Omaha Public Power District

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July 30, 1979

Director of Nuclear Reactor Regulation
ATTN: Mr. Robert W. Reid, Chief
Operating Reactors Branch No. 4
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Reference: Docket No. 50-285

Gentlemen:

The Omaha Public Power District received a letter from the Commission dated September 29, 1977, requesting additional information regarding the long term core cooling method used at the Fort Calhoun Station. The District's reply, dated November 8, 1978, provided responses to questions posed and indicated that a detailed quantitative response to Question 5 and a modifications schedule were forthcoming. Accordingly, the following information is provided by enclosure.

Enclosure (1) - Responses to Questions 1 through 5 of the Commission's September 19, 1977, letter. Question 4 has been revised for clarification purposes; Questions 1 through 3 are included for completeness; and Question 5 contains additional quantitative information.

Enclosure (2) - Modifications Schedule.

Please note that the modifications schedule is preliminary; it is contingent upon the availability of equipment which must be procured. The District believes that the proposed modifications will assure that long term core cooling can effectively be accomplished without boron precipitation difficulties.

Sincerely,

R. Andrews for

T. E. Short
Assistant General Manager

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TES/KJM/BJH/lp

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RESPONSES TO THE COMMISSION'S CONCERNS REGARDING LONG TERM CORE COOLING

Question 1

In the hot leg suction method a sufficient level of coolant must be available at the bottom of the hot leg (assuming cold leg break) to prevent degraded performance because of cavitation of the residual heat removal pump. The hot leg coolant level depends on the system pressure in the upper plenum as determined by the total loop hydraulic resistance encountered by the steam escaping from the cold leg break. It has been demonstrated that in most cases this resistance will be sufficently low and the level of the water in the hot leg will be adequate. However, for certain break locations the hydraulic resistance of the steam escape path may be high enough to cause excessive loss of water level in the hot leg. Review the ECCS for this facility and provide detailed analyses that demonstrate, regardless of the cold leg break size and location, that the hydraulic resistance of the escaping steam would be low enough to maintain hot leg water as required to prevent pump cavitation.

Response

The hot leg suction method is not intended for use as a permanent post-LOCA long term cooling procedure. Therefore, this question is not addressed.

Question 2

The pump used to draw water from the hot leg is designed to operate with relatively cold liquid. Show that this pump can satisfactorily operate in the hot leg suction mode. That is, show that the pump can simultaneously draw saturated water from the hot leg and subcooled water from the containment sump.

Response

The hot leg suction method is not intended for use as a permanent post-LOCA long term cooling procedure. Therefore, this question is not addressed.

Question 3

The procedure for hot leg suction calls for a careful control of the flow of water from the hot leg and from the containment sump. Show that:

a. The presently existing valve is adequate for controlling the flow.

b. The valve is located in a sufficiently low radiation area so that it would be accessible to the operator in a post-LOCA condition.

c. There is sufficient instrumentation for monitoring the flow of water from the hot leg and from the sump.

Response

The hot leg suction method is not intended for use as a permanent post-LOCA long term cooling procedure. Therefore, this question is not addressed.

Question 4

In order to assure adequate flow of water through the core during simultaneous hot and cold leg injection mode, the flow of water to the hot and cold legs should be carefully balanced. This requires the knowledge of the flow path characteristics of the system. In view of the fact that the hot leg flow path is very complicated, involving several different lines and valves, you are requested to provide the following information:

a. Show that all the lines in the hot leg injection flow path have sufficient capacity for maintaining adequate hot leg injection flow, regardless of the location of the break.

b. Show that satisfactory procedures and instrumentation exists for monitoring hot leg injection flow.

c. Explain in detail the procedures used for aligning the flow path for hot leg injection during the long term cooling after a LOCA.

Response

a. As indicated above, in response to Questions 1, 2, and 3, the hot leg suction method, involving a very complicated hot leg flow path, is not intended for use as a permanent post-LOCA long term cooling procedure. The District, instead, has decided to utilize the pressurizer auxiliary spray line as a means of hot leg injection. This path in conjunction with the cold leg injection paths ensures post-LOCA core flushing regardless of break location.

   The proposed system for hot leg injection has been analyzed with regard to the hydraulic performance and system reliability. It has been calculated that the hot leg injection path and cold leg injection paths will each have a flow of 175 gpm. This value is in excess of the requirements during the time of core flushing. Also, modifications will be made to the system in order to enhance the system reliability. A basic sketch of the modified system is provided as Attachment 1.

b. The proposed system of simultaneous hot and cold leg injection is enhanced by its use of existing instrumentation. The safety injection system instrumentation in conjunction with the CVCS flow instrument (FIA-236) is used for flow monitoring during hot and cold leg injection. The CVCS flow instrument will be modified (increase range) to be able to read hot leg injection flow.

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c. The procedure for ECCS realignment for simultaneous hot and cold leg injection is provided as Attachment 2.

Question 5

During the long term cooling mode following a postulated small LOCA, boron precipitation is prevented by maintaining the system pressure, and therefore the saturation temperature, at sufficiently high levels. However, the system must ultimately be depressurized and cooled in order to remove the head and inspect and/or replace the fuel. Describe the procedures that would be used to ultimately cool down and depressurize the system following a small LOCA. Clearly specify the equipment that would be required and show that the equipment has adequate capacity.

Response

A detailed description of the long term cooling plant and performance evaluation along with the description of equipment functions and capacities, assumed in the analysis, is provided as Attachment 3.

Since Question 5 addresses the small break LOCA response, the discussion in Attachment 3 provides detailed procedures for the small break LOCA. However, for completeness in describing the post-LOCA long term cooling procedures, a discussion of the large break response is also included.

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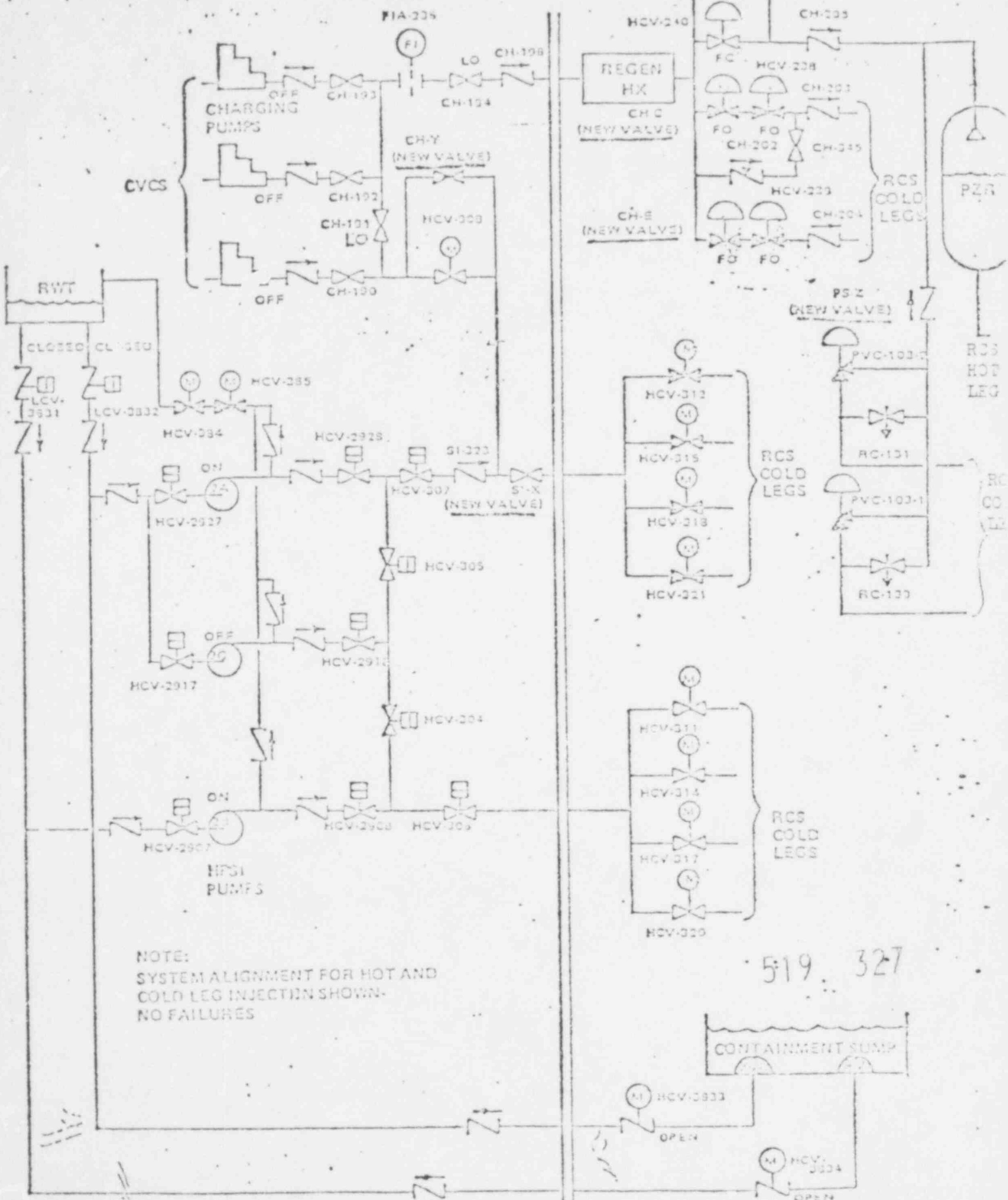
MODIFICATIONS FOR SIMULTANEOUS HOT AND COLD LEG INJECTION



ATTACHMENT 1

Fort Calhoun Station Unit No. 1
Long Term ECCS Realignment Following a LOCA
(for simultaneous hot leg and cold leg injection)

A. Purpose

To describe the operator action required to realign the ECCS to assure adequate core flushing.

B. Prerequisites

1. LOCA has occurred.
2. Safety injection has been initiated.
3. SIRWT has been emptied.
4. Safety injection system is operating in the recirculation mode.
5. RCS pressure $\leq$700psia.

C. Precautions

1. Observe suitable radiological precautions at manual operating stations.
2. Charging pumps must be stopped.

D. Procedure

1. Close HCV-238, HCV-239, CH-C, and CH-E.
2. Open HCV-240 (or CH-A).
3. Open HCV-308 (or CH-Y).

IF HPSI PUMPS 2A (or 2C) AND HPSI PUMPS 2B ARE OPERATING, PROCEED WITH STEP 4:

4. Close HCV-304.
5. Close HCV-312, HCV-315, HCV-321, and HCV-318 (or SI-X).
6. Monitor flow through FIA-236 for a minimum of 175 gpm.

IF ONLY HPSI PUMP 2A (or 2C) IS OPERATING, PROCEED WITH STEP 7:

7. Close HCV-304

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ATTACHMENT 2
(2 pages)

D. Procedure (Continued)

8. Throttle HCV-312, HCV-315, HCV-318 and HCV-321 (or SI-X) until each HPSI cold leg flow is 44 gpm as indicated by FI-313, FI-316, FI-319, and FI-322.

9. Monitor flow through FIA-236 for a minimum of 175 gpm.

IF ONLY HPSI PUMP 2B IS OPERATING, PROCEED WITH STEP 10:

10. Close HCV-312, HCV-315, HCV-318, and HCV-321, (or SI-X).

11. Throttle HCV-311, HCV-314, HCV-317, and HCV-320 (or HCV-306) until each HPSI cold leg flow is 44 gpm as indicated by FI-313, FI-316, FI-319, and FI-322.

12. Monitor flow through FIA-236 for a minimum of 175 gpm.

E. References

Drawings No. E-23866-210-130, Rev. 08
E-23866-210-120, Rev. 07
E-23866-210-110, Rev. 04

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FORT CALHOUN STATION UNIT NO. 1
LONG TERM COOLING PLAN AND PERFORMANCE EVALUATION

1.0 INTRODUCTION

The post-LOCA Long Term Cooling ECCS performance evaluation for Fort Calhoun Station presented herein demonstrates conformance with criterion (5) of 10 CFR 50.46(b). The results of the post-LOCA long term cooling analysis demonstrate acceptable ECCS performance wherein the core temperatures are maintained at acceptably low values and decay heat is removed for an indefinite period of time. The following sections describe the long term cooling procedure along with the results of the performance evaluation.

2.0 LONG TERM COOLING PLAN

Long term cooling is initiated when the core is reflooded after a LOCA and is continued until the plant is secured. The objective of long term cooling is to maintain the core temperature at an acceptably low value while removing decay heat for the extended period of time required by the long-lived radioactivity remaining in the core. In satisfying this objective, the post-LOCA long term cooling plant makes provision for maintaining core cooling and boric acid flushing by simultaneous hot and cold leg injection for the large break LOCA, or for initiating cooldown of the reactor coolant system (RCS) if the break is sufficiently small that the success of such operation is assured. Knowledge of RCS pressure gives the plant operator the indication of the break size range.

For the small break LOCA, cooldown of the reactor coolant system (RCS) and long term decay heat removal is provided by actuation of the pressurizer power operated relief valves (PORV) by releasing steam from the RCS. This action depressurizes and maintains the RCS pressure below the high pressure safety injection (HPSI) pump shutoff head, allowing the HPSI pumps to flush the core and accelerate refilling of the RCS.

For the large break LOCA, the HPSI flow is injected simultaneously into the hot and cold legs. This injection mode provides cooling for the RCS and prevents boric acid accumulation in the vessel following the large break LOCA. Hot side injection is provided through the pressurizer auxiliary spray system.

Figure 1 shows the basic sequence of events and timing of operator actions in the long term cooling plan. As indicated in the diagram, the safety injection pumps are automatically actuated by the safety injection actuation signal. At 10 minutes post-LOCA, the auxiliary feedwater flow is confirmed or actuated; while at 30 minutes post-LOCA, the charging flow is terminated.

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ATTACHMENT 3
(19 pages)

2.0 LONG TERM COOLING PLAN (Continued)

At three hours after the LOCA, the operator determines, based on RCS pressure, whether the small break LOCA or the large break LOCA procedures are to be implemented. If the RCS pressure is above 700 psia, then the small break procedure is appropriate and the PORV's are opened. If the RCS pressure is below 700 psia, then the large break procedure applies and HPSI pump discharge lines are realigned so that the total injection flow is split equally between the hot and cold legs. The hot side injection is achieved by injection in the RCS through the pressurizer auxiliary spray system. Both procedures provide sufficient injection flow to both cool the core and flush the reactor vessel for an indefinite period of time.

3.0 PERFORMANCE EVALUATION OF THE LONG TERM COOLING PLAN

3.1 Method of Analysis

The performance analysis for the long term cooling plan was performed using the codes and methodologies documented in CENPD-254[1]. However, the procedures used in implementing the long term cooling plan for Fort Calhoun Station differ somewhat from those described in CENPD-254. The difference between the Fort Calhoun Station and CENPD-254 procedures are due to different systems used in satisfying the objectives post-LOCA long term cooling for both the small and large break LOCA. The use of the different systems in the long term performance evaluation results in different system responses. As a consequence of the different system responses, the decision pressures and decision times differ. A discussion of the major differences between the Fort Calhoun Station and CENPD-254 procedures is presented below in terms of the small and large break LOCA.

(1) In CENPD-254, in the small break LOCA procedure, RCS cooldown is achieved using the steam generators. In the Fort Calhoun Station plan, cooldown of the RCS is performed using the PORV's. Since the RCS response following cooldown with the PORV's differs from that if the steam generators are used, the decision time and decision pressure also differ. RCS cooldown for Fort Calhoun Station, however, can also be initiated with the steam generator atmospheric dump system. However, for additional conservatism, credit for

[1] CENPD-254, "Post-LOCA Long Term Cooling Evaluation Model," June, 1977.

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3.0 PERFORMANCE EVALUATION OF THE LONG TERM COOLING PLAN (Continued)

3.1 Method of Ar .ysis (Continued)

this system was neglected since the response achieved with the cooldown with the PORV's is the most limiting analysis condition. Even in the unlikely event that the PORV's are used, the performance analyses results contained herein demonstrate a large degree of margin, both in terms of boric acid accumulation and long term decay heat removal when this system is utilized to cool the RCS. Since CENPD-254 does not make provision for the use of the PORV's, a modification to the model was made. The methods used in modeling the performance of the PORV's are described in Appendix A.

(2) In CENPD-254 and in the Fort Calhoun Station long term cooling plan, simultaneous hot and cold side injection is the appropriate procedure for the large break LOCA. However, in CENPD-254, hot side injection is achieved by injecting directly into the hot leg; whereas in the Fort Calhoun Station procedure, injection is achieved through the pressurizer auxiliary spray system. The results of the analysis presented in Section 3.4 demonstrate that injection into the hot legs via the pressurizer auxiliary spray system provides an effective and time increasing flow to flush the core very early following a LOCA.

3.2 Assumptions Used in the Performance Evaluation of the Long Term Cooling Plan

The major assumptions used in performing the LTC analysis are the same as those listed in CENPD-254. Those assumptions which differ from CENPD-254 are listed below.

(1) The atmospheric dump valves on the steam generator secondary were assumed to remain closed.

(2) One of the two PORV's was assumed to fail closed.

3.3 Parameters Used in the Performance Evaluation of the LTC Plan

(1)	Reactor Power Level (102% of Nominal)	1448 MWt
(2)	SDC Entry Temperature	300^{o}F, max.
(3)	SDC Entry Pressure	300 psig, max.
(4)	Pressurizer PORV Capacity Per Valve	27.5 lb/sec (steam) min., at 2350 psia

3.0 PERFORMANCE EVALUATION OF THE LONG TERM COOLING PLAN (Continued)

3.3 Parameters Used in the Performance Evaluation of the LTC Plan (Cont'd)

(5) Operating Pressure Range of PORV 2350 psia to 200 psia

(6) Emergency Feedwater Storage Tank Volume 51,600 gal., min.

(7) The maximum possible boric acid concentration is assumed from each of these sources.

RCS = .71 wt %

RWT = 1.41 wt %

SIT = 1.41 wt %

BAST = 12.00 wt %

(8) The water inventories from each source are determined such that the effect of injection into the RCS maximizes the boric acid concentration in the RCS.

RCS 272,945 lb - minimum

RWT = 2,590,484 lb - maximum

SIT = 323,888 lb - maximum

BAST = 98,456 lb - maximum (Injection terminated @ 1/2 hour, 30,000 lbm injected)

(9) The following pumps inject water into the RCS.

Pump	Source	Run Out Flow Rate (gpm)	No. Pumps	Total Flow (gpm)
HPSI	RWT, sump	423	1	423
LPSI	RWT	2200	1	2200
CSP (via sump)	RWT, sump	2550	1	2550
CHARGING	BAST	40	3	120

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3.4 Results of the Performance Evaluation of the LTC Plan

The results of the performance evaluation are discussed in terms of the small and large break procedures comprising the Fort Calhoun Station long term cooling plan. As discussed earlier, for small breaks cooling and boric acid flushing is provided by actuation of the PORV's; while for large breaks, simultaneous hot and cold side injection maintains core cooling and provides for boric acid flushing. In this plan, the operator implements the appropriate procedure based on RCS pressure at three hours after the LOCA. Three hours is the earliest time post-LOCA in which the operator has sufficient information regarding RCS pressure and then can implement the appropriate small or large break procedure. That is, at three hours post-LOCA, the RCS pressure will have attained those values for the entire range of break sizes, small and large, wherein the operator can readily identify whether the small or large break LOCA procedures are applicable.

(1) Small Break Procedure

In evaluating the ECCS performance for the small break LOCA procedures, cooldown of the RCS is initiated by activating the PORV's if the RCS pressure is above 700 psia. Opening of the PORV's results in cooling and reducing RCS pressure sufficiently such that the HPSI pump refills and subcools the RCS. The refilling and subcooling of the RCS results in maintaining the boric acid concentration in the vessel well below the precipitation limit by dispersing the boron through the RCS by natural circulation. Figure 2 shows that for the range of small breaks wherein the small break procedure applies, breaks as large as .02 ft^2 result in refilling the RCS. Therefore, the small break procedure demonstrates that for breaks .02 ft^2 or smaller, the RCS will refill and subcool, thereby maintaining the boric acid concentration well below the precipitation limit and cooling the core for an indefinite period of time. The results of the smaller breaks are shown in Figure 2 to demonstrate that breaks smaller than .02 ft^2 are less limiting.

While the small break procedure demonstrates that the RCS will achieve a subcooled condition subsequent to refilling of the RCS for the small break LOCA, the boric acid concentration in the vessel is also maintained well

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3.4 Results of the Performance Evaluation of the LTC Plan (Continued)

(1) Small Break Procedure (Continued)

below the precipitation limit prior to refill. Figure 3 demonstrates that the small break procedure maintains the boric acid concentration well below the precipitation limit of 75 wt % prior to refill for breaks as large as .02 ft^2. As shown in Figure 4, the minimum RCS temperature determined for the small break procedure is 328°F (saturation at 100 psia) for the .02 ft^2 break. The results of the .00037 ft^2 break are also shown to demonstrate that smaller breaks will have higher RCS temperatures and thus higher solubility limits. However, the minimum temperature of 328°F for the 0.02 ft^2 break establishes the boric acid solubility limit of 75 wt % shown in Figure 3. Figure 3 also shows that the small break response is also well below the solubility limit of 32 wt % at the minimum temperature of 228°F (saturation at 20 psia), applicable to the large break results.

(2) Large Break Procedure

In evaluating the ECCS performance for the large break LOCA procedures, the limiting break with respect to long term boric acid accumulation in the inner vessel regions is the 9.8 ft^2 break in the cold leg. This break is the most limiting because the rate of accumulation of boric acid will be greatest for this break size in addition to having the lowest associated precipitation limit (32 wt %). For this break and all other large breaks, the boric acid accumulation is reduced by the core flushing flow which is provided by the simultaneous hot side and cold side injection from a HPSI pump. The simultaneous hot side and cold side injection mode is initiated at three hours post-LOCA if the RCS pressure is below 700 psia.

Figure 5 shows that the initiation of simultaneous hot and cold side HPSI flow at three hours results in a substantial and time increasing core flushing flow. Figure 6 shows that even with no core flushing flow, the boric acid would not begin to precipitate until after 25 hours post-LOCA. The margin provided for the prevention of boric acid accumulation by the net core flushing flow over the minimum desired flushing flow of 5 gpm is shown in Figure 6.

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3.4 Results of the Performance Evaluation of the LTC Plan (Continued)

(2) Large Break Procedure (Continued)

The time at which all hot leg steam entrainment of injection water terminates has been calculated to be 1.4 hours post-LOCA. Therefore, the initiation of hot and cold side injection at three hours post-LOCA occurs well after any potential for hot leg entrainment has been terminated and more than 22 hours prior to the time at which boric acid precipitation is predicted to occur.

The large break long term cooling procedure applies to those break sizes for which simultaneous hot and cold side injection can both flush and cool the core. Analyses of smaller breaks applying the large break procedure demonstreates that the 0.005 ft^2 break is the smallest for which simultaneous injection can cool and flush the core. The plot of RCS pressure versus time determined using the large break procedure is shown for several smaller break sizes in Figure 7. The .005 ft^2 break is the smallest for which the large break procedure applies since the depressurization maintains the RCS pressure sufficiently low to allow the HPSI pump to flush and cool the RCS.

The performance evaluation results discussed above demonstrate that the small break procedure is applicable for breaks as large as .02 ft^2, and the large break procedure is applicable for breaks as small as .005 ft^2. The operator must choose the appropriate procedure according to the RCS pressure at three hours post-LOCA. The RCS pressure is listed, for the entire range of break sizes, in Figure 8. As show, the decision point pressure of 700 psia fits well within the break size range of .005 to .02 ft^2 for which both the small and large break procedures are applicable. This result is also illustrated in Figure 9.

The analysis results presented herein demonstrate that the small and large break LOCA procedures satisfy the objectives for post-LOCA long term cooling. A summary of the margins in this procedure is presented in Table 1.

This analysis considered only the condition wherein offsite power is unavailable. However, with offsite power available, it is possible to more quickly cooldown the RCS using the turbine bypass system and thereby initiate operation of the shutdown cooling system. An alternate procedure would be required to identify these conditions. However, the analysis considered

3.0 PERFORMANCE EVALUATION OF THE LONG TERM COOLING PLAN (Continued)

3.4 Results of the Performance Evaluation of the LTC Plan (Continued)

herein is based on the more limiting condition wherein offsite power is unavailable and cooldown of the RCS is accomplished with the PORV's. According to this plan, opening of the PORV's is sufficient to maintain decay heat removal for an indefinite period of time such that it is not necessary to initiate operation of the shutdown cooling system to assure continued heat removal. That is, the procedures identified in the long term cooling plan do not require eventual initiation of the shutdown cooling system although conditions will exist wherein this system can be operated. Because it is the intent of this report to present the most limiting condition, the analysis presented herein addressed only the RCS cooldown with the PORV's.

4.0 CONCLUSION

The post-LOCA long term cooling plan demonstrates that the core temperature can be maintained at acceptably low values and decay heat can be removed for an indefinite period of time following a LOCA. This objective is accomplished by initiating simultaneous hot and cold leg injection to cool and flush the reactor vessel for the large break LOCA and opening the PORV's to cooldown and depressurize the RCS for the small break LOCA. The performance analysis results also demonstrate that there is a large range of intermediate break sizes wherein either the small break or large break procedures satisfy the long term cooling performance objectives. Furthermore, the analysis demonstrates that even under the most limiting of conditions, wherein the PORV's are used to cool the RCS, acceptable ECCS performance is assured during the long term.

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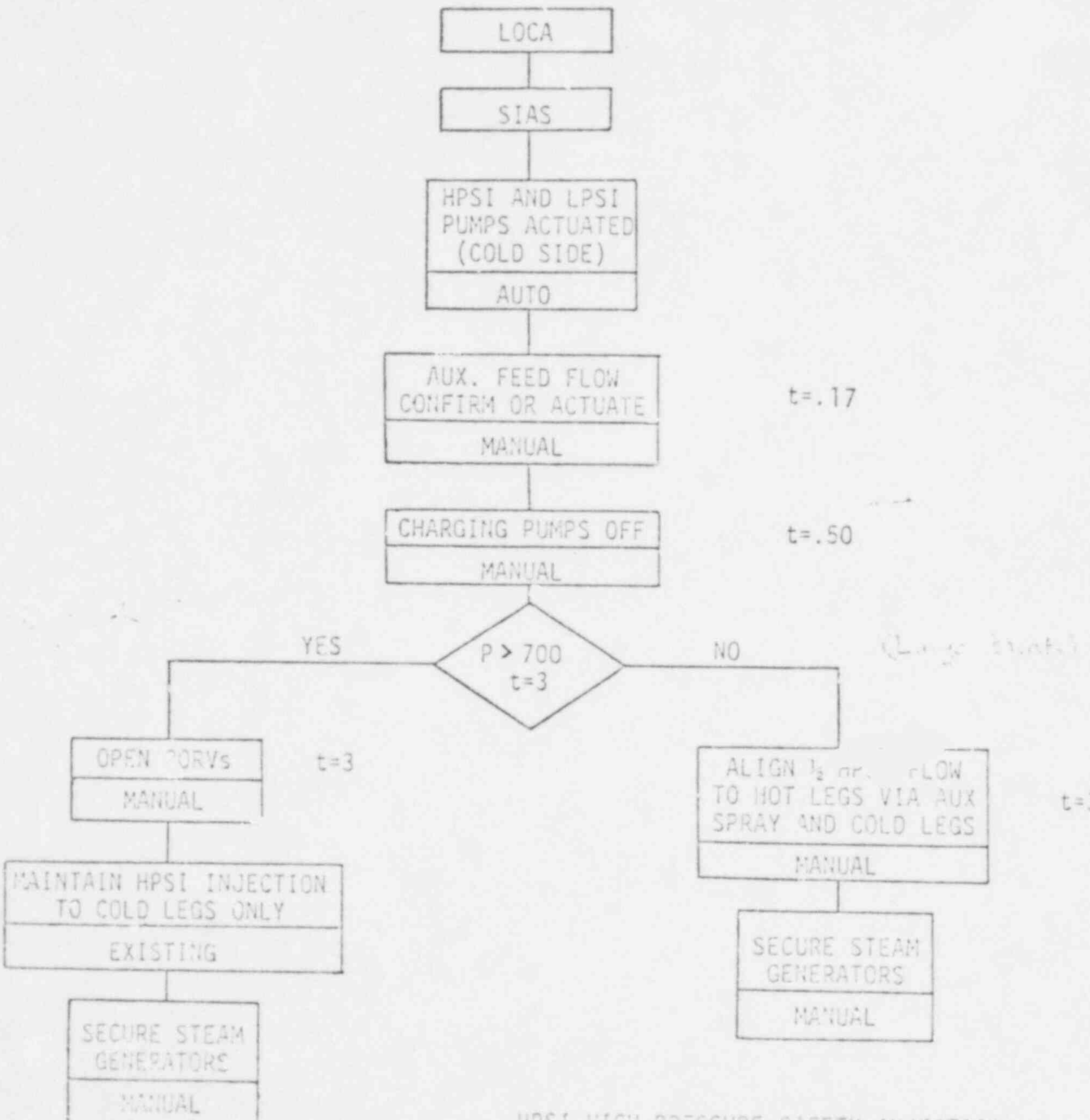
FIGURE 1

LONG TERM COOLING PLAN
FOR THE MOST LIMITING CONDITION
FOR FT CALHOUN



HPSI-HIGH PRESSURE SAFETY INJECTION
LPSI-LOW PRESSURE SAFETY INJECTION
SIAS-SAFETY INJECTION ACTUATION SIGNAL
t-TIME AFTER LOCA, HRS
P-PRIMARY SYSTEM PRESSURE, PSIA

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FIGURE 2

FT. CALHOUN LTC PERFORMANCE EVALUATION

TIME TO REFILL THE RCS vs BREAK AREA

OPEN PORV'S AT 3 HOURS

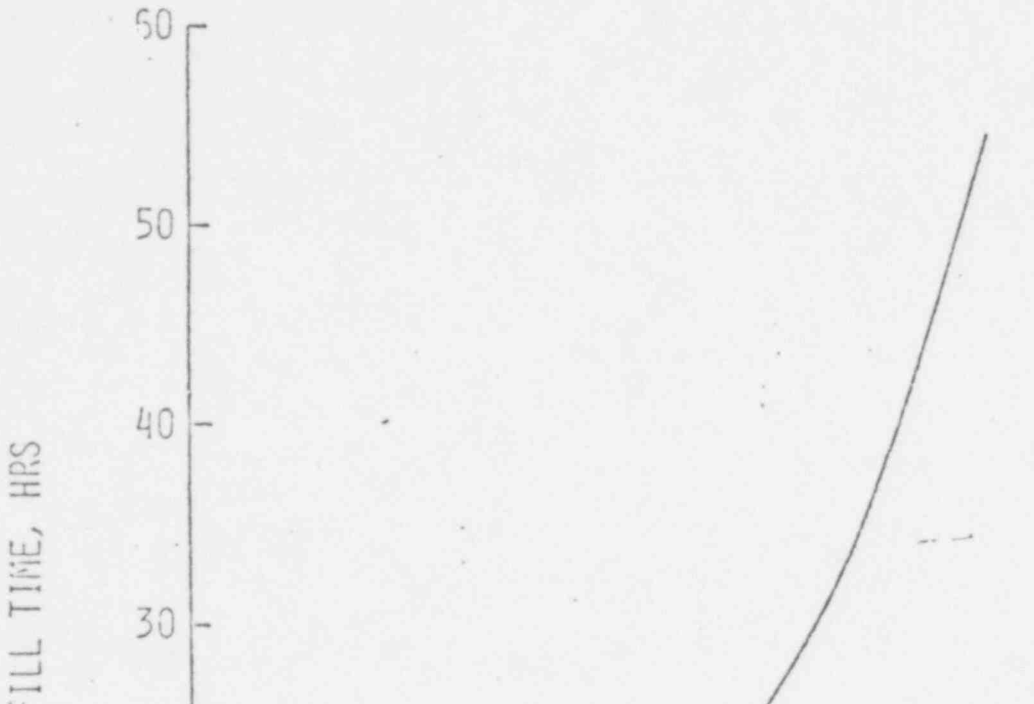

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FIGURE 3

FT. CALHOUN LTC PERFORMANCE EVALUATION

BORIC ACID CONCENTRATION IN REACTOR VESSEL

OPEN PORV'S AT 3 HRS.

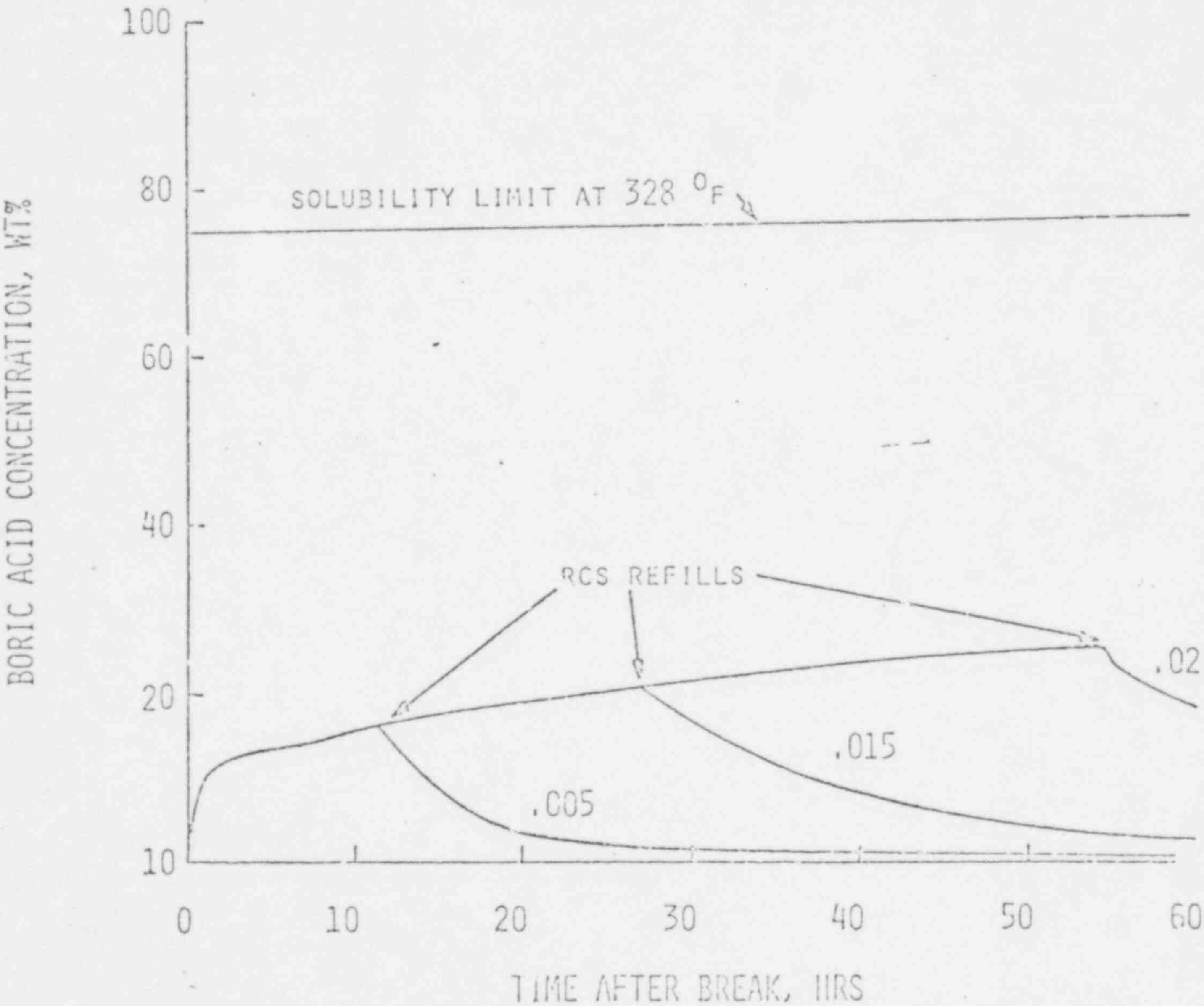

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FIGURE 4

FT. CALHOUN LTC PERFORMANCE EVALUATION
REACTOR COOLANT SYSTEM TEMPERATURE

OPEN PORV'S AT 3 HOURS

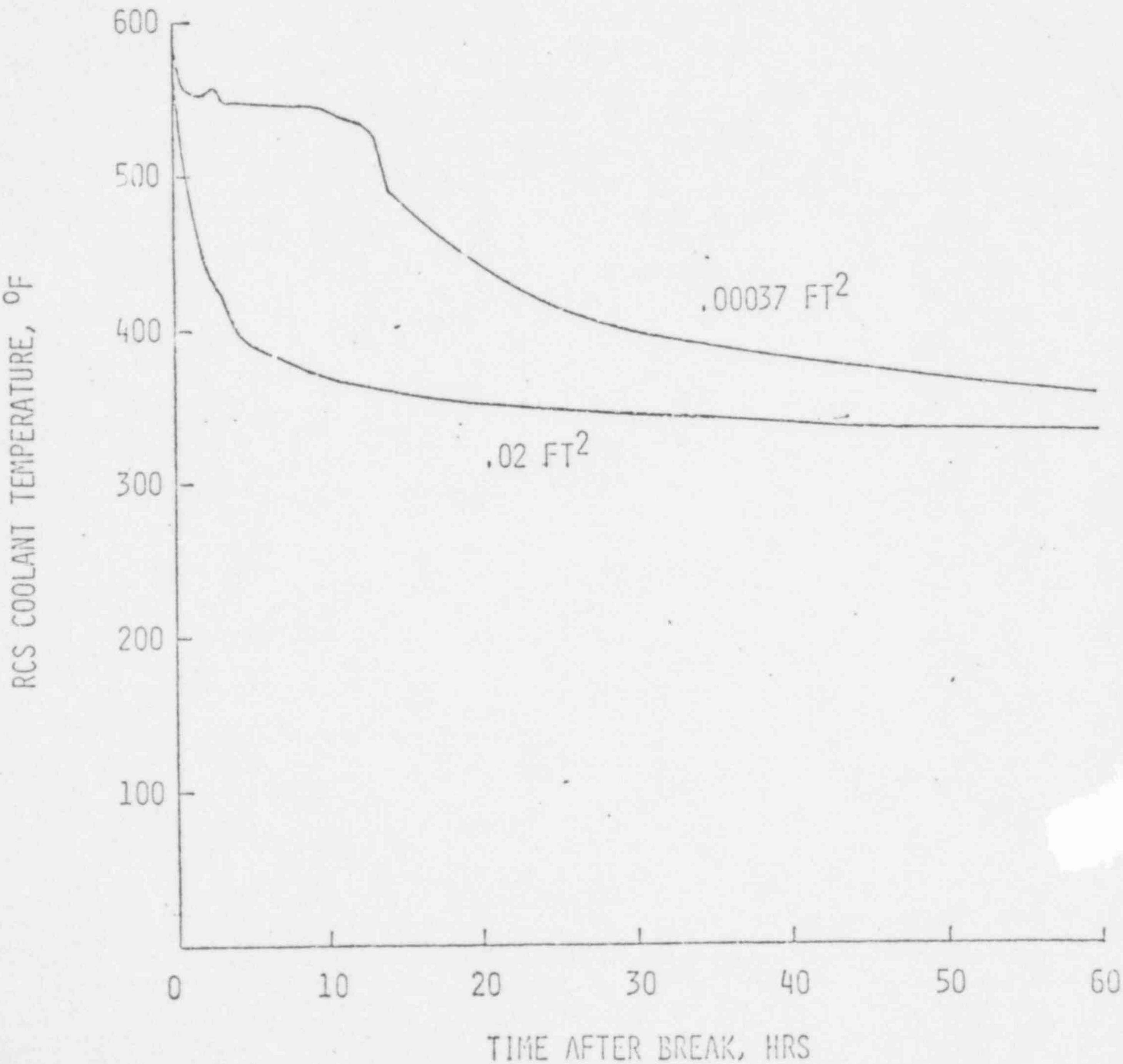

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FIGURE 5

FT CALHOUN LTC PERFORMANCE EVALUATION

CORE F_JSHING FLOW DUE TO HOT SIDE INJECTION
FOR A 9.8 FT^2 COLD LEG BREAK

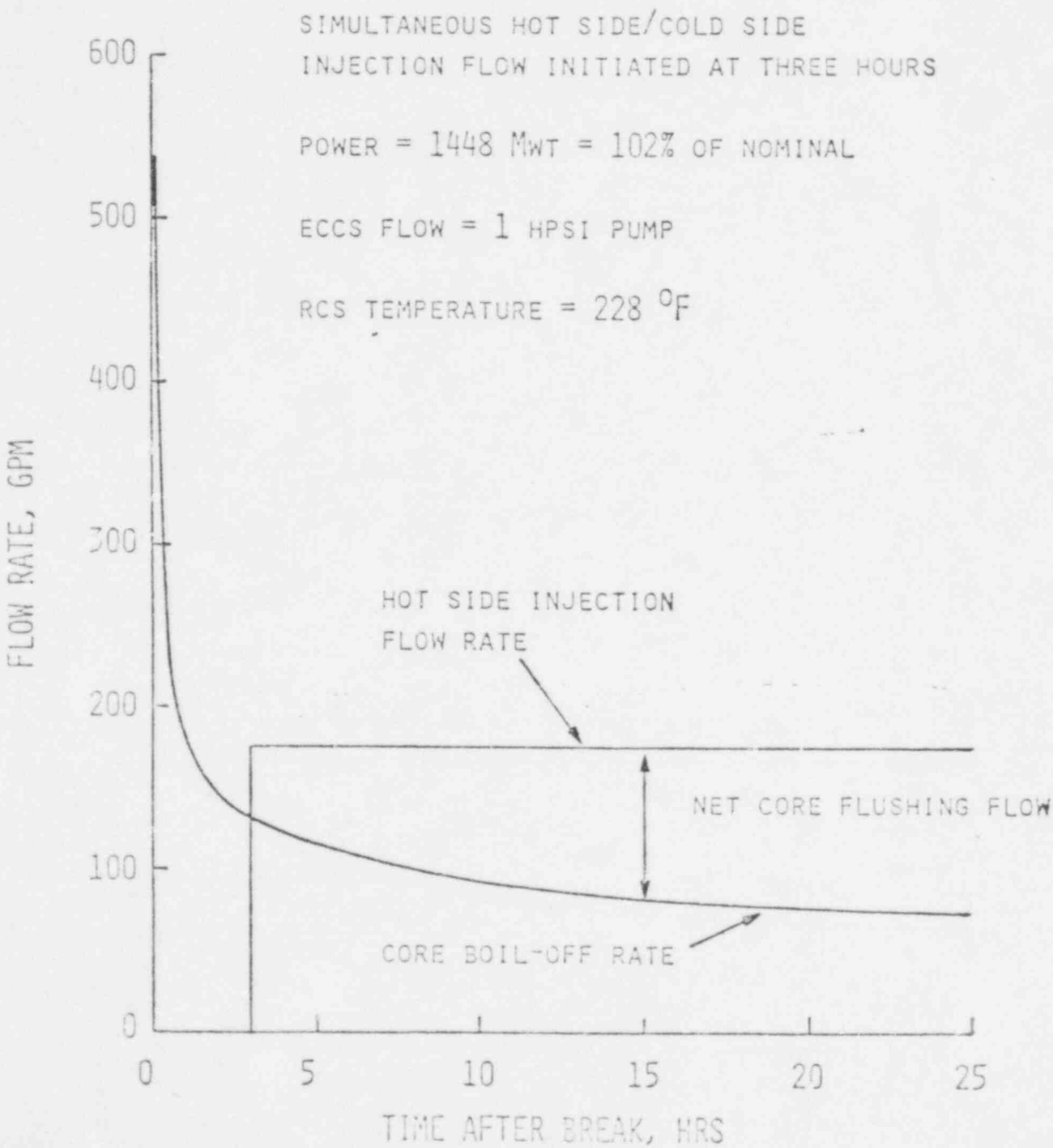

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FIGURE 6

FT CALHOUN LTC PERFORMANCE EVALUATION

BORIC ACID CONCENTRATION VS TIME
IN THE REACTOR VESSEL

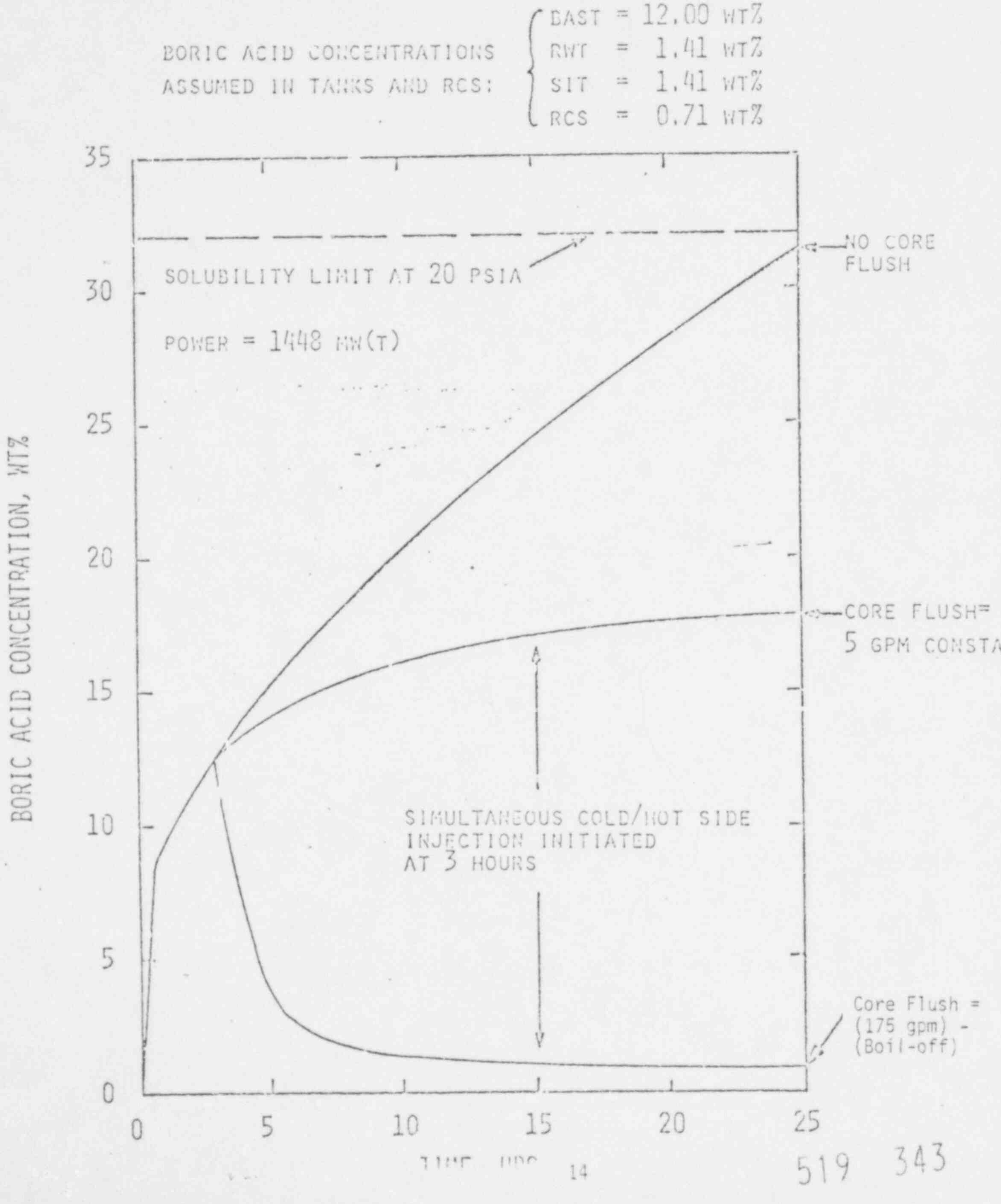

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FIGURE 7

FC. CALHOUN LTC PERFORMANCE EVALUATION
RCS PRESSURE VS. TIME

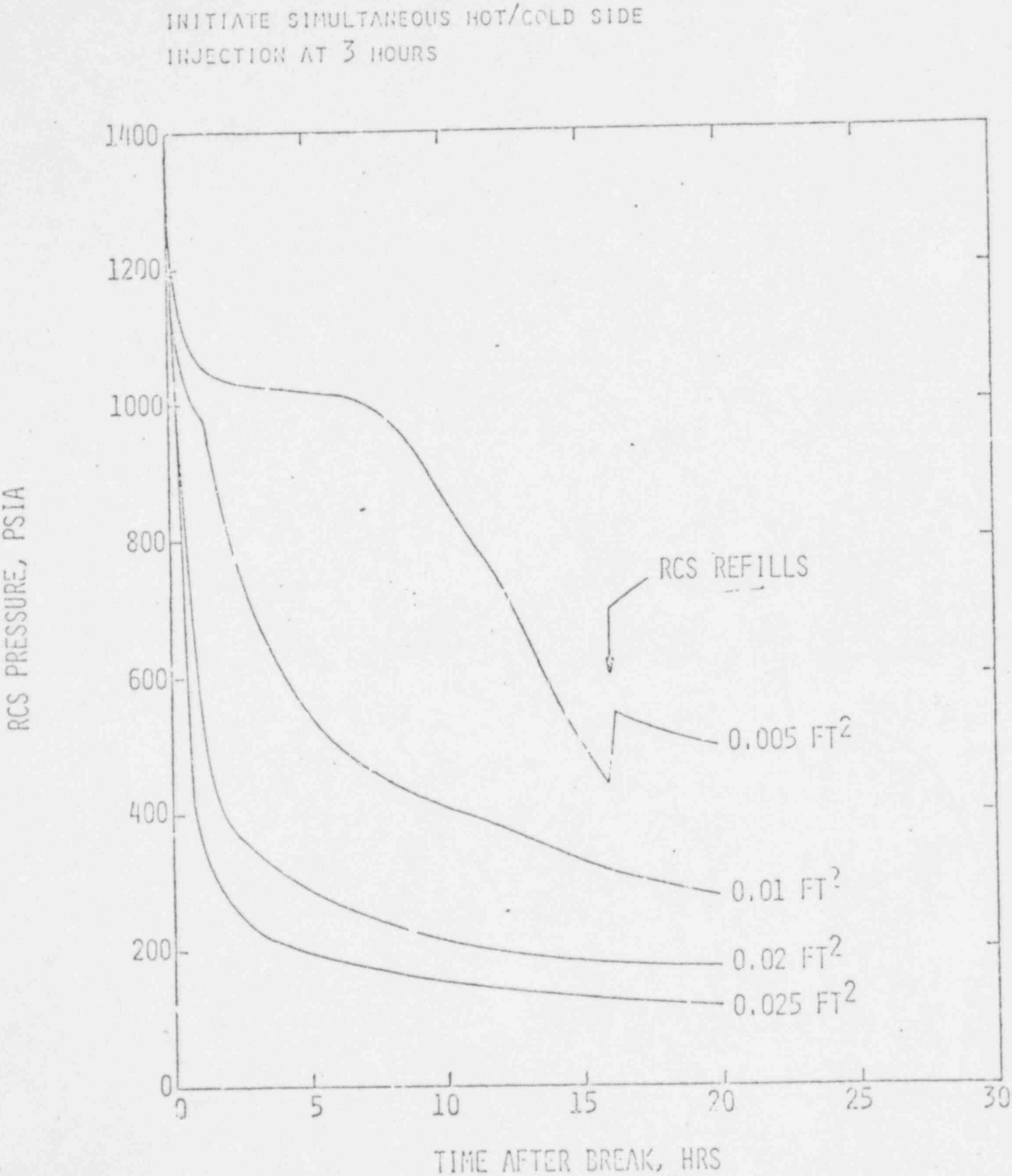

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FIGURE 8

FT. CALHOUN LTC PERFORMANCE EVALUATION

OVERLAP OF ACCEPTABLE LTC PROCEDURES

IN TERMS OF COLD LEG BREAK SIZE

	BREAK SIZE, FT^2	RCS PRESSURE AT T=3 HOURS PSIA
SIMULTANEOUS	9.8	20
HOT LEG/COLD LEG	5	20
INJECTION COOLS CORE	2	20
AND FLUSHES BORIC ACID	1	20
FROM VESSEL	0.5	20
	0.030	229
	0.025	276
	0.020	344
PRESSURIZER PORVs	0.015	445
REMOVE DECAY HEAT	0.010	688
AND ALLOW HPSI FLOW	0.005	1031
TO SUBCOOL THE RCS	0.0025	1055
AND FLUSH THE REACTOR	0.0010	1259
VESSEL	0.0005	1317
	0.00037	1331

(Bracket: SIMULTANEOUS HOT LEG/COLD LEG INJECTION COOLS CORE AND FLUSHES BORIC ACID FROM VESSEL — 9.8 through 0.005)

(Bracket: PRESSURIZER PORVs REMOVE DECAY HEAT AND ALLOW HPSI FLOW TO SUBCOOL THE RCS AND FLUSH THE REACTOR VESSEL — 0.020 through 0.00037)

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FIGURE 9

FT. CALHOUN LTC PERFORMANCE EVALUATION

RCS PRESSURE AT 3 HRS VS BREAK SIZE

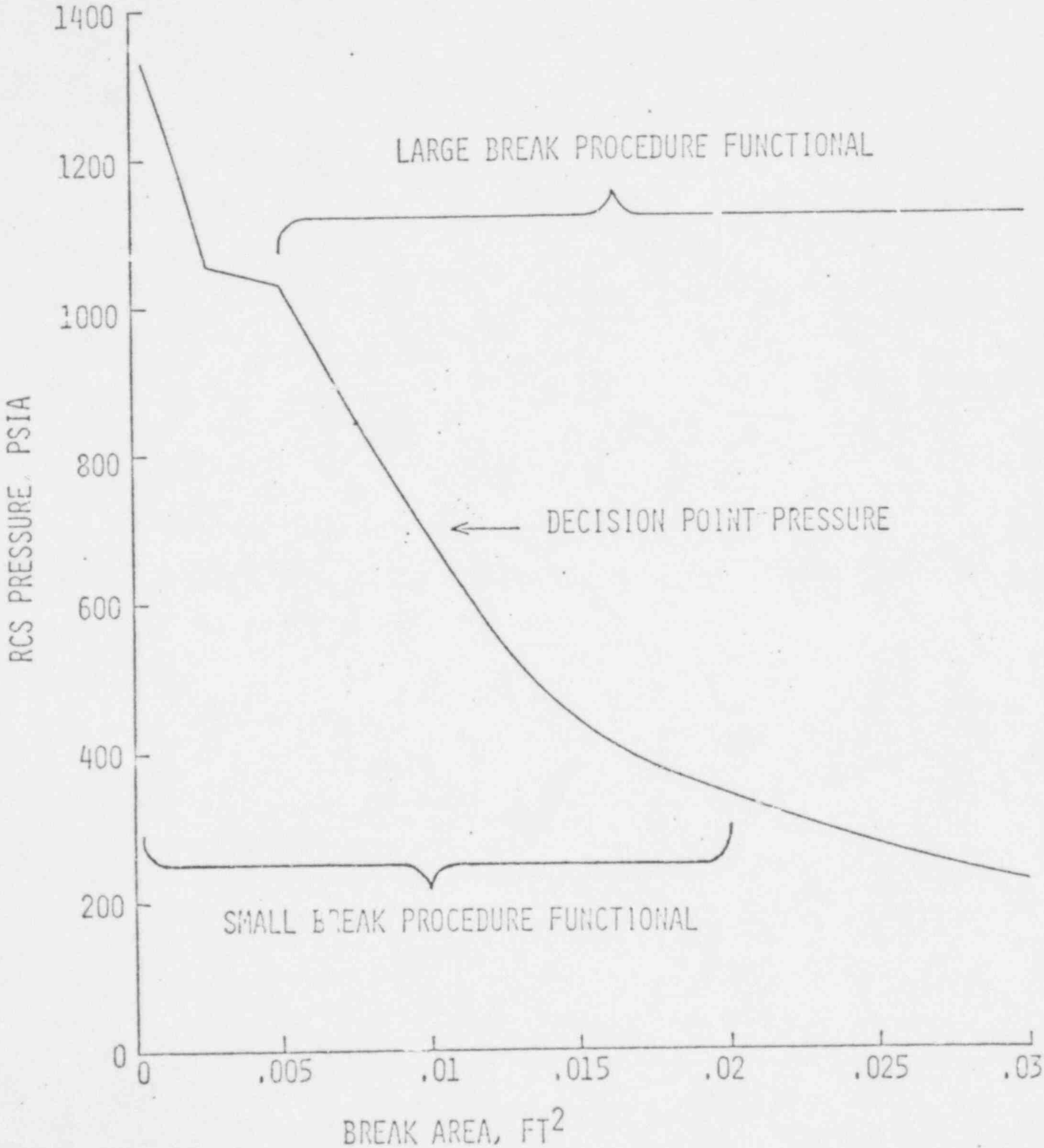

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TABLE 1

MARGINS IN THE LONG TERM COOLING PLAN

1. The boric acid will not precipitate before 25 hours post-LOCA in the absence of flushing. Simultaneous injection is initiated at 3 hours post-LOCA or 22 hours before precipitation will occur in the absence of flushing.

2. The range in break sizes, 0.005 ft^2 to 0.02 ft^2, defines significant overlap wherein both the small and large break procedures apply.

3. The decision pressure of 700 psia at three hours post-LOCA has an associated allowable error of ± 300 psi.

4. The operator need only make one decision; the decision at three hours pst-LOCA.

5. The operator need not make any decision before 3 hours post-LOCA.

6. The Long Term Cooling Plan does not require the availability of off-site power.

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APPENDIX A

MODEL USED FOR THE PRESSURIZER POWER OPERATED RELIEF VALVES

The post-LOCA Long Term Cooling evaluation model documented in CENPD-254 has been modified to include modeling of the pressurizer power operated relief valves (PORV's). The modification is summarized below.

a. An additional leak path was added to the CELDA code to model the PORV. The leak flow rate is calculated using the critical flow model described in Section A.3.6 in Appendix A of CENPD-254.

b. For conservatism, the discharge coefficient applied to the PORV, is defined as follows:

$$F_D = 0.8 + 0.2 - X_{valve}$$

where:

F_D = discharge flow multiplier

X_{valve} = fluid quality exiting the valve

Use of this expression for F_D will result in a 20% reduction in the flow capacity through the PORV when liquid is expelled.

c. The enthalpy of the fluid exiting the RCS through the PORV is determined in the same manner as the methods presented in CENPD-254.

d. In computing the flushing flow for the purpose of calculating the boron concentration when the PORV is open, it is conservatively assumed that the core flow is equal to the liquid flow expelled through the PORV.

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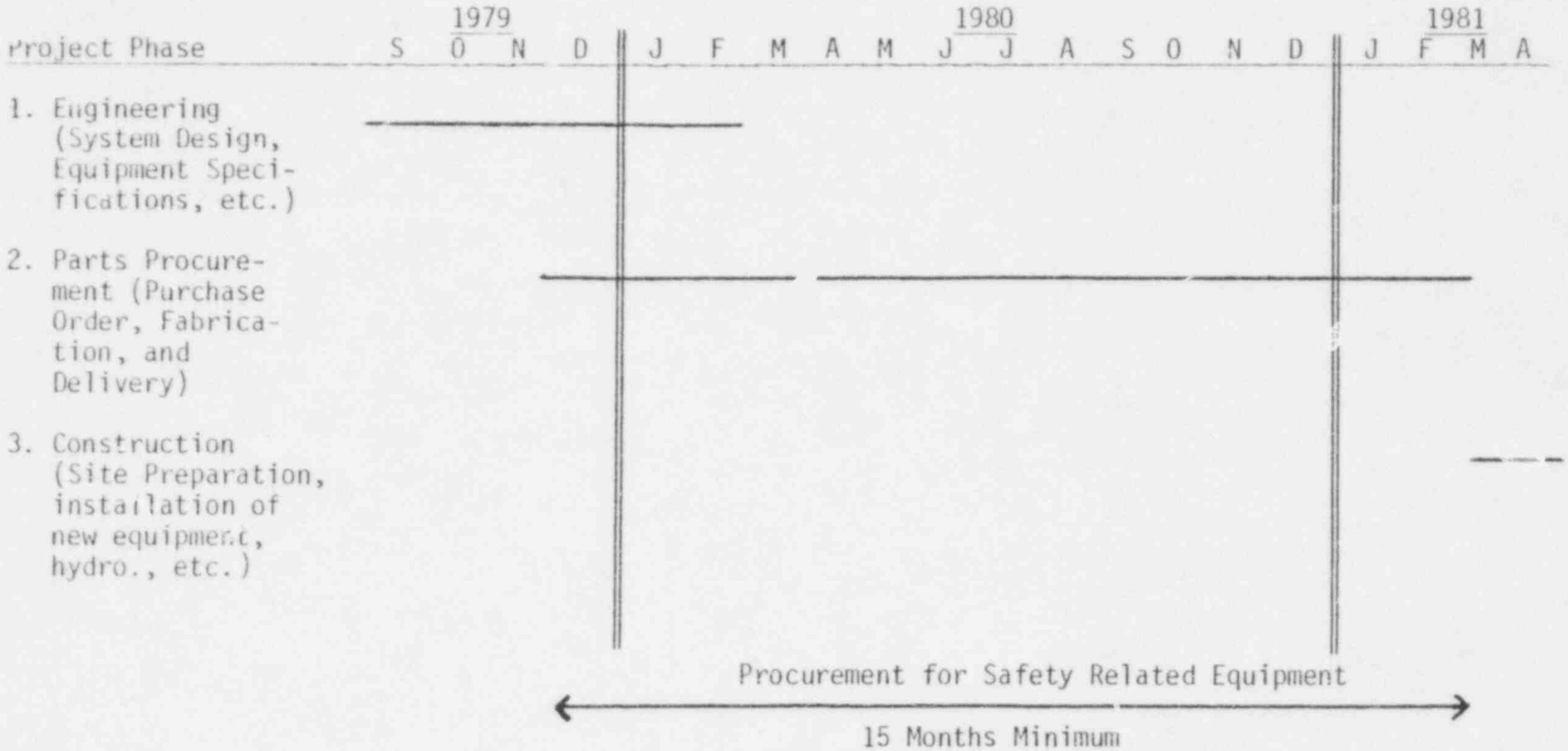
ENCLOSURE (2)

MODIFICATION SCHEDULE FOR
LONG TERM COOLING (BORON PRECIPITATION)



NOTE: Every effort will be made to procure and install the necessary equipment during the 1981 refueling outage, scheduled in March, 1981. Otherwise, modifications will be performed during the 1982 refueling outage.

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