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ILLINOIS POWER COMPANY

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CLINTON POWER STATION, P.O. BOX 678, CLINTON, ILLINOIS 61727

May 25, 1984

Docket No. 50-461

Director of Nuclear Reactor Regulation
Attention: Mr. A. Schwencer, Chief
Licensing Branch No. 2
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Subject: Clinton Power Station Unit 1
SER Confirmatory Issue No. 71
Humphrey Concerns

Dear Mr. Schwencer:

Illinois Power Company letter dated June 17, 1983 (refer U-0644) addressed some of the John Humphrey concerns as applicable to the Clinton Power Station (CPS). Enclosed are CPS responses on some additional Humphrey issues for NRC Staff review. Included are Action Plans #5, 6, 8, 21 and revised responses to Action Plans #2 and 3. We believe that these responses will resolve the particular concern involved.

If there are any questions regarding this material, please contact me or J. H. Shepard at (217) 424-6785.

Sincerely yours,

Daniel I. Herborn

Daniel I. Herborn
Director - Nuclear Licensing
and Configuration
Nuclear Station Engineering

Attachments

GEW/lam
GEW15/M2

cc: G. A. Harrison, NRC Clinton Licensing Project Manager
L. C. Ruth, NRC CSB
NRC Resident Office
Illinois Department of Nuclear Safety

B001
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Action Plan 2 (Revised)

1.3 Additional submerged structure loads may be applied to submerged structures near local encroachments.

1.4 Piping impact loads may be revised as a result of higher pool swell velocity.

Response

A new SOLAV01 analysis was performed for Clinton in response to a design change to the encroachment of the CPS suppression pool. The design change consisted of increasing the 5.5 foot encroachments in the suppression pool to 8.5 feet. The encroachment was increased by replacing the existing grating with steel plate (see response to Action Plan 3). The SOLAV01 analysis was reperformed using FSAR pressure histories.

The loads on the submerged structures in encroached regions of the suppression pool during pool swell have been evaluated and compared to identical structures and locations using GESSAR II design loads. The GESSAR II design loads bound all the encroached submerged structures except for the hydrogen compressor sparger which has a calculated load of 718 lb/ft. The structure has sufficient margin in the design to withstand the pool swell load.

The effect on the Clinton boundary loads have been reanalyzed for the design change to the CPS encroachment. The analysis shows that CPS vent air clearing boundary loads under the encroachment do not exceed the design base loads.

The SOLAV01 analysis results show that pool swell in the encroached regions of the pool will result in froth and water impact on pipes above the suppression pool. The piping above the encroached region of the pool was identified by a review of the design drawings. Five piping subsystems were identified in that review to be the "worst case", based on an assessment of pipes having significant horizontal runs or are not presently shielded from the pool swell loads. These subsystems were evaluated for the pool swell loads and results reveal that the piping is adequately designed for the froth/water impact.

Action Plan 3 (Revised)

1.5 Impact loads on the HCU floor may be imparted and the HCU modules may fail which could prevent successful scram if the bubble breakthrough height is raised appreciably by local encroachments.

Response

A new SOLAV01 analysis was performed in response to a design change to the encroachment of the CPS suppression pool. The encroachment was increased by replacing the existing grating with 1¼" steel plate, as shown in Figures 3-1 and 3-2. The plate extension has the effect of diverting the water toward the outer portion of the containment, which prevents water slug impact on the HCU floor. Loads for various structural members of the HCU floor over the equipment and personnel hatches were calculated using FSAR pressure histories.

Figures 3-1 and 3-2 show the plate modification which extends three feet radially beyond the equipment hatch and personnel hatch, respectively. SOLAV01 predicts the worst-case pool swell to occur at the midpoint of the circumferential cross section of the encroachment that is the furthest from the clean pool.

GE's containment response model was run for Clinton's new pool geometry using FSAR input assumptions to determine the drywell and wetwell pressure time histories (see Figure 3-7). The small decrease in open pool area has a negligible effect on the bulk pressure response.

The initial bubble pressure under the modeled encroachment is equal to the bubble pressure determined for the SOLAV01 case that assumes the encroachment covers a 360° arc. This bubble pressure is used until coalescence occurs circumferentially. The 360° encroached bubble pressure is ramped down to a new equilibrium pressure in the time that it takes for an acoustic wave to make two round trips between the encroached bubble and the clean case bubble using an acoustic speed of 1100 ft/sec. The new equilibrium pressure was taken to be the bubble pressure under a theoretical 360° average encroachment case such that the total surface area of the encroachments is maintained. The average encroachment was calculated to be a 4.4-foot 360° encroachment as seen in Figure 3-3. At the time that the clean pool experiences breakthrough (the time at which the water slug thins to 2.5 feet) the bubble pressure is ramped down to the wetwell airspace pressure and remains there for the duration of the transient.

Figure 3-4 shows the resultant SOLAVO1 mesh for the 5.5 foot encroachment plus 3-foot extension case. Figure 3-5 shows the resultant bubble pressure time history.

The analysis indicates that liquid impact does not occur on the concrete portion of the HCU floor and steam tunnel. Figure 3-6 shows how the bubble and pool surfaces grow.

The pool swell velocity results generated by SOLAVO1 were used to calculate impact loads on the radial and circumferential HCU floor beams using the equation:

$$P\ max = \frac{2\ I}{144\tau}$$

where

P max = peak pressure (psi)
I = impulse per unit area ($lbf\text{-}sec/ft^2$)
τ = impulse duration (sec)

The Mark II method was used to determine the values for I and τ with the exception of the radial beams. The duration of the impact load for these beams was found by calculating the "sweep' time. The "sweep" time is defined as the difference in time when the beam is first impacted and when the last impact occurs.

Drag loads were calculated by using the peak impact velocity and the drag coefficient, C_D =2.0, in Darcy's equation. The durations of the drag loads were assumed to be equal to the time it takes the impacting surface to decelerate with gravity to zero.

Grating does not experience an impact load (reference 1). The drag load experienced by the grating above the HCU floor beams is bounded by the design grating drag loads.

Since there is no encroachment beneath the main steam tunnel and since Figure 3-8 (Clinton FSAR Base Case Pool Simulation) shows breakthrough at 14.5 feet above the initial pool surface, the original GESSAR II impact loads still apply.

The HCU floor beams were analyzed for the developed water impact and drag loads. A dynamic analysis showed that the loads due to water slug impact are bounded by the froth impact design loads. Resultant stresses in the radial beams were calculated to be 15% of the allowable. Resultant stresses in the concrete portion of the HCU floor were calculated to be 22% of the allowable.

In conclusion, the loads as the result of pool swell around the extended encroachment are bounded by design basis loads.

References: GESSAR II, Appendix 3B.10.1,
GE Report No. 22A7007, Rev. 0, 1982

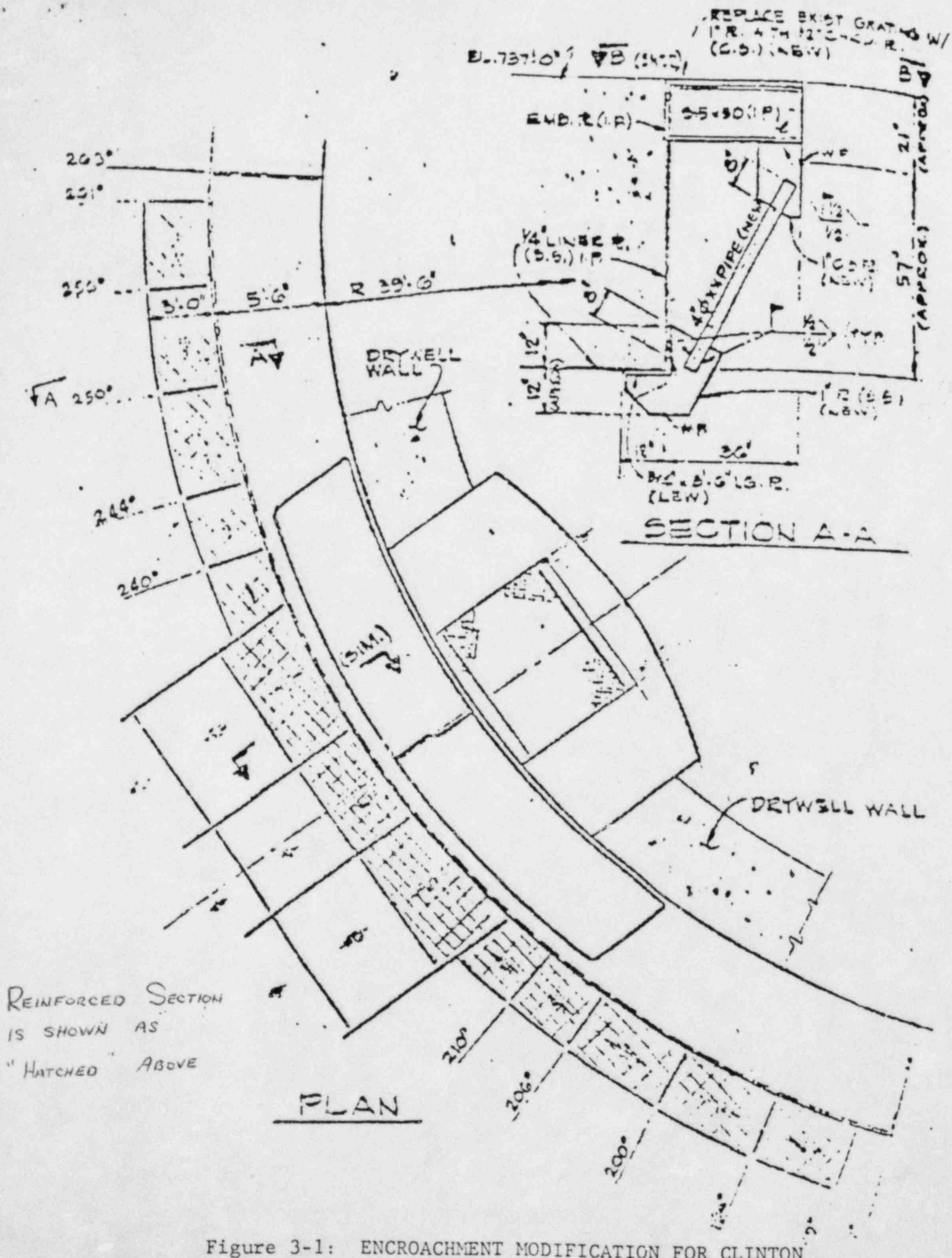

Figure 3-1: ENCROACHMENT MODIFICATION FOR CLINTON

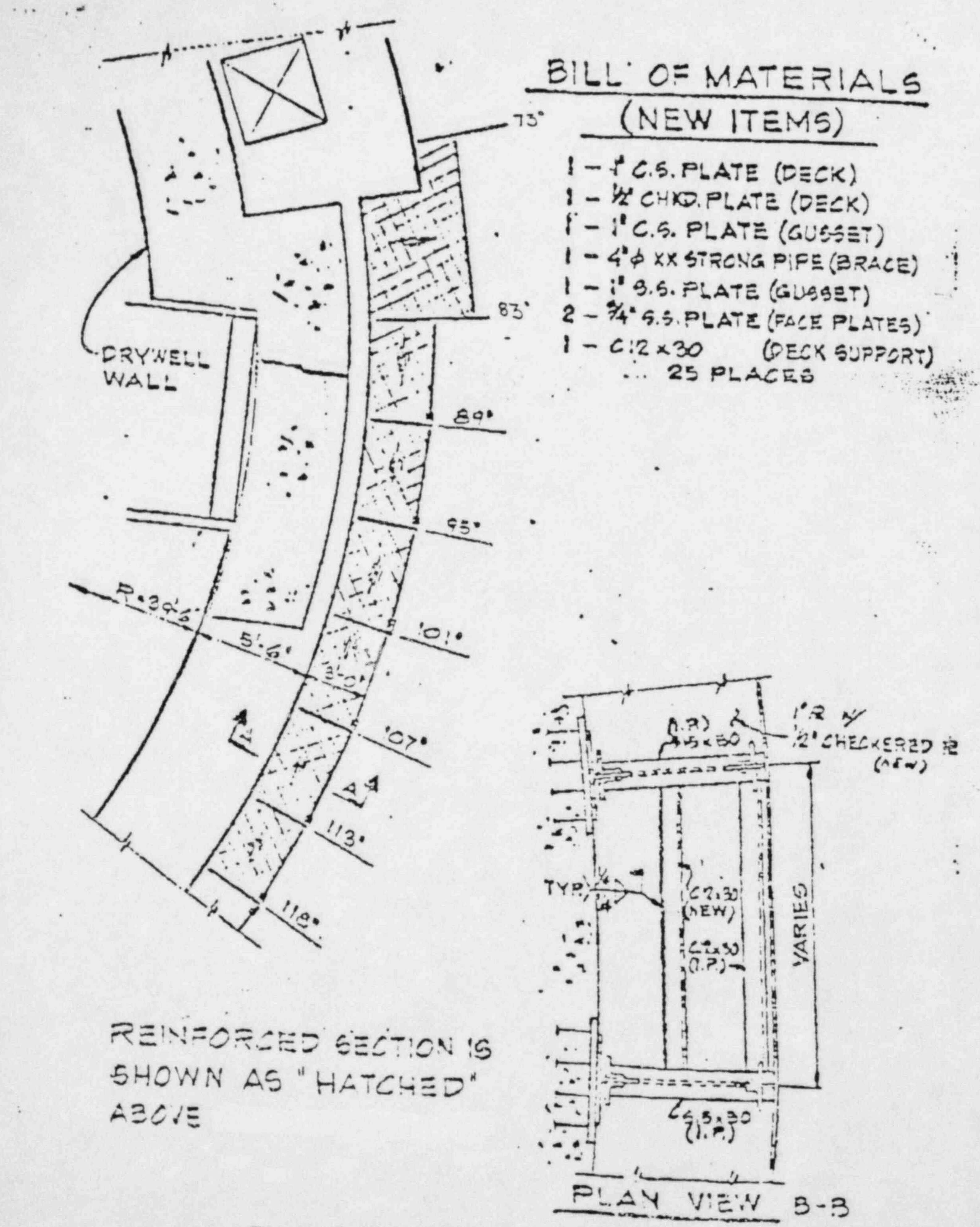

Figure 3-2: ENCROACHMENT MODIFICATION FOR CLINTON

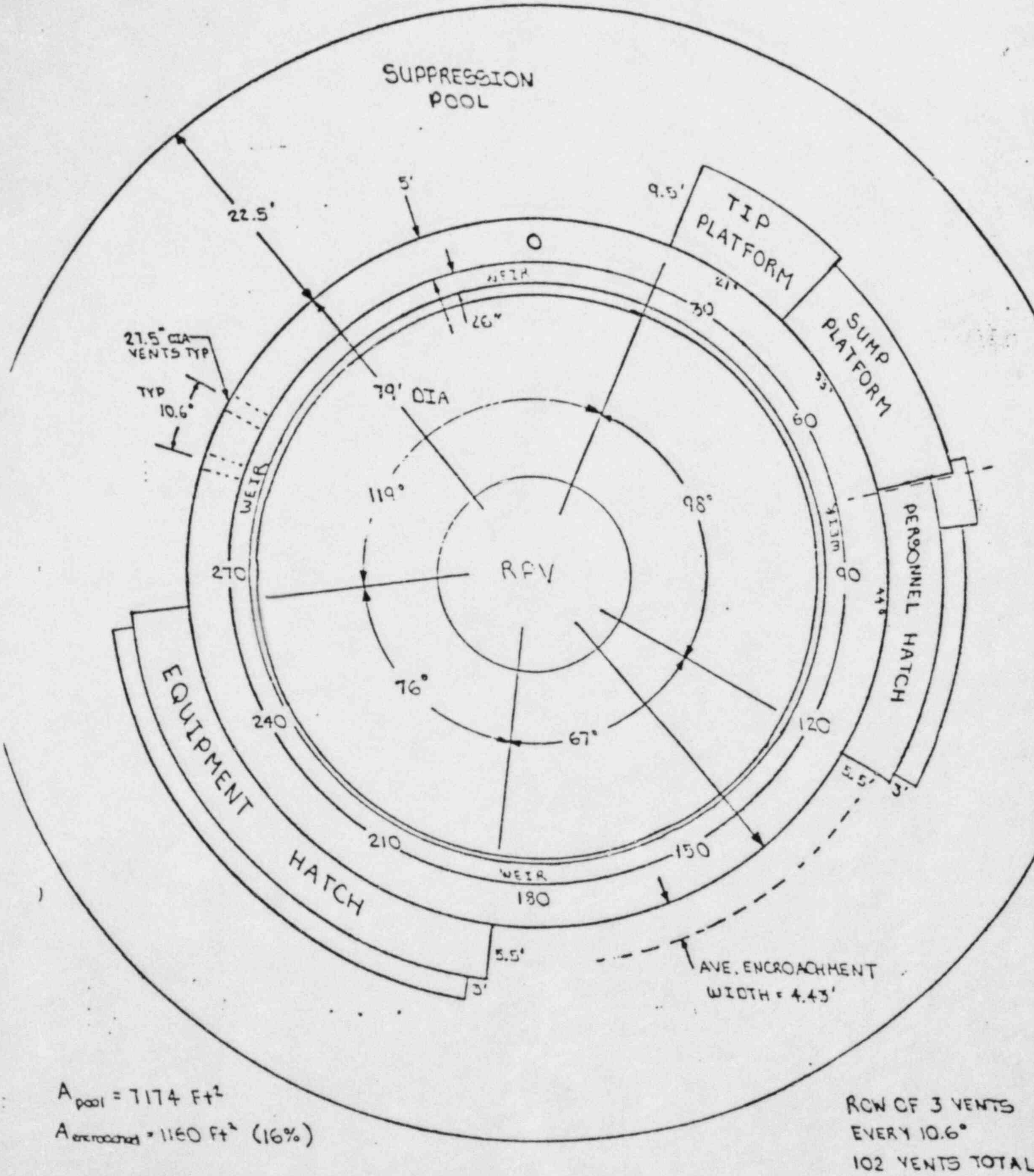

Figure 3-3: CLINTON MODIFIED SUPPRESSION POOL GEOMETRY

TOP VIEW

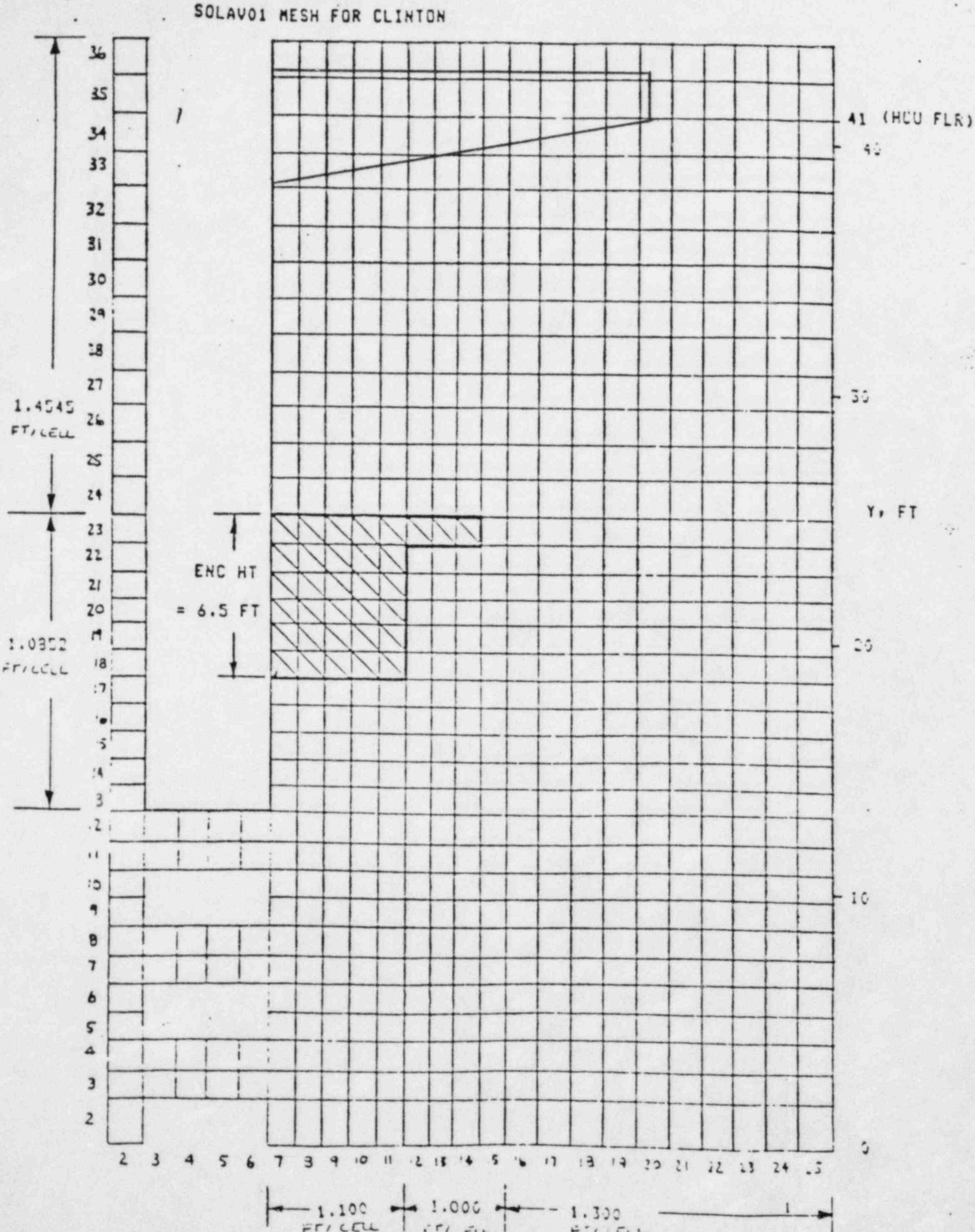

Figure 3-4: CLINTON SUPPRESSION POOL SOLAV01 MESH

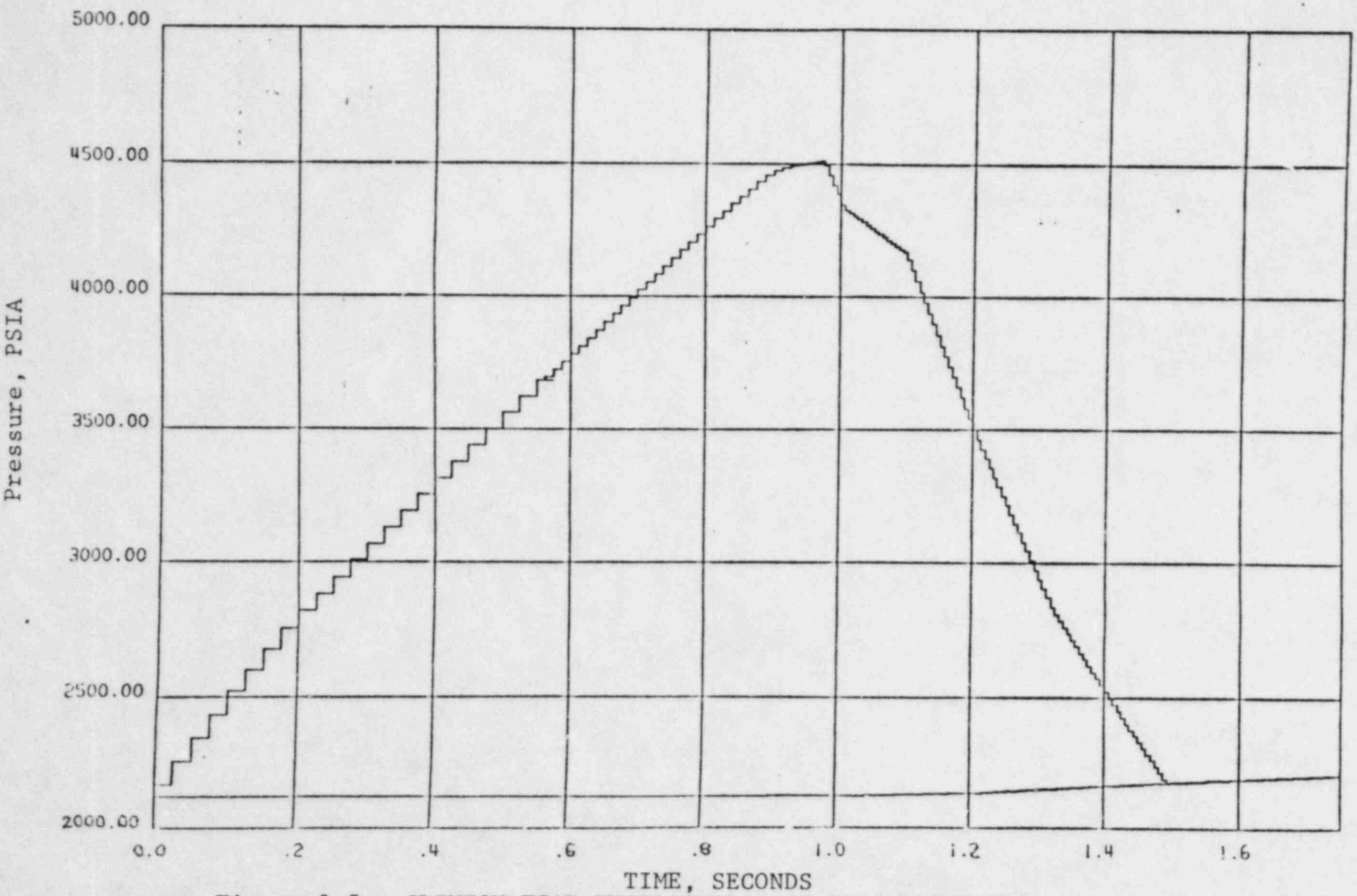

Figure 3-5: CLINTON FSAR ENCROACHED CASE PRESSURE HISTORIES, Personnel Hatch with Plate Extension

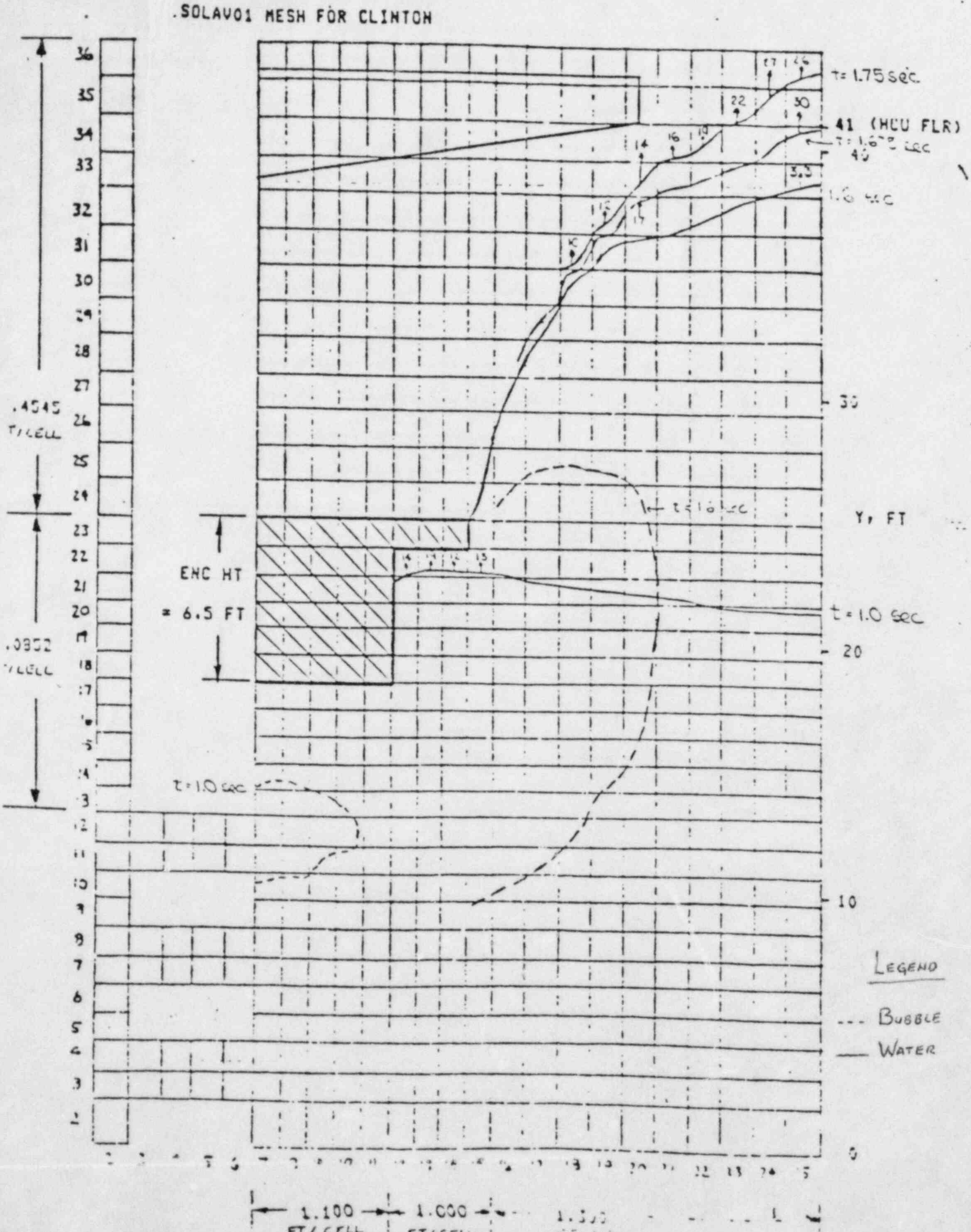

Figure 3-6: CLINTON FSAR ENCROACHED CASE POOL SIMULATION, PERSONNEL HATCH WITH PLATE EXTENSION

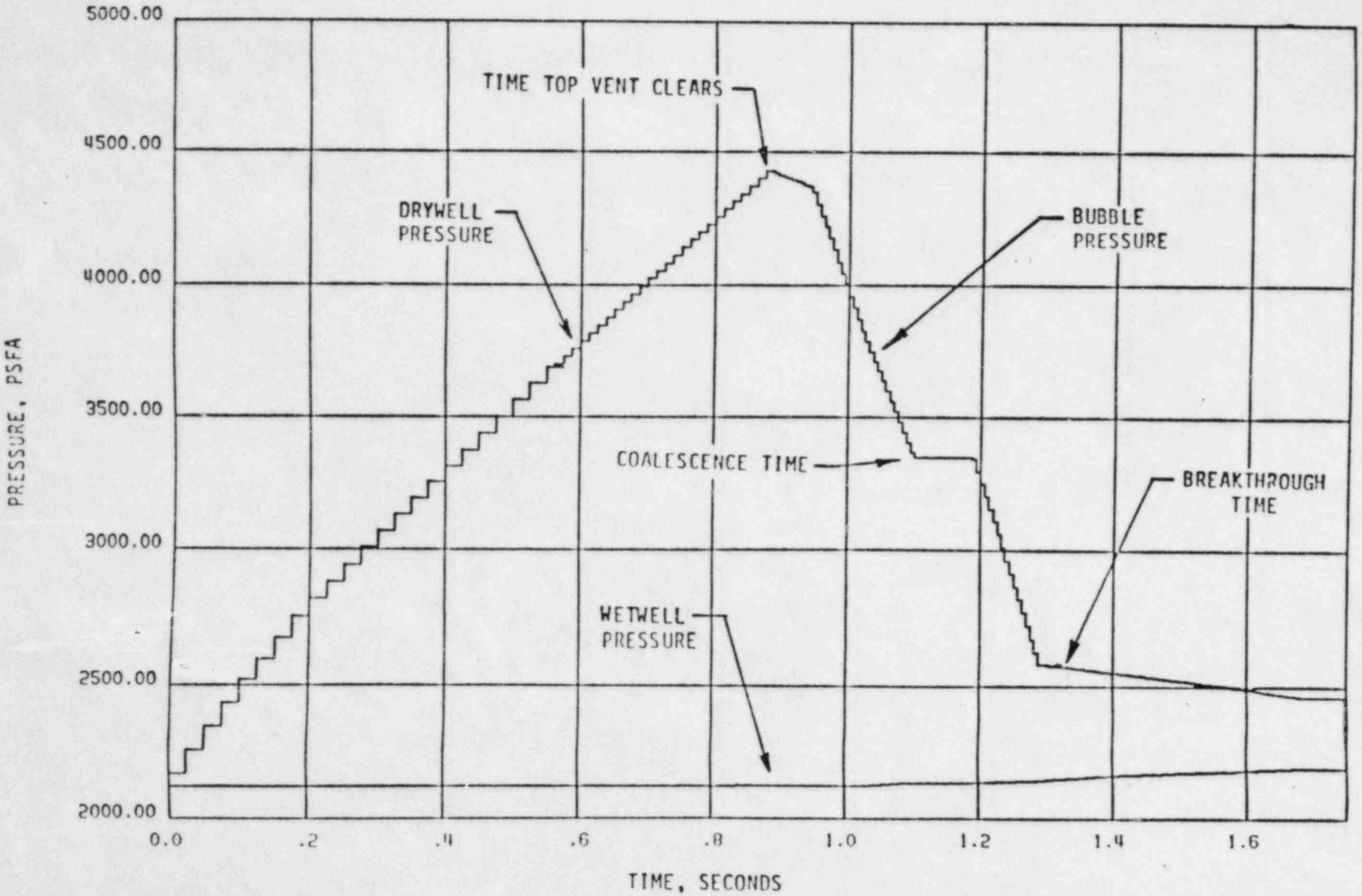

Figure 3-7: CLINTON FSAR BASE CASE PRESSURE HISTORIES

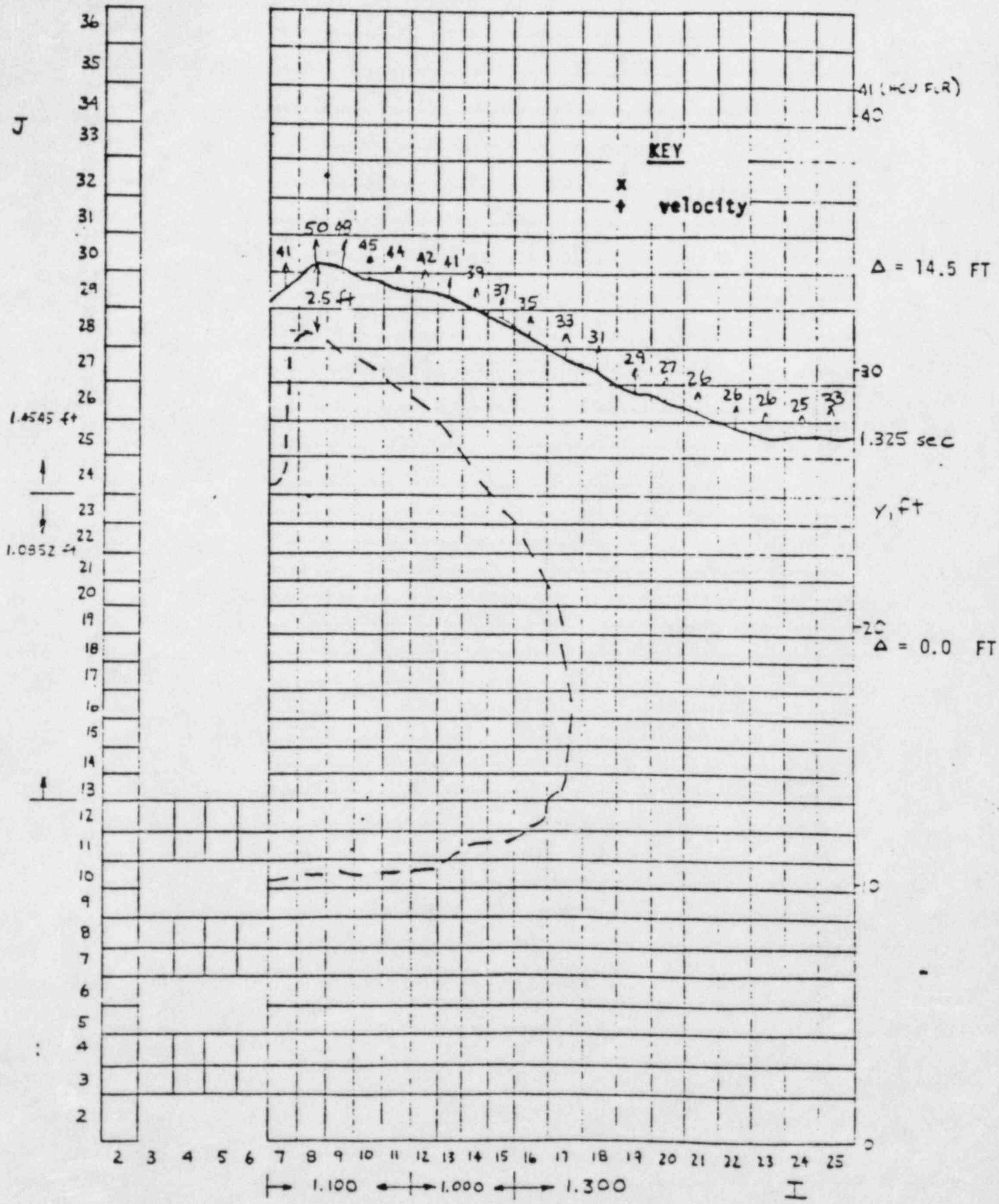

Figure 3-8: CLINTON FSAR BASE CASE POOL SIMULATION

Action Plan 5

2.1 The annular regions between the safety relief valve lines and the drywell wall penetration sleeves may produce condensation oscillation (CO) frequencies near the drywell and containment wall structural resonance frequencies.

2.2 The potential CO and chugging loads produced through the annular area between the SRVDL and sleeve may apply unaccounted-for loads to the SRVDL. Since the SRVDL is unsupported from the quencher to the inside of the drywell wall, this may result in failure of the line.

2.3 The potential CO and chugging loads produced through the annular area between the SRVDL and sleeve may apply unaccounted-for loads to the penetration sleeve. The loads may also be at or near the natural frequency of the sleeve.

Response

The program for resolution to close this issue at Clinton is as follows:

5.1 The existing condensation data will be reviewed to verify that no significant frequency shifts occurred. The data will also be reviewed to confirm that the amplitudes were not closely related to acoustic effects.

5.2 The driving conditions for CO at the SRVDL exit will be calculated. Based on these calculations, existing test data will be used to estimate the frequency and bounding pressure amplitude of CO at the SRVDL annulus exit.

5.3 A wide difference between the CO frequency and structural resonances will be demonstrated. The margin between the new loads and existing loads will be quantified.

5.4 Provide a detailed description of all hydrodynamic and thermal loads that are imposed on the SRVDL and the SRVDL sleeve during LOCA blowdowns.

5.5 Assure that thermal loads created by steam flow through the annulus have been accounted for in the design.

5.6 State the external pressure loads which the portion of the SRVDL enclosed by the sleeve can withstand.

5.7 Calculate the maximum lateral loads which could be applied to the sleeve by phenomena analogous to the Mark I and Mark II downcomer lateral loads.

Items 5.1 and 5.2 have been completed. Results were submitted in letter from L. F. Dale, MP&L, to H. R. Denton, NRC, Reference #AECM-82/574, dated December 3, 1982. These results are applicable to Clinton.

Item 5.3, a sleeve CO pressure time history was constructed for Clinton. This Clinton specific pressure time history assumed the hydraulic diameter of the sleeve annulus was the appropriate parameter for scaling this load from the main vent to load definition. The Containment Issues Review Panel (CIRP) contended that for scaling the CO load the appropriate parameter should have been the penetration sleeve diameter. The Clinton specific analysis considers the more severe load magnitude and a frequency range of 5.5 to 56 Hz.

The SRVDL sleeve CO load described induces additional stresses in all of the submerged structures in the Clinton suppression pool. The additional stresses induced by the consideration of SRVDL sleeve CO are within the capability of these submerged structures.

In response to 5.4 a detailed description of the hydrodynamic and thermal loads included in the design basis of the SRVDL piping and the SRVDL sleeve during LOCA blowdown is given below.

SRVDL Piping

a. Hydrodynamic Loads

1) Dynamic response due to SRV (single valve, all valves and ADS actuation
2) Horizontal Vent Chugging/Condensation Oscillation
3) Drywell Negative Pressure
4) Drag Loads due to Quencher Air Clearing
5) Steam Hammer due to Fast Valve Opening/Closing
6) Main Vent Air Clearing
7) Impact, Drag, and Fallback Loads due to Pool Swell

8) SRVDL Sleeve Water Jet Load
9) SRVDL Sleeve Annuli Chugging/Condensation Oscillation
10) SRVDL Sleeve Lateral Loads

b. Thermal Loads

Thermal loads on piping based upon the maximum steam temperature in the MSRV line.

SRVDL Sleeve

a. Hydrodynamic Loads

1) Dynamic response due to SRV (single valve, all valves), ADS Actuation
2) Horizontal Vent Chugging/Condensation Oscillation
3) Drag Loads due to Quencher Air Clearing
4) Seismic Pool Slosh
5) Vent Air Clearing
6) Impact, Drag, and Fallback Loads due to Pool Swell
7) SRVDL Sleeve Annuli Chugging/Condensation Oscillation
8) SRVDL Sleeve Lateral Loads

b. Thermal Design

Thermal stresses based on steam flow through the annulus or accident condition have been accounted for.

Item 5.5, external drag loads due to the sleeve CO have been generated for the DBA condition. Evaluation of this new sleeve CO drag loads and the thermal loads created by steam flow has been performed. Results showed that both the SRVDL and the penetration sleeve have sufficient margin in the design to accomplish the new loads.

External drag loads due to sleeve CO were assessed for the non-MSRV structures in the suppression pool by reviewing the submerged piping stress report. Results showed sufficient margin to accommodate this new load.

Item 5.6, the maximum allowable external pressure load which the safety relief valve discharge lines (SRVDL) can withstand in the region enclosed by the drywell wall penetration sleeve is 500 psi (per ASME Code Section III, ND 3133.8). The maximum external pressure load these pipes may be subject to is the lateral load described in Item 5.7. The maximum lateral load on an SRVDL is conservatively calculated to be 217 psi.

In response to 5.7 the maximum lateral load which would be applied to the Clinton SRVDL s and sleeves based upon General Electric's response to the CIRP Question 5.7.1 is 28 Kips. The resultant loading is defined to be:

$$F = 28000 \sin \left(\frac{\pi t}{.003}\right) \text{ lbf};\ 0 < t < .003 \text{ sec}$$

Results of assessments which applied this load to the SRVDL as a uniformly distributed force over 1 to 4 feet from the vent end, show sufficient margin in the SRVDL design to accommodate this additional load. The SRVDL sleeve can also accommodate this load when similarly applied.

Action Plan 6

3.1 The design of the STRIDE plant did not consider vent clearing, condensation oscillation and chugging loads which might be produced by the actuation of the RHR heat exchanger relief valves.

3.3 Discharge from the RHR relief valves may produce bubble discharge or other submerged structure loads on equipment in the suppression pool.

3.7 The concerns related to the RHR heat exchanger relief valve discharge lines should also be addressed for all relief lines that exhaust into the pool.

Response

The following items have been evaluated to address the above issues:

6.1 The vent clearing loads associated with actuation of the RHR relief valves will be calculated. The water jet loads will also be calculated. The dynamic loads associated with relief valve operation will be recalculated to evaluate relief valve discharge line design.

The following information will be submitted for all relief valves which discharge to the suppression pool.

6.2 Isometric drawings and P&ID s showing line and vacuum breaker location will be provided. This information will include the following: The geometry (diameter, routing, height above the suppression pool, etc.) of the pipe line from immediately downstream of the relief valve up to the line exit. The maximum and minimum expected submergence of the discharge line exit below the pool surface will be included. Also, any lines equipped with load mitigating devices (e.g., spargers, quenchers) will be noted.

6.3 The range of flow rates and character of fluid (i.e., air, water, steam) which is discharged through the line and the plant conditions (e.g., pool temperatures) when discharges occur will be defined.

6.4 The sizing and performance characteristics (including make, model, size, opening characteristics and flow characteristics) of any vacuum breakers provided for relief valve discharge lines will be noted.

6.5 The potential for oscillatory operation of the relief valves in any given discharge line will be discussed.

6.6 The potential for failure of any relief valve to reseat following initial or subsequent opening will be evaluated.

6.7 The location of all components and piping in the vicinity of the discharge line exit and the design bases will be provided.

Item 6.1

The RHR/SRV air clearing loads have been calculated based upon failure of the pressure control valve (PCV) during either a steam condensing mode (SCM) start-up or a normal steady SCM of operation. The air clearing loads are conservatively based upon the maximum RHR/SRV flow rate, a maximum water reflood height of 12.95 ft. and Clinton unique vacuum breaker and discharge line characteristics.

These subsequent actuation air clearing loads on the CPS suppression pool boundary have been generated in a manner consistent with the main steam SRV boundary load definition. The maximum predicted RHR/SRV bubble pressure on the suppression pool boundary (containment wall) was calculated to be 54.9 psid. The effect of this load has been assessed and found to be within the design basis.

The effect of a RHR/SRV subsequent actuation air clearing load on the RHR relief line's supports has been assessed. The resulting stresses are within the design basis for these structures. All RHR/SRV air clearing loads act symmetrically on the RHR relief line, therefore self loading was not considered.

Water jet loads resulting from the actuation of the RHR/SRV do not impact any submerged structure in the Clinton suppression pool and are therefore were not considered.

The Mark II lateral load on 24-inch downcomers of 65 Kips, which has a non-exceedance probability of 10^{-5} (see NUREG-0808), has been scaled to account for lateral loads on the smaller RHR safety relief valve lines. The resulting definition for the lateral load on the RHR heat exchanger relief line used by GE is:

$$F = 32500 \sin \left(\frac{\pi t}{0.003}\right) lb_f \quad 0 \leq t \leq 0.003 \text{ sec}$$

This load was uniformly distributed along the final 1 to 4 feet of the RHR relief line. The effect of this load has been assessed and found to be within the design basis.

Items 6.2, 6.3, and 6.4

Lines discharging into or taking suction from the CPS suppression pool are described in Table 6.1. The flow rates and character of the fluid (air, steam, water, etc.) which is discharged through these lines and the plant conditions (fluid discharge temperature) when discharging occurs are described. The characteristic of vacuum breaker used on the CPS discharge line are also described in Table 6.2. Isometric drawings and P&ID s showing line and vacuum breaker location are listed in Table 6.3.

Item 6.5

The RHR heat exchanger relief valves, E12F055A and B, could experience oscillatory action due to undefined cyclic behavior of the steam pressure reducing valves E12F051A and B, which are air operated solenoid valves that fail close. The time for these pressure reducing valves to reach full open is 16 seconds, thus any postulated oscillation of the relief valves would be slow.

Item 6.6

In this scenario, it is postulated that the RHR/SRV fails open due to a mechanical failure during steady SCM operation. The PCV will open and try to maintain the RHR pressure at 200 psig. Assuming substantial steam condensation in the RHR, the PCV will not be able to maintain the RHR pressure at 200 psig. The RHR pressure will drop to a new steady-state value such that the steam flow into the RHR through the PCV is equal to the sum of the steam condensation rate and the steam flow through the failed open SRV. The flow rate through the failed open RHR/SRV is below the flow conditions at the 500 psig setpoint.

Item 6.7

All submerged structures in the CPS suppression pool were assessed for the effects of the RHR/SRV air clearing loads. Only nine non-MSRV lines and supports were found to be subject to RHR/SRV air clearing loads which are more severe than the MSRV air clearing loads to which they were designed. Results indicate that there is no need for design changes based upon present load combinations even when the RHR/SRV subsequent actuation air clearing load is incorporated.

TABLE 6.1

ECCS RELIEF/VALVE LINE DISCHARGES TO SUPPRESSION POOL - DESIGN CONDITIONS

Line Description	System Valve No.	Line, Size	Capacity	Set Pressure (psig)	Size, Model & Make	Pool Submergence	Fluid Chara.	Operating Mode & R/V Inlet Temp.	Drawing	Function
RCIC	1E51F090	1RI24C2"	69 gpm	1478	Dresser 3/4-1975-3 (3-1-1-2)-XFA50-NC 3007 Size: 3/4x1(in.)	726'-11"	water	170°F	M05-1079, sht. 2	Return to RCIC Tank
RCIC Turbine Exhaust	-	1RI08B12"**	3.9×10^4 lbm/hr	-	-	723'-2-1/8"	steam	Steam Condensing 240°F	M05-1079, sht. 1	Turbine Exhaust (Sparger)
LPCS	1E21F018	1LP21B4"	164.1 gpm	554	Dresser-1-1/2-1970 -2(3-1-3-2)-XFA19-NC3007 Size:1½"x2"	726'-11"	water	Accident Conditions	M05-1073	LPCS Pump Disc. R/V
	1E21F031	1LP21B4"	30 gpm	100	Dresser-1-1970 -2(3-1-1-2) XFA31-NC3007 Size:1"x1½"	726'-11"	water	Sys. Standby Duty 200°F	M05-1073	LPCS Jockey Pump Suc. R/V
RHR	1E12F025A	1RH41CA1½"*	65.8 gpm	477	Dresser-1-1970 -2(3-1-1-2)-XFA32-NC3007 Size:1½"x1"	726'-11"	water	LPCI 170°F	M05-1075, sht. 1	RHR Pump A Dis. R/V
	1E12F025B	1RH41BB1½"*	66.4 gpm	484	Dresser-1-1970 -2(3-1-1-2)-XFA32-NC3007 Size:1½"x2"	726'-11"	water	LPCI 170°F	M05-1075, sht. 2	RHR Pump B Dis. R/V
	1E12F025C	1RH41CC1½"*	66.4 gpm	484	Dresser-1-1970 -2(3-1-1-2)-XFA32-NC3007 Size:1½"x1"	726'-11"	water	LPCI 170°F	M05-1075, sht. 3	RHR Pump C Dis. R/V

TABLE 6.1 (Cont'd)

ECCS RELIEF/VALVE LINE DISCHARGE TO SUPPRESSION POOL - DESIGN CONDITIONS

Line Description	System Valve No.	Line, Size	Capacity	Set Pressure (psig)	Size, Model & Make	Pool Submergence	Fluid Chara.	Operating Mode & R/V Inlet Temp.	Drawing	Function
RHR	1E12F017A	1RH17CA1½"*	43 gpm	200	Dresser-1-1970 -2(3-1-1-2)-XFA32-NC3007 Size:1½"x1"	726'-11"	water	Sys. Standby Duty 90°F	M05-1075, Sht. 1	RHR Jockey Pump A Suc. R/V
	1E12F017B	1RH17BB1½"*	43 gpm	200	Dresser-1-1970 -2(3-1-1-2)-XFA32-NC3007 Size:1½"x2"	726'-11"	water	Sys. Standby Duty 90°F	M05-1075, Sht. 2	RHR Jockey Pump B Suc. R/V
RHR	1E12F055A	1RH30CA12"*	$5.6x10^5$ lbm/hr	500	Crosby DS-C-64339 Size:12"x8"	726'-11"	Steam	Steam Condensing 480°F	M05-1075, Sht. 4	RHR H.Xch. A R/V
	1E12F055B	1RH30CB12"*	$5x6x10^5$ lbm/hr	500	Crosby DS-C-64339 Size:12"x8"	726'-11"	Steam	Steam Condensing 480°F	M05-1075, Sht. 4	RHR H.Xch. B R/V
RHR	1E12F101	1RH17CC1½"	30 gpm	100	Dresser-1-1970 -2(3-1-1-2)-XFA31-NC3007 Size:1½"x1"	726'-11"	water	200°F	M05-1075, Sht. 3	RHR Pump C Suction
RHR	1E12F005	1RH12C1½"*	40.5 gpm	200	Dresser-1-1970 -2(3-1-1-2)-XFA32-NC3007 Size:1½"x1"	726'-11"	water	Shutdown Cooling 358°F	M05-1075, Sht. 1	RHR Shutdown Suc. R/V Disc.
RHR	1E12F036	1RH28B6"*	374.4 gpm	75	Dresser-4-1910L -1(1-1-3-2)-XNC3007 Size:6"x4"	726'-11"	water	Steam Condensing 140°F	M05-1075, Sht. 4	Condensate to RCIC Pump Suction
RHR	1E12F030	1RH56B1½"	42.7 gpm	197	Dresser-1-1970 -2(3-1-1-2)-XFA32-NC3007 Size:1½"x2"	726'-11"	water	200°F	M05-1075, Sht. 2	Flush to Radwaste
RHR	None	1RH39C14"	-		-	726'-11"	-	-	M05-1075, Sht. 3	-

TABLE 6.1 (Cont'd)

ECCS RELIEF/VALVE LINE DISCHARGES TO SUPPRESSION POOL - DESIGN CONDITIONS

Line Description	System Valve No.	Line, Size	Capacity	Set Pressure (psig)	Size, Model & Make	Pool Submergence	Fluid Chara.	Operating Mode & R/V Inlet Temp.	Drawing	Function
HPCS	1E22F014	1HP18C12"*	15 gpm	100	Dresser-3/4-1975 -3(1-1-2)-XFA49-NC3007 Size:3/4"x1"	726'-11"	water	Sys. Standby Duty 90°F	M05-1074, Sht. 1	HPCS Jockey Pump Suc. R/V
HPCS	1E22F039	1HP18C12"	66 gpm	1560	Dresser-3/4-1975 -3(3-1-1-2)-XFA50-NC3007 Size:3/4"x1"	726'-11"			M05-1974, Sht. 1	
HPCS	1E22F035	1HP18C12"*	66 gpm	1560	Dresser-3/4-1970 -2(3-1-1-2)-XFA55-NC3007 Size:3/4"x1"	726'-11"	water	Accident Conditions 170°F	M05-1074, Sht. 1	HPCS Pump Disc. R/V
HG	None	1HG05CB6"** @249° AZ Div II	N/A	N/A	N/A	723'-11"	air/steam >4 psid	N/A	M05-1063 M06-1063	H_2 Sparger
HG	None	1HG05CA6"** @69° AZ Div I	N/A	N/A	N/A	723'-11"	air/steam >4 psid	N/A	M06-1063 M05-1063	H_2 Sparger
SF	None	1SF02A12"	N/A	N/A	N/A	726'-11"	N/A	N/A	M05-1060	Suppression Pool Clean-up & Transf-
SF	None	1SF01F12"	N/A	N/A	N/A	720'-0" @66° AZ	N/A	N/A	M05-1060	Suppression Pool Clean-up & Transf-

* Discharge Line

** Discharge Line with Sparger

TABLE 6.2

VACUUM BREAKER DATA

RHR DISCHARGE LINES

VACUUM BREAKER RELIEF VALVES: 1E12F103A&B, 1E12F104A&B

MANUFACTURER: GPE CONTROLS

SIZE: 2" VACUUM RELIEF VALVE, 600# FLANGE W/OPERATOR

DISC AREA: 3.14 IN^2

FLOW AREA: 2.96 IN^2

FLOW COEFFICIENT - FULLY OPEN: $A/\sqrt{K} = 0.029ft^2$

SET PRESSURE: 0.2 PSID MINIMUM OPENING PRESSURE

RCIC DISCHARGE LINE

VACUUM BREAKER RELIEF VALVES: 1E51F079, 1E51F081

MANUFACTURER: GPE CONTROLS

SIZE: 2" VACUUM RELIEF VALVE, 600# FLANGE W/OPERATOR

DISC AREA: 3.14 IN^2

FLOW AREA: 2.96 IN^2

FLOW COEFFICIENT - FULLY OPEN: $A/\sqrt{K} = 0.029ft^2$

SET PRESSURE: 0.2 PSID MINIMUM OPENING PRESSURE

TABLE 6.3

MO5-1060	Sh. 1	Rev. K
MO5-1063	Sh. 1	Rev. F
MO6-1063	Sh. 1	Rev. S
MO6-1063	Sh. 3	Rev. R
MO5-1073	Sh. 1	Rev. M
MO5-1074	Sh. 1	Rev. K
MO5-1075	Sh. 1	Rev. L
MO5-1075	Sh. 2	Rev. L
MO5-1075	Sh. 3	Rev. K
MO5-1075	Sh. 4	Rev. J
MO6-1075	Sh. 4	Rev. V
MO6-1075	Sh. 10	Rev. AA
MO6-1075	Sh. 19	Rev. Y
MO6-1075	Sh. 20	Rev. V
MO6-1075	Sh. 23	Rev. Z
MO7-1075	Sh. 4	Rev. M
MO5-1079	Sh. 1	Rev. J
MO5-1079	Sh. 2	Rev. [illegible]
MO6-1079	Sh. 3	[illegible]

Action Plan 8

3.4 The RHR heat exchanger relief valve discharge lines are provided with vacuum breakers to prevent negative pressure in the lines when discharging steam is condensed in the pool. If the valves experience repeated actuation, the vacuum breaker sizing may not be adequate to prevent drawing slugs of water back through the discharge piping. These slugs of water may apply impact loads to the relief valve or be discharged back into the pool at the next relief valve actuation and apply impact loads to submerged structures.

3.5 The RHR relief valves must be capable of correctly functioning following an upper pool dump which may increase the suppression pool level as much as five feet creating higher back pressures on the relief valves.

Response

The following items have been evaluated to address the above issues:

8.1 A failure mode analysis on the pressure controller to establish all possible failure modes will be performed.

8.2 The system design will be reviewed to determine if subsequent valve operation is feasible.

8.3 Based on the results of Item 2, the appropriate loads will be determined. This will be the water jet and air bubble load created by a first actuation of the relief valve and either a second "pop" load based on subsequent actuation or condensation oscillation loads based on continuous venting.

8.4 The vacuum breaker performance will be quantified as applicable. This will include a calculation showing the maximum elevation to which water can be drawn into the RHR relief valve discharge line.

8.5 Analyses demonstrating that the heat exchangers are capable of withstanding an overpressure transient will be completed. RHR relief valves will be demonstrated to be capable of functioning following an upper pool dump.

Item 8.1

Possible failure scenarios for the RHR leading to steam flow through the RHR/SRV discharge line are described below.

Steam discharge through the RHR/SRV discharge line can only occur during the steam condensing mode (SCM). In this mode the RHR heat exchanger is used as a condenser to absorb the decay heat from the BWR during hot standby. The steam condensing mode may also be used for heat rejection in the post-LOCA period.

A schematic of the RHR in SCM is shown in Figure 8.1. The steam flow into the RHR heat exchanger is controlled by a pressure control valve (PCV) that is set to maintain a desired pressure in the RHR heat exchanger. The Clinton Power Station RHR system design does not have non-condensible bleed lines running between the RHR heat exchangers and the relief discharge lines. This fact makes the Clinton RHR system design different from both Perry and Grand Gulf designs. The only way that steam flow into the Clinton RHR relief discharge line can occur is through the safety relief valves (SRV) that are provided to prevent over-pressurization of the RHR heat exchangers. The various scenarios leading to steam flow through the discharge line are discussed below.

Summary

The worst water/air clearing loads are expected for Scenario 3 or 7 where the PCV fails open. The expected steam mass flux through the discharge pipe covers a wide range from less than 0.5 lbm/sec./sq. ft. to 198 lbm/sec./sq. ft. and backflow from the RHR heat exchanger line. Significant reflood of the discharge line is generally expected during conditions where steam mass flux is below 6 lbm/sec./sq. ft. Reflood is expected in these same scenarios and is addressed in the response to Action Plan 8.2 and 8.4.

Scenario 1 - Normal SCM Start-up

During normal SCM start-up there will be no steam mass flow through the discharge line into the suppression pool.

Scenario 2 - SRV Failure during SCM Start-up

During the SCM start-up it is postulated that the SRV fails open due to a mechanical failure. The PCV will open to maintain the pressure in the RHR heat exchanger at the 50 psig set pressure. The sudden opening of the SRV will cause the water and air to clear from the discharge line. Moderate water and air clearing loads are expected.

After the initial transient caused by the failed open SRV, equilibrium is rapidly established in the RHR system with the input steam flow through the PCV being balanced by the outflow through the fully open SRV. Note that no steam condensation occurs in the RHR heat exchanger because the tube sheet is covered with water during start-up. The resulting steam mass flux through the discharge line is expected to be between 8 and 16 lbm/sec./sq. ft. and rigorous chugging is expected at the exit of the discharge line.

Scenario 3 - PCV Failure During SCM Start-up

In this scenario it is postulated that a mechanical failure of the PCV (see Figure 8.1) occurs and it pops open as soon as the steam block valve from reactor is opened. The RHR heat exchanger will pressurize rapidly to the SRV set point. At this point, the SRV will open and discharge steam to the suppression pool through the discharge line.

Again during the SCM start-up, no condensation occurs in the RHR heat exchanger; therefore, all the steam flow through the failed-open PCV must flow out through the SRV discharge line. Sonic condensation is expected at the discharge line exit.

The maximum flow through the RHR/SRV at these conditions is only slightly greater than that through the failed-open PCV. Therefore, the SRV will cycle rapidly, a subsequent failure of the SRV must be considered. Failure of the SRV will only cause the pressure in the RHR heat exchanger to drop a little below the set point for the SRV. This is due to the RHR/SRV failing in the open position and slowly relieving the system pressure until equilibrium flow through both the PCV and SRV is achieved.

Scenario 4 - PCV and SRV Failure During SCM Start-up

The final scenario that can be postulated during SCM start-up is the one where there is a simultaneous failure of both the PCV and the SRV. Such double failure exceeds the single failure criteria. In any case, the water and air-clearing loads as well as the condensation loads for this scenario are bounded by the worst-case loads.

Scenario 5 - Normal Steady-State SCM

This is the same as "Scenario 1 - Normal SCM Start-up." Clinton's design does not allow for a bleed steam flow to the RHR/SRV discharge line.

Scenario 6 - SRV Failure During Steady SCM

In this scenario it is postulated that the SRV fails open due to a mechanical failure during steady SCM operation. The PCV will open and try to maintain the RHR heat exchanger pressure at 200 psig. Assuming substantial steam condensation in the RHR heat exchanger, the PCV will not be able to maintain the RHR heat exchanger pressure at 200 psig. The RHR heat exchanger pressure will drop to a new steady-state value such that the steam flow into the RHR system through the PCV is equal to the sum of the steam condensation rate and the steam flow through the failed-open SRV. The flow rate through the failed-open RHR/SRV is well below the flow conditions at the 500 psig set point.

Scenario 7 - PCV Failure During Steady SCM

When the PCV fails open, the RHR system pressure will rise. The increase in the RHR system pressure has the following consequences. First, the condensation rate in the RHR will increase (primarily due to the increased temperature difference between the steam and the tube surface). This will cause the water level in the RHR heat exchanger to rise which in turn will cause the level control valve to open as it attempts to keep the level in the RHR heat exchanger at the set point. However, this level control valve must also keep the pressure to the RCIC pump suction below 45 psig. Therefore, the level control valve will move to a position where it is able to maintain both the level in the RHR heat exchanger at the set point and maintain RCIC suction pressure below 45 psig. If this is not possible, the level control valve will maintain RCIC suction at or below 45 psig in which case the level in the RHR heat exchanger will increase.

It may not be possible to know whether the level control valve will be able to maintain RHR heat exchanger level following a failed-open PCV. Therefore, both of the above discussed possibilities were examined. The first case considered is where the level control valve is able to maintain the RHR heat exchanger level at the set point. At the time the PCV fails open, the condensation rate is the normal condensation rate for the steady SCM. The failed-open PCV will pass more flow than can be condensed by the RHR heat exchanger. Therefore, the RHR system pressure will increase. At some point in time the RHR system pressure will reach the set point for the SRV. The net flow through the SRV will be the difference between the flow through the failed-open PCV and the condensation rate. Since the SRV has a higher flow capability than the PCV, this implies that the SRV will cycle.

The second case considered is where the level control valve is unable to control the water level in the RHR heat exchanger. This condition results in the RHR heat exchanger water level rising and hence reduces the tube sheet area exposed to steam. It is estimated that the 3 to 4 ft. of exposed tube sheet during normal SCM operation will be covered between 1 and 5 minutes depending on the condensation rate assumed in the RHR heat exchanger. Once the tube sheet is completely covered the entire steam flow through the PCV is discharged via the SRV into the suppression pool at a high mass flux.

Therefore, in this scenario, the steam mass flux discharged into the pool can vary from a low value (if the RHR heat exchanger condensation rate is high) to a high value (corresponding to the PCV flow) if the tube sheet is covered.

Scenario 8 - SRV Leaking During Steady SCM

Steam leakage through the SRV when in the SCM results in a steam flow which gradually pressurizes the discharge line. The water and air normally in the line are forced out. While the time required to pressurize and clear the discharge line is dependent on the leakage rate through the SRV, the air and water clearing loads that could be generated by this scenario are bounded by the worst-case loads.

After the water and air have been cleared out of the discharge line, the leaking steam will start condensing in the suppression pool. Both condensation oscillation loads are expected to result depending on the steam leakage rate through the RHR/SRV and the steam condensation rate in the RHR relief line.

Scenario 9 - PCV and SRV Failure During Steady SCM

The final scenario that can be postulated during steady SCM operation is the one where there is a simultaneous failure of both the PCV and the SRV. Such a double failure exceeds the single failure criteria. In any case, the water and air clearing loads as well as the condensation loads for this scenario are bounded by the worst-case loads.

Items 8.2 and 8.4

The RHR heat exchanger relief valve discharge lines at Clinton may experience some reflooding due to the possibility of subsequent or cyclic actuations of the RHR/SRVs. (The RHR/SRV was sized larger than the upstream PCV). Reflood of the RHR system SRV discharge line following the plant normal first actuation of the RHR/SRV was calculated using the reflood prediction code RVRIZ02. The maximum amount of reflood for Clinton's RHR system occurs when the suppression pool temperature is low ($\sim 77^{o}F$). The reflood height predicted by RVRIZ02 is 12.95 ft. above the submerged end of the RHR/SRV discharge line. Since the vacuum breakers are located more than 15.33 ft. above the end of the RHR/SRV discharge line, reflood to the vacuum breakers is not expected after SRV actuation for normal plant design conditions.

Examination of reflood conditions based on scenarios involving an inadvertent upper pool dump, followed by a RHR system failure, resulting in actuation of the RHR safety relief valve, have not been considered. Such a double failure exceeds the single failure criteria.

Item 8.3

The subsequent actuation RHR/SRV loads described in Action Plans 6 and 8, were based upon a reflood height in the RHR/SRV discharge line of 12.95 ft. Air bubble loads based upon a first actuation of the RHR/SRV are smaller in magnitude than the RHR/SRV subsequent actuation air-clearing loads. Since both of these loads have approximately the same frequency, only the RHR/SRV subsequent actuation air-clearing loads on submerged structures and the suppression pool boundary were analyzed (see Action Plan 6).

Water jet loads resulting from actuation of the RHR/SRV do not impact any submerged structure in the Clinton suppression pool and are therefore were not considered.

Item 8.5

Inadvertent initiation of an upper pool dump for Clinton would require multiple, non-related single active failures in plant equipment or remote manual opening of one of the pool dump valves plus a single active failure in plant equipment (see CPS-FSAR Section 6.2.7.3.3).

Simultaneous signals indicating a low-low water level (LLWL) in the suppression pool and a loss-of-coolant accident (LOCA) are required for an automatic upper pool dump. Since an upper pool dump causes the suppression pool water level to increase two feet and the LLWL is two feet below the suppression pool normal/high water level (HWL), the effect of an automatic upper pool dump is simply to restore a normal/high water level in the suppression pool. Back pressures in the discharge line resulting from RHR/SRV actuation following an automatic upper pool dump are no worse than those occurring with the suppression pool at HWL.

Examination of scenarios involving an inadvertant pool dump, followed by a RHR system failure, resulting in actuation of the RHR safety relief valve, have not been considered. Such a double failure exceeds the single failure criteria.

A detailed discussion of the RHR heat exchanger peak pressure and overpressure allowables is not warranted. The maximum normal operating condition for the RHR heat exchanger in the SCM is 200 psig. The design basis for the RHR heat exchanger and the set point of the RHR/SRV are both 500 psig. Both shell and tube sides of the RHR heat exchanger have been hydrostatically tested to 750 psig (per ASME Section III requirements). This is adequate design margin in the RHR heat exchanger's construction.

Action Plan 21

5.5 Equipment may be exposed to local conditions which exceed environmental qualification envelope as a result of direct drywell-to-containment bypass leakage.

Response

An assessment was made to determine which equipment is located near any drywell penetration. The only equipment located near any drywell penetration is instrument panel 1H22-P011 located on elevation 778'0" in area 1 of the containment. A 3.5" Ø sleeve (conduit) designated for lighting/communications is located approximately 4 feet from the nearest instrument on this panel.

The construction of this penetration will be such that any leakage flow through the 5-foot thick concrete wall will be prevented from direct impingement on panel 1H22-P011. Any leakage would then rise as it entered the containment due to buoyancy. The qualification temperature for panel 1H22-P011 is 265°F, which is conservative enough to account for any local temperature increase due to bypass leakage.

Thus, instruments on panel 1H22-P011 will not be affected by this direct drywell-to-containment bypass leakage.

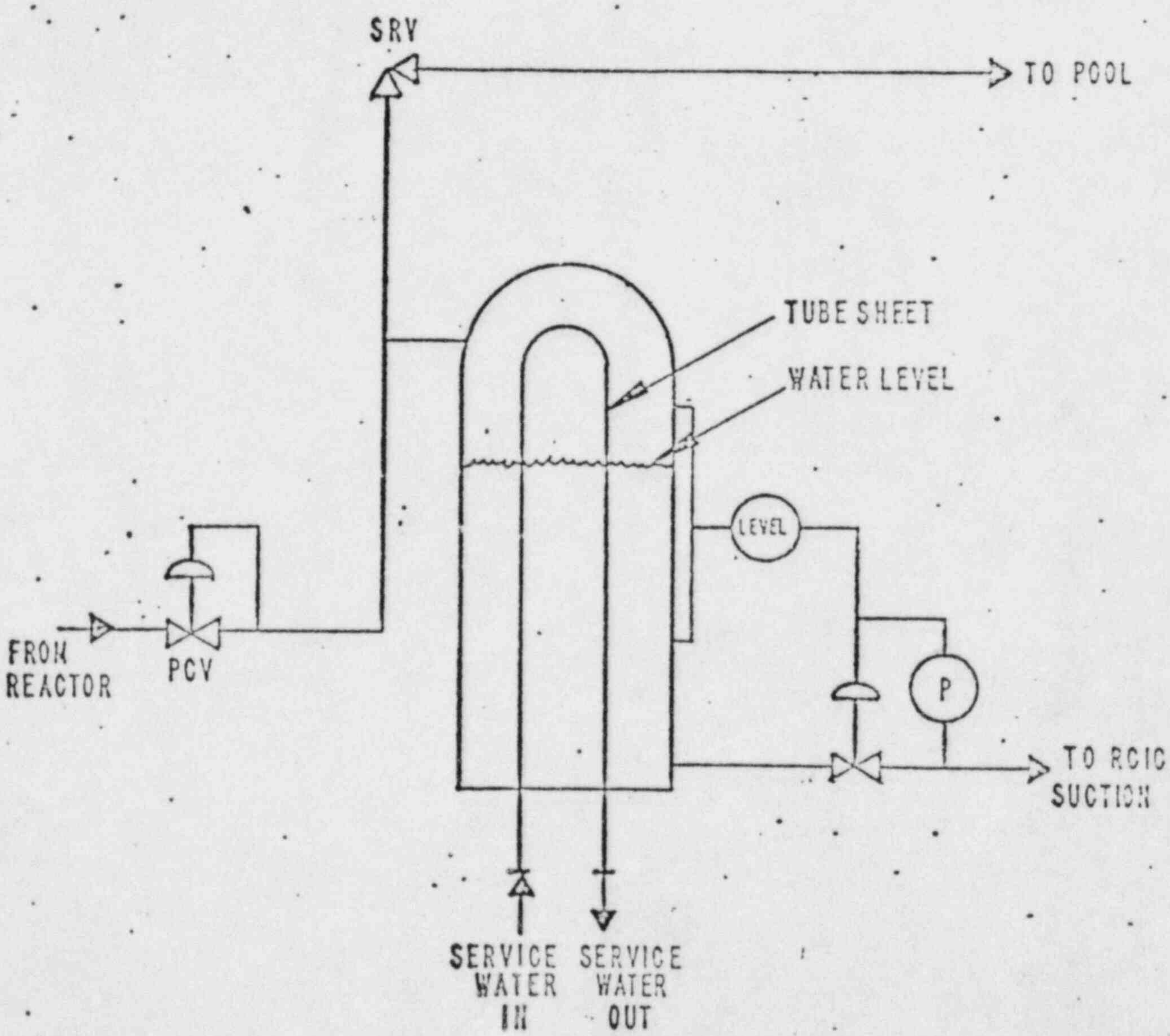

Figure 8.1. Schematic of Clinton RHR Heat Exchanger