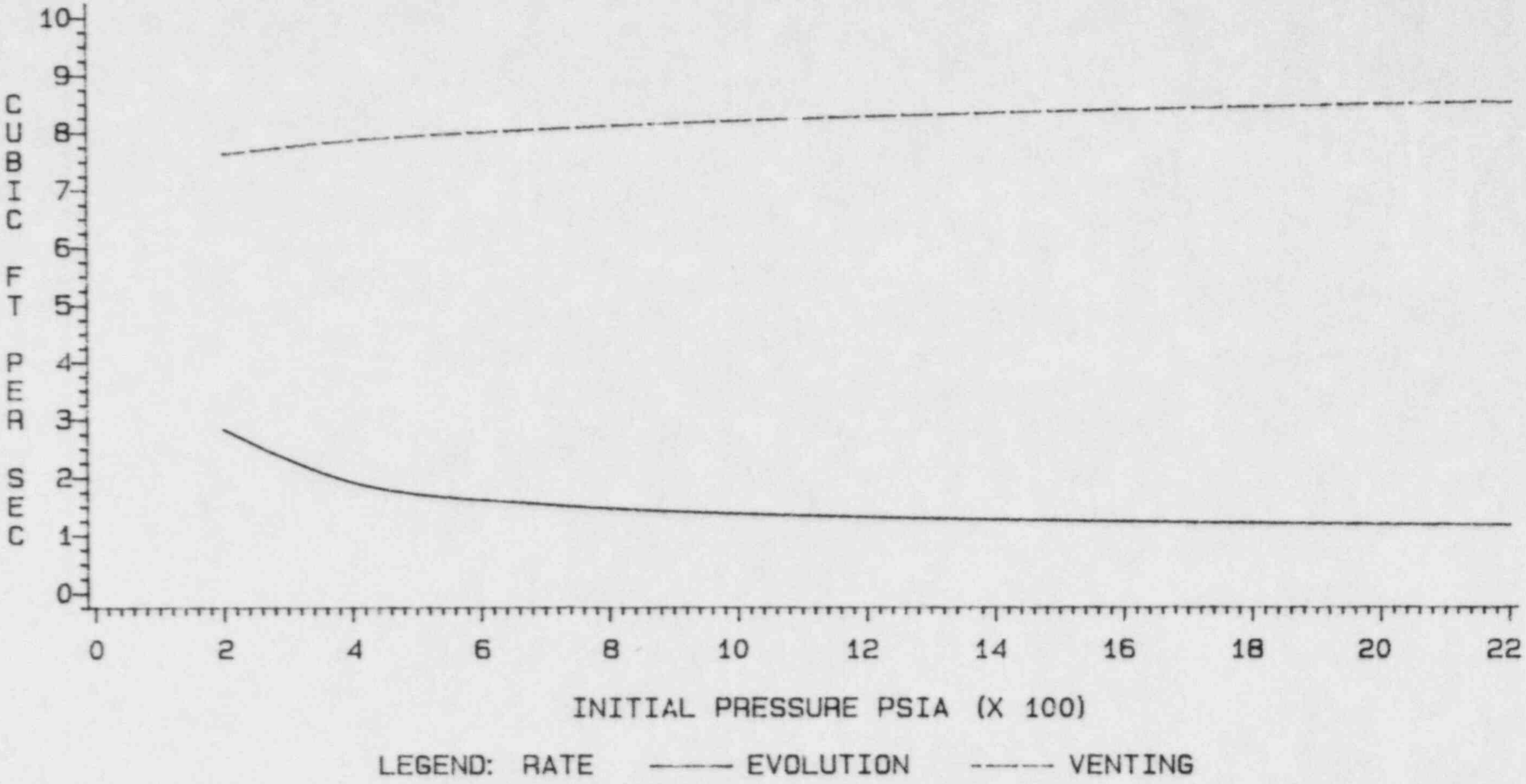
VENT AREA SCALING
FPC/SMUD TESTS 240100 & 240200

205 PLANTS/OTIS:

S. G. TUBE RATIO =	$\frac{32,034}{19}$ =	1,686

177 PLANTS/OTIS:	RS	CR-3
POWER RATIO	1,300	1,245
POWER ADJUSTED SCALING FACTOR	$\frac{1,686}{1,300}$	$\frac{1,686}{1,245}$
PLANT VENT AREAS, EACH	0.954cm^2	0.713cm^2
2 PLANT VENTS	1.909cm^2	1.425cm^2
DESIRED SCALED VENT AREA	2.48cm^2	1.93cm^2
SCALED AREA USED	2.11cm^2	2.11cm^2

EVOLUTION/VENTING RATE
CALCULATED FOR CR-3
(DEPRESSURIZATION RATE LIMITED BY USE OF PZHPV)



NOTE1: VENTING RATE FOR HYDROGEN USING 2 HLHPV
NOTE2: EVOLUTION RATE FOR HYDROGEN FROM RV HEAD AND RCS

FIGURE 1

5. **Request:**

Demonstrate how CR-3 operators have been trained on reactor coolant pressurizer control effects with a non-condensable bubble in the RV head.

Response:

This item is a part of the operator training. The training department will also explore with B&W the possible addition of a recently developed non-condensable option into the simulator training curriculum.

6. **Request:**

Provide information on how the operators limit the depressurization rate following an ICC event to assure that natural circulation is not interrupted with the present size hot leg vents.

Response:

The current limit is a temperature reduction rate of 10°F/hr. Depressurization rates are not currently specified for recovery from ICC. However, procedure revisions are planned which will limit depressurization following ICC to the use of the pressurizer high point vent, rather than the PORV. Results of calculations consistent with these assumptions are shown in Figure 1 (See also Attachment 3).

7. **Request:**

Indicate whether FPC procedures will be revised so that a distinction is made between "hard" (non-condensables) and "soft" (steam) bubbles.

Response:

Procedures have been revised and are being reviewed prior to implementation (See also Attachment 2, Response Item 2.vii) Implementation is planned by December 1, 1984.

8. **Request:**

Provide the slides used during the July 20, 1984 presentation by FPC.

Response:

The slides requested are given in Attachment 3.

9. **Request:**

Indicate what training the operators have received in ICC and handling non-condensables in the RCS.

Response:

The following course materials address ICC concerns. These courses are also used during licensed operator requalification:

Lesson Plan Number	Title
RO - 46 thru 50	CR3 ATOG Guidelines
SRO - 46 thru 50	CR3 ATOG Guidelines
RO - 76, SRO - 74	Emergency/Abnormal Procedures: Inadequate Core Cooling
RO - 44, SRO - 44	B&W Degraded Core Recognition & Mitigation
B&W Simulator	NUREG 0737 Control Manipulations

ATTACHMENT 3

SILIDES USED IN FPC PRESENTATION TO NRC ON
JULY 20, 1984

MEETING TO DISCUSS REACTOR HEAD VENT EXEMPTION

PRESENTATION BY FLORIDA POWER CORPORATION

TO

U.S. NUCLEAR REGULATORY COMMISSION

PHILLIPS BUILDING

BETHESDA, MD.

JULY 20, 1984

REACTOR HEAD VENT EXEMPTION MEETING

AGENDA

I.	INTRODUCTION	G.R. WESTAFER
	- PURPOSE OF MEETING	
II.	DISCUSSION OF OTIS TESTS	E.H. DAVIDSON
	- TEST I: NATURAL CIRCULATION COOLING	
	PURPOSE PROCEDURE AND TESTING TECHNIQUES RESULTS	
	- TEST II: HPI/PORV COOLING	
	PURPOSE PROCEDURE AND TESTING TECHNIQUES RESULTS	
III.	SUMMARY & CONCLUSIONS OF TESTING	E.H.DAVIDSON
IV.	APPLICATION OF TESTS TO PLANT PROCEDURES	W.A. STEPHENSON
	- DISCUSSION OF PLANT OPERATING PHILOSOPHY AND PROCEDURE ENHANCEMENTS	
V.	DISCUSSION OF EXEMPTION	G.R.WESTAFER

I. INTRODUCTION

- ATTENDEES FROM FPC

- PURPOSE OF MEETING

  * TO DISCUSS OTIS TESTS AND RESULTS

  * TO COMPARE TEST CONCLUSIONS TO CR-3 INADEQUATE CORE COOLING (ICC) PROCEDURES AND PROPOSED ENHANCEMENT

  * TO DISCUSS BASIS FOR PERMANENT EXEMPTION FROM INSTALLATION OF REACTOR HEAD VENT IN CR-3

II. DISCUSSION OF OTIS TESTS

PURPOSE OF OTIS TEST I

DEMONSTRATE THAT WITH A BUBBLE OF NON-CONDENSABLE GAS IN THE HEAD AND THE HOTLEG VENTS OPEN THE CORE CAN BE COOLED DOWN USING NATURAL CIRCULATION.

INITIAL CONDITIONS

OTIS TEST I

* INADEQUATE CORE COOLING
  - SATURATE SYSTEM WITH NON-CONDENSABLE GAS
  - INJECT NON-CONDENSABLE GAS INTO RV HEAD
  - SIMULATE DECAY HEAT AT CONSTANT 1% POWER
* RCS PRESSURE BOUNDARY INTACT
* EMERGENCY FEEDWATER AVAILABLE TO STEAM GENERATORS
* HIGH PRESSURE INJECTION AVAILABLE
* REACTOR COOLANT PUMPS UNAVAILABLE

PROCEDURE USED IN

OTIS TEST I

1. ESTABLISH NATURAL CIRCULATION COOLING OF CORE.

2. INTERRUPT NATURAL CIRCULATION BY INJECTING NON-CONDENSABLE AT HOTLEG HIGH POINT VENT (HLHPV).

3. OPEN HLHPV, REGAIN NATURAL CIRCULATION, AND KEEP HLHPV OPEN DURING TEST.

4. DEPRESSURIZE AND COOL SYSTEM TO 284 psig AND 280°F USING NATURAL CIRCULATION WITH A 50 TO 100°F COOLDOWN RATE AND APPROPRIATE SUBCOOLING MARGIN.

RESULTS OF OTIS TEST I

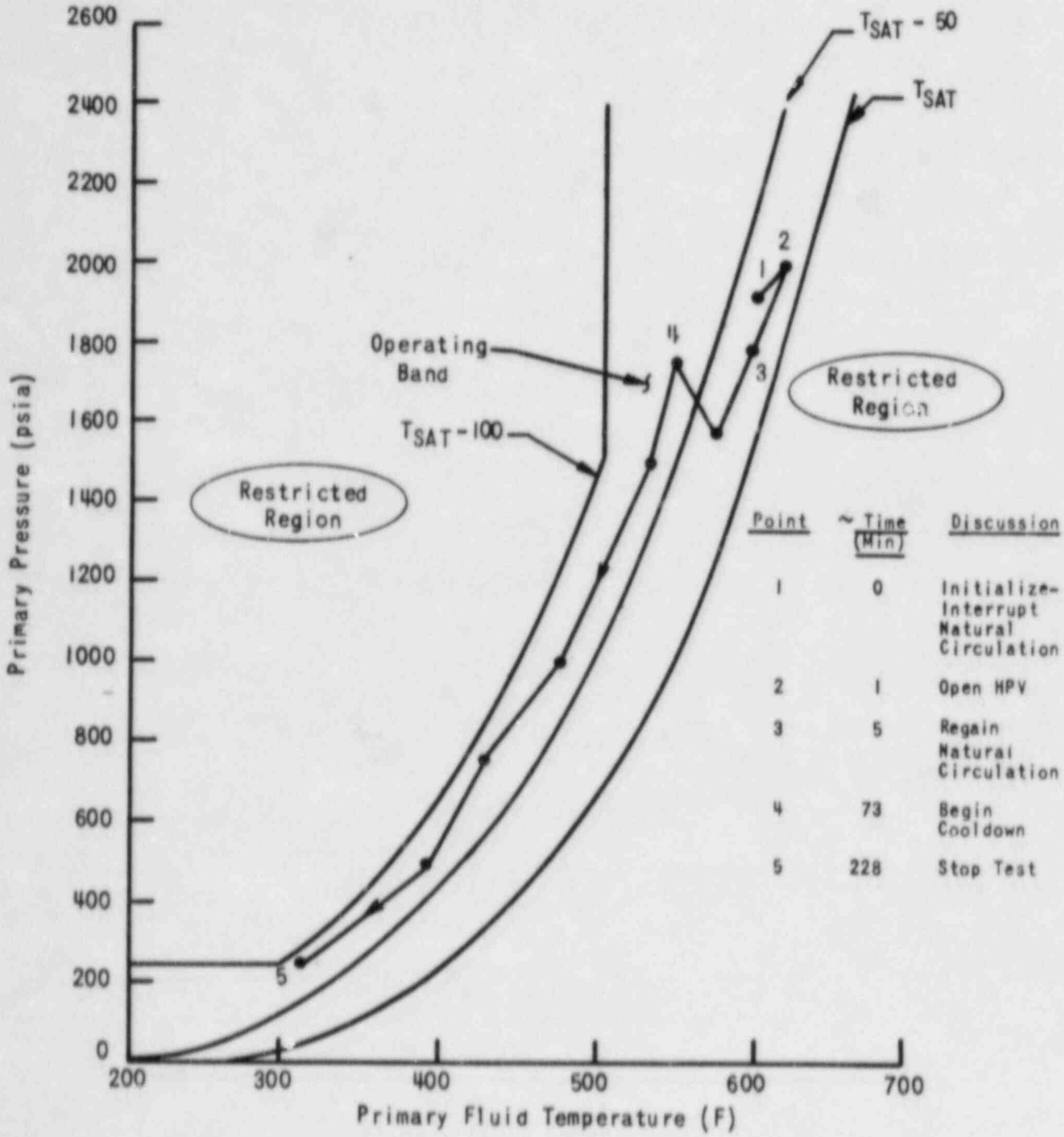
1. NATURAL CIRCULATION COOLING OF CORE IS NOT INTERRUPTED WITH HLHPV CONTINUOUSLY OPEN DURING COOLDOWN AND DEPRESSURIZATION.

2. COOLDOWN RATES OF 50°F/HR TO 100°F/HR WERE EASILY CONTROLLED.

3. ADEQUATE SUBCOOLING MARGIN (50–100°F) WAS EASILY MAINTAINED THROUGHOUT SYSTEM COOLDOWN.

4. THE NON-CONDENSABLE GAS BUBBLE IN THE HEAD HAD NO EFFECT ON THE ABILITY TO COOLDOWN.

TEST-240100-OTIS NONCONDENSABLE GAS TEST
CONTINUOUS VENTING THROUGH
HIGH POINT VENT



8

PURPOSE OF OTIS TEST II

DEMONSTRATE THAT IF NATURAL CIRCULATION COOLING IS INTERRUPTED BY NON–CONDENSABLES. THE CORE CAN BE COOLED BY THE HPI/PORV (FEED AND BLEED) TECHNIQUE.

INITIAL CONDITIONS

OTIS TEST II

(Same as Test I)

* INADEQUATE CORE COOLING
  - SATURATE SYSTEM WITH NON-CONDENSABLE GAS
  - INJECT NON-CONDENSABLE GAS INTO RV .D
  - SIMULATE DECAY HEAT AT CONSTANT , POWER
* RCS PRESSURE BOUNDARY INTACT
* EMERGENCY FEEDWATER AVAILABLE TO STEAM GENERATORS
* HIGH PRESSURE INJECTION AVAILABLE
* REACTOR COOLANT PUMPS UNAVAILABLE

PROCEDURE INTENDED FOR

OTIS TEST II

1. ESTABLISH NATURAL CIRCULATION COOLING OF CORE.

2. INTERRUPT NATURAL CIRCULATION BY INJECTING NON-CONDENSABLES AT HLHPV.

3. OPEN HLHPV TO RESTORE NATURAL CIRCULATION COOLDOWN OF CORE.

4. CLOSE HLHPV, CONTINUE COOLDOWN AND DEPRESSURIZATION UNTIL NON-CONDENSABLES INTERRUPT NATURAL CIRCULATION.

5. TRANS[illegible]LDOWN OF CORE FROM NATURAL CIRCULATION TO FEED/BLEED COOLING USING HPI/PORV.

6. DEPRESSURIZE AND COOL SYSTEM TO 284 psig AND 280°F.

RESULTS OF OTIS TEST II

1. NATURAL CIRCULATION WAS INTERRUPTED AFTER CLOSING HLHPV.

2. COOLDOWN OF CORE WAS TRANSFERRED FROM NATURAL CIRCULATION TO FEED/BLEED COOLING BY ADDING HPI AND OPENING PORV.

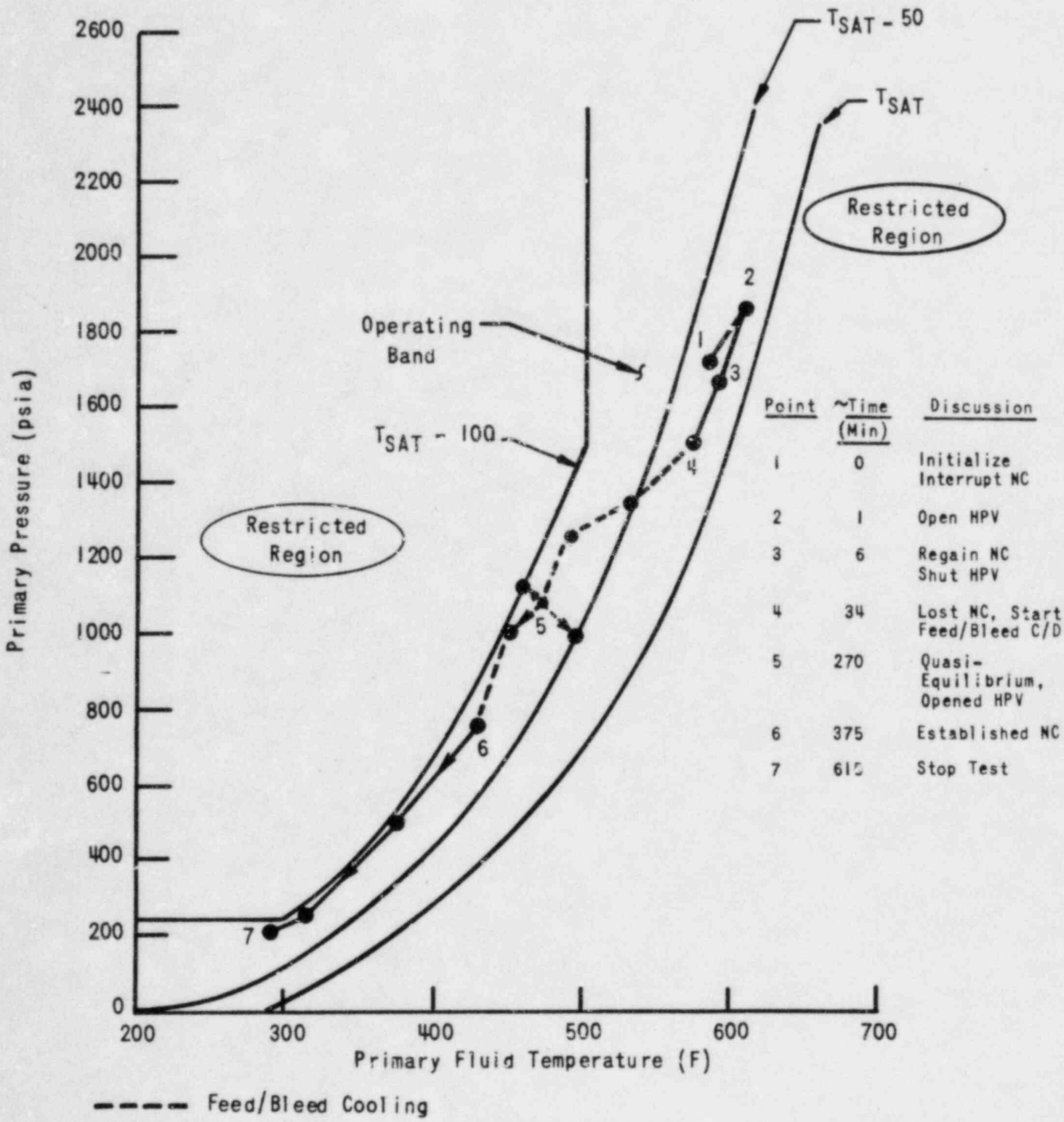
3. THE FEED/BLEED HEAT REMOVAL METHOD REACHED AN EQUILIBRIUM CONDITION BEFORE COMPLETE COOLDOWN COULD BE OBTAINED.

4. TO CONTINUE COOLDOWN, HLHPV WAS ALSO OPENED TO INCREASE FLOW THROUGH CORE.

5. PRIOR TO REACHING NEW FEED/BLEED AND DECAY HEAT POWER EQUILIBRIUM, A TRANSITION WAS MADE FROM FEED/BLEED COOLING TO NATURAL CIRCULATION COOLING.

6. COOLDOWN CONTINUED TO 284 psig, 280°F.

TEST 240200-OTIS NONCONDENSABLE GAS TEST
NATURAL CIRCULATION-FEED/BLEED-
NATURAL CIRCULATION COOLDOWN
TRANSITIONS



III. SUMMARY AND CONCLUSIONS OF TESTING

IF THE LOW PROBABILITY EVENT OF INADEQUATE CORE COOLING OCCURRED AND THE COOLANT WERE SATURATED WITH NON-CONDENSABLES WITH A BUBBLE IN THE RV HEAD:

* TWO MECHANISMS ARE AVAILABLE FOR CORE COOLING;

  - NATURAL CIRCULATION

  - HPI/PORV (FEED/BLEED)

  THE TWO MECHANISMS ARE COMPLEMENTARY AND INTERCHANGEABLE IN SEQUENCE.

* NON-CONDENSABLES WHICH REMAIN IN THE RV HEAD DO NOT AFFECT CORE COOLING.

* NON-CONDENSABLE GASES IN THE REACTOR COOLANT CAN BE VENTED THROUGH THE REACTOR COOLANT SYSTEM HPV's AND DO NOT AFFECT CORE COOLDOWN.

* NATURAL CIRCULATION COOLING CAN BE MAINTAINED WITH HLHPV's ALWAYS OPEN.

* IF INTERMITTENT OPERATION OF THE HLHPV's WERE DESIRED TO MINIMIZE RELEASE OF H_2 TO THE CONTAINMENT, NATURAL CIRCULATION COULD BE RESTORED IF INTERRUPTED.

IV. APPLICATION OF OTIS TESTS TO CR-3 PLANT PROCEDURES

INITIAL CONDITIONS

* INADEQUATE CORE COOLING

  - FUEL IN REACTOR PARTIALLY OR COMPLETELY UNCOVERED

  - FUEL CLADDING TEMPERATURE GREATER THAN 1400°F

  - GROSS AMOUNTS OF HYDROGEN IN REACTOR COOLANT SYSTEM

* RCS PRESSURE BOUNDARY INTACT

* EMERGENCY FEEDWATER AVAILABLE TO STEAM GENERATORS

* HIGH PRESSURE INJECTION AVAILABLE

* REACTOR COOLANT PUMPS UNAVAILABLE

IMMEDIATE ACTIONS UPON DETERMINATION OF INADEQUATE CORE COOLING

EXISTING PROCEDURES	PROPOSED CHANGE
ENSURE FULL HPI FLOW	
ENSURE CORE FLOOD TANK OUTLET VALVES OPEN	
USE PORV/HOTLEG VENTS TO MAINTAIN RCS PRESSURE LESS THAN 2300 PSI	
ENSURE STEAM GENERATOR LEVELS AT 95%	
REDUCE STEAM GENERATOR PRESSURE	

ACTIONS WHEN GAS PRODUCTION IS INDICATED

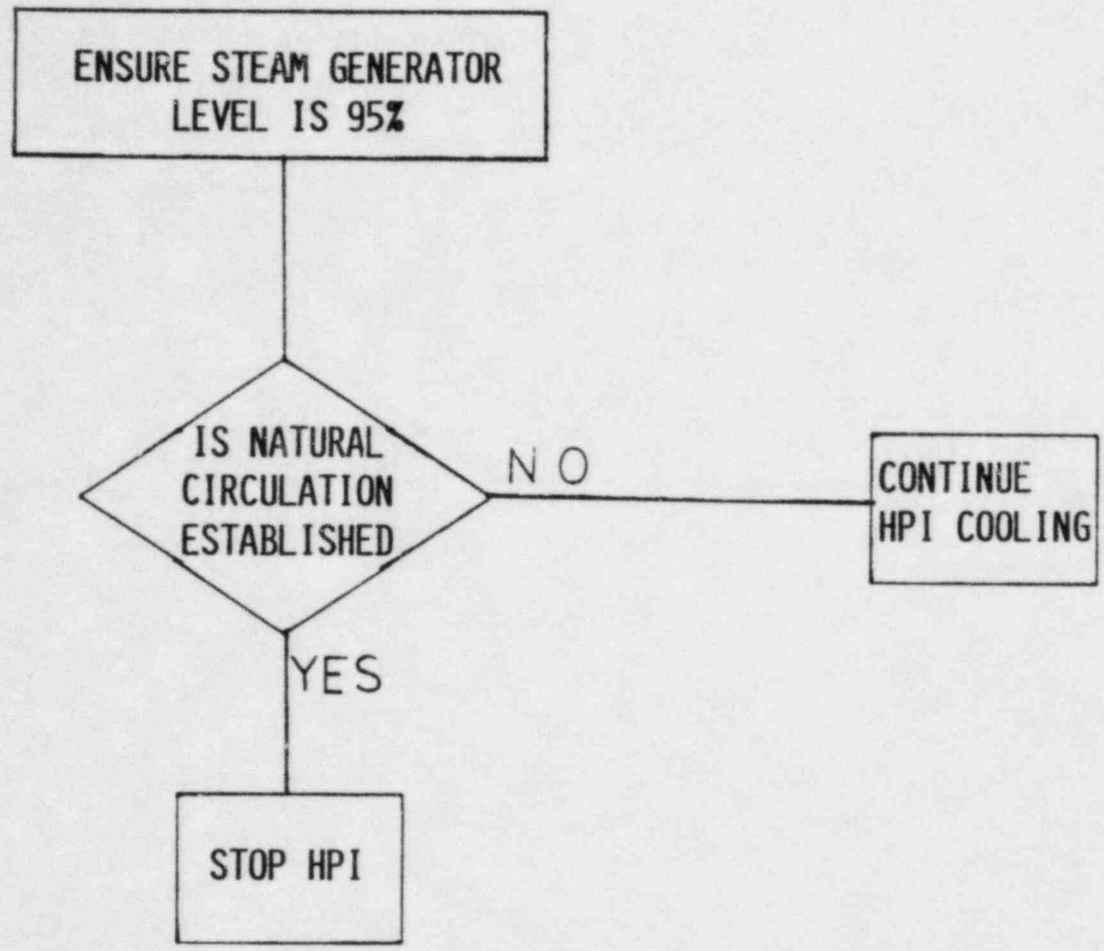
EXISTING PROCEDURES	PROPOSED CHANGE
OPEN HOTLEG VENTS	
FURTHER REDUCE STEAM GENERATOR PRESSURE	

ACTIONS WHEN CORE COOLING IS ESTABLISHED

EXISTING PROCEDURES	PROPOSED CHANGE
MAINTAIN ALL COOLING METHODS UNTIL REQUIRED SUBCOOLING MARGIN IS RESTORED	
WHEN SUBCOOLING MARGIN IS RESTORED CLOSE PORV AND HOTLEG VENTS	MAINTAIN HOTLEG VENTS OPEN, CLOSE PORV
MAINTAIN SUBCOOLING MARGIN WITHIN REQUIRED BAND BY THROTTLING HPI FLOW	
ESTABLISH NATURAL CIRCULATION	

NATURAL CIRCULATION

EXISTING PROCEDURE	PROPOSED CHANGE
ENSURE STEAM GENERATOR LEVELS AT 95%	
VERIFY NATURAL CIRCULATION	
STOP HPI	
CHECK FOR PTS	
ESTABLISH BUBBLE IN PRESSURIZER	
BEGIN COOLDOWN	



ENSURE STEAM GENERATOR LEVEL IS 95%
IS NATURAL CIRCULATION ESTABLISHED
NO
CONTINUE HPI COOLING
YES
STOP HPI

21

HIGH POINT VENT CLOSURE

EXISTING PROCEDURES	PROPOSED CHANGE
	WHEN CORE COOLING IN DECAY HEAT REMOVAL MODE IS ESTABLISHED, CLOSE HIGH POINT VENTS OR WHEN NATURAL CIRCULATION IS COOLING THE CORE AND RCS TEMPERATURE IS APPROXIMATELY 212°F, CLOSE HIGH POINT VENTS

22

END CONDITIONS

* REACTOR COOLANT AVERAGE TEMPERATURE APPROXIMATELY 212°F

* REACTOR COOLANT PRESSURE NEAR ATMOSPHERIC

* CORE COOLING PROVIDED BY:

  - NATURAL CIRCULATION

OR

  - DECAY HEAT REMOVAL SYSTEM

* HIGH POINT VENTS CLOSED

V. DISCUSSION OF EXEMPTION

FPC BELIEVES A HEAD VENT IS NOT NECESSARY AT CR-3 FOR COOLING THE CORE FOLLOWING AN INADEQUATE CORE COOLING EVENT BECAUSE:

* NON-CONDENSABLES CAN BE VENTED THROUGH HPV's.
* NON-CONDENSABLES REMAINING IN HEAD DO NOT AFFECT THE ABILITY TO COOLDOWN.
* NATURAL CIRCULATION COOLING CAN BE ESTABLISHED AND RE-ESTABLISHED IF INTERRUPTED.
* FEED/BLEED COOLING OF THE CORE IS AVAILABLE AS A SUFFICIENT AND COMPLEMENTARY METHOD.
* ADEQUACY OF FEED/BLEED COOLING OF THE CORE WAS DEMONSTRATED AT CR-3 DURING INCIDENT OF FEBRUARY 1980.
* THE COSTS ($ MILLIONS) ASSOCIATED WITH THE INSTALLATION OF THE REACTOR VESSEL HEAD VENT CANNOT BE JUSTIFIED BY ANY ADDED BENEFIT.

ATTACHMENT 4
REPORTS

(4)a. Babcock & Wilcox Report 12-1152307-00,"OTIS Hot Leg High Point Vent Test #240100" for Florida Power Corporation and Sacramento Municipal Utility District, July 1984.

b. Babcock & Wilcox Report 11-1152308-00, "OTIS Hot Leg High Point Vent Test #2040200" for Florida Power Corporation and Sacramento Municipal Utility District, July 1984.

c. Babcock & Wilcox Report RDD:84:4091-24-01-01, "Once Through Integral System Test Program, OTIS Loop Functional Specification", issued for review 9/13/84.