CALCULATION COVER SHEET

PILGRIM NUCLEAR POWER STATION

SHEET 1 OF 84

CALC. NO. M-662	REV. E1	FILE NO.	SR ☒ NSR ☐	RTYPE
Subject: RHR and Core Spray Pump NPSH and Suction Pressure Drop			Preliminary Calc. ☐	
Discipline Division Manager: T.F. White / J.L. Rogers			Finalization Due Date:	
Approval/s/: Thomas White T.F. White 3/26/96 J.L. Rogers 3/25/96		Date:	Final Calc. ☒	

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See Note	/s/ Philip D. Harizi	3-20-96	/s/ Patrick J. Doody	3/20/96	Yes
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See Note	/s/ Patrick J. Doody	3/20/96	/s/ Philip D. Harizi	3-20-96	YES

Note:

Section preparers are as indicated on individual calculation pages.

This revision E1 provides NPSH analyses for 75 °F heat sink temperature.

This design analysis ☐ DOES, ☒ DOES NOT require revision to affected design documents.
Affected Design Documents:
A PDC ☐ IS, ☒ IS NOT Required.
A Safety Evaluation ☒ IS, ☐ IS NOT Required. *Refer to SE-2971, SE2983*
This design analysis ☐ DOES, ☒ DOES NOT affect the piping analysis index (PAI). If the PAI is affected, initiate a revision to Calculation M561.

Minor revisions made on pages _____ of this calculation. See next revision.

Replaces Calc. No.	Voided By Calc. No. _____ ☐ Or Attached Memo

Table of Contents

Table of Contents

Table Number	Table Description
1	Section 3 Input Values
2	Pump Suction Line Configuration
3	Pipe Line Losses
4	Total Suction Loss
5	NPSH & Maximum Suction dP
6	NPSH & Maximum Suction dP
7	NPSH & Maximum Suction dP
8	Section 4 Input Values
9	Benchmark Case - Containment Pressure Available and Required
10	Benchmark Case - Net Positive Suction Head Available
11	Updated Analysis - Containment Pressure Available at 1%/Day Leakage Rate 65°F Seawater Temperature
12	Updated Analysis - Containment Pressure Available at 5%/Day Leakage Rate 65°F Seawater Temperature
13	Updated Analysis - Containment Pressure for RHR Pump NPSHR and NPSHM at 1%/Day Leakage Rate - 65°F Seawater Temperature
14	Updated Analysis - Containment Pressure for Core Spray Pump NPSHR and NPSHM at 1%/Day Leakage Rate - 65°F Seawater Temperature
15	Updated Analysis - Containment Pressure for RHR Pump NPSHR and NPSHM at 5%/Day Leakage Rate - 65°F Seawater Temperature
16	Updated Analysis - Containment Pressure for Core Spray Pump NPSHR and NPSHM at 5%/Day Leakage Rate - 65°F Seawater Temperature
17	Updated Analysis - Containment Pressure Available at 1%/Day Leakage Rate 75°F Seawater Temperature
18	Updated Analysis - Containment Pressure Available at 5%/Day Leakage Rate 75°F Seawater Temperature
19	Updated Analysis - Containment Pressure for RHR Pump NPSHR and NPSHM at 1%/Day Leakage Rate - 75°F Seawater Temperature
20	Updated Analysis - Containment Pressure for Core Spray Pump NPSHR and NPSHM at 1%/Day Leakage Rate - 75°F Seawater Temperature
21	Updated Analysis - Containment Pressure for RHR Pump NPSHR and NPSHM at 5%/Day Leakage Rate - 75°F Seawater Temperature
22	Updated Analysis - Containment Pressure for Core Spray Pump NPSHR and NPSHM at 5%/Day Leakage Rate - 75°F Seawater Temperature
23	Updated Analysis - ECCS Pump NPSHA

Figure Number	Figure Description
1	Head Loss for Debris Thickness of 2.63 inches and 2.03 inches using GE Extrapolation Method
2	Amendment 9 Benchmark Case - FSAR Figure 14.5-10
3	Amendment 9 Benchmark Case - FSAR Figure 14.5-9
4	Figure 14.5-10 NPSH Availability for RHR and Core Spray System After a DBA-LOCA 65°F Seawater Temperature
5	Figure 14.5-13 NPSH Margin for RHR and Core Spray System after a DBA-LOCA 65°F Seawater Temperature
6	Figure 14.5-XX NPSH Margin for RHR and Core Spray System after a DBA-LOCA 75°F Seawater Temperature
7	Figure 14.5-XX NPSH Margin for RHR and Core Spray System after a DBA-LOCA 75°F Seawater Temperature
8	Figure 14.5-9 NPSH Availability for RHR and Core Spray System

1.0 Statement of Problem

This calculation provides an analysis of NPSH conditions for the RHR and Core Spray Pumps during performance test conditions and following the design basis loss of coolant accident (DBA LOCA). Proper and reliable performance of Emergency Core Cooling System (ECCS) pumps requires adequate net positive suction head (NPSH) which is defined as the absolute pressure at the pump impeller datum less the vapor pressure of the fluid being pumped. If the available NPSH is less than the NPSH required by the pump, cavitation will occur within the pump. Cavitation reduces the pump performance and may cause mechanical damage.

It is necessary to calculate the head losses in the suction lines for the RHR and Core Spray Pumps under normal testing and accident conditions. The suction head losses will be used to evaluate pump NPSH at the normal testing and DBA LOCA conditions to determine whether adequate margin will be available to accommodate potential degradation of the suction strainers from LOCA-generated debris. Using postulated values for post-accident strainer head losses from debris, the NPSH available to the RHR and Core Spray pumps will be evaluated and may be used as the basis for allowable strainer head loss at normal conditions to be applied during pump testing.

It is necessary to perform a time dependent analysis of NPSH conditions following the DBA LOCA using the predicted suppression pool temperature profiles and postulated values for containment leakage to determine the minimum NPSH margin that will be available. The suppression pool profiles are based on the design basis recirculation line break DBA LOCA with 65°F and 75°F ultimate heat sinks. An updated analysis as presented in FSAR Figures 14.5-9, 14.5-10, and 14.5-13 is performed in this calculation to demonstrate that available NPSH will exceed that required by low pressure ECCS pumps when NPSH margin is at its minimum value following a DBA LOCA.

2.0 Summary of Results and Recommendations

Table 4 provides the suction pressure drop that is calculated for each RHR and Core Spray Pump operating at the normal IST performance test conditions and at accident conditions. The test condition value represents the pressure drop at the pump suction between the idle pump no-flow condition and with the normal pump test flow rate.

Tables 5 and 6 provide calculations of the available NPSH and margin for suppression pool temperatures of 166 °F and 178 °F. These are the peak suppression pool temperature for the 65 °F and 75 °F heat sink design cases [Refs. 10 & 37]. The RHR and Core Spray Pumps are provided adequate NPSH under design conditions at the peak

pool temperature with the initial wetwell pressure of 0.5 psig. With the suction conditions degraded due to LOCA-generated debris, a positive NPSH margin is maintained at the peak pool temperature based on the corresponding wetwell pressure shown on Figures 4 and 6 (described below). Conditions associated with the DBA LOCA are used because this event produces the highest peak in suppression pool temperature.

Table 7 provides a calculation of the available NPSH and margin for the point of minimum NPSH margin following a DBA LOCA based on the results shown in Figures 5 and 7 (described below). The 112°F data corresponds to the 1% per day leakage case and the 119°F data corresponds to the 5% per day leakage case at the point of minimum margin when the containment pressure has decreased to atmospheric pressure for the 65°F heat sink design case. The 115°F data corresponds to the 1% per day leakage case and the 126°F data corresponds to the 5% per day leakage case at the point of minimum margin when the containment pressure has decreased to atmospheric pressure for the 75°F heat sink design case. With the suction conditions degraded due to LOCA-generated debris, a positive NPSH margin is maintained at the point of minimum margin.

Figures 4 and 6 provide graphical presentations of the calculated values for "primary containment pressure" and the "containment pressure necessary to meet NPSH required" for both the RHR and Core Spray pumps after a DBA LOCA with 65°F and 75°F heat sinks. Containment pressure is evaluated for a containment leakage rate equal to the Technical Specification (TS) limit (1%/day) and 5 times the TS limit. The evaluation of NPSH for 5 times the TS leakage rate limit demonstrates that significant impairment of containment will not cause available NPSH to drop below the NPSH required for either the Core Spray or RHR pump.

Figures 5 and 7 provide graphical presentations of NPSH margin as a function of time after a DBA LOCA with 65°F and 75°F heat sinks. The margin curves shown on this figure are the difference between the primary containment pressure and the containment pressure required for NPSHR. The Core Spray pumps are predicted to have smaller NPSH margin throughout the accident response. For the 65°F heat sink case, the point of least margin for the Core Spray pump occurs during the suppression pool cooldown, approximately 52 hours after the accident at which time Core Spray pump margin is approximately 11.5 feet. The minimum RHR pump margin occurs at approximately the same time and is approximately 17.3 feet. For the 75°F heat sink case, the point of least margin for the Core Spray pump occurs during the suppression pool cooldown, approximately 90 hours after the accident at which time Core Spray pump margin is approximately 10.8 feet. The minimum RHR pump margin occurs at approximately the same time and is approximately 16.6 feet.

As presented in Section 3.C.3, the potential exists for additional head loss for the Core Spray and RHR pumps from fibrous debris deposition on suction strainers in the amount of 8.6 feet and 14.5 feet respectively. For the 65°F heat sink case, the minimum margin for the CS pumps exceeds the debris related loss by 2.9 feet (11.5 feet - 8.6 feet) and the minimum margin for the limiting RHR pump exceeds the debris-related loss by 2.8 feet (17.3 feet - 14.5 feet). For the 75°F heat sink case, the minimum margin for the CS pumps exceeds the debris related loss by 2.2 feet (10.8 feet - 8.6 feet) and the minimum margin for the limiting RHR pump exceeds the debris-related loss by 2.1 feet (16.6 feet - 14.5 feet).

Based on the information presented, NPSH margin will be available to assure reliable operation of the RHR and Core Spray pumps. Available NPSH will exceed required NPSH over the entire range of suppression pool temperatures that are predicted following the DBA LOCA.

3.0 Calculation of Total Suction Losses and NPSH Available

3.A Method of Solution

This calculation determines the suction line losses for the RHR and Core Spray Pump. These losses are used to predict the suction pressure drop that will occur with a clean strainer. The suction line head loss is calculated at the conditions for temperature and pump flow rate for the pump performance In-Service Test (IST). The calculation for suction head loss is repeated at the predicted accident conditions for wetwell temperature, pressure, and pump flow rate. This calculation also predicts the NPSH available at the ECCS pump suctions under accident conditions and the resulting margin between NPSH Available and NPSH Required.

A number of variables determine the NPSH available to the pumps. Principally they are:

Suppression pool water level, temperature, and density.
Wetwell pressure.
Vapor Pressure of the suppression pool water.
Pump suction line head loss which is principally a function of geometry and flowrate (which includes the clean suction strainer head loss).
Head loss caused by LOCA-generated debris partially clogging the pump suction strainer.

The suction pressure drop as would be read on a pressure gage mounted at the pump suction is also calculated. The pressure drop is the difference in the pressure read with the pump idle (0 gpm) and with the pump at the test flow rate. This measurement method cancels out the effect of gage height versus the datum such that only the delta-P is important.

There is a maximum amount of strainer fouling that can be tolerated such that there will be adequate NPSH to the ECCS pumps under containment accident conditions. This calculation determines the margin that will be available for NPSH with the predicted strainer head losses due to debris from the accident. This margin plus the calculated suction line losses at the accident conditions for wetwell temperature, pressure, and pump flow rate are used to calculate the maximum pressure drop that can allowed during the pump performance testing.

The difference ($P_{GAGE-STATIC}$ - $P_{GAGE-RUNNING}$) provides a measure of the dynamic pressure drop caused by resistances and restrictions in the suction line plus the conversion of static head to velocity head as follows:

$$dP = P_{GAGE-STATIC} - P_{GAGE-RUNNING} = \text{Suction Line Pressure Drop} + \text{Velocity Head}$$

The allowable suction dP attributable to pre-existing strainer fouling (i.e., prior to accident) must be less than the NPSH Margin that is predicted to exist at the accident conditions.

3.B Input Data and Assumptions

The physical configurations of the suction lines to the RHR and Core Spray Pumps are taken from the drawings listed in the Reference section.

The head losses due to pipe fittings are in accordance with [Ref. 7].

Pipe friction values are based on the Moody diagram [Ref. 7]. The pipe roughness value was selected for steel pipe with light rust per [Ref. 8].

The strainer characteristics are in accordance with [Ref. 14] and debris fouling is based on [Ref. 3] values.

The design basis accident conditions inside containment are in accordance with [Ref. 10, 37].

The 5100 gpm RHR Pump flow rate is based on the flow limitations for the RHR heat exchanger. This single pump value of flow bounds the per-pump flow for the two-pump case used in accident analyses [Ref. 11, 12]. The 4400 gpm Core Spray Pump flow rate is the minimum pump runout flow rate assumed in the accident analysis (4100 gpm) plus an assumed minimum flow line flow rate of 300 gpm [Ref. 11, 12].

The following assumptions apply:

1. The RHR and Core Spray Pump accident flow rates of 5100 gpm and 4400 gpm, respectively, correspond to the flow at zero reactor pressure.

2. The RHR and Core Spray Pump performance test flow rates of 4800 gpm and 3300 gpm, respectively, correspond to the IST test conditions with 80F torus water.

3.C Calculations / Analyses

3.C.1 Suction Line Head Loss Calculation

Definition of Terms

K	=	*resistance coefficient for velocity head loss calculation*
Q	=	*rate of flow (gpm)*
V	=	*mean velocity of flow (ft/sec)*
h_V	=	*velocity head (ft)*
$h_{LV\&F}$	=	*head loss due to fluid flow through valves and fittings (ft)*
$h_{L\ STRAINER}$	=	*head loss due to flow through a clean suction strainer (ft)*
$h_{L\ PIPE}$	=	*head loss due to flow through suction pipe (ft)*
h_{SL}	=	*total head loss due to flow in the suction line with a clean suction strainer (ft)*
ρ	=	*density (lbm/ft^3)*
g	=	*acceleration of gravity equal to 32.2 ft/sec^2*
dP	=	*pressure drop at pump suction (psi)*
a	=	*cross sectional area of pipe or orifice, or flow area in valve (in^2)*
A	=	*cross sectional area of pipe or orifice, or flow area in valve (ft^2)*
d	=	*internal diameter of pipe (in)*
D	=	*internal diameter of pipe (ft)*
ε	=	*absolute roughness (in)*
ε/D	=	*relative roughness*
f	=	*friction factor in Equation 5 read from Moody diagram [Ref. 7]*
L	=	*length of pipe (ft)*
L/D	=	*equivalent length of a resistance to flow, in pipe diameters*
v	=	*kinematic viscosity (ft^2/sec)*

Head Loss Formulas

Average Flow Velocity

$$V = \frac{\left(Q \times 1/7.4805 \times 1/60\right)}{A} \qquad \textit{Equation 1}$$

Velocity Head

$$h_V = \frac{V^2}{2g} \qquad \textit{Equation 2}$$

Reynolds Number

$$\mathrm{Re} = \frac{D \times V}{\nu} \qquad \textit{Equation 3}$$

Losses For Valves and Fittings

$$h_{LV\&F} = K\frac{V^2}{2g} \qquad \textit{Equation 4}$$

Losses For Straight Pipe

$$h_{LPIPE} = \left(f\frac{L}{D}\right)\frac{V^2}{2g} \qquad \textit{Equation 5}$$

Clean Strainer Losses

The clean strainer rated pressure drop was taken from the data sheet [Ref. 14] and used to generate a table of values at different flow rates by using a flow-squared relationship.

The head loss K-factor due to the piping inlet from the torus was based on [Ref. 7] for an inward projecting entrance (K=0.78). In addition, the initial pipe spool piece is 16" ID which connects to the 17.25" ID suction lines. A head loss K-factor for the sudden enlargement (K=0.036) was added to obtain the total inlet K-factor = 0.816 for each strainer.

Total Line Loss

$$h_{SL} = h_{LV\&F} + h_{L\,PIPE} + h_{L\,STRAINER} \qquad \textit{Equation 6}$$

Pump Suction Pressure Drop

$$dP = (h_{SL} + h_V) \times (\rho/144) \qquad \textit{Equation 7}$$

Note: This pressure drop (psi) represents the difference between the gage pressure readings taken at the pump suction with the pump idle (0 gpm) and with the pump at the normal flow rate. Since the gage is reading from a static pressure tap, the velocity head (h_V) is added to the line loss to give the total change in head.

3.C.2 Net Positive Suction Head Calculation

Definition of Terms

$NPSHA$	=	*Net positive suction head available at the centerline of the pump inlet (ft)*
$NPSHR$	=	*Net positive suction head required at the centerline of the pump inlet (ft)*
$NPSHM$	=	*Net positive suction head margin; NPSHA - NPSHR (ft)*
h_Z	=	*Elevation head of suppression pool water measured at the centerline of the pump inlet (ft)*
h_{SL}	=	*Dynamic head loss caused by flow through a clean suction strainer and the suction line (ft)*
T_{POOL}	=	*Temperature of the suppression pool water (°F)*
P_C	=	*Primary containment positive pressure (psig)*
P_{VP}	=	*Vapor pressure at the temperature of the pumped fluid (psia)*
V_{SP}	=	*Specific volume of fluid (ft^3/lbm)*
h_{DEBRIS}	=	*Additional head loss at the pump suction strainer caused by insulation debris (ft)*

Equations

$$NPSHA = h_Z - h_{SL} + \left[(14.696 + P_C - P_{VP})(144)(V_{SP})\right] - h_{DEBRIS} \qquad \text{Equation 8}$$

$$NPSHM = NPSHA - NPSHR \qquad \text{Equation 9}$$

Constant Inputs

$NPSHR$	=	*RHR Pumps: 23 feet at 5100 gpm [Ref. 6]* *Core Spray Pumps: 29 feet at 4400 gpm [Ref. 5]*
h_Z	=	*12.5 feet from minimum normal suppression water level (-3'0") to the pump inlet centerline at (-15'5")*
P_C	=	*The minimum value of 0.5 psig corresponds to the initial containment pressure. The minimum value of wetwell pressure with debris head loss included is calculated as the wetwell pressure required to maintain the required NPSH at the associated peak accident water temperature with zero NPSH margin.* *The wetwell pressure of 5.6 psig is the predicted accident wetwell pressure at the point of peak pool temperature for the 166°F case in Figure 4* *The wetwell pressure of 7.4 psig is the predicted accident wetwell pressure at the point of peak pool temperature for the 178°F case in Figure 6*
P_{VP}	=	*From the ASME Steam Table 1 "Properties of Saturated Steam and Saturated Water (Temperature)".*
V_{SP}	=	*Same as above.*

3.C.3 Strainer Head Loss w/ Debris

The following values are from GE Report [Ref. 3]:

13.8 feet for RHR Pumps @ 5000 gpm
5.5 feet for Core Spray Pumps @ 3750 gpm

For this calculation, the following pump flow rates will be used:

RHR = 5100 gpm
Core Spray = 4400 gpm

The strainer head loss at the new flow rates will be determined consistent with the methods used in [Ref. 3]. The total amount of debris in each torus segment was distributed between the RHR and Core Spray Pumps in relation to the flow rates as follows:

RHR = 8.1 (5100 / (5100 + 5100 + 4400) = 2.829 ft^3 debris
C.S. = 8.1 (4400 / (5100 + 5100 + 4400) = 2.441 ft^3 debris

The strainer surface area is 13 ft^2 and the debris is uniformly deposited to the following depths:

RHR = (2.829/13) x 12 = 2.61 in
C.S. = (2.441/13) x 12 = 2.25 in

The "strainer velocity" is defined as follows:

$$V = \frac{(Q \times 1/7.4805 \times 1/60)}{A}$$

where: A = 12.4 ft^2 (see note)
Q = 5100 gpm RHR
Q = 4400 gpm Core Spray

Note: For the calculation of strainer velocity, the strainer is assumed to have 5% of surface area completely blocked by fabric in addition to insulation debris. This yields a strainer net area of 12.4 ft^2.

V = 0.92 ft/sec RHR
V = 0.79 ft/sec Core Spray

The data in [Ref. 3] was used to make a plot of strainer head loss versus strainer velocity as shown in the attached graph. The plotted values are for the debris thickness evaluated in the GE Report (2.63 and 2.03 inches). To get the head loss for the new values of debris thickness and strainer velocity, an interpolation between the two known curves was performed with the following results to be used in this calculation:

RHR Pumps:
h_{DEBRIS} : = 14.5 ft

Core Spray Pumps:
h_{DEBRIS} : = 8.6 ft

3.C.4 Maximum Allowable Pump Suction dP @ IST Conditions

The maximum allowable pump suction pressure drop as measured at the IST testing conditions is based on the suction head losses and available NPSH margin at the accident conditions for wetwell temperature, pressure, pump flow rate, and strainer debris fouling. The total suction head loss (h_{SL}) is calculated at both the IST conditions for temperature and pump flow rate and for the accident conditions. The available NPSH margin (NPSHM) is calculated for the accident condition and then used to calculate a maximum dP for the test conditions that will ensure that NPSHA will meet or exceed NPSHR at the accident conditions using the following relationship:

Equation 10

$$dP_{MAX} = \left\{ \left[(h_{SL\text{-}PEAK} + NPSHM) \times (h_{SL\text{-}TEST} / h_{SL\text{-}PEAK}) \right] + h_{V\text{-}TEST} \right\} \times (\rho_{TEST} / 144)$$

dP_{MAX} = *Maximum allowable suction pressure drop at IST conditions (psi)*
$NPSHM$ = *Available NPSH margin at accident conditions (ft)*
$h_{SL\text{-}PEAK}$ = *Suction head loss at accident conditions (ft)*
$h_{SL\text{-}TEST}$ = *Suction head loss at IST conditions (ft)*
$h_{V\text{-}TEST}$ = *Velocity head at IST conditions (ft)*
ρ_{TEST} = *Density at IST temperature (lbm/ft^3)*

3.C.5 Initial Containment Pressure

The initial conditions assumed for containment temperature and pressure prior to a Loss of Coolant Accident (see Table 8) are:

	Volume (ft^3)	Temperature (°F)	Pressure (psig)	Relative Humidity (ϕ)
Drywell	147,000	150	1.30	80
Wetwell Airspace	124,500	80	0.00	100

The drywell and wetwell airspace volumes are assumed to be mixed and in equilibrium following an accident that results in a reactor blowdown to the primary containment. The temperature and pressure for this mixed volume is calculated based solely on the temperature and pressure conditions that exist prior to the accident. This is considered to be the "initial condition" in containment (drywell and wetwell) for the NPSH analysis.

Calculate Initial Mass of Noncondensible Gas:

$$M_D = \frac{\left[\left(P_D + 14.696\right) - \left(\phi P_{VP}\right)\right]\left(V_D\right) * 144\, in^2/ft^2}{R\left(T_D + 460\right)} \qquad \text{(Drywell)}$$

$$M_W = \frac{\left[\left(P_W + 14.696\right) - \left(\phi P_{VP}\right)\right]\left(V_W\right) * 144\, in^2/ft^2}{R\left(T_W + 460\right)} \qquad \text{(Wetwell)}$$

where: R = 53.3 ft-lbf/lbm-°R
P_{VP} = 3.7184 psia @ 150 °F
0.5068 psia @ 80 °F

Drywell = 8,478 lbm
Wetwell Airspace = 8,838 lbm
Total Noncondensible Gas = 17,316 lbm

Calculate mixture temperature of both air volumes:

$$T_{MIX} = \frac{V_D(T_D) + V_W(T_W)}{V_D + V_W}$$

$$T_{MIX} = \frac{147{,}000(150) + 124{,}500(80)}{271{,}500} = 118\,^{\circ}\mathrm{F}$$

Calculate pressure at mixture temperature:

$$P_C = \frac{(M_T)R(T_{MIX} + 460)}{V_T\left(144\,in^2/ft^2\right)} + (\phi P_{VP}) - 14.696\ psig$$

The mixture will have relative humidity of 100% at 118 °F:

$$P_C = \frac{(17{,}316)*53.3*(118+460)}{271{,}500\left(144\,in^2/ft^2\right)} + 1.6009 - 14.696 = 0.55\ psig$$

The minimum value for the initial containment pressure to be used in the Section 3 NPSH calculation is 0.50 psig except where noted, e.g., at the point of minimum NPSH margin.

Table 1 - Input Values

Friction Factor f for 18" Fittings =	0.012
Piping Absolute Roughness e (in) =	0.006

K Values (Crane)	45 LR EL	90 LR EL	90 SR EL	Tee Branch	Tee Run	Gate Valve	B'fly Valve
Effective L/D for Fitting	10	14	20	60	20	8	25
f_T Turbulent Flow Friction Factor	0.0120	0.0120	0.0120	0.0120	0.0120	0.0120	0.0120
$K = (L/D) * f_T$ FOR 18" FITTINGS	0.1200	0.1680	0.2400	0.7200	0.2400	0.0960	0.3000

K Values (Crane)	Entrance	Exit	Reducer
Effective K for Fittings	Strainer	Any	Eccentric
Independent of Friction Factor	n/a	n/a	18 x 12
K = fixed	0.8160	1.0000	0.0900

RHR and Core Spray Suction Strainer Loss (Clean) Reference SUDDS/RF #84-59 Procurement of RHR and CS Suction Strainers Inside Torus, dated 7/13/95

Flow	Loss (psi)	Loss (ft)
3000	0.0135	0.0320
3300	0.0163	0.0387
3600	0.0194	0.0461
3750	0.0211	0.0500
4100	0.0252	0.0598
4400	0.0290	0.0688
4600	0.0317	0.0752
4800	0.0346	0.0819
4990	0.0374	0.0885
5000	0.0375	0.0889
5100	0.0390	0.0925
10000	0.1500	0.3555

Rated delta 0.15 psi at 10000 gpm

Table 2 - Pump Suction Line Configuration

Pipe No.	*L* Length (ft)	*d* Diameter (inches)	*D* Diameter (ft)	*a* Area (in^2)	*A* Area (ft^2)	Pipe Class	Pipe Schedule
CS A-1	75.0	17.25	1.438	233.71	1.62	18"-HL/HD	Std
CS A-2	1.0	11.25	0.938	99.40	0.69	12"-HD	Std
CS B-1	74.0	17.25	1.438	233.71	1.62	18"-HL/HD	Std
CS B-2	1.0	11.25	0.938	99.40	0.69	12"-HD	Std
RHR A	90.0	17.25	1.438	233.71	1.62	18"-HL/HB	Std
RHR B	52.0	17.25	1.438	233.71	1.62	18"-HL/HB	Std
RHR C	52.0	17.25	1.438	233.71	1.62	18"-HL/HB	Std
RHR D	90.0	17.25	1.438	233.71	1.62	18"-HL/HB	Std

Valve or Fitting	CS A-1 Count	CS A-1 *K*	CS A-2 Count	CS A-2 *K*	CS B-1 Count	CS B-1 *K*	CS B-2 Count	CS B-2 *K*
45 LR EL	3	0.360	0	0.000	3	0.360	0	0.000
90 LR EL	1	0.168	0	0.000	1	0.168	0	0.000
90 SR EL	3	0.720	0	0.000	3	0.720	0	0.000
Tee Branch	0	0.000	0	0.000	0	0.000	0	0.000
Tee Run	1	0.240	0	0.000	1	0.240	0	0.000
Gate Valve	1	0.096	0	0.000	1	0.096	0	0.000
Butterfly Valve	1	0.300	0	0.000	1	0.300	0	0.000
Entrance	1	0.816	0	0.000	1	0.816	0	0.000
Exit	0	0.000	0	0.000	0	0.000	0	0.000
Reducer	0	0.000	1	0.090	0	0.000	1	0.090
V & F Total *K* =		2.700		0.090		2.700		0.090

Valve or Fitting	RHR A Count	RHR A *K*	RHR B Count	RHR B *K*	RHR C Count	RHR C *K*	RHR D Count	RHR D *K*
45 LR EL	2	0.240	3	0.360	2	0.240	2	0.240
90 LR EL	4	0.672	1	0.168	2	0.336	4	0.672
90 SR EL	0	0.000	0	0.000	0	0.000	0	0.000
Tee Branch	0	0.000	0	0.000	0	0.000	0	0.000
Tee Run	1	0.240	1	0.240	1	0.240	1	0.240
Gate Valve	1	0.096	1	0.096	1	0.096	1	0.096
Butterfly Valve	1	0.300	1	0.300	1	0.300	1	0.300
Entrance	1	0.816	1	0.816	1	0.816	1	0.816
Exit	0	0.000	0	0.000	0	0.000	0	0.000
Reducer	0	0.000	0	0.000	0	0.000	0	0.000
V & F Total *K* =		2.364		1.980		2.028		2.364

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REV. E1 DATE 29-FEB-96

SHEET 19 OF 84

Table 3 - Pipe Line Losses

Pipe No.	Flow Rate Q (gpm)	(Eq 1) Velocity V (ft/sec)	(Eq 3) Reynolds Number Re	(Ref 8) Pipe Relative Roughness e / D	(Ref 7) Pipe Friction Factor f	(Eq 4) Valves & Fittings $h_{LV\&F}$ (ft)	(Eq 5) Pipe $h_{L\ PIPE}$ (ft)
For Torus Testing Temp T_{POOL} (F) =			80.00				
CS A-1	3300	4.53	6.93E+05	0.00035	0.0160	0.861	0.266
CS A-2	3300	10.65	1.06E+06	0.00053	0.0170	0.159	0.032
CS B-1	3300	4.53	6.93E+05	0.00035	0.0160	0.861	0.263
CS B-2	3300	10.65	1.06E+06	0.00053	0.0170	0.159	0.032
RHR A	4800	6.59	1.01E+06	0.00035	0.0160	1.594	0.676
RHR B	4800	6.59	1.01E+06	0.00035	0.0160	1.335	0.390
RHR C	4800	6.59	1.01E+06	0.00035	0.0160	1.368	0.390
RHR D	4800	6.59	1.01E+06	0.00035	0.0160	1.594	0.676
For Torus Peak Temp T_{POOL} (F) =			120.00				
CS A-1	4400	6.04	1.41E+06	0.00035	0.0155	1.530	0.458
CS A-2	4400	14.20	2.16E+06	0.00053	0.0170	0.282	0.057
CS B-1	4400	6.04	1.41E+06	0.00035	0.0155	1.530	0.452
CS B-2	4400	14.20	2.16E+06	0.00053	0.0170	0.282	0.057
RHR A	5100	7.00	1.63E+06	0.00035	0.0155	1.800	0.739
RHR B	5100	7.00	1.63E+06	0.00035	0.0155	1.507	0.427
RHR C	5100	7.00	1.63E+06	0.00035	0.0155	1.544	0.427
RHR D	5100	7.00	1.63E+06	0.00035	0.0155	1.800	0.739
For Torus Peak Temp T_{POOL} (F) =			166.00				
CS A-1	4400	6.04	2.05E+06	0.00035	0.0155	1.530	0.458
CS A-2	4400	14.20	3.15E+06	0.00053	0.0170	0.282	0.057
CS B-1	4400	6.04	2.05E+06	0.00035	0.0155	1.530	0.452
CS B-2	4400	14.20	3.15E+06	0.00053	0.0170	0.282	0.057
RHR A	5100	7.00	2.38E+06	0.00035	0.0155	1.800	0.739
RHR B	5100	7.00	2.38E+06	0.00035	0.0155	1.507	0.427
RHR C	5100	7.00	2.38E+06	0.00035	0.0155	1.544	0.427
RHR D	5100	7.00	2.38E+06	0.00035	0.0155	1.800	0.739

Table 3 (Cont.) - Pipe Line Losses

Pipe No.	Flow Rate Q (gpm)	(Eq 1) Velocity V (ft/sec)	(Eq 3) Reynolds Number Re	(Ref 8) Pipe Relative Roughness e / D	(Ref 7) Pipe Friction Factor f	(Eq 4) Valves & Fittings $h_{LV\&F}$ (ft)	(Eq 5) Pipe $h_{L\ PIPE}$ (ft)
For Torus Peak Temp T_{POOL} (F) =			178.00				
CS A-1	4400	6.04	2.22E+06	0.00035	0.0155	1.530	0.458
CS A-2	4400	14.20	3.40E+06	0.00053	0.0170	0.282	0.057
CS B-1	4400	6.04	2.22E+06	0.00035	0.0155	1.530	0.452
CS B-2	4400	14.20	3.40E+06	0.00053	0.0170	0.282	0.057
RHR A	5100	7.00	2.57E+06	0.00035	0.0155	1.800	0.739
RHR B	5100	7.00	2.57E+06	0.00035	0.0155	1.507	0.427
RHR C	5100	7.00	2.57E+06	0.00035	0.0155	1.544	0.427
RHR D	5100	7.00	2.57E+06	0.00035	0.0155	1.800	0.739

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CALC. # M-662 CHECKED BY: P. Doody

REV. E1 DATE 29-FEB-96

SHEET 21 OF 84

Table 4 - Total Suction Loss

Pump No.	Flow Rate Q (gpm)	(Table 3) Valve & Fitting Losses $h_{LV\&F}$ (ft)	(Table 3) Total Piping Head Loss $h_{L\ PIPE}$ (ft)	(Table 1) Clean Suction Strainer $h_{L\ STRAINER}$ (ft)	(Eq 6) Total Suction Head Loss h_{SL} (ft)	(Eq 2) Velocity Head @ PI h_V (ft)	(Eq 7) Total Suction Pressure Drop (psi)
For Torus Testing Temp T_{POOL} (F) =			80.00				
Core Spray A	3300	1.019	0.298	0.03871	1.356	1.762	1.347
Core Spray B	3300	1.019	0.294	0.03871	1.352	1.762	1.346
RHR A	4800	1.594	0.676	0.08191	2.352	0.674	1.307
RHR B	4800	1.335	0.390	0.08191	1.807	0.674	1.072
RHR C	4800	1.368	0.390	0.08191	1.840	0.674	1.086
RHR D	4800	1.594	0.676	0.08191	2.352	0.674	1.307
For Torus Peak Temp T_{POOL} (F) =			120.00				
Core Spray A	4400	1.812	0.515	0.06882	2.396	3.132	2.370
Core Spray B	4400	1.812	0.509	0.06882	2.390	3.132	2.367
RHR A	5100	1.800	0.739	0.09247	2.631	0.761	1.454
RHR B	5100	1.507	0.427	0.09247	2.027	0.761	1.195
RHR C	5100	1.544	0.427	0.09247	2.063	0.761	1.211
RHR D	5100	1.800	0.739	0.09247	2.631	0.761	1.454
For Torus Peak Temp T_{POOL} (F) =			166.00				
Core Spray A	4400	1.812	0.515	0.06882	2.396	3.132	2.337
Core Spray B	4400	1.812	0.509	0.06882	2.390	3.132	2.335
RHR A	5100	1.800	0.739	0.09247	2.631	0.761	1.434
RHR B	5100	1.507	0.427	0.09247	2.027	0.761	1.179
RHR C	5100	1.544	0.427	0.09247	2.063	0.761	1.194
RHR D	5100	1.800	0.739	0.09247	2.631	0.761	1.434
For Torus Peak Temp T_{POOL} (F) =			178.00				
Core Spray A	4400	1.812	0.515	0.06882	2.396	3.132	2.329
Core Spray B	4400	1.812	0.509	0.06882	2.390	3.132	2.326
RHR A	5100	1.800	0.739	0.09247	2.631	0.761	1.429
RHR B	5100	1.507	0.427	0.09247	2.027	0.761	1.174
RHR C	5100	1.544	0.427	0.09247	2.063	0.761	1.190
RHR D	5100	1.800	0.739	0.09247	2.631	0.761	1.429

Table 5 - NPSH & Max Suction dP

				(Table 4)			(Eq 8)	(Ref 5&6)	(Eq 9)	(Eq 10)
Torus Temp T_{POOL} (F)	Vapor Press P_{VP} (psia)	Spec Volume V_{SP} (ft^3/lbm)	Suction Elev Head h_Z (ft)	Suction Head Loss h_{SL} (ft)	Wetwell Press P_C (psig)	Allow Debris Head Loss h_{DEBRIS} (ft)	Available $NPSH_A$ (ft)	Required $NPSH_R$ (ft)	Available Margin $NPSH_M$ (ft)	Max Suction dP Measured @ IST Conditions (psi)
Core Spray Pumps A & B @ 4400 GPM:										
166.00	5.4620	0.016428	12.50	2.40	0.500	0.00	33.13	29.00	4.13	2.35
					0.500	8.60	24.53	29.00	-4.47	n/a
					2.390	8.60	29.00	29.00	0.00	1.35
					5.600	8.60	36.59	29.00	7.59	3.20
RHR Pumps A & D @ 5100 GPM:										
166.00	5.4620	0.016428	12.50	2.63	0.500	0.00	32.90	23.00	9.90	5.13
					0.500	14.50	18.40	23.00	-4.60	n/a
					2.445	14.50	23.00	23.00	0.00	1.31
					5.600	14.50	30.46	23.00	7.46	4.19
RHR Pumps B & C @ 5100 GPM:										
166.00	5.4620	0.016428	12.50	2.06	0.500	0.00	33.47	23.00	10.47	5.13
					0.500	14.50	18.97	23.00	-4.03	n/a
					2.204	14.50	23.00	23.00	0.00	1.09
					5.600	14.50	31.03	23.00	8.03	4.19

Table 6 - NPSH & Max Suction dP

Torus Temp T_{POOL} (F)	Vapor Press P_{VP} (psia)	Spec Volume V_{SP} (ft^3/lbm)	Suction Elev Head h_Z (ft) (Table 4)	Suction Head Loss h_{SL} (ft)	Wetwell Press P_C (psig)	Allow Debris Head Loss h_{DEBRIS} (ft) (Eq 8)	Available $NPSH_A$ (ft)	Required $NPSH_R$ (ft) (Ref 5&6)	Available Margin $NPSH_M$ (ft) (Eq 9)	Max Suction dP Measured @ IST Conditions (psi) (Eq 10)
Core Spray Pumps A & B @ 4400 GPM:										
178.00	7.1840	0.016498	12.50	2.40	0.500	0.00	29.13	29.00	0.13	1.38
					0.500	8.60	20.53	29.00	-8.47	n/a
					4.062	8.60	29.00	29.00	0.00	1.35
					7.400	8.60	36.93	29.00	7.93	3.28
RHR Pumps A & D @ 5100 GPM:										
178.00	7.1840	0.016498	12.50	2.63	0.500	0.00	28.90	23.00	5.90	3.59
					0.500	14.50	14.40	23.00	-8.60	n/a
					4.118	14.50	23.00	23.00	0.00	1.31
					7.400	14.50	30.80	23.00	7.80	4.32
RHR Pumps B & C @ 5100 GPM:										
178.00	7.1840	0.016498	12.50	2.06	0.500	0.00	29.47	23.00	6.47	3.58
					0.500	14.50	14.97	23.00	-8.03	n/a
					3.880	14.50	23.00	23.00	0.00	1.09
					7.400	14.50	31.37	23.00	8.37	4.31

Table 7 - NPSH & Max Suction dP

Torus Temp T_{POOL} (F)	Vapor Press P_{VP} (psia)	Spec Volume V_{SP} (ft^3/lbm)	Suction Elev Head h_Z (ft)	Suction Head Loss h_{SL} (ft) (Table 4)	Wetwell Press P_C (psig)	Allow Debris Head Loss h_{DEBRIS} (ft)	Available $NPSH_A$ (ft) (Eq 8)	Required $NPSH_R$ (ft) (Ref 5&6)	Available Margin $NPSH_M$ (ft) (Eq 9)	Max Suction dP Measured @ IST Conditions (psi) (Eq 10)
Core Spray Pumps A & B @ 4400 GPM										
Max Temp @ 0 psig:										
112.00	1.3505	0.016173	12.50	2.40	0.000	0.00	41.18	29.00	12.18	4.32
					0.000	8.60	32.58	29.00	3.58	2.22
115.00	1.4716	0.016184	12.50	2.40	0.000	0.00	40.92	29.00	11.92	4.26
					0.000	8.60	32.32	29.00	3.32	2.16
119.00	1.6468	0.016200	12.50	2.40	0.000	0.00	40.54	29.00	11.54	4.16
					0.000	8.60	31.94	29.00	2.94	2.07
126.00	1.9959	0.016229	12.50	2.40	0.000	0.00	39.78	29.00	10.78	3.98
					0.000	8.60	31.18	29.00	2.18	1.88
RHR Pumps A & D @ 5100 GPM										
Max Temp @ 0 psig:										
112.00	1.3505	0.016173	12.50	2.63	0.000	0.00	40.95	23.00	17.95	8.24
					0.000	14.50	26.45	23.00	3.45	2.64
115.00	1.4716	0.016184	12.50	2.63	0.000	0.00	40.69	23.00	17.69	8.14
					0.000	14.50	26.19	23.00	3.19	2.54
119.00	1.6468	0.016200	12.50	2.63	0.000	0.00	40.31	23.00	17.31	8.00
					0.000	14.50	25.81	23.00	2.81	2.39
126.00	1.9959	0.016229	12.50	2.63	0.000	0.00	39.55	23.00	16.55	7.70
					0.000	14.50	25.05	23.00	2.05	2.10
RHR Pumps B & C @ 5100 GPM										
Max Temp @ 0 psig:										
112.00	1.3505	0.016173	12.50	2.06	0.000	0.00	41.52	23.00	18.52	8.23
					0.000	14.50	27.02	23.00	4.02	2.64
115.00	1.4716	0.016184	12.50	2.06	0.000	0.00	41.26	23.00	18.26	8.13
					0.000	14.50	26.76	23.00	3.76	2.54
119.00	1.6468	0.016200	12.50	2.06	0.000	0.00	40.88	23.00	17.88	7.99
					0.000	14.50	26.38	23.00	3.38	2.39
126.00	1.9959	0.016229	12.50	2.06	0.000	0.00	40.12	23.00	17.12	7.69
					0.000	14.50	25.62	23.00	2.62	2.10

Section 4.0 Updated FSAR NPSH Analyses and Figures

Section 4.A Method of Solution

This section of the calculation prepares updated NPSH analysis for the FSAR. The original analysis was submitted to the AEC during the original licensing review via Amendments 9 and 24 to the SAR. This analysis was incorporated into the FSAR and remains there currently as FSAR Figures 14.5-9, 14.5-10, and 14.5-13 and Section 14.5.3.1.3. The revised analysis in this calculation will be incorporated in the UFSAR by the 10CFR50.59 process.

The same approach used in the original FSAR analysis is used. Considering a known suppression pool temperature profile, the coincident containment pressure is calculated using the ideal gas law. The "containment pressure required" to provide the required NPSH is calculated and plotted with the coincident containment pressure. The difference between the containment pressure at any point in time and the containment pressure required represents margin. All calculation results are presented in various plots.

Section 4.B **Input Data and Assumptions**

Table 8 - Section 4 Inputs

Parameter	Amendment 9 Benchmark	Ref. * See Note 1	65°F Seawater Temperature Revised Analysis	Ref. * See Note 1	75°F Seawater Temperature Revised Analysis	Ref. * See Note 1
Containment Leakage Rate	.5%/day	31,33c	1%/day	34f	1%/day	34f
Impaired Containment Leakage Rate	5%/day	31,33c	5%/day	33c	5%/day	33c
Pool temperature profile	Amendment 9 Figure 1-2 (FSAR Fig. 14.5-10)	31,33c	FSAR Fig. 14.5-7	33d (6)	Figure 5-2 from referenced report.	37 (8)
Ultimate Heat Sink Temperature[1]	65 °F	31,33c	65 °F	33c	75 °F	37
Operator action time to initiate containment cooling[1]	10 min	33b	10 min	33b	10 min	37
SSW Flowrate[1]	5000 gpm	33d	5000 gpm[2]	33e	4500 gpm	37
Core Spray NPSH Required	28 feet	31,33c	29 ft at 4400 gpm	8	29 ft at 4400 gpm	8
RHR NPSH Required	28 feet	31,33c	23 ft at 5100 gpm	9	23 ft at 5100 gpm	9
Drywell Free Volume	147,000 ft^3	33a	147,000 ft^3	33a	147,000 ft^3	33a
Wetwell Free Volume	120,000 ft^3	33a	124,500 ft^3	35a	124,500 ft^3	35a
Torus Water Volume	5.2E6 lbm	31,33c	84000 ft^3	34a	84000 ft^3	34a
Initial Torus Water Temperature	80°F	31,33c	80°F	34c	80°F	34c
Initial Drywell Relative Humidity	100%	31,33c	80%	(5)	80%	(5)

[1] This parameter is an input for calculation of the suppression pool temperature profile.

[2] The current FSAR requirement for SSW flowrate is 4500 gpm and it has been determined that the suppression pool temperature profile Figure 14.5-7 is unaffected by the reduced flow based on heat exchanger performance.

Table 8 - Section 4 Inputs

Parameter	Amendment 9 Benchmark	Ref. * See Note 1	65°F Seawater Temperature Revised Analysis	Ref. * See Note 1	75°F Seawater Temperature Revised Analysis	Ref. * See Note 1
Initial Wetwell Relative Humidity	100%	31,33c	100%	33c	100%	33c
Initial Wetwell Airspace Temperature	80°F	31,33c	80°F	(3)	80°F	(3)
Initial Drywell Temperature	150°F	31,33c	150°F	33c (4)	150°F	33c (4)
Initial Drywell Pressure	0 psig	31,33c	1.30 psig	(2)	1.30 psig	(2)
Initial Wetwell Airspace Pressure	0 psig	31,33c	0 psig	33c	0 psig	33c
Containment Reference Pressure P_T	n/a		45 psig or 59.696 psia	34f	45 psig or 59.696 psia	34f
Containment Reference Leak Rate L_T	n/a		1%/day of *Mt*	34f	1%/day of *Mt*	34f
RHR Pump Suction line Head Loss	4.2 feet	(7)	2.63 feet	Table 5.	2.63 feet	Table 5.
CS Pump Suction line Head Loss	4.2 feet	(7)	2.40 feet	Table 5.	2.40 feet	Table 5.
Elevation head	12.5 feet	Section 3.C.2.b	12.5 feet	Section 3.C.2.b	12.5 feet	Section 3.C.2.b

Notes for Table 8

1. Numbers in parentheses refer to the following notes. Numbers not in parentheses refer to the corresponding references at the end of this section.
2. Initial "Drywell Airspace Pressure" is assumed equal 1.30 psig which is a conservative nominal value for drywell pressure based on a review of randomly selected summer and winter drywell pressures. Drywell pressure, temperature, and humidity along with wetwell pressure, temperature and humidity are used to calculate the initial mass of noncondensible gas inside containment. The combination of the values selected for each of these six parameters provides a conservative estimate of the initial mass of noncondensible gas.

Section 4.B Input Data and Assumptions

3. Initial wetwell airspace temperature is assumed to equal the initial suppression pool temperature.
4. Initial Drywell Temperature is assumed to equal a uniform value of 150°F instead of the 135°F (General area temperature per Table 5.2-2 "Drywell Atmosphere Cooling Data Sheet") which is used in containment and decay heat removal system analysis [Ref. 14]. A higher initial temperature is conservative because less initial noncondensible mass is present in containment. Therefore, the partial pressure of noncondensible gas is less initially and less over the course of the transient and cooldown resulting in a lower (conservative) NPSHA calculation.
5. The initial drywell humidity used is 20% less than that assumed in the Amendment 9 analysis. A lower humidity at a given pressure results in a higher initial mass of noncondensible gas in the containment. This design value remains conservative since the drywell is initially inerted with dry nitrogen and then sealed. A leak inside containment will raise the humidity, offset by condensation on drywell surfaces and the drywell cooling coils.
6. A table of values for suppression pool temperature as a function of time after the accident is taken from the pool temperature curve specified in the above table.
7. Amendment 9 analysis was prepared before the actual piping configuration was known. The suction line head loss used in the benchmark analysis was estimated between 4.2 and 4.7 feet. Use of the value of 4.2 feet gives good agreement between the benchmark case for Figure 14.5-10. Use of the value of 4.7 feet gives good agreement between the benchmark case and Figure 14.5-9. The suction line head losses are somewhat lower based on the as-built piping configuration.
8. The data table for the suppression pool temperature curve contained in reference 37 was provided via the GE letter reference 38. Selected data points for the suppression pool temperature as indicated in the attached tables for 75°F seawater NPSH analysis were taken from reference 38. Between 4 and 5 days, 17 additional pool temperature data points were established by linear interpolation between the pool temperature at 4 days and 5 days. These additional data points were necessary to find the point of minimum margin which occurs before the 5th day for the 5%/day leakage case. Between 7 and 8 days, 9 additional pool temperature data points were established by linear interpolation between the pool temperature at 7 days and 8 days. These additional data points were necessary to find the point of minimum margin which occurs before the 8th day for the 1%/day leakage case.

Section 4.C Calculations/Analyses

Section 4.C.1 Definition of Terms

Hz	*Elevation of suppression pool water surface above the pump inlet, ft*
Hsl	*Suction line losses, ft*
L_T	*Reference mass leakage rate at reference pressure P_T, lbm/sec*
Mt	*Initial mass of dry air inside the drywell and suppression chamber, lbm*
*Mt**	*Mass of dry air remaining inside the drywell and suppression chamber after leakage, lbm*
m_{gas}	*Mass of air/nitrogen in mixture, lbm/sec*
m_{leak}	*Mass leakage rate from containment, lbm/sec*
m_{water}	*Mass of water vapor in mixture, lbm/sec*
NPSHA	*Net positive suction head available, feet*
NPSHM	*Net positive suction head margin, feet*
NPSHR	*Net positive suction head required, feet*
Pc	*Pressure of primary containment, psia*
Pc Req'd	*Pressure of primary containment required to provide NPSHR, psia*
Pd	*Initial pressure of drywell, psia*
Pgas	*Pressure of gas in a mixture of gas and water vapor, psia*
Pwater	*Pressure of water vapor in a mixture of gas and water vapor, psia*
Ps	*Initial pressure of suppression chamber air space, psia*
P_T	*Reference pressure for mass leakage rate L_T, psia*
Pvd	*Partial pressure of vapor initially in drywell, psia*
Pvs	*Partial pressure of vapor initially in suppression chamber airspace, psia*
Pvp	*Vapor pressure at pool temperature, psia*
R or Rgas	*Specific gas constant for air/nitrogen, 53.3 ft-lbf/lbm-°R*
Rwater	*Specific gas constant for water vapor, 85.8 ft-lbf/lbm-°R*
ΔT	*Length of time step, sec*
Td	*Temperature of gas and water mixture in drywell, °R*
Tp	*Temperature of suppression pool water, °F*
Ts	*Temperature of gas and water mixture in suppression chamber, °R*
Vs	*Volume of free air space in suppression chamber, ft^3*
Vd	*Free drywell volume, ft^3*
ρ	*Density of water in pool, lb/ft^3*
ϕ	*Relative humidity*
ω	*Humidity Ratio*

Section 4.C.2 Equations

An expression for calculating the initial mass of noncondensible gas inside the drywell and torus can be derived based on the ideal gas law:

$$PV = MRT$$

Solving for the mass (M):

$$M = \frac{PV}{RT}$$

The total initial mass of noncondensible gas inside containment is the sum of the initial mass located in two separate volumes (torus airspace, and drywell):

$$Mt = Md + Ms$$

The initial mass in each volume is composed of water vapor and noncondensible gas (air/nitrogen). To calculate the initial mass of noncondensible gas, the contribution to the initial pressure from water vapor is subtracted. The magnitude of this water vapor contribution is a function of relative humidity ϕ and the saturation pressure corresponding to the mixture temperature:

Per Dalton's Rule:

$$P_{mixture} = P_{gas} + P_{water\ vapor}$$

so $$P_{gas} = P_{mixture} - P_{water\ vapor}$$

$$\phi = \frac{Pwater\ vapor}{Pvp} \quad and \quad P_{water\ vapor} = \phi\, Pvp$$

Equation 11 is used to calculate the total initial mass in the drywell and wetwell airspace. As discussed above the equation is derived from the ideal gas law, Dalton's rule and the definition of relative humidity. The result of Equation 11 provides the initial mass of noncondensible gas in primary containment:

Eq. 11
$$Mt = \frac{\left[Pd - (\phi\, Pvd)\right](144\frac{in^2}{ft^2})Vd}{RTd} + \frac{\left[Ps - (\phi\, Pvs)\right](144\frac{in^2}{ft^2})Vs}{RTs}$$

Equation 11 is the general equation to calculate the initial mass of noncondensible gas inside containment as a function of initial pressure, humidity, and temperature. Amendment 9 analysis used Eq. 12 which is derived from Eq. 11 by setting drywell pressure equal to 14.7 psia (0 gage), wetwell airspace pressure equal to 14.7 psia (0 gage), and drywell and wetwell humidity equal to 100%. Equation 12 was used to calculate the Amendment 9 FSAR curves.

Eq. 12
$$Mt = \frac{(14.7 - Pvd)(144\frac{in^2}{ft^2})Vd}{RTd} + \frac{(14.7 - Pvs)(144\frac{in^2}{ft^2})Vs}{RTs}$$

Section 4.C.2 Equations

Equations' 13a and 13b were used in the Amendment 9 analysis to calculate the percentage of the original mass of noncondensibles in containment after 1.5 days:

Eq. 13a At 5% per day: $M_t^* = (0.95)^{1.5} M_i = 0.926 M_t$

Eq. 13b At 0.5% per day $M_t^* = (0.995)^{1.5} M_t = 0.9925 M_t$

The above ratio's for 5%/day and 0.5%/day were applied as a flat amount in Amendment 9 analysis. Although conservative, this approach is unrealistic and arbitrary. FSAR Appendix R (Equation R.49) provides a rational basis for calculating the leakage from containment based on the calculated pressure during any time step, and a reference leakage at a reference pressure. This equation is presented as Equation 14:

Eq. 14
$$m_{leak} = L_T \left[\frac{1 - \left(\frac{1}{P}\right)^2}{1 - \left(\frac{1}{P_T}\right)^2} \right]^{0.5}$$
(atmosphere's)

Where: L_T = *Leak rate at reference pressure (lbm/unit time)*
P_T = *Reference pressure in atmospheres*
P = *Containment pressure at time step in atmospheres*

Equation 14 is modified as shown in Equation 15 to calculate leakage as a function of pressure measured in units of psia.

Eq. 15
$$m_{leak} = L_T \left[\frac{1 - \left(\frac{14.696}{Pc}\right)^2}{1 - \left(\frac{14.696}{P_T}\right)^2} \right]^{0.5}$$
(psia)

Only a portion of the mass leaked from the containment is gas since the mixture leaking from containment is a mixture of water vapor and noncondensible gas. The humidity ratio "ω" can be used to determine the amount of dry gas contained in the vapor/gas mixture. This ratio is derived from the ideal gas law since *Vair=Vwater* (i.e., the water vapor and gas are homogeneously mixed in the containment volume (drywell and wetwell) and *Tair = Twater* (i.e., both the water vapor and gas are at the suppression pool temperature). Equation 16 which provides the humidity ratio based on the ratio of gas and water vapor pressure is derived from the ideal gas law as follows:

Section 4.C.2 Equations

$$\omega = \frac{m_{water}}{m_{gas}} = \frac{Rgas\ Pwater}{Rwater\ Pgas} = \frac{53.3\ Pwater}{85.8\ Pgas}$$

$$\omega = 0.621 \frac{Pwater}{Pgas}$$

$$Pgas = Pc - Pvp$$

Eq. 16 $$\omega = 0.621 \frac{Pvp}{Pc - Pvp}$$

Since "m_{leak}" from Equation 15 is a mixture gas and water vapor where:

$$m_{leak} = m_{water} + m_{gas}$$

and $$\omega = \frac{m_{water}}{m_{gas}}$$

Solving for and m_{water}:

$$m_{water} = \omega\ m_{gas}$$

Substituting $\omega\ m_{gas}$ for m_{water} in the first equation yields:

$$m_{leak} = \omega\ m_{gas} + m_{gas}$$

Solving for m_{gas} yields:

Eq. 17 $$m_{gas} = \frac{m_{leak}}{(\omega + 1)}$$

Equation 17 provides the mass of noncondensible gas in a mixture with total mass equal to m_{leak} and a humidity ratio ω.

The noncondensible gas remaining in containment at any time after the containment isolates is the initial mass minus the mass of noncondensible gas that has leaked. The remaining mass (Mt^*) is calculated by the following formula:

Eq. 18 $$Mt^* = Mt - \sum \frac{m_{leak}}{(\omega + 1)} (\Delta T)$$

Section 4.C.2 Equations

Equation 19 is used to calculate the containment pressure at any time as the sum of the partial pressure of the remaining noncondensible gas and the vapor pressure corresponding to the suppression pool temperature.

Eq. 19 $$Pc = \frac{Mt * R\,Tp}{Vd + Vs}\left(\frac{ft^2}{144 in^2}\right) + Pvp$$

NPSHA is defined by the following terms:

Eq. 20 $$NPSHA = (Pc - Pvp)\frac{\left(144\frac{in^2}{ft^2}\right)}{\rho} + H_z - H_{sl}$$

The term *(Pc-Pvp)* represents the net pressure above the vapor pressure provided by the noncondensible gas inside containment. Therefore:

Eq. 21 $$Pgas = (Pc - Pvp)$$

NPSHA is calculated as follows, where Pgas is measured in feet of water:

Eq. 22 $$NPSHA = Pgas\frac{\left(144\frac{in^2}{ft^2}\right)}{\rho} + H_z - H_{sl}$$

The containment pressure required to provide adequate NPSH is derived using Equation 20 by letting NPSHA equal NPSHR and solving for the containment pressure *Pc*. When NPSHA equals NPSHR the containment pressure is by definition equal to the required containment pressure *Pc Req'd*.

Eq. 23 $$Pc\ Req'd = Pvp + (NPSHR - Hz + Hsl)\frac{\rho}{\left(144\frac{in^2}{ft^2}\right)}$$

The NPSH margin is the difference between the containment pressure that is available (calculated using Equation 19) and the containment pressure required (calculated using Equation 23).

Eq. 24 $$NPSHM = (Pc - Pc\,Req'd)\frac{\left(144\frac{in^2}{ft^2}\right)}{\rho}$$

or $$NPSHM = NPSHA - NPSHR$$

Section 4.C.2 Equations

The following three equations are general conversions used throughout this calculation:

Eq. 25 $$P(feet) = P(psi)\frac{144\left(in^2/ft^2\right)}{\rho\left(lbm/ft^3\right)}$$

Eq. 26 $$P(psi) = P(feet)\frac{\rho\left(lbm/ft^3\right)}{144\left(in^2/ft^2\right)}$$

Eq. 27 $$T(^\circ R) = T(^\circ F) + 460$$

Section 4.C.3 Benchmark Case

The calculation performed to prepare the curves currently presented in the FSAR is repeated to benchmark the methodology. This case is the first case performed and is hereafter referred to as the "Benchmark Case".

Per Amendment 9 to the FSAR, the following methodology is used:

1. Calculate the initial mass of air [or nitrogen] inside the primary containment assuming atmospheric pressure and a 100% relative humidity in both the wetwell and drywell. The initial drywell temperature was assumed to be 150°F, and the wetwell temperature 80°F. The total mass is given by Equation 12.
2. Assume the containment leaked at a constant rate of 5% free vol/day for 1.5 days, the time required following an accident for the pool temperature to return to 130°F with one RHR loop operating. The reduced mass is then given by Equation 13a and 13b.
3. Due to flow through the drywell vents or vacuum breakers, the drywell and wetwell pressures will be approximately equal, i.e., $Pd = Ps$.
4. The drywell and wetwell airspace masses and volumes can be combined and the containment (drywell and wetwell) pressure calculated as a function of the suppression pool temperature for the following reasons:
   a) Water from the pool is being pumped into the reactor vessel by a core spray cooling system pump. This water is heated by the decay heat of the reactor core and pours out of the vessel via the break and into the suppression pool via the drywell vent system. The water which returns to the wetwell is hotter than the suppression pool water by approximately 50°F.
   b) Because of the large flow of water involved, the low thermal capacity of the drywell atmosphere, and the slow time rate of change of the temperature of the water flowing through the drywell, the drywell atmospheric temperature will track the water temperature.
   c) The drywell airspace temperature will always be hotter than the pool temperature because of the elevated temperature of the break flow.
5. The containment pressure is then given by Equation 19.
6. The total NPSH available to the pumps is given by Equation 20.

Section 4.C.3 Benchmark Case

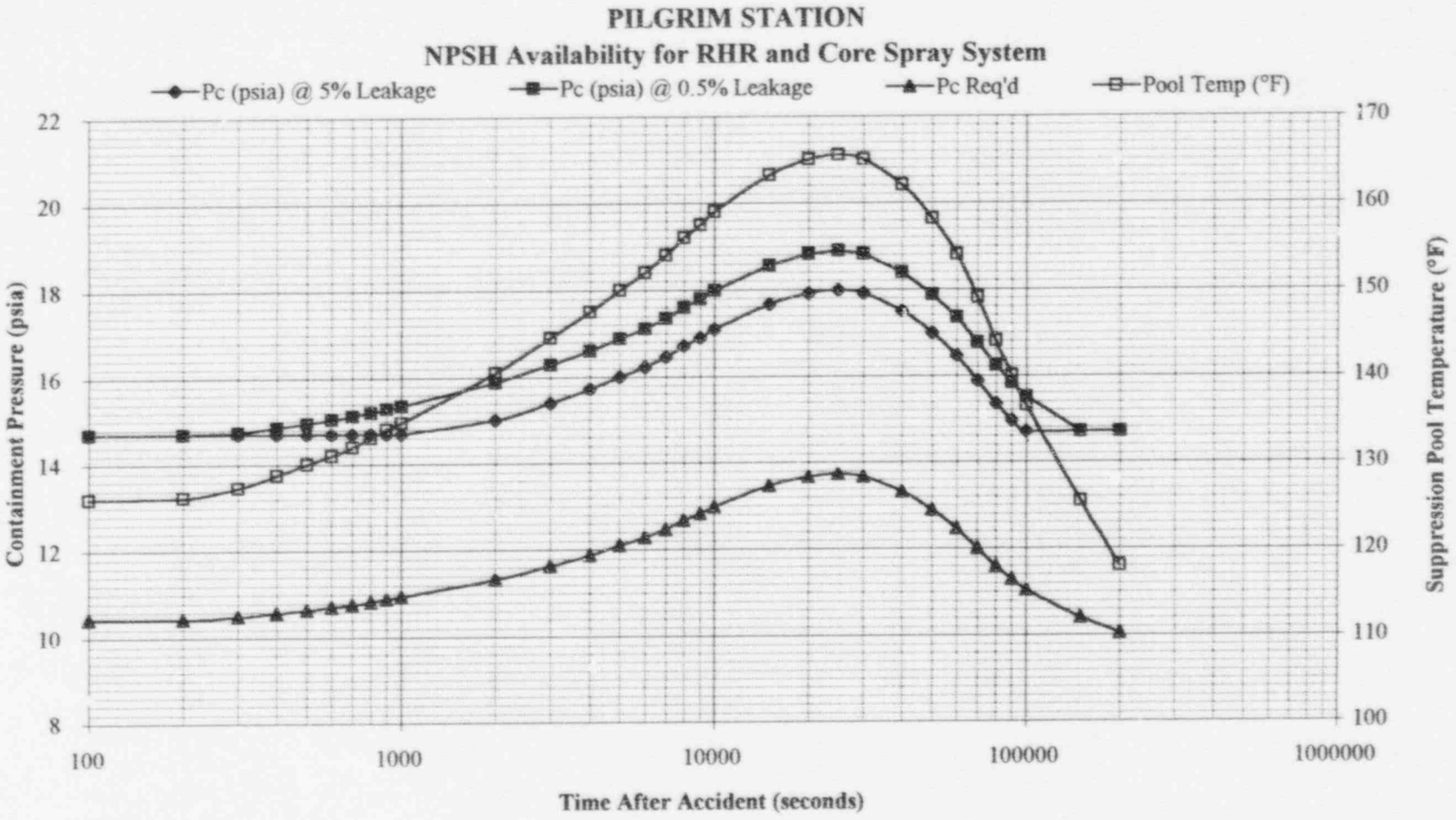
In following table the methodology used to calculate values plotted on FSAR Figure 14.5-10 is repeated. Based on a comparison, the values contained in the following table and plotted on the attached Figure 2 are consistent with the results presented in the FSAR Figure 14.5-10. The minor differences in calculated values are most likely due to small variations with inputs.

Table 9 - Benchmark Case Containment Pressure Available and Required at 0.5% and 5%/day Leakage

	F14.5-10	Eq. 27	Lookup	Eq. 13a	Eq. 19	Eq. 21	Eq. 13b	Eq. 19	Eq. 21			Eq. 23
Time (sec)	*Pool Temp (°F)*	*Tp (°R)*	*Pvp (psia)*	*Mt*/Mt @ 5%/day Leakage Rate (%)*	*Pc @ 5% Leakage (psia)*	*Pgas (feet)*	*Mt*/Mt @ 0.5%/day Leakage Rate (%)*	*Pc @ 0.5% Leakage (psia)*	*Pgas (feet)*	*Hz (feet)*	*Hsl (feet)*	*Pc Req'd for NPSHA of 28 feet (psia)*
	Values below plotted on Figure 2 ⇓				Values below plotted on Figure 2 ⇓			Values below plotted on Figure 2 ⇓				Values below plotted on Figure 2 ⇓
100	126.0	586	1.996	0.926	14.696	29.68	0.9925	14.696	29.68	12.5	4.2	10.42
200	126.2	586	2.007	0.926	14.696	29.66	0.9925	14.696	29.66	12.5	4.2	10.44
300	127.3	587	2.069	0.926	14.696	29.52	0.9925	14.732	29.61	12.5	4.2	10.49
400	128.8	589	2.153	0.926	14.696	29.34	0.9925	14.849	29.70	12.5	4.2	10.58
500	130.0	590	2.225	0.926	14.696	29.18	0.9925	14.947	29.77	12.5	4.2	10.64
600	131.0	591	2.286	0.926	14.696	29.04	0.9925	15.029	29.82	12.5	4.2	10.70
700	132.0	592	2.347	0.926	14.696	28.91	0.9925	15.111	29.88	12.5	4.2	10.76
800	133.0	593	2.407	0.926	14.696	28.77	0.9925	15.194	29.94	12.5	4.2	10.82
900	134.0	594	2.473	0.926	14.696	28.63	0.9925	15.281	30.00	12.5	4.2	10.88
1000	134.8	595	2.526	0.926	14.696	28.52	0.9925	15.351	30.05	12.5	4.2	10.93
2000	140.5	601	2.928	0.926	15.008	28.35	0.9925	15.876	30.39	12.5	4.2	11.32
3000	144.5	605	3.242	0.926	15.402	28.57	0.9925	16.276	30.62	12.5	4.2	11.63
4000	147.5	608	3.496	0.926	15.717	28.74	0.9925	16.595	30.81	12.5	4.2	11.87

Table 9 - Benchmark Case Containment Pressure Available and Required at 0.5% and 5%/day Leakage

	F14.5-10	Eq. 27	Lookup	Eq. 13a	Eq. 19	Eq. 21	Eq. 13b	Eq. 19	Eq. 21			Eq. 23
Time (sec)	*Pool Temp (°F)*	*Tp (°R)*	*Pvp (psia)*	*Mt*/Mt @ 5%/day Leakage Rate (%)*	*Pc @ 5% Leakage (psia)*	*Pgas (feet)*	*Mt*/Mt @ 0.5%/day Leakage Rate (%)*	*Pc @ 0.5% Leakage (psia)*	*Pgas (feet)*	*Hz (feet)*	*Hsl (feet)*	*Pc Req'd for NPSHA of 28 feet (psia)*
5000	150.0	610	3.721	0.926	15.993	28.88	0.9925	16.874	30.95	12.5	4.2	12.09
6000	152.0	612	3.908	0.926	16.220	28.99	0.9925	17.104	31.08	12.5	4.2	12.27
7000	154.0	614	4.103	0.926	16.454	29.11	0.9925	17.342	31.20	12.5	4.2	12.46
8000	156.0	616	4.311	0.926	16.703	29.22	0.9925	17.593	31.32	12.5	4.2	12.67
9000	157.5	618	4.468	0.926	16.890	29.31	0.9925	17.782	31.41	12.5	4.2	12.82
10000	159.0	619	4.633	0.926	17.085	29.39	0.9925	17.980	31.50	12.5	4.2	12.98
15000	163.2	623	5.118	0.926	17.655	29.63	0.9925	18.555	31.76	12.5	4.2	13.45
20000	165.0	625	5.336	0.926	17.909	29.73	0.9925	18.812	31.87	12.5	4.2	13.67
25000	165.5	626	5.401	0.926	17.984	29.76	0.9925	18.888	31.90	12.5	4.2	13.73
30000	165.0	625	5.336	0.926	17.909	29.73	0.9925	18.812	31.87	12.5	4.2	13.67
40000	162.0	622	4.972	0.926	17.485	29.56	0.9925	18.384	31.68	12.5	4.2	13.31
50000	158.2	618	4.542	0.926	16.979	29.35	0.9925	17.872	31.45	12.5	4.2	12.89
60000	154.0	614	4.103	0.926	16.454	29.11	0.9925	17.342	31.20	12.5	4.2	12.46
70000	149.0	609	3.631	0.926	15.882	28.82	0.9925	16.762	30.89	12.5	4.2	12.00
80000	144.0	604	3.200	0.926	15.350	28.54	0.9925	16.223	30.59	12.5	4.2	11.59
90000	140.0	600	2.889	0.926	14.959	28.32	0.9925	15.826	30.36	12.5	4.2	11.28
100000	136.5	597	2.640	0.926	14.696	28.26	0.9925	15.502	30.15	12.5	4.2	11.04
150000	125.5	586	1.970	0.926	14.696	29.74	0.9925	14.696	29.74	12.5	4.2	10.40
200000	118.0	578	1.601	0.926	14.696	30.55	0.9925	14.696	30.55	12.5	4.2	10.05



Amendment 9 Benchmark Case
Current FSAR Figure 14.5-10 NPSH Availability for RHR and Core Spray System

Figure 2

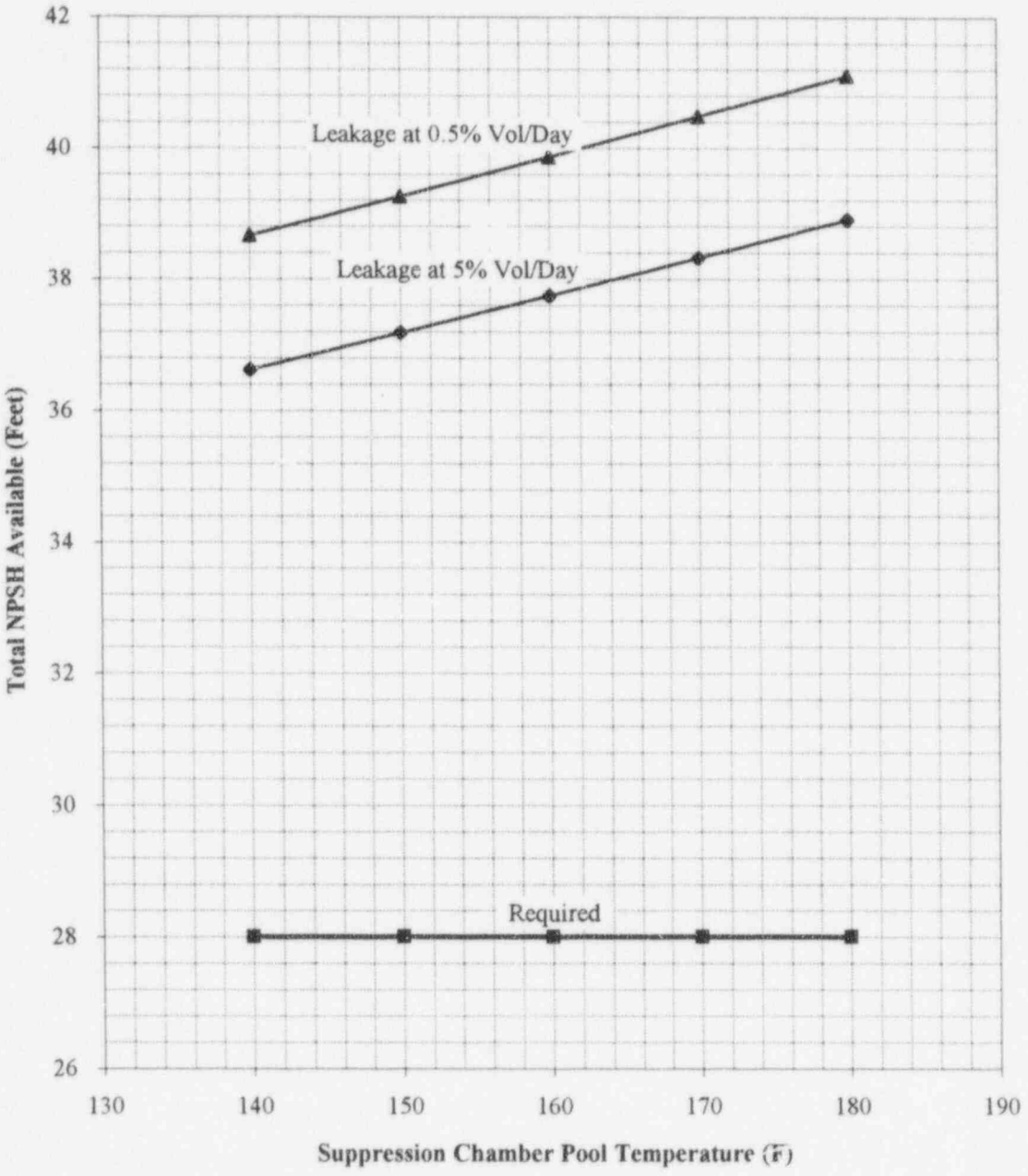
Section 4.C.3 Benchmark Case

In following table the methodology used to calculate values plotted on FSAR Figure 14.5-9 is repeated, and the results of the recalculation are plotted. Based on a comparison, the values contained in the following table and plotted on the attached Figure 3 are consistent with the results presented in the FSAR and Amendment 9. The minor differences in calculated values are most likely due to small variations with inputs.

Table 10 - Benchmark Case NPSH Available and Required

	Eq. 27	Lookup			Eq. 13a	Eq. 19	Eq. 21	Eq. 22	
Pool Temperature (°F)	*Tp (°R)*	*Pvp (psia)*	*Hz (feet)*	*Hsl (feet)*	*Mt*/Mt @ 5% Leakage (%)*	*Pc @ 5% Leakage (psia)*	*Pgas (feet)*	*NPSHA (feet)*	*NPSHR (feet)*
								Values below plotted on Figure 3 ⇓	Values below plotted on Figure 3 ⇓
140	600	2.889	12.5	4.2	0.926	14.959	28.3	36.6	28
150	610	3.721	12.5	4.2	0.926	15.993	28.9	37.2	28
160	620	4.746	12.5	4.2	0.926	17.219	29.4	37.7	28
170	630	5.995	12.5	4.2	0.926	18.669	30.0	38.3	28
180	640	7.511	12.5	4.2	0.926	20.386	30.6	38.9	28

	Eq. 27	Lookup			Eq. 13a	Eq. 19	Eq. 21	Eq. 22	
Pool Temperature (°F)	*Tp (°R)*	*Pvp (psia)*	*Hz (feet)*	*Hsl (feet)*	*Mt*/Mt @ .5% Leakage (%)*	*Pc @ .5% Leakage (psia)*	*Pgas (feet)*	*NPSHA (feet)*	*NPSHR (feet)*
								Values below plotted on Figure 3 ⇓	Values below plotted on Figure 3 ⇓
140	600	2.889	12.5	4.2	0.9925	15.826	30.4	38.7	28
150	610	3.721	12.5	4.2	0.9925	16.874	31.0	39.3	28
160	620	4.746	12.5	4.2	0.9925	18.114	31.6	39.9	28
170	630	5.995	12.5	4.2	0.9925	19.579	32.2	40.5	28
180	640	7.511	12.5	4.2	0.9925	21.311	32.8	41.1	28



Note:
Drywell Initially Saturated at 150 F and 0 psig

Amendment 9 Benchmark Case
Current FSAR Figure 14.5-9 Total NPSH Available Rated Flow

Figure 3

Section 4.C.4 Updated FSAR NPSH Analysis and Figures

The calculation performed to prepare the updated FSAR curves is fundamentally consistent with that used in the "Benchmark Case". Revised inputs are utilized in this analysis per Table 8.

The following methodology is used:

1. Calculate the initial mass of air [or nitrogen] inside the primary containment. The total initial mass is given by Equation 11:

$$Mt = \frac{\left[15.996 - \left(.80\,(3.718)\right)\right]\left(144\,\frac{in^2}{ft^2}\right)(147{,}000)}{53.3\,(610)} + \cdots\cdots\cdots$$

$$\frac{\left[14.696 - \left(1.0\,(.5069)\right)\right]\left(144\,\frac{in^2}{ft^2}\right)(124{,}500)}{53.3\,(540)} = 17316.12\ lbm$$

2. Calculate the reference leakage rate L_T:

   The reference leakage rate is a percentage of the initial mass of noncondensibles per unit time. So for the 1%/day and 5%/day cases, the reference leak rate is:

$$L_T[1\%] = 17316.12\ lbm\,(.01/day) = 173.16\ lbm/day\ or\ 0.002004\ lbm/sec$$
$$L_T[5\%] = 17316.12\ lbm\,(.05/day) = 865.81\ lbm/day\ or\ 0.010021\ lbm/sec$$

3. In successive steps from 100 seconds after the accident till the point of minimum NPSHM is passed, calculate:
   a) mass leakage (water vapor + gas) from containment (m_{leak}) using Eq. 15
   b) relative humidity ω using Eq. 16
   c) noncondensible gas leakage from containment (m_{gas}) using Eq. 17
   d) remaining mass of noncondensible gas in containment (Mt^*) using Eq. 18
   e) containment pressure (Pc) using Eq. 19.

   This calculation is performed for a:

   1%/Day leakage rate - Table 11 for a 65°F seawater temperature
   Table 17 for a 75°F seawater temperature
   5%/Day leakage rate - Table 12 for a 65°F seawater temperature
   Table 18 for a 75°F seawater temperature

4. Using the same suppression pool temperature data and time steps from the previous step, calculate the:
   a) pressure provided by the remaining mass of noncondensible gas in containment ($Pgas$) is calculated using Eq. 21,
   b) NPSHA using Eq. 22,
   c) *Pc Req'd* using Eq. 23,
   d) NPSHM using Eq. 24.

These steps are performed separately for the RHR and Core Spray pumps. The results are contained in the following tables:

RHR pump at 1%/Day leakage rate - 65°F Seawater Temperature (Table 13)
RHR pump at 5%/Day leakage rate - 65°F Seawater Temperature (Table 15)
CS pump at 1%/Day leakage rate - 65°F Seawater Temperature (Table 14)
CS pump at 5%/Day leakage rate - 65°F Seawater Temperature (Table 16)

RHR pump at 1%/Day leakage rate - 75°F Seawater Temperature (Table 19)
RHR pump at 5%/Day leakage rate - 75°F Seawater Temperature (Table 21)
CS pump at 1%/Day leakage rate - 75°F Seawater Temperature (Table 20)
CS pump at 5%/Day leakage rate - 75°F Seawater Temperature (Table 22)

5. As in the Amendment 9 methodology; due to flow through the drywell vents or vacuum breakers, the drywell and wetwell pressures will be approximately equal, i.e., $Pd = Ps$. The drywell and wetwell airspace masses and volumes can be combined and the containment (drywell and wetwell) pressure calculated as a function of the suppression pool temperature for the following reasons:

a) Water from the pool is being pumped into the reactor vessel by a core spray cooling system pump for the 65°F case (by a core spray pump and LPCI pump for the 75°F). This water is heated by the decay heat of the reactor core and pours out of the vessel via the break and into the suppression pool via the drywell vent system. The water which returns to the wetwell is hotter than the suppression pool water by approximately 50°F.

b) Because of the large flow of water involved, the low thermal capacity of the drywell atmosphere, and the slow time rate of change of the temperature of the water flowing through the drywell, the drywell atmospheric temperature will track the water temperature.

c) The drywell airspace temperature will always be hotter than the pool temperature because of the elevated temperature of the break flow.

Table 11 - Containment Pressure Available @ 1%/Day Leakage Rate - 65°F Seawater Temperature

	Lookup			*Eq. 15*	*Eq. 16*	*Eq. 17*		*Eq. 18*	*Eq. 19*
Time (seconds)	*Tp (°F)*	*Tp (°R)*	*Pvp (psia)*	m_{leak} *(lbm/sec)*	ω	m_{gas} *(lbm/sec)*	ΔT *(sec)*	Mt^* *(lbm)*	P_C *(psia)*
	128.75	588.75	2.150					17316.12	16.049
100	128.75	588.75	2.150	0.00083	0.096	0.00076	100	17316.04	16.049
200	131.75	591.75	2.331	0.00083	0.096	0.00076	100	17315.96	16.301
400	133.10	593.10	2.414	0.00089	0.104	0.00081	200	17315.80	16.415
600	133.70	593.70	2.453	0.00092	0.107	0.00083	200	17315.64	16.469
1000	135.90	595.90	2.598	0.00093	0.109	0.00084	400	17315.30	16.665
2000	141.25	601.25	2.986	0.00098	0.115	0.00087	1000	17314.42	17.179
4000	148.33	608.33	3.571	0.00107	0.131	0.00095	2000	17312.53	17.929
6000	153.65	613.65	4.069	0.00118	0.155	0.00103	2000	17310.48	18.550
10000	160.70	620.70	4.825	0.00126	0.175	0.00107	4000	17306.18	19.470
14000	164.50	624.50	5.275	0.00136	0.205	0.00113	4000	17301.68	20.006
16000	165.65	625.65	5.421	0.00140	0.223	0.00115	2000	17299.39	20.176
20000	166.40	626.40	5.518	0.00142	0.228	0.00115	4000	17294.77	20.287
24000	166.20	626.20	5.492	0.00143	0.232	0.00116	4000	17290.14	20.253
30000	165.03	625.03	5.340	0.00142	0.231	0.00116	6000	17283.21	20.067
35000	163.63	623.63	5.170	0.00141	0.226	0.00115	5000	17277.47	19.859
40000	162.00	622.00	4.972	0.00139	0.219	0.00114	5000	17271.76	19.618
60000	154.00	614.00	4.103	0.00137	0.211	0.00113	20000	17249.14	18.541
80000	145.95	605.95	3.363	0.00126	0.177	0.00107	20000	17227.71	17.595
100000	138.20	598.20	2.761	0.00114	0.147	0.00099	20000	17207.89	16.795
120000	132.25	592.25	2.362	0.00100	0.122	0.00089	20000	17190.05	16.241
140000	127.50	587.50	2.080	0.00088	0.106	0.00080	20000	17174.13	15.836
150000	125.50	585.50	1.970	0.00077	0.094	0.00070	10000	17167.09	15.673
160000	123.80	583.80	1.882	0.00072	0.089	0.00066	10000	17160.49	15.540
180000	120.75	580.75	1.730	0.00067	0.086	0.00062	20000	17148.11	15.307
190000	119.25	579.25	1.660	0.00058	0.079	0.00054	10000	17142.75	15.197

Table 11 - Containment Pressure Available @ 1%/Day Leakage Rate - 65°F Seawater Temperature

	Lookup			*Eq. 15*	*Eq. 16*	*Eq. 17*		*Eq. 18*	*Eq. 19*
Time (seconds)	*Tp (°F)*	*Tp (°R)*	*Pvp (psia)*	m_{leak} *(lbm/sec)*	ω	m_{gas} *(lbm/sec)*	ΔT *(sec)*	Mi^* *(lbm)*	P_C *(psia)*
200000	118.00	578.00	1.601	0.00053	0.076	0.00049	10000	17137.85	15.105
210000	116.75	576.75	1.547	0.00048	0.074	0.00045	10000	17133.40	15.019
220000	115.57	575.57	1.496	0.00043	0.071	0.00040	10000	17129.42	14.937
230000	114.50	574.50	1.451	0.00037	0.069	0.00035	10000	17125.96	14.865
240000	113.50	573.50	1.412	0.00031	0.067	0.00029	10000	17123.05	14.799
250000	112.50	572.50	1.372	0.00024	0.066	0.00023	10000	17120.76	14.735
260000	111.53	571.53	1.333	0.00015	0.064	0.00014	10000	17119.36	14.696
270000	110.68	570.68	1.301	0.00000	0.062	0.00000	10000	17119.36	14.696
280000	110.00	570.00	1.276	0.00000	0.060	0.00000	10000	17119.36	14.696
290000	109.12	569.12	1.244	0.00000	0.059	0.00000	10000	17119.36	14.696
300000	108.40	568.40	1.218	0.00000	0.058	0.00000	10000	17119.36	14.696
310000	107.75	567.75	1.195	0.00000	0.056	0.00000	10000	17119.36	14.696
320000	107.00	567.00	1.170	0.00000	0.055	0.00000	10000	17119.36	14.696
330000	106.32	566.32	1.147	0.00000	0.054	0.00000	10000	17119.36	14.696
340000	105.75	565.75	1.128	0.00000	0.053	0.00000	10000	17119.36	14.696
350000	105.08	565.08	1.106	0.00000	0.052	0.00000	10000	17119.36	14.696
360000	104.40	564.40	1.083	0.00000	0.051	0.00000	10000	17119.36	14.696
380000	103.39	563.39	1.051	0.00000	0.049	0.00000	20000	17119.36	14.696
400000	102.25	562.25	1.017	0.00000	0.048	0.00000	20000	17119.36	14.696
500000	97.50	557.50	0.881	0.00000	0.046	0.00000	100000	17119.36	14.696
600000	94.00	554.00	0.791	0.00000	0.040	0.00000	100000	17119.36	14.696
700000	91.38	551.38	0.730	0.00000	0.035	0.00000	100000	17119.36	14.696
800000	89.25	549.25	0.682	0.00000	0.033	0.00000	100000	17119.36	14.696
900000	87.38	547.38	0.644	0.00000	0.030	0.00000	100000	17119.36	14.696
920000	87.00	547.00	0.636	0.00000	0.028	0.00000	20000	17119.36	14.696

Boston Edison

PREPARED BY: P. Doody

CHECKED BY: P.D. Harizi

Table 12 - Containment Pressure Available @ 5%/Day Leakage Rate- 65°F Seawater Temperature

	Lookup			*Eq. 15*	*Eq. 16*	*Eq. 17*		*Eq. 18*	*Eq. 19*
Time (seconds)	*Tp (°F)*	*Tp (°R)*	*Pvp (psia)*	m_{leak} *(lbm/sec)*	ω	m_{gas} *(lbm/sec)*	ΔT *(sec)*	M_i^* *(lbm)*	P_C *(psia)*
	128.75	588.75	2.150					17316.12	16.049
100	128.75	588.75	2.150	0.00415	0.096	0.00379	100	17315.74	16.049
200	131.75	591.75	2.331	0.00415	0.096	0.00379	100	17315.36	16.300
400	133.10	593.10	2.414	0.00447	0.104	0.00405	200	17314.55	16.414
600	133.70	593.70	2.453	0.00461	0.107	0.00416	200	17313.72	16.467
1000	135.90	595.90	2.598	0.00466	0.109	0.00421	400	17312.03	16.662
2000	141.25	601.25	2.986	0.00487	0.115	0.00437	1000	17307.66	17.173
4000	148.33	608.33	3.571	0.00535	0.131	0.00473	2000	17298.20	17.917
6000	153.65	613.65	4.069	0.00591	0.155	0.00512	2000	17287.96	18.532
10000	160.70	620.70	4.825	0.00630	0.175	0.00536	4000	17266.52	19.436
14000	164.50	624.50	5.275	0.00677	0.205	0.00561	4000	17244.06	19.957
16000	165.65	625.65	5.421	0.00699	0.223	0.00572	2000	17232.63	20.119
20000	166.40	626.40	5.518	0.00706	0.229	0.00574	4000	17209.65	20.215
24000	166.20	626.20	5.492	0.00710	0.234	0.00576	4000	17186.63	20.164
30000	165.03	625.03	5.340	0.00708	0.233	0.00574	6000	17152.18	19.956
35000	163.63	623.63	5.170	0.00699	0.227	0.00570	5000	17123.68	19.729
40000	162.00	622.00	4.972	0.00690	0.221	0.00565	5000	17095.43	19.469
60000	154.00	614.00	4.103	0.00678	0.213	0.00559	20000	16983.65	18.319
80000	145.95	605.95	3.363	0.00617	0.179	0.00523	20000	16878.98	17.307
100000	138.20	598.20	2.761	0.00546	0.150	0.00475	20000	16784.02	16.449
120000	132.25	592.25	2.362	0.00464	0.125	0.00413	20000	16701.49	15.847
140000	127.50	587.50	2.080	0.00387	0.109	0.00349	20000	16631.72	15.401
150000	125.50	585.50	1.970	0.00309	0.097	0.00282	10000	16603.53	15.223
160000	123.80	583.80	1.882	0.00270	0.092	0.00247	10000	16578.84	15.077
180000	120.75	580.75	1.730	0.00231	0.089	0.00212	20000	16536.40	14.823

Table 12 - Containment Pressure Available @ 5%/Day Leakage Rate- 65°F Seawater Temperature

	Lookup			*Eq. 15*	*Eq. 16*	*Eq. 17*		*Eq. 18*	*Eq. 19*
Time (seconds)	*Tp (°F)*	*Tp (°R)*	*Pvp (psia)*	m_{leak} *(lbm/sec)*	ω	m_{gas} *(lbm/sec)*	ΔT *(sec)*	Mt^* *(lbm)*	P_C *(psia)*
190000	119.25	579.25	1.660	0.00135	0.082	0.00125	10000	16523.92	14.709
200000	118.00	578.00	1.601	0.00043	0.079	0.00040	10000	16519.96	14.696
210000	116.75	576.75	1.547	0.00000	0.076	0.00000	10000	16519.96	14.696
220000	115.57	575.57	1.496	0.00000	0.073	0.00000	10000	16519.96	14.696
230000	114.50	574.50	1.451	0.00000	0.070	0.00000	10000	16519.96	14.696
240000	113.50	573.50	1.412	0.00000	0.068	0.00000	10000	16519.96	14.696
250000	112.50	572.50	1.372	0.00000	0.066	0.00000	10000	16519.96	14.696
260000	111.53	571.53	1.333	0.00000	0.064	0.00000	10000	16519.96	14.696
270000	110.68	570.68	1.301	0.00000	0.062	0.00000	10000	16519.96	14.696
280000	110.00	570.00	1.276	0.00000	0.060	0.00000	10000	16519.96	14.696
290000	109.12	569.12	1.244	0.00000	0.059	0.00000	10000	16519.96	14.696
300000	108.40	568.40	1.218	0.00000	0.058	0.00000	10000	16519.96	14.696
310000	107.75	567.75	1.195	0.00000	0.056	0.00000	10000	16519.96	14.696
320000	107.00	567.00	1.170	0.00000	0.055	0.00000	10000	16519.96	14.696
330000	106.32	566.32	1.147	0.00000	0.054	0.00000	10000	16519.96	14.696
340000	105.75	565.75	1.128	0.00000	0.053	0.00000	10000	16519.96	14.696
350000	105.08	565.08	1.106	0.00000	0.052	0.00000	10000	16519.96	14.696
360000	104.40	564.40	1.083	0.00000	0.051	0.00000	10000	16519.96	14.696
380000	103.39	563.39	1.051	0.00000	0.049	0.00000	20000	16519.96	14.696
400000	102.25	562.25	1.017	0.00000	0.048	0.00000	20000	16519.96	14.696
500000	97.50	557.50	0.881	0.00000	0.046	0.00000	100000	16519.96	14.696
600000	94.00	554.00	0.791	0.00000	0.040	0.00000	100000	16519.96	14.696
700000	91.38	551.38	0.730	0.00000	0.035	0.00000	100000	16519.96	14.696
800000	89.25	549.25	0.682	0.00000	0.033	0.00000	100000	16519.96	14.696
900000	87.38	547.38	0.644	0.00000	0.030	0.00000	100000	16519.96	14.696
920000	87.00	547.00	0.636	0.00000	0.028	0.00000	20000	16519.96	14.696

Table 13 - Updated Analysis - Containment Pressure for RHR Pump NPSHR at 1%/Day Leakage Rate- 65°F Seawater Temperature

		F14.5-10	*Lookup*	*Lookup*	*Eq. 19*	*Eq. 21*			*Eq. 22*	*Eq. 23*	*Eq. 24*
Time (secs)	*Time* (hours)	*Tp* (°F)	*ρ* (lbm/ft³)	*Pvp* (psia)	P_C (psia)	*Pgas* (feet)	*Hz* (feet)	*Hsl* (feet)	*NPSHA* (feet)	P_c *Req'd for NPSHA of 23 feet* (psia)	*Margin* (feet)
		Values below plotted on Figure 4 ⇓			*Values below plotted on Figure 4* ⇓					*Values below plotted on Figure 4* ⇓	*Values below plotted on Figure 5* ⇓
100	0.028	128.8	61.56	2.150	16.049	32.51	12.5	2.63	42.4	7.76	19.4
200	0.056	131.8	61.52	2.331	16.301	32.70	12.5	2.63	42.6	7.94	19.6
400	0.111	133.1	61.50	2.414	16.415	32.78	12.5	2.63	42.7	8.02	19.7
600	0.167	133.7	61.48	2.453	16.469	32.82	12.5	2.63	42.7	8.06	19.7
1000	0.278	135.9	61.43	2.598	16.665	32.97	12.5	2.63	42.8	8.20	19.8
2000	0.556	141.3	61.35	2.986	17.179	33.31	12.5	2.63	43.2	8.58	20.2
4000	1.111	148.3	61.22	3.571	17.929	33.77	12.5	2.63	43.6	9.15	20.6
6000	1.667	153.7	61.11	4.069	18.550	34.13	12.5	2.63	44.0	9.64	21.0
10000	2.778	160.7	60.98	4.825	19.470	34.58	12.5	2.63	44.5	10.39	21.5
14000	3.889	164.5	60.90	5.275	20.006	34.83	12.5	2.63	44.7	10.83	21.7
16000	4.444	165.7	60.88	5.421	20.176	34.90	12.5	2.63	44.8	10.97	21.8
20000	5.556	166.4	60.87	5.518	20.287	34.94	12.5	2.63	44.8	11.07	21.8
24000	6.667	166.2	60.87	5.492	20.253	34.92	12.5	2.63	44.8	11.04	21.8
30000	8.333	165.0	60.89	5.340	20.067	34.83	12.5	2.63	44.7	10.89	21.7
35000	9.722	163.6	60.92	5.170	19.859	34.72	12.5	2.63	44.6	10.72	21.6
40000	11.111	162.0	60.96	4.972	19.618	34.60	12.5	2.63	44.5	10.53	21.5
60000	16.667	154.0	61.10	4.103	18.541	34.03	12.5	2.63	43.9	9.67	20.9
80000	22.222	146.0	61.26	3.363	17.595	33.45	12.5	2.63	43.3	8.95	20.3
100000	27.778	138.2	61.40	2.761	16.795	32.91	12.5	2.63	42.8	8.36	19.8
120000	33.333	132.3	61.51	2.362	16.241	32.49	12.5	2.63	42.4	7.97	19.4
140000	38.889	127.5	61.59	2.080	15.836	32.16	12.5	2.63	42.0	7.70	19.0
150000	41.667	125.5	61.62	1.970	15.673	32.02	12.5	2.63	41.9	7.59	18.9
160000	44.444	123.8	61.65	1.882	15.540	31.90	12.5	2.63	41.8	7.50	18.8
180000	50.000	120.8	61.70	1.730	15.307	31.69	12.5	2.63	41.6	7.36	18.6

Table 13 - Updated Analysis - Containment Pressure for RHR Pump NPSHR at 1%/Day Leakage Rate- 65°F Seawater Temperature

		F14.5-10	*Lookup*	*Lookup*	*Eq. 19*	*Eq. 21*			*Eq. 22*	*Eq. 23*	*Eq. 24*
Time (secs)	*Time* (hours)	*Tp* (°F)	*ρ* (lbm/ft^3)	*Pvp* (psia)	P_C (psia)	*Pgas* (feet)	*Hz* (feet)	*Hsl* (feet)	*NPSHA* (feet)	P_c *Req'd for NPSHA of 23 feet* (psia)	*Margin* (feet)
190000	52.778	119.3	61.71	1.660	15.197	31.59	12.5	2.63	41.5	7.29	18.5
200000	55.556	118.0	61.73	1.601	15.105	31.50	12.5	2.63	41.4	7.23	18.4
210000	58.333	116.8	61.75	1.547	15.019	31.42	12.5	2.63	41.3	7.18	18.3
220000	61.111	115.6	61.77	1.496	14.937	31.33	12.5	2.63	41.2	7.13	18.2
230000	63.889	114.5	61.79	1.451	14.865	31.26	12.5	2.63	41.1	7.09	18.1
240000	66.667	113.5	61.80	1.412	14.799	31.19	12.5	2.63	41.1	7.05	18.1
250000	69.444	112.5	61.82	1.372	14.735	31.13	12.5	2.63	41.0	7.01	18.0
260000	72.222	111.5	61.83	1.333	14.696	31.12	12.5	2.63	41.0	6.97	18.0
270000	75.000	110.7	61.85	1.301	14.696	31.19	12.5	2.63	41.1	6.94	18.1
280000	77.778	110.0	61.86	1.276	14.696	31.24	12.5	2.63	41.1	6.92	18.1
290000	80.556	109.1	61.87	1.244	14.696	31.31	12.5	2.63	41.2	6.89	18.2
300000	83.333	108.4	61.88	1.218	14.696	31.36	12.5	2.63	41.2	6.86	18.2
310000	86.111	107.8	61.89	1.195	14.696	31.41	12.5	2.63	41.3	6.84	18.3
320000	88.889	107.0	61.90	1.170	14.696	31.47	12.5	2.63	41.3	6.81	18.3
330000	91.667	106.3	61.91	1.147	14.696	31.52	12.5	2.63	41.4	6.79	18.4
340000	94.444	105.8	61.91	1.128	14.696	31.56	12.5	2.63	41.4	6.77	18.4
350000	97.222	105.1	61.92	1.106	14.696	31.61	12.5	2.63	41.5	6.75	18.5
360000	100.000	104.4	61.93	1.083	14.696	31.66	12.5	2.63	41.5	6.73	18.5
380000	105.556	103.4	61.94	1.051	14.696	31.72	12.5	2.63	41.6	6.70	18.6
400000	111.111	102.3	61.95	1.017	14.696	31.80	12.5	2.63	41.7	6.67	18.7
500000	138.889	97.5	62.02	0.881	14.696	32.08	12.5	2.63	41.9	6.54	18.9
600000	166.667	94.0	62.06	0.791	14.696	32.26	12.5	2.63	42.1	6.45	19.1
700000	194.444	91.4	62.09	0.730	14.696	32.39	12.5	2.63	42.3	6.39	19.3
800000	222.222	89.3	62.11	0.682	14.696	32.49	12.5	2.63	42.4	6.35	19.4
900000	250.000	87.4	62.13	0.644	14.696	32.57	12.5	2.63	42.4	6.31	19.4
920000	255.556	87.0	62.14	0.636	14.696	32.58	12.5	2.63	42.5	6.30	19.5

Table 14 - Updated Analysis - Containment Pressure for Core Spray Pump NPSHR at 1%/Day Leakage Rate- 65°F Seawater Temperature

		F14.5-10	*Lookup*	*Lookup*	*Eq. 19*	*Eq. 21*			*Eq. 22*	*Eq. 23*	*Eq. 24*
Time (secs)	*Time* (hours)	*Tp* (°F)	*ρ* (lbm/ft^3)	*Pvp* (psia)	P_C (psia)	*Pgas* (feet)	*Hz* (feet)	*Hsl* (feet)	*NPSHA* (feet)	P_c *Req'd for NPSHA of 29 feet* (psia)	*Margin* (feet)
		Values below plotted on Figure 4 ⇓			*Values below plotted on Figure 4* ⇓					*Values below plotted on Figure 4* ⇓	*Values below plotted on Figure 5* ⇓
100	0.028	128.8	61.56	2.150	16.049	32.51	12.5	2.40	42.6	10.23	13.6
200	0.056	131.8	61.52	2.331	16.301	32.70	12.5	2.40	42.8	10.41	13.8
400	0.111	133.1	61.50	2.414	16.415	32.78	12.5	2.40	42.9	10.49	13.9
600	0.167	133.7	61.48	2.453	16.469	32.82	12.5	2.40	42.9	10.52	13.9
1000	0.278	135.9	61.43	2.598	16.665	32.97	12.5	2.40	43.1	10.66	14.1
2000	0.556	141.3	61.35	2.986	17.179	33.31	12.5	2.40	43.4	11.04	14.4
4000	1.111	148.3	61.22	3.571	17.929	33.77	12.5	2.40	43.9	11.61	14.9
6000	1.667	153.7	61.11	4.069	18.550	34.13	12.5	2.40	44.2	12.09	15.2
10000	2.778	160.7	60.98	4.825	19.470	34.58	12.5	2.40	44.7	12.83	15.7
14000	3.889	164.5	60.90	5.275	20.006	34.83	12.5	2.40	44.9	13.27	15.9
16000	4.444	165.7	60.88	5.421	20.176	34.90	12.5	2.40	45.0	13.41	16.0
20000	5.556	166.4	60.87	5.518	20.287	34.94	12.5	2.40	45.0	13.51	16.0
24000	6.667	166.2	60.87	5.492	20.253	34.92	12.5	2.40	45.0	13.48	16.0
30000	8.333	165.0	60.89	5.340	20.067	34.83	12.5	2.40	44.9	13.33	15.9
35000	9.722	163.6	60.92	5.170	19.859	34.72	12.5	2.40	44.8	13.17	15.8
40000	11.111	162.0	60.96	4.972	19.618	34.60	12.5	2.40	44.7	12.97	15.7
60000	16.667	154.0	61.10	4.103	18.541	34.03	12.5	2.40	44.1	12.12	15.1
80000	22.222	146.0	61.26	3.363	17.595	33.45	12.5	2.40	43.6	11.40	14.6
100000	27.778	138.2	61.40	2.761	16.795	32.91	12.5	2.40	43.0	10.82	14.0
120000	33.333	132.3	61.51	2.362	16.241	32.49	12.5	2.40	42.6	10.44	13.6
140000	38.889	127.5	61.59	2.080	15.836	32.16	12.5	2.40	42.3	10.16	13.3
150000	41.667	125.5	61.62	1.970	15.673	32.02	12.5	2.40	42.1	10.06	13.1
160000	44.444	123.8	61.65	1.882	15.540	31.90	12.5	2.40	42.0	9.97	13.0

Table 14 - Updated Analysis - Containment Pressure for Core Spray Pump NPSHR at 1%/Day Leakage Rate- 65°F Seawater Temperature

		F14.5-10	*Lookup*	*Lookup*	*Eq. 19*	*Eq. 21*			*Eq. 22*	*Eq. 23*	*Eq. 24*
Time (secs)	*Time* (hours)	*Tp* (°F)	*ρ* (lbm/ft³)	*Pvp* (psia)	*P_C* (psia)	*Pgas* (feet)	*Hz* (feet)	*Hsl* (feet)	*NPSHA* (feet)	*P_c Req'd for NPSHA of 29 feet* (psia)	*Margin* (feet)
180000	50.000	120.8	61.70	1.730	15.307	31.69	12.5	2.40	41.8	9.83	12.8
190000	52.778	119.3	61.71	1.660	15.197	31.59	12.5	2.40	41.7	9.76	12.7
200000	55.556	118.0	61.73	1.601	15.105	31.50	12.5	2.40	41.6	9.70	12.6
210000	58.333	116.8	61.75	1.547	15.019	31.42	12.5	2.40	41.5	9.65	12.5
220000	61.111	115.6	61.77	1.496	14.937	31.33	12.5	2.40	41.4	9.60	12.4
230000	63.889	114.5	61.79	1.451	14.865	31.26	12.5	2.40	41.4	9.56	12.4
240000	66.667	113.5	61.80	1.412	14.799	31.19	12.5	2.40	41.3	9.52	12.3
250000	69.444	112.5	61.82	1.372	14.735	31.13	12.5	2.40	41.2	9.49	12.2
260000	72.222	111.5	61.83	1.333	14.696	31.12	12.5	2.40	41.2	9.45	12.2
270000	75.000	110.7	61.85	1.301	14.696	31.19	12.5	2.40	41.3	9.42	12.3
280000	77.778	110.0	61.86	1.276	14.696	31.24	12.5	2.40	41.3	9.39	12.3
290000	80.556	109.1	61.87	1.244	14.696	31.31	12.5	2.40	41.4	9.36	12.4
300000	83.333	108.4	61.88	1.218	14.696	31.36	12.5	2.40	41.5	9.34	12.5
310000	86.111	107.8	61.89	1.195	14.696	31.41	12.5	2.40	41.5	9.32	12.5
320000	88.889	107.0	61.90	1.170	14.696	31.47	12.5	2.40	41.6	9.29	12.6
330000	91.667	106.3	61.91	1.147	14.696	31.52	12.5	2.40	41.6	9.27	12.6
340000	94.444	105.8	61.91	1.128	14.696	31.56	12.5	2.40	41.7	9.25	12.7
350000	97.222	105.1	61.92	1.106	14.696	31.61	12.5	2.40	41.7	9.23	12.7
360000	100.000	104.4	61.93	1.083	14.696	31.66	12.5	2.40	41.8	9.21	12.8
380000	105.556	103.4	61.94	1.051	14.696	31.72	12.5	2.40	41.8	9.18	12.8
400000	111.111	102.3	61.95	1.017	14.696	31.80	12.5	2.40	41.9	9.15	12.9
500000	138.889	97.5	62.02	0.881	14.696	32.08	12.5	2.40	42.2	9.02	13.2
600000	166.667	94.0	62.06	0.791	14.696	32.26	12.5	2.40	42.4	8.94	13.4
700000	194.444	91.4	62.09	0.730	14.696	32.39	12.5	2.40	42.5	8.88	13.5
800000	222.222	89.3	62.11	0.682	14.696	32.49	12.5	2.40	42.6	8.83	13.6
900000	250.000	87.4	62.13	0.644	14.696	32.57	12.5	2.40	42.7	8.80	13.7
920000	255.556	87.0	62.14	0.636	14.696	32.58	12.5	2.40	42.7	8.79	13.7

Table 15 - Updated Analysis - Containment Pressure for RHR Pump NPSHR at 5%/Day Leakage Rate- 65°F Seawater Temperature

		F14.5-10	*Lookup*	*Lookup*	*Eq. 19*	*Eq. 21*			*Eq. 22*	*Eq. 23*	*Eq. 24*
Time (secs)	*Time* (hours)	*Tp* (°F)	*ρ* (lbm/ft^3)	*Pvp* (psia)	P_C (psia)	*Pgas* (feet)	*Hz* (feet)	*Hsl* (feet)	*NPSHA* (feet)	P_c *Req'd for NPSHA of 23 feet* (psia)	*Margin* (feet)
		Values below plotted on Figure 4 ⇓			*Values below plotted on Figure 4* ⇓					*Values below plotted on Figure 4* ⇓	*Values below plotted on Figure 5* ⇓
100	0.028	128.8	61.56	2.150	16.049	32.51	12.5	2.63	42.4	7.76	19.4
200	0.056	131.8	61.52	2.331	16.300	32.70	12.5	2.63	42.6	7.94	19.6
400	0.111	133.1	61.50	2.414	16.414	32.78	12.5	2.63	42.7	8.02	19.7
600	0.167	133.7	61.48	2.453	16.467	32.82	12.5	2.63	42.7	8.06	19.7
1000	0.278	135.9	61.43	2.598	16.662	32.97	12.5	2.63	42.8	8.20	19.8
2000	0.556	141.3	61.35	2.986	17.173	33.30	12.5	2.63	43.2	8.58	20.2
4000	1.111	148.3	61.22	3.571	17.917	33.75	12.5	2.63	43.6	9.15	20.6
6000	1.667	153.7	61.11	4.069	18.532	34.08	12.5	2.63	44.0	9.64	21.0
10000	2.778	160.7	60.98	4.825	19.436	34.50	12.5	2.63	44.4	10.39	21.4
14000	3.889	164.5	60.90	5.275	19.957	34.71	12.5	2.63	44.6	10.83	21.6
16000	4.444	165.7	60.88	5.421	20.119	34.77	12.5	2.63	44.6	10.97	21.6
20000	5.556	166.4	60.87	5.518	20.215	34.77	12.5	2.63	44.6	11.07	21.6
24000	6.667	166.2	60.87	5.492	20.164	34.71	12.5	2.63	44.6	11.04	21.6
30000	8.333	165.0	60.89	5.340	19.956	34.56	12.5	2.63	44.4	10.89	21.4
35000	9.722	163.6	60.92	5.170	19.729	34.41	12.5	2.63	44.3	10.72	21.3
40000	11.111	162.0	60.96	4.972	19.469	34.24	12.5	2.63	44.1	10.53	21.1
60000	16.667	154.0	61.10	4.103	18.319	33.51	12.5	2.63	43.4	9.67	20.4
80000	22.222	146.0	61.26	3.363	17.307	32.77	12.5	2.63	42.6	8.95	19.6
100000	27.778	138.2	61.40	2.761	16.449	32.10	12.5	2.63	42.0	8.36	19.0
120000	33.333	132.3	61.51	2.362	15.847	31.57	12.5	2.63	41.4	7.97	18.4
140000	38.889	127.5	61.59	2.080	15.401	31.15	12.5	2.63	41.0	7.70	18.0
150000	41.667	125.5	61.62	1.970	15.223	30.97	12.5	2.63	40.8	7.59	17.8
160000	44.444	123.8	61.65	1.882	15.077	30.82	12.5	2.63	40.7	7.50	17.7

Table 15 - Updated Analysis - Containment Pressure for RHR Pump NPSHR at 5%/Day Leakage Rate- 65°F Seawater Temperature

		F14.5-10	*Lookup*	*Lookup*	*Eq. 19*	*Eq. 21*			*Eq. 22*	*Eq. 23*	*Eq. 24*
Time (secs)	*Time* (hours)	*Tp* (°F)	*ρ* (lbm/ft³)	*Pvp* (psia)	P_C (psia)	*Pgas* (feet)	*Hz* (feet)	*Hsl* (feet)	*NPSHA* (feet)	P_c *Req'd for NPSHA of 23 feet* (psia)	*Margin* (feet)
180000	50.000	120.8	61.70	1.730	14.823	30.56	12.5	2.63	40.4	7.36	17.4
190000	52.778	119.3	61.71	1.660	14.709	30.45	12.5	2.63	40.3	7.29	17.3
200000	55.556	118.0	61.73	1.601	14.696	30.55	12.5	2.63	40.4	7.23	17.4
210000	58.333	116.8	61.75	1.547	14.696	30.66	12.5	2.63	40.5	7.18	17.5
220000	61.111	115.6	61.77	1.496	14.696	30.77	12.5	2.63	40.6	7.13	17.6
230000	63.889	114.5	61.79	1.451	14.696	30.87	12.5	2.63	40.7	7.09	17.7
240000	66.667	113.5	61.80	1.412	14.696	30.95	12.5	2.63	40.8	7.05	17.8
250000	69.444	112.5	61.82	1.372	14.696	31.04	12.5	2.63	40.9	7.01	17.9
260000	72.222	111.5	61.83	1.333	14.696	31.12	12.5	2.63	41.0	6.97	18.0
270000	75.000	110.7	61.85	1.301	14.696	31.19	12.5	2.63	41.1	6.94	18.1
280000	77.778	110.0	61.86	1.276	14.696	31.24	12.5	2.63	41.1	6.92	18.1
290000	80.556	109.1	61.87	1.244	14.696	31.31	12.5	2.63	41.2	6.89	18.2
300000	83.333	108.4	61.88	1.218	14.696	31.36	12.5	2.63	41.2	6.86	18.2
310000	86.111	107.8	61.89	1.195	14.696	31.41	12.5	2.63	41.3	6.8	18.3
320000	88.889	107.0	61.90	1.170	14.696	31.47	12.5	2.63	41.3	6.8	18.3
330000	91.667	106.3	61.91	1.147	14.696	31.52	12.5	2.63	41.4	6.7	18.4
340000	94.444	105.8	61.91	1.128	14.696	31.56	12.5	2.63	41.4	6.77	18.4
350000	97.222	105.1	61.92	1.106	14.696	31.61	12.5	2.63	41.5	6.75	18.5
360000	100.000	104.4	61.93	1.083	14.696	31.66	12.5	2.63	41.5	6.73	18.5
380000	105.556	103.4	61.94	1.051	14.696	31.72	12.5	2.63	41.6	6.70	18.6
400000	111.111	102.3	61.95	1.017	14.696	31.80	12.5	2.63	41.7	6.67	18.7
500000	138.889	97.5	62.02	0.881	14.696	32.08	12.5	2.63	41.9	6.54	18.9
600000	166.667	94.0	62.06	0.791	14.696	32.26	12.5	2.63	42.1	6.45	19.1
700000	194.444	91.4	62.09	0.730	14.696	32.39	12.5	2.63	42.3	6.39	19.3
800000	222.222	89.3	62.11	0.682	14.696	32.49	12.5	2.63	42.4	6.35	19.4
900000	250.000	87.4	62.13	0.644	14.696	32.57	12.5	2.63	42.4	6.31	19.4
920000	255.556	87.0	62.14	0.636	14.696	32.58	12.5	2.63	42.5	6.30	19.5

Table 16 - Updated Analysis - Containment Pressure for Core Spray Pump NPSHR at 5%/Day Leakage Rate- 65°F Seawater Temperature

		F14.5-10	*Lookup*	*Lookup*	*Eq. 19*	*Eq. 21*			*Eq. 22*	*Eq. 23*	*Eq. 24*
Time (secs)	*Time* (hours)	*Tp* (°F)	*ρ* (lbm/ft^3)	*Pvp* (psia)	P_C (psia)	*Pgas* (feet)	*Hz* (feet)	*Hsl* (feet)	*NPSHA* (feet)	P_c *Req'd for NPSHA of 29 feet* (psia)	*Margin* (feet)
		Values below plotted on Figure 4 ⇓			*Values below plotted on Figure 4* ⇓					*Values below plotted on Figure 4* ⇓	*Values below plotted on Figure 5* ⇓
100	0.028	128.8	61.56	2.150	16.049	32.51	12.5	2.40	42.6	10.23	13.6
200	0.056	131.8	61.52	2.331	16.300	32.70	12.5	2.40	42.8	10.41	13.8
400	0.111	133.1	61.50	2.414	16.414	32.78	12.5	2.40	42.9	10.49	13.9
600	0.167	133.7	61.48	2.453	16.467	32.82	12.5	2.40	42.9	10.52	13.9
1000	0.278	135.9	61.43	2.598	16.662	32.97	12.5	2.40	43.1	10.66	14.1
2000	0.556	141.3	61.35	2.986	17.173	33.30	12.5	2.40	43.4	11.04	14.4
4000	1.111	148.3	61.22	3.571	17.917	33.75	12.5	2.40	43.8	11.61	14.8
6000	1.667	153.7	61.11	4.069	18.532	34.08	12.5	2.40	44.2	12.09	15.2
10000	2.778	160.7	60.98	4.825	19.436	34.50	12.5	2.40	44.6	12.83	15.6
14000	3.889	164.5	60.90	5.275	19.957	34.71	12.5	2.40	44.8	13.27	15.8
16000	4.444	165.7	60.88	5.421	20.119	34.77	12.5	2.40	44.9	13.41	15.9
20000	5.556	166.4	60.87	5.518	20.215	34.77	12.5	2.40	44.9	13.51	15.9
24000	6.667	166.2	60.87	5.492	20.164	34.71	12.5	2.40	44.8	13.48	15.8
30000	8.333	165.0	60.89	5.340	19.956	34.56	12.5	2.40	44.7	13.33	15.7
35000	9.722	163.6	60.92	5.170	19.729	34.41	12.5	2.40	44.5	13.17	15.5
40000	11.111	162.0	60.96	4.972	19.469	34.24	12.5	2.40	44.3	12.97	15.3
60000	16.667	154.0	61.10	4.103	18.319	33.51	12.5	2.40	43.6	12.12	14.6
80000	22.222	146.0	61.26	3.363	17.307	32.77	12.5	2.40	42.9	11.40	13.9
100000	27.778	138.2	61.40	2.761	16.449	32.10	12.5	2.40	42.2	10.82	13.2
120000	33.333	132.3	61.51	2.362	15.847	31.57	12.5	2.40	41.7	10.44	12.7
140000	38.889	127.5	61.59	2.080	15.401	31.15	12.5	2.40	41.2	10.16	12.2
150000	41.667	125.5	61.62	1.970	15.223	30.97	12.5	2.40	41.1	10.06	12.1
160000	44.444	123.8	61.65	1.882	15.077	30.82	12.5	2.40	40.9	9.97	11.9

Table 16 - Updated Analysis - Containment Pressure for Core Spray Pump NPSHR at 5%/Day Leakage Rate- 65°F Seawater Temperature

		F14.5-10	*Lookup*	*Lookup*	*Eq. 19*	*Eq. 21*			*Eq. 22*	*Eq. 23*	*Eq. 24*
Time (secs)	*Time* (hours)	*Tp* (°F)	*ρ* (lbm/ft³)	*Pvp* (psia)	*Pc* (psia)	*Pgas* (feet)	*Hz* (feet)	*Hsl* (feet)	*NPSHA* (feet)	*Pc Req'd for NPSHA of 29 feet* (psia)	*Margin* (feet)
180000	50.000	120.8	61.70	1.730	14.823	30.56	12.5	2.40	40.7	9.83	11.7
190000	52.778	119.3	61.71	1.660	14.709	30.45	12.5	2.40	40.5	9.76	11.5
200000	55.556	118.0	61.73	1.601	14.696	30.55	12.5	2.40	40.6	9.70	11.6
210000	58.333	116.8	61.75	1.547	14.696	30.66	12.5	2.40	40.8	9.65	11.8
220000	61.111	115.6	61.77	1.496	14.696	30.77	12.5	2.40	40.9	9.60	11.9
230000	63.889	114.5	61.79	1.451	14.696	30.87	12.5	2.40	41.0	9.56	12.0
240000	66.667	113.5	61.80	1.412	14.696	30.95	12.5	2.40	41.1	9.52	12.1
250000	69.444	112.5	61.82	1.372	14.696	31.04	12.5	2.40	41.1	9.49	12.1
260000	72.222	111.5	61.83	1.333	14.696	31.12	12.5	2.40	41.2	9.45	12.2
270000	75.000	110.7	61.85	1.301	14.696	31.19	12.5	2.40	41.3	9.42	12.3
280000	77.778	110.0	61.86	1.276	14.696	31.24	12.5	2.40	41.3	9.39	12.3
290000	80.556	109.1	61.87	1.244	14.696	31.31	12.5	2.40	41.4	9.36	12.4
300000	83.333	108.4	61.88	1.218	14.696	31.36	12.5	2.40	41.5	9.34	12.5
310000	86.111	107.8	61.89	1.195	14.696	31.41	12.5	2.40	41.5	9.32	12.5
320000	88.889	107.0	61.90	1.170	14.696	31.47	12.5	2.40	41.6	9.29	12.6
330000	91.667	106.3	61.91	1.147	14.696	31.52	12.5	2.40	41.6	9.27	12.6
340000	94.444	105.8	61.91	1.128	14.696	31.56	12.5	2.40	41.7	9.25	12.7
350000	97.222	105.1	61.92	1.106	14.696	31.61	12.5	2.40	41.7	9.23	12.7
360000	100.000	104.4	61.93	1.083	14.696	31.66	12.5	2.40	41.8	9.21	12.8
380000	105.556	103.4	61.94	1.051	14.696	31.72	12.5	2.40	41.8	9.18	12.8
400000	111.111	102.3	61.95	1.017	14.696	31.80	12.5	2.40	41.9	9.15	12.9
500000	138.889	97.5	62.02	0.881	14.696	32.08	12.5	2.40	42.2	9.02	13.2
600000	166.667	94.0	62.06	0.791	14.696	32.26	12.5	2.40	42.4	8.94	13.4
700000	194.444	91.4	62.09	0.730	14.696	32.39	12.5	2.40	42.5	8.88	13.5
800000	222.222	89.3	62.11	0.682	14.696	32.49	12.5	2.40	42.6	8.83	13.6
900000	250.000	87.4	62.13	0.644	14.696	32.57	12.5	2.40	42.7	8.80	13.7
920000	255.556	87.0	62.14	0.636	14.696	32.58	12.5	2.40	42.7	8.79	13.7

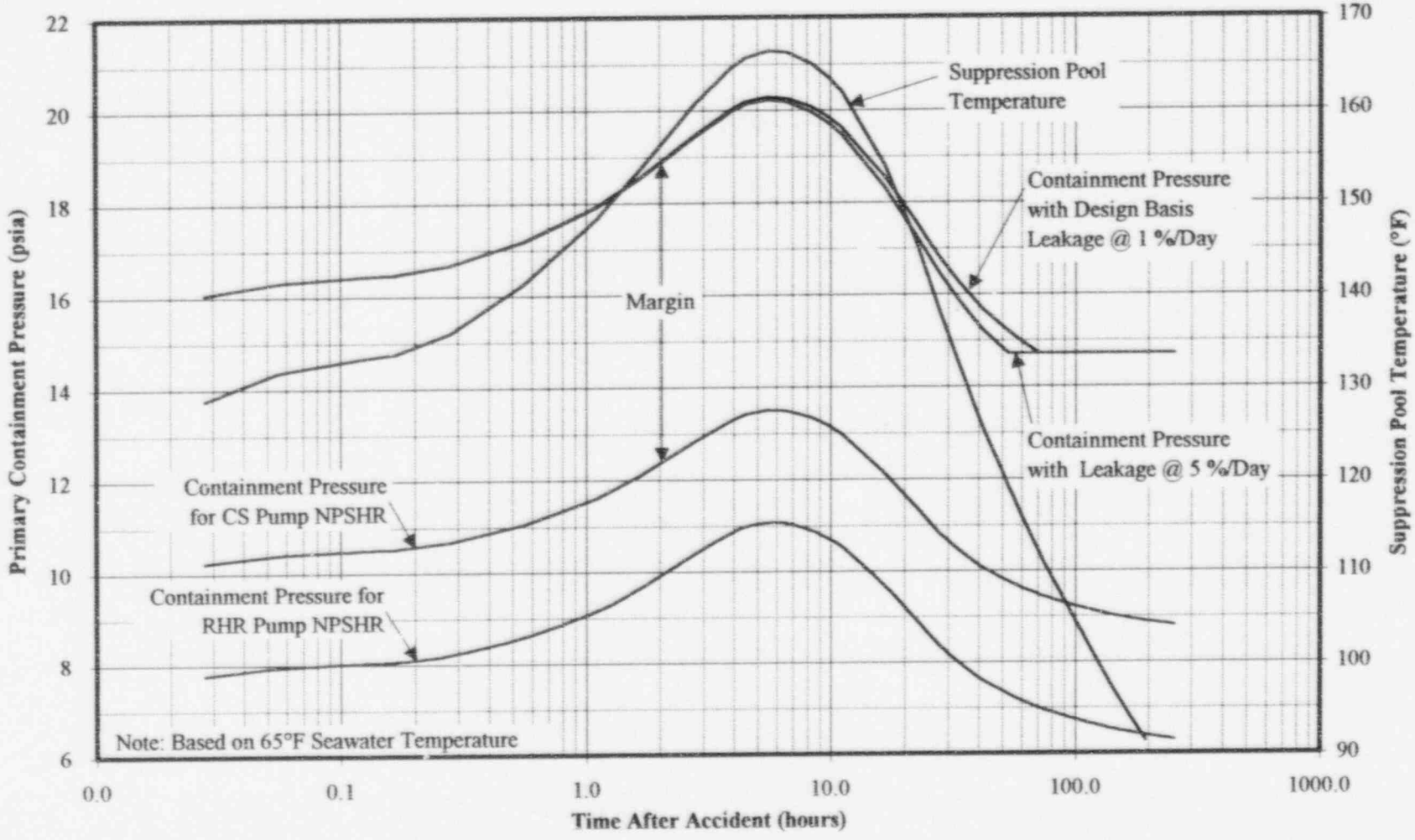


Figure 14.5-10 NPSH Availability for RHR and Core Spray System After a DBA-LOCA

Figure 4

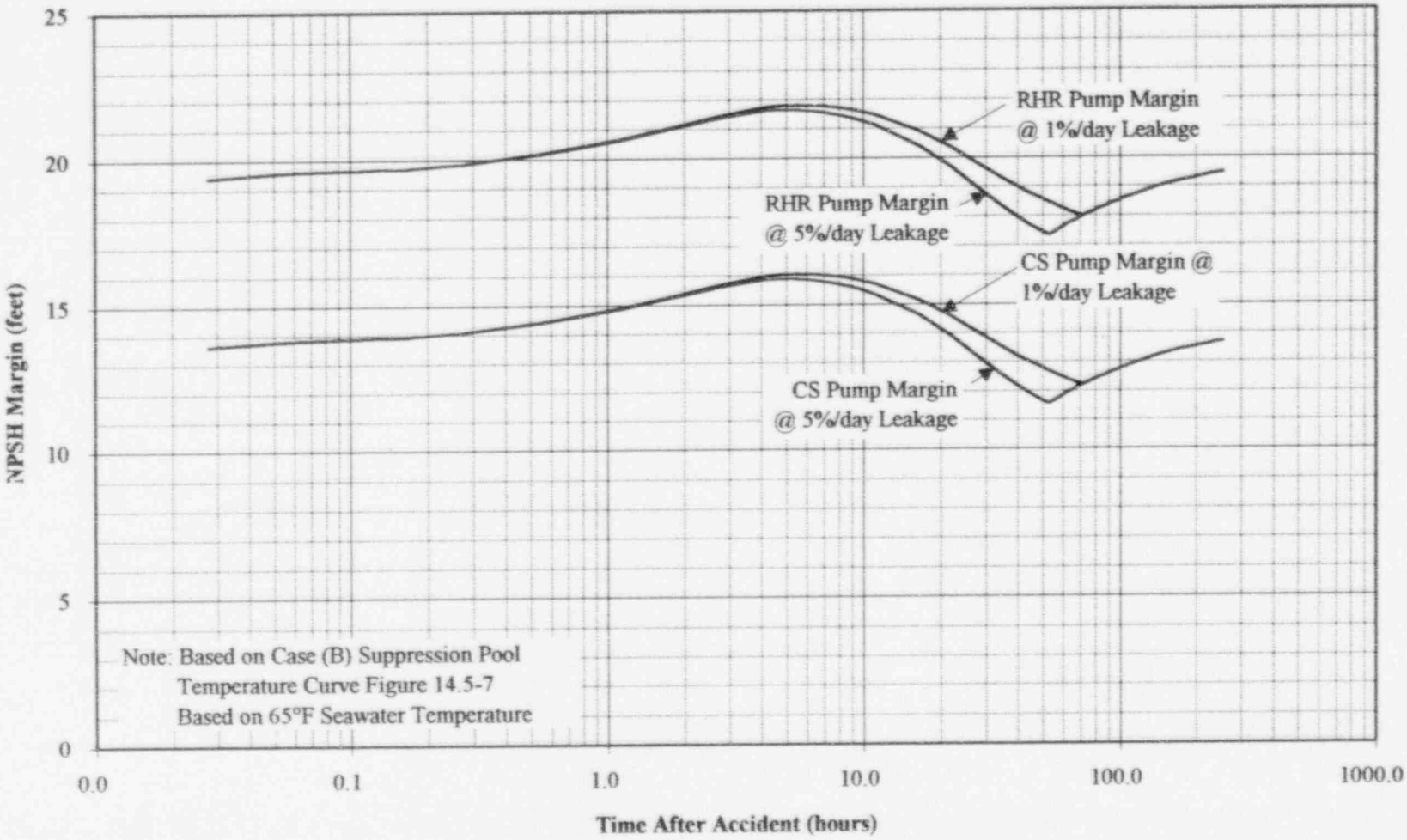


Figure 14.5-13 NPSH Margin for RHR and Core Spray System After a DBA-LOCA

Figure 5

Table 17 - Containment Pressure Available @ 1%/Day Leakage Rate - 75°F Seawater Temperature

	Lookup			Eq. 15	Eq. 16	Eq. 17		Eq. 18	Eq. 19
Time (seconds)	Tp (°F)	Tp (°R)	Pvp (psia)	m_{leak} (lbm/sec)	ω	m_{gas} (lbm/sec)	ΔT (sec)	Mt* (lbm)	P_C (psia)
	124.70	584.70	1.929					17316.12	15.732
101.84	124.70	584.70	1.929	0.00074	0.087	0.00068	101.84	17316.05	15.732
201.84	126.60	586.60	2.030	0.00074	0.087	0.00068	100.00	17315.98	15.877
401.84	128.90	588.90	2.159	0.00078	0.091	0.00072	200.00	17315.84	16.061
603.62	135.60	595.60	2.578	0.00083	0.097	0.00076	201.78	17315.68	16.639
1003.62	143.80	603.80	3.184	0.00097	0.114	0.00087	400.00	17315.33	17.438
2005.66	154.20	614.20	4.123	0.00111	0.139	0.00098	1002.04	17314.35	18.621
2786.91	159.10	619.10	4.644	0.00127	0.177	0.00108	781.25	17313.51	19.257
3568.16	162.70	622.70	5.057	0.00134	0.198	0.00112	781.25	17312.64	19.754
4349.41	165.40	625.40	5.388	0.00138	0.214	0.00114	781.25	17311.75	20.148
5130.66	167.40	627.40	5.648	0.00141	0.227	0.00115	781.25	17310.85	20.455
5911.91	169.10	629.10	5.870	0.00144	0.237	0.00116	781.25	17309.94	20.716
6693.16	170.70	630.70	6.093	0.00146	0.246	0.00117	781.25	17309.03	20.976
10447.91	174.80	634.80	6.690	0.00148	0.255	0.00118	3754.75	17304.61	21.666
19633.66	177.60	637.60	7.126	0.00152	0.278	0.00119	9185.75	17293.69	22.158
28998.41	176.70	636.70	6.981	0.00155	0.295	0.00120	9364.75	17282.50	21.983
38913.91	174.10	634.10	6.586	0.00154	0.289	0.00119	9915.50	17270.67	21.516
49139.91	170.40	630.40	6.051	0.00151	0.274	0.00119	10226.00	17258.55	20.884
59757.16	166.40	626.40	5.518	0.00147	0.254	0.00117	10617.25	17246.11	20.246
70590.16	162.60	622.60	5.045	0.00142	0.233	0.00115	10833.00	17233.62	19.673
81643.66	159.20	619.20	4.655	0.00137	0.215	0.00113	11053.50	17221.10	19.193
92860.66	156.20	616.20	4.332	0.00133	0.199	0.00111	11217.00	17208.66	18.788
104289.91	153.50	613.50	4.054	0.00129	0.186	0.00109	11429.25	17196.25	18.437
116030.91	150.90	610.90	3.802	0.00125	0.175	0.00106	11741.00	17183.78	18.114
127890.66	148.40	608.40	3.577	0.00121	0.165	0.00104	11859.75	17171.47	17.820
139876.91	146.10	606.10	3.375	0.00117	0.156	0.00101	11986.25	17159.35	17.554
151928.91	144.00	604.00	3.200	0.00113	0.148	0.00099	12052.00	17147.48	17.320
164009.41	142.10	602.10	3.052	0.00109	0.141	0.00096	12080.50	17135.89	17.118

Table 17 - Containment Pressure Available @ 1%/Day Leakage Rate - 75°F Seawater Temperature

	Lookup			Eq. 15	Eq. 16	Eq. 17		Eq. 18	Eq. 19
Time (seconds)	Tp (°F)	Tp (°R)	Pvp (psia)	m_{leak} (lbm/sec)	ω	m_{gas} (lbm/sec)	ΔT (sec)	Mt* (lbm)	P_C (psia)
172800	140.80	600.80	2.951	0.00106	0.135	0.00093	8790.59	17127.68	16.980
259200	130.30	590.30	2.243	0.00104	0.131	0.00092	86400	17048.54	15.963
328600	125.96	585.96	1.994	0.00081	0.102	0.00073	69400	16997.67	15.573
329600	125.90	585.90	1.991	0.00068	0.091	0.00063	1000	16997.05	15.567
330600	125.84	585.84	1.987	0.00068	0.091	0.00063	1000	16996.42	15.562
331600	125.78	585.78	1.984	0.00068	0.091	0.00062	1000	16995.80	15.557
332600	125.71	585.71	1.981	0.00068	0.091	0.00062	1000	16995.18	15.552
333600	125.65	585.65	1.978	0.00068	0.091	0.00062	1000	16994.56	15.547
334600	125.59	585.59	1.975	0.00067	0.091	0.00062	1000	16993.94	15.541
335600	125.53	585.53	1.971	0.00067	0.091	0.00062	1000	16993.32	15.536
336600	125.46	585.46	1.968	0.00067	0.090	0.00062	1000	16992.71	15.531
337600	125.40	585.40	1.965	0.00067	0.090	0.00061	1000	16992.09	15.526
338600	125.34	585.34	1.962	0.00067	0.090	0.00061	1000	16991.48	15.521
339600	125.28	585.28	1.958	0.00067	0.090	0.00061	1000	16990.87	15.516
340600	125.21	585.21	1.955	0.00066	0.090	0.00061	1000	16990.26	15.510
341600	125.15	585.15	1.952	0.00066	0.090	0.00061	1000	16989.65	15.505
342600	125.09	585.09	1.949	0.00066	0.090	0.00061	1000	16989.05	15.500
343600	125.03	585.03	1.945	0.00066	0.089	0.00060	1000	16988.45	15.495
344600	124.96	584.96	1.942	0.00066	0.089	0.00060	1000	16987.84	15.490
345600	124.90	584.90	1.939	0.00065	0.089	0.00060	1000	16987.24	15.485
432000	120.60	580.60	1.723	0.00065	0.089	0.00060	86400	16935.56	15.128
518400	117.90	577.90	1.597	0.00049	0.080	0.00045	86400	16896.29	14.908
604800	115.90	575.90	1.510	0.00035	0.075	0.00032	86400	16868.32	14.754
613440	115.70	575.70	1.501	0.00018	0.071	0.00017	8640	16866.84	14.739
622080	115.50	575.50	1.493	0.00016	0.071	0.00015	8640	16865.56	14.725
630720	115.30	575.30	1.484	0.00013	0.070	0.00012	8640	16864.51	14.711
639360	115.10	575.10	1.475	0.00009	0.070	0.00009	8640	16863.76	14.697
648000	114.90	574.90	1.467	0.00003	0.069	0.00003	8640	16863.53	14.696
656640	114.70	574.70	1.459	0.00000	0.069	0.00000	8640	16863.53	14.696

Table 17 - Containment Pressure Available @ 1%/Day Leakage Rate - 75°F Seawater Temperature

	Lookup			Eq. 15	Eq. 16	Eq. 17		Eq. 18	Eq. 19
Time (seconds)	Tp (°F)	Tp (°R)	Pvp (psia)	m_{leak} (lbm/sec)	ω	m_{gas} (lbm/sec)	ΔT (sec)	Mt* (lbm)	P_C (psia)
665280	114.50	574.50	1.451	0.00000	0.069	0.00000	8640	16863.53	14.696
673920	114.30	574.30	1.443	0.00000	0.068	0.00000	8640	16863.53	14.696
682560	114.10	574.10	1.435	0.00000	0.068	0.00000	8640	16863.53	14.696
691200	113.90	573.90	1.427	0.00000	0.067	0.00000	8640	16863.53	14.696
777600	111.90	571.90	1.348	0.00000	0.067	0.00000	86400	16863.53	14.696
864000	110.00	570.00	1.276	0.00000	0.063	0.00000	86400	16863.53	14.696
950400	108.80	568.80	1.232	0.00000	0.059	0.00000	86400	16863.53	14.696

Boston Edison

PREPARED BY: P. Doody

CHECKED BY: P.D. Harizi

Table 18 - Containment Pressure Available @ 5%/Day Leakage Rate- 75°F Seawater Temperature

	Lookup			Eq. 15	Eq. 16	Eq. 17		Eq. 18	Eq. 19
Time (seconds)	Tp (°F)	Tp (°R)	Pvp (psia)	m_{leak} (lbm/sec)	ω	m_{gas} (lbm/sec)	ΔT (sec)	Mt* (lbm)	P_C (psia)
	124.70	584.70	1.929					17316.12	15.732
101.84	124.70	584.70	1.929	0.00369	0.087	0.00339	101.84	17315.77	15.732
201.84	126.60	586.60	2.030	0.00369	0.087	0.00339	100.00	17315.43	15.877
401.84	128.90	588.90	2.159	0.00391	0.091	0.00359	200.00	17314.71	16.060
603.62	135.60	595.60	2.578	0.00417	0.097	0.00380	201.78	17313.95	16.637
1003.62	143.80	603.80	3.184	0.00485	0.114	0.00435	400.00	17312.21	17.435
2005.66	154.20	614.20	4.123	0.00556	0.139	0.00488	1002.04	17307.31	18.616
2786.91	159.10	619.10	4.644	0.00635	0.177	0.00539	781.25	17303.10	19.248
3568.16	162.70	622.70	5.057	0.00668	0.198	0.00557	781.25	17298.74	19.743
4349.41	165.40	625.40	5.388	0.00690	0.214	0.00569	781.25	17294.30	20.133
5130.66	167.40	627.40	5.648	0.00707	0.227	0.00576	781.25	17289.80	20.437
5911.91	169.10	629.10	5.870	0.00718	0.238	0.00581	781.25	17285.27	20.695
6693.16	170.70	630.70	6.093	0.00728	0.246	0.00584	781.25	17280.70	20.951
10447.91	174.80	634.80	6.690	0.00737	0.255	0.00587	3754.75	17258.66	21.627
19633.66	177.60	637.60	7.126	0.00759	0.279	0.00593	9185.75	17204.16	22.080
28998.41	176.70	636.70	6.981	0.00772	0.296	0.00595	9364.75	17148.42	21.867
38913.91	174.10	634.10	6.586	0.00766	0.292	0.00593	9915.50	17089.65	21.360
49139.91	170.40	630.40	6.051	0.00750	0.277	0.00587	10226.00	17029.58	20.687
59757.16	166.40	626.40	5.518	0.00728	0.257	0.00579	10617.25	16968.13	20.009
70590.16	162.60	622.60	5.045	0.00702	0.237	0.00567	10833.00	16906.68	19.395
81643.66	159.20	619.20	4.655	0.00675	0.219	0.00554	11053.50	16845.48	18.876
92860.66	156.20	616.20	4.332	0.00649	0.204	0.00539	11217.00	16785.01	18.433
104289.91	153.50	613.50	4.054	0.00624	0.191	0.00524	11429.25	16725.13	18.043
116030.91	150.90	610.90	3.802	0.00600	0.180	0.00508	11741.00	16665.46	17.682
127890.66	148.40	608.40	3.577	0.00575	0.170	0.00491	11859.75	16607.20	17.352
139876.91	146.10	606.10	3.375	0.00550	0.162	0.00473	11986.25	16550.47	17.051
151928.91	144.00	604.00	3.200	0.00524	0.154	0.00455	12052.00	16495.69	16.783
164009.41	142.10	602.10	3.052	0.00499	0.147	0.00436	12080.50	16443.08	16.550

Table 18 - Containment Pressure Available @ 5%/Day Leakage Rate- 75°F Seawater Temperature

	Lookup			Eq. 15	Eq. 16	Eq. 17		Eq. 18	Eq. 19
Time (seconds)	Tp (°F)	Tp (°R)	Pvp (psia)	m_{leak} (lbm/sec)	ω	m_{gas} (lbm/sec)	ΔT (sec)	Mt* (lbm)	P_C (psia)
172800	140.80	600.80	2.951	0.00475	0.141	0.00417	8791	16406.44	16.389
259200	130.30	590.30	2.243	0.00458	0.137	0.00403	86400	16058.51	15.167
328600	125.96	585.96	1.994	0.00256	0.108	0.00231	69400	15898.45	14.696
329600	125.90	585.90	1.991	0.00000	0.098	0.00000	1000	15898.45	14.696
330600	125.84	585.84	1.987	0.00000	0.097	0.00000	1000	15898.45	14.696
331600	125.78	585.78	1.984	0.00000	0.097	0.00000	1000	15898.45	14.696
332600	125.71	585.71	1.981	0.00000	0.097	0.00000	1000	15898.45	14.696
333600	125.65	585.65	1.978	0.00000	0.097	0.00000	1000	15898.45	14.696
334600	125.59	585.59	1.975	0.00000	0.097	0.00000	1000	15898.45	14.696
335600	125.53	585.53	1.971	0.00000	0.097	0.00000	1000	15898.45	14.696
336600	125.46	585.46	1.968	0.00000	0.096	0.00000	1000	15898.45	14.696
337600	125.40	585.40	1.965	0.00000	0.096	0.00000	1000	15898.45	14.696
338600	125.34	585.34	1.962	0.00000	0.096	0.00000	1000	15898.45	14.696
339600	125.28	585.28	1.958	0.00000	0.096	0.00000	1000	15898.45	14.696
340600	125.21	585.21	1.955	0.00000	0.096	0.00000	1000	15898.45	14.696
341600	125.15	585.15	1.952	0.00000	0.095	0.00000	1000	15898.45	14.696
342600	125.09	585.09	1.949	0.00000	0.095	0.00000	1000	15898.45	14.696
343600	125.03	585.03	1.945	0.00000	0.095	0.00000	1000	15898.45	14.696
344600	124.96	584.96	1.942	0.00000	0.095	0.00000	1000	15898.45	14.696
345600	124.90	584.90	1.939	0.00000	0.095	0.00000	1000	15898.45	14.696
432000	120.60	580.60	1.723	0.00000	0.095	0.00000	86400	15898.45	14.696
518400	117.90	577.90	1.597	0.00000	0.083	0.00000	86400	15898.45	14.696
604800	115.90	575.90	1.510	0.00000	0.076	0.00000	86400	15898.45	14.696
613440	115.70	575.70	1.501	0.00000	0.071	0.00000	8640	15898.45	14.696
622080	115.50	575.50	1.493	0.00000	0.071	0.00000	8640	15898.45	14.696
630720	115.30	575.30	1.484	0.00000	0.070	0.00000	8640	15898.45	14.696
639360	115.10	575.10	1.475	0.00000	0.070	0.00000	8640	15898.45	14.696
648000	114.90	574.90	1.467	0.00000	0.069	0.00000	8640	15898.45	14.696
656640	114.70	574.70	1.459	0.00000	0.069	0.00000	8640	15898.45	14.696

Table 18 - Containment Pressure Available @ 5%/Day Leakage Rate- 75°F Seawater Temperature

	Lookup			Eq. 15	Eq. 16	Eq. 17		Eq. 18	Eq. 19
Time (seconds)	Tp (°F)	Tp (°R)	Pvp (psia)	m_{leak} (lbm/sec)	ω	m_{gas} (lbm/sec)	ΔT (sec)	Mt* (lbm)	P_C (psia)
665280	114.50	574.50	1.451	0.00000	0.069	0.00000	8640	15898.45	14.696
673920	114.30	574.30	1.443	0.00000	0.068	0.00000	8640	15898.45	14.696
682560	114.10	574.10	1.435	0.00000	0.068	0.00000	8640	15898.45	14.696
691200	113.90	573.90	1.427	0.00000	0.067	0.00000	8640	15898.45	14.696
777600	111.90	571.90	1.348	0.00000	0.067	0.00000	86400	15898.45	14.696
864000	110.00	570.00	1.276	0.00000	0.063	0.00000	86400	15898.45	14.696
950400	108.80	568.80	1.232	0.00000	0.059	0.00000	86400	15898.45	14.696

Boston Edison

PREPARED BY: P. Doody

CHECKED BY: P.D. Harizi

Table 19 - Updated Analysis - Containment Pressure for RHR Pump NPSHR at 1%/Day Leakage Rate- 75°F Seawater Temperature

		F14.5-10	*Lookup*	*Lookup*	*Eq. 19*	*Eq. 21*			*Eq. 22*	*Eq. 23*	*Eq. 24*
Time (secs)	*Time* (hours)	*Tp* (°F)	*ρ* (lbm/ft³)	*Pvp* (psia)	*Pc* (psia)	*Pgas* (feet)	*Hz* (feet)	*Hsl* (feet)	*NPSHA* (feet)	*Pc Req'd for NPSHA of 23 feet* (psia)	*Margin* (feet)
		Values below plotted on Figure 6 ⇓			*Values below plotted on Figure 6* ⇓					*Values below plotted on Figure 6* ⇓	*Values below plotted on Figure 7* ⇓
101.84	0.028	124.70	61.63	1.929	15.732	32.25	12.5	2.63	42.1	7.55	19.1
201.84	0.056	126.60	61.60	2.030	15.877	32.37	12.5	2.63	42.2	7.65	19.2
401.84	0.112	128.90	61.56	2.159	16.061	32.52	12.5	2.63	42.4	7.77	19.4
603.62	0.168	135.60	61.44	2.578	16.639	32.95	12.5	2.63	42.8	8.18	19.8
1003.62	0.279	143.80	61.31	3.184	17.438	33.48	12.5	2.63	43.3	8.77	20.3
2005.66	0.557	154.20	61.10	4.123	18.621	34.17	12.5	2.63	44.0	9.69	21.0
2786.91	0.774	159.10	61.01	4.644	19.257	34.49	12.5	2.63	44.4	10.21	21.4
3568.16	0.991	162.70	60.94	5.057	19.754	34.73	12.5	2.63	44.6	10.61	21.6
4349.41	1.208	165.40	60.88	5.388	20.148	34.91	12.5	2.63	44.8	10.94	21.8
5130.66	1.425	167.40	60.85	5.648	20.455	35.04	12.5	2.63	44.9	11.20	21.9
5911.91	1.642	169.10	60.82	5.870	20.716	35.15	12.5	2.63	45.0	11.42	22.0
6693.16	1.859	170.70	60.77	6.093	20.976	35.26	12.5	2.63	45.1	11.63	22.1
10447.91	2.902	174.80	60.68	6.690	21.666	35.54	12.5	2.63	45.4	12.22	22.4
19633.66	5.454	177.60	60.63	7.126	22.158	35.70	12.5	2.63	45.6	12.65	22.6
28998.41	8.055	176.70	60.65	6.981	21.983	35.62	12.5	2.63	45.5	12.51	22.5
38913.91	10.809	174.10	60.70	6.586	21.516	35.42	12.5	2.63	45.3	12.12	22.3
49139.91	13.650	170.40	60.78	6.051	20.884	35.14	12.5	2.63	45.0	11.59	22.0
59757.16	16.599	166.40	60.87	5.518	20.246	34.84	12.5	2.63	44.7	11.07	21.7
70590.16	19.608	162.60	60.95	5.045	19.673	34.56	12.5	2.63	44.4	10.60	21.4
81643.66	22.679	159.20	61.01	4.655	19.193	34.31	12.5	2.63	44.2	10.22	21.2
92860.66	25.795	156.20	61.06	4.332	18.788	34.09	12.5	2.63	44.0	9.90	21.0
104289.9	28.969	153.50	61.11	4.054	18.437	33.89	12.5	2.63	43.8	9.63	20.8
116030.9	32.231	150.90	61.17	3.802	18.114	33.69	12.5	2.63	43.6	9.38	20.6

Table 19 - Updated Analysis - Containment Pressure for RHR Pump NPSHR at 1%/Day Leakage Rate- 75°F Seawater Temperature

		F14.5-10	Lookup	Lookup	Eq. 19	Eq. 21			Eq. 22	Eq. 23	Eq. 24
Time (secs)	Time (hours)	Tp (°F)	ρ (lbm/ft³)	Pvp (psia)	P_C (psia)	Pgas (feet)	Hz (feet)	Hsl (feet)	NPSHA (feet)	P_c Req'd for NPSHA of 23 feet (psia)	Margin (feet)
127890.7	35.525	148.40	61.22	3.577	17.820	33.50	12.5	2.63	43.4	9.16	20.4
139876.9	38.855	146.10	61.26	3.375	17.554	33.33	12.5	2.63	43.2	8.96	20.2
151928.9	42.202	144.00	61.31	3.200	17.320	33.16	12.5	2.63	43.0	8.79	20.0
164009.4	45.558	142.10	61.34	3.052	17.118	33.02	12.5	2.63	42.9	8.65	19.9
172800	48.000	140.80	61.36	2.951	16.980	32.92	12.5	2.63	42.8	8.55	19.8
259200	72.000	130.30	61.54	2.243	15.963	32.10	12.5	2.63	42.0	7.85	19.0
328600	91.278	125.96	61.61	1.994	15.573	31.74	12.5	2.63	41.6	7.61	18.6
329600	91.556	125.90	61.61	1.991	15.567	31.73	12.5	2.63	41.6	7.61	18.6
330600	91.833	125.84	61.61	1.987	15.562	31.73	12.5	2.63	41.6	7.61	18.6
331600	92.111	125.78	61.61	1.984	15.557	31.72	12.5	2.63	41.6	7.60	18.6
332600	92.389	125.71	61.62	1.981	15.552	31.72	12.5	2.63	41.6	7.60	18.6
333600	92.667	125.65	61.62	1.978	15.547	31.71	12.5	2.63	41.6	7.60	18.6
334600	92.944	125.59	61.62	1.975	15.541	31.71	12.5	2.63	41.6	7.59	18.6
335600	93.222	125.53	61.62	1.971	15.536	31.70	12.5	2.63	41.6	7.59	18.6
336600	93.500	125.46	61.62	1.968	15.531	31.70	12.5	2.63	41.6	7.59	18.6
337600	93.778	125.40	61.62	1.965	15.526	31.69	12.5	2.63	41.6	7.58	18.6
338600	94.056	125.34	61.62	1.962	15.521	31.69	12.5	2.63	41.6	7.58	18.6
339600	94.333	125.28	61.62	1.958	15.516	31.68	12.5	2.63	41.6	7.58	18.6
340600	94.611	125.21	61.62	1.955	15.510	31.68	12.5	2.63	41.5	7.57	18.5
341600	94.889	125.15	61.62	1.952	15.505	31.67	12.5	2.63	41.5	7.57	18.5
342600	95.167	125.09	61.63	1.949	15.500	31.67	12.5	2.63	41.5	7.57	18.5
343600	95.444	125.03	61.63	1.945	15.495	31.66	12.5	2.63	41.5	7.56	18.5
344600	95.722	124.96	61.63	1.942	15.490	31.66	12.5	2.63	41.5	7.56	18.5
345600	96.000	124.90	61.63	1.939	15.485	31.65	12.5	2.63	41.5	7.56	18.5
432000	120.000	120.60	61.70	1.723	15.128	31.29	12.5	2.63	41.2	7.35	18.2
518400	144.000	117.90	61.73	1.597	14.908	31.05	12.5	2.63	40.9	7.23	17.9
604800	168.000	115.90	61.77	1.510	14.754	30.88	12.5	2.63	40.7	7.14	17.7

Table 19 - Updated Analysis - Containment Pressure for RHR Pump NPSHR at 1%/Day Leakage Rate- 75°F Seawater Temperature

		F14.5-10	*Lookup*	*Lookup*	*Eq. 19*	*Eq. 21*			*Eq. 22*	*Eq. 23*	*Eq. 24*
Time (secs)	*Time* (hours)	*Tp* (°F)	*ρ* (lbm/ft^3)	*Pvp* (psia)	P_C (psia)	*Pgas* (feet)	*Hz* (feet)	*Hsl* (feet)	*NPSHA* (feet)	P_c *Req'd for NPSHA of 23 feet* (psia)	*Margin* (feet)
613440	170.400	115.70	61.77	1.501	14.739	30.86	12.5	2.63	40.7	7.13	17.7
622080	172.800	115.50	61.77	1.493	14.725	30.85	12.5	2.63	40.7	7.13	17.7
630720	175.200	115.30	61.78	1.484	14.711	30.83	12.5	2.63	40.7	7.12	17.7
639360	177.600	115.10	61.78	1.475	14.697	30.82	12.5	2.63	40.7	7.11	17.7
648000	180.000	114.90	61.78	1.467	14.696	30.83	12.5	2.63	40.7	7.10	17.7
656640	182.400	114.70	61.78	1.459	14.696	30.85	12.5	2.63	40.7	7.09	17.7
665280	184.800	114.50	61.79	1.451	14.696	30.87	12.5	2.63	40.7	7.09	17.7
673920	187.200	114.30	61.79	1.443	14.696	30.88	12.5	2.63	40.8	7.08	17.8
682560	189.600	114.10	61.79	1.435	14.696	30.90	12.5	2.63	40.8	7.07	17.8
691200	192.000	113.90	61.80	1.427	14.696	30.92	12.5	2.63	40.8	7.06	17.8
777600	216.000	111.90	61.83	1.348	14.696	31.09	12.5	2.63	41.0	6.99	18.0
864000	240.000	110.00	61.86	1.276	14.696	31.24	12.5	2.63	41.1	6.92	18.1
950400	264.000	108.80	61.88	1.232	14.696	31.33	12.5	2.63	41.2	6.87	18.2

Table 20 - Updated Analysis - Containment Pressure for Core Spray Pump NPSHR at 1%/Day Leakage Rate- 75°F Seawater Temperature

		F14.5-10	*Lookup*	*Lookup*	*Eq. 19*	*Eq. 21*			*Eq. 22*	*Eq. 23*	*Eq. 24*
Time (secs)	*Time* (hours)	*Tp* (°F)	*ρ* (lbm/ft³)	*Pvp* (psia)	*Pc* (psia)	*Pgas* (feet)	*Hz* (feet)	*Hsl* (feet)	*NPSHA* (feet)	*Pc Req'd for NPSHA of 29 feet* (psia)	*Margin* (feet)
		Values below plotted on Figure 6 ⇓			*Values below plotted on Figure 6* ⇓					*Values below plotted on Figure 6* ⇓	*Values below plotted on Figure 7* ⇓
101.84	0.028	124.70	61.63	1.929	15.732	32.25	12.5	2.40	42.3	10.02	13.3
201.84	0.056	126.60	61.60	2.030	15.877	32.37	12.5	2.40	42.5	10.11	13.5
401.84	0.112	128.90	61.56	2.159	16.061	32.52	12.5	2.40	42.6	10.24	13.6
603.62	0.168	135.60	61.44	2.578	16.639	32.95	12.5	2.40	43.1	10.64	14.1
1003.62	0.279	143.80	61.31	3.184	17.438	33.48	12.5	2.40	43.6	11.23	14.6
2005.66	0.557	154.20	61.10	4.123	18.621	34.17	12.5	2.40	44.3	12.14	15.3
2786.91	0.774	159.10	61.01	4.644	19.257	34.49	12.5	2.40	44.6	12.65	15.6
3568.16	0.991	162.70	60.94	5.057	19.754	34.73	12.5	2.40	44.8	13.06	15.8
4349.41	1.208	165.40	60.88	5.388	20.148	34.91	12.5	2.40	45.0	13.38	16.0
5130.66	1.425	167.40	60.85	5.648	20.455	35.04	12.5	2.40	45.1	13.63	16.1
5911.91	1.642	169.10	60.82	5.870	20.716	35.15	12.5	2.40	45.3	13.85	16.3
6693.16	1.859	170.70	60.77	6.093	20.976	35.26	12.5	2.40	45.4	14.07	16.4
10447.91	2.902	174.80	60.68	6.690	21.666	35.54	12.5	2.40	45.6	14.66	16.6
19633.66	5.454	177.60	60.63	7.126	22.158	35.70	12.5	2.40	45.8	15.08	16.8
28998.41	8.055	176.70	60.65	6.981	21.983	35.62	12.5	2.40	45.7	14.94	16.7
38913.91	10.809	174.10	60.70	6.586	21.516	35.42	12.5	2.40	45.5	14.55	16.5
49139.91	13.650	170.40	60.78	6.051	20.884	35.14	12.5	2.40	45.2	14.03	16.2
59757.16	16.599	166.40	60.87	5.518	20.246	34.84	12.5	2.40	44.9	13.51	15.9
70590.16	19.608	162.60	60.95	5.045	19.673	34.56	12.5	2.40	44.7	13.04	15.7
81643.66	22.679	159.20	61.01	4.655	19.193	34.31	12.5	2.40	44.4	12.66	15.4
92860.66	25.795	156.20	61.06	4.332	18.788	34.09	12.5	2.40	44.2	12.35	15.2
104289.9	28.969	153.50	61.11	4.054	18.437	33.89	12.5	2.40	44.0	12.07	15.0
116030.9	32.231	150.90	61.17	3.802	18.114	33.69	12.5	2.40	43.8	11.83	14.8

Table 20 - Updated Analysis - Containment Pressure for Core Spray Pump NPSHR at 1%/Day Leakage Rate- 75°F Seawater Temperature

		F14.5-10	*Lookup*	*Lookup*	*Eq. 19*	*Eq. 21*			*Eq. 22*	*Eq. 23*	*Eq. 24*
Time (secs)	*Time* (hours)	*Tp* (°F)	*ρ* (lbm/ft³)	*Pvp* (psia)	*Pc* (psia)	*Pgas* (feet)	*Hz* (feet)	*Hsl* (feet)	*NPSHA* (feet)	*Pc Req'd for NPSHA of 29 feet* (psia)	*Margin* (feet)
127890.7	35.525	148.40	61.22	3.577	17.820	33.50	12.5	2.40	43.6	11.61	14.6
139876.9	38.855	146.10	61.26	3.375	17.554	33.33	12.5	2.40	43.4	11.42	14.4
151928.9	42.202	144.00	61.31	3.200	17.320	33.16	12.5	2.40	43.3	11.25	14.3
164009.4	45.558	142.10	61.34	3.052	17.118	33.02	12.5	2.40	43.1	11.10	14.1
172800	48.000	140.80	61.36	2.951	16.980	32.92	12.5	2.40	43.0	11.00	14.0
259200	72.000	130.30	61.54	2.243	15.963	32.10	12.5	2.40	42.2	10.32	13.2
328600	91.278	125.96	61.61	1.994	15.573	31.74	12.5	2.40	41.8	10.08	12.8
329600	91.556	125.90	61.61	1.991	15.567	31.73	12.5	2.40	41.8	10.08	12.8
330600	91.833	125.84	61.61	1.987	15.562	31.73	12.5	2.40	41.8	10.07	12.8
331600	92.111	125.78	61.61	1.984	15.557	31.72	12.5	2.40	41.8	10.07	12.8
332600	92.389	125.71	61.62	1.981	15.552	31.72	12.5	2.40	41.8	10.07	12.8
333600	92.667	125.65	61.62	1.978	15.547	31.71	12.5	2.40	41.8	10.06	12.8
334600	92.944	125.59	61.62	1.975	15.541	31.71	12.5	2.40	41.8	10.06	12.8
335600	93.222	125.53	61.62	1.971	15.536	31.70	12.5	2.40	41.8	10.06	12.8
336600	93.500	125.46	61.62	1.968	15.531	31.70	12.5	2.40	41.8	10.06	12.8
337600	93.778	125.40	61.62	1.965	15.526	31.69	12.5	2.40	41.8	10.05	12.8
338600	94.056	125.34	61.62	1.962	15.521	31.69	12.5	2.40	41.8	10.05	12.8
339600	94.333	125.28	61.62	1.958	15.516	31.68	12.5	2.40	41.8	10.05	12.8
340600	94.611	125.21	61.62	1.955	15.510	31.68	12.5	2.40	41.8	10.04	12.8
341600	94.889	125.15	61.62	1.952	15.505	31.67	12.5	2.40	41.8	10.04	12.8
342600	95.167	125.09	61.63	1.949	15.500	31.67	12.5	2.40	41.8	10.04	12.8
343600	95.444	125.03	61.63	1.945	15.495	31.66	12.5	2.40	41.8	10.03	12.8
344600	95.722	124.96	61.63	1.942	15.490	31.66	12.5	2.40	41.8	10.03	12.8
345600	96.000	124.90	61.63	1.939	15.485	31.65	12.5	2.40	41.8	10.03	12.8
432000	120.000	120.60	61.70	1.723	15.128	31.29	12.5	2.40	41.4	9.82	12.4
518400	144.000	117.90	61.73	1.597	14.908	31.05	12.5	2.40	41.2	9.70	12.2
604800	168.000	115.90	61.77	1.510	14.754	30.88	12.5	2.40	41.0	9.62	12.0

Table 20 - Updated Analysis - Containment Pressure for Core Spray Pump NPSHR at 1%/Day Leakage Rate- 75°F Seawater Temperature

		F14.5-10	*Lookup*	*Lookup*	*Eq. 19*	*Eq. 21*			*Eq. 22*	*Eq. 23*	*Eq. 24*
Time (secs)	*Time* (hours)	*Tp* (°F)	*ρ* (lbm/ft^3)	*Pvp* (psia)	P_C (psia)	*Pgas* (feet)	*Hz* (feet)	*Hsl* (feet)	*NPSHA* (feet)	P_c *Req'd for NPSHA of 29 feet* (psia)	*Margin* (feet)
613440	170.400	115.70	61.77	1.501	14.739	30.86	12.5	2.40	41.0	9.61	12.0
622080	172.800	115.50	61.77	1.493	14.725	30.85	12.5	2.40	40.9	9.60	11.9
630720	175.200	115.30	61.78	1.484	14.711	30.83	12.5	2.40	40.9	9.59	11.9
639360	177.600	115.10	61.78	1.475	14.697	30.82	12.5	2.40	40.9	9.58	11.9
648000	180.000	114.90	61.78	1.467	14.696	30.83	12.5	2.40	40.9	9.58	11.9
656640	182.400	114.70	61.78	1.459	14.696	30.85	12.5	2.40	41.0	9.57	12.0
665280	184.800	114.50	61.79	1.451	14.696	30.87	12.5	2.40	41.0	9.56	12.0
673920	187.200	114.30	61.79	1.443	14.696	30.88	12.5	2.40	41.0	9.55	12.0
682560	189.600	114.10	61.79	1.435	14.696	30.90	12.5	2.40	41.0	9.55	12.0
691200	192.000	113.90	61.80	1.427	14.696	30.92	12.5	2.40	41.0	9.54	12.0
777600	216.000	111.90	61.83	1.348	14.696	31.09	12.5	2.40	41.2	9.46	12.2
864000	240.000	110.00	61.86	1.276	14.696	31.24	12.5	2.40	41.3	9.39	12.3
950400	264.000	108.80	61.88	1.232	14.696	31.33	12.5	2.40	41.4	9.35	12.4

Table 21 - Updated Analysis - Containment Pressure for RHR Pump NPSHR at 5%/Day Leakage Rate- 75°F Seawater Temperature

		F14.5-10	*Lookup*	*Lookup*	*Eq. 19*	*Eq. 21*			*Eq. 22*	*Eq. 23*	*Eq. 24*
Time (secs)	*Time* (hours)	*Tp* (°F)	*ρ* (lbm/ft³)	*Pvp* (psia)	P_C (psia)	*Pgas* (feet)	*Hz* (feet)	*Hsl* (feet)	*NPSHA* (feet)	P_c *Req'd for NPSHA of 23 feet* (psia)	*Margin* (feet)
		Values below plotted on Figure 6 ⇓			*Values below plotted on Figure 6* ⇓					*Values below plotted on Figure 6* ⇓	*Values below plotted on Figure 7* ⇓
101.84	0.028	124.7	61.63	1.929	15.732	32.25	12.5	2.63	42.1	7.55	19.1
201.84	0.056	126.6	61.60	2.030	15.877	32.37	12.5	2.63	42.2	7.65	19.2
401.84	0.112	128.9	61.56	2.159	16.060	32.52	12.5	2.63	42.4	7.77	19.4
603.62	0.168	135.6	61.44	2.578	16.637	32.95	12.5	2.63	42.8	8.18	19.8
1003.62	0.279	143.8	61.31	3.184	17.435	33.47	12.5	2.63	43.3	8.77	20.3
2005.66	0.557	154.2	61.10	4.123	18.616	34.16	12.5	2.63	44.0	9.69	21.0
2786.91	0.774	159.1	61.01	4.644	19.248	34.47	12.5	2.63	44.3	10.21	21.3
3568.16	0.991	162.7	60.94	5.057	19.743	34.70	12.5	2.63	44.6	10.61	21.6
4349.41	1.208	165.4	60.88	5.388	20.133	34.88	12.5	2.63	44.7	10.94	21.7
5130.66	1.425	167.4	60.85	5.648	20.437	35.00	12.5	2.63	44.9	11.20	21.9
5911.91	1.642	169.1	60.82	5.870	20.695	35.10	12.5	2.63	45.0	11.42	22.0
6693.16	1.859	170.7	60.77	6.093	20.951	35.21	12.5	2.63	45.1	11.63	22.1
10447.91	2.902	174.8	60.68	6.690	21.627	35.44	12.5	2.63	45.3	12.22	22.3
19633.66	5.454	177.6	60.63	7.126	22.080	35.52	12.5	2.63	45.4	12.65	22.4
28998.41	8.055	176.7	60.65	6.981	21.867	35.34	12.5	2.63	45.2	12.51	22.2
38913.91	10.809	174.1	60.70	6.586	21.360	35.05	12.5	2.63	44.9	12.12	21.9
49139.91	13.650	170.4	60.78	6.051	20.687	34.67	12.5	2.63	44.5	11.59	21.5
59757.16	16.599	166.4	60.87	5.518	20.009	34.28	12.5	2.63	44.2	11.07	21.2
70590.16	19.608	162.6	60.95	5.045	19.395	33.91	12.5	2.63	43.8	10.60	20.8
81643.66	22.679	159.2	61.01	4.655	18.876	33.56	12.5	2.63	43.4	10.22	20.4
92860.66	25.795	156.2	61.06	4.332	18.433	33.25	12.5	2.63	43.1	9.90	20.1
104289.91	28.969	153.5	61.11	4.054	18.043	32.96	12.5	2.63	42.8	9.63	19.8
116030.91	32.231	150.9	61.17	3.802	17.682	32.67	12.5	2.63	42.5	9.38	19.5

Boston Edison

PREPARED BY: P. Doody

CHECKED BY: P.D. Harizi

Table 21 - Updated Analysis - Containment Pressure for RHR Pump NPSHR at 5%/Day Leakage Rate- 75°F Seawater Temperature

		F14.5-10	*Lookup*	*Lookup*	*Eq. 19*	*Eq. 21*			*Eq. 22*	*Eq. 23*	*Eq. 24*
Time (secs)	*Time* (hours)	*Tp* (°F)	*ρ* (lbm/ft³)	*Pvp* (psia)	*P_C* (psia)	*Pgas* (feet)	*Hz* (feet)	*Hsl* (feet)	*NPSHA* (feet)	*P_c Req'd for NPSHA of 23 feet* (psia)	*Margin* (feet)
127890.66	35.525	148.4	61.22	3.577	17.352	32.40	12.5	2.63	42.3	9.16	19.3
139876.91	38.855	146.1	61.26	3.375	17.051	32.15	12.5	2.63	42.0	8.96	19.0
151928.91	42.202	144.0	61.31	3.200	16.783	31.90	12.5	2.63	41.8	8.79	18.8
164009.41	45.558	142.1	61.34	3.052	16.550	31.69	12.5	2.63	41.6	8.65	18.6
172800	48.000	140.8	61.36	2.951	16.389	31.54	12.5	2.63	41.4	8.55	18.4
259200	72.000	130.3	61.54	2.243	15.167	30.24	12.5	2.63	40.1	7.85	17.1
328600	91.278	126.0	61.61	1.994	14.696	29.69	12.5	2.63	39.6	7.61	16.6
329600	91.556	125.9	61.61	1.991	14.696	29.69	12.5	2.63	39.6	7.61	16.6
330600	91.833	125.8	61.61	1.987	14.696	29.70	12.5	2.63	39.6	7.61	16.6
331600	92.111	125.8	61.61	1.984	14.696	29.71	12.5	2.63	39.6	7.60	16.6
332600	92.389	125.7	61.62	1.981	14.696	29.72	12.5	2.63	39.6	7.60	16.6
333600	92.667	125.7	61.62	1.978	14.696	29.72	12.5	2.63	39.6	7.60	16.6
334600	92.944	125.6	61.62	1.975	14.696	29.73	12.5	2.63	39.6	7.59	16.6
335600	93.222	125.5	61.62	1.971	14.696	29.74	12.5	2.63	39.6	7.59	16.6
336600	93.500	125.5	61.62	1.968	14.696	29.74	12.5	2.63	39.6	7.59	16.6
337600	93.778	125.4	61.62	1.965	14.696	29.75	12.5	2.63	39.6	7.58	16.6
338600	94.056	125.3	61.62	1.962	14.696	29.76	12.5	2.63	39.6	7.58	16.6
339600	94.333	125.3	61.62	1.958	14.696	29.77	12.5	2.63	39.6	7.58	16.6
340600	94.611	125.2	61.62	1.955	14.696	29.77	12.5	2.63	39.6	7.57	16.6
341600	94.889	125.2	61.62	1.952	14.696	29.78	12.5	2.63	39.6	7.57	16.6
342600	95.167	125.1	61.63	1.949	14.696	29.79	12.5	2.63	39.7	7.57	16.7
343600	95.444	125.0	61.63	1.945	14.696	29.79	12.5	2.63	39.7	7.56	16.7
344600	95.722	125.0	61.63	1.942	14.696	29.80	12.5	2.63	39.7	7.56	16.7
345600	96.000	124.9	61.63	1.939	14.696	29.81	12.5	2.63	39.7	7.56	16.7
432000	120.000	120.6	61.70	1.723	14.696	30.28	12.5	2.63	40.1	7.35	17.1
518400	144.000	117.9	61.73	1.597	14.696	30.56	12.5	2.63	40.4	7.23	17.4
604800	168.000	115.9	61.77	1.510	14.696	30.74	12.5	2.63	40.6	7.14	17.6

Table 21 - Updated Analysis - Containment Pressure for RHR Pump NPSHR at 5%/Day Leakage Rate- 75°F Seawater Temperature

		F14.5-10	*Lookup*	*Lookup*	*Eq. 19*	*Eq. 21*			*Eq. 22*	*Eq. 23*	*Eq. 24*
Time (secs)	*Time* (hours)	*Tp* (°F)	*ρ* (lbm/ft^3)	*Pvp* (psia)	P_C (psia)	*Pgas* (feet)	*Hz* (feet)	*Hsl* (feet)	*NPSHA* (feet)	P_c *Req'd for NPSHA of 23 feet* (psia)	*Margin* (feet)
613440	170.400	115.7	61.77	1.501	14.696	30.76	12.5	2.63	40.6	7.13	17.6
622080	172.800	115.5	61.77	1.493	14.696	30.78	12.5	2.63	40.6	7.13	17.6
630720	175.200	115.3	61.78	1.484	14.696	30.80	12.5	2.63	40.7	7.12	17.7
639360	177.600	115.1	61.78	1.475	14.696	30.82	12.5	2.63	40.7	7.11	17.7
648000	180.000	114.9	61.78	1.467	14.696	30.83	12.5	2.63	40.7	7.10	17.7
656640	182.400	114.7	61.78	1.459	14.696	30.85	12.5	2.63	40.7	7.09	17.7
665280	184.800	114.5	61.79	1.451	14.696	30.87	12.5	2.63	40.7	7.09	17.7
673920	187.200	114.3	61.79	1.443	14.696	30.88	12.5	2.63	40.8	7.08	17.8
682560	189.600	114.1	61.79	1.435	14.696	30.90	12.5	2.63	40.8	7.07	17.8
691200	192.000	113.9	61.80	1.427	14.696	30.92	12.5	2.63	40.8	7.06	17.8
777600	216.000	111.9	61.83	1.348	14.696	31.09	12.5	2.63	41.0	6.99	18.0
864000	240.000	110.0	61.86	1.276	14.696	31.24	12.5	2.63	41.1	6.92	18.1
950400	264.000	108.8	61.88	1.232	14.696	31.33	12.5	2.63	41.2	6.87	18.2

Table 22 - Updated Analysis - Containment Pressure for Core Spray Pump NPSHR at 5%/Day Leakage Rate- 75°F Seawater Temperature

		F14.5-10	*Lookup*	*Lookup*	*Eq. 19*	*Eq. 21*			*Eq. 22*	*Eq. 23*	*Eq. 24*
Time (secs)	*Time* (hours)	*Tp* (°F)	*ρ* (lbm/ft^3)	*Pvp* (psia)	*Pc* (psia)	*Pgas* (feet)	*Hz* (feet)	*Hsl* (feet)	*NPSHA* (feet)	*Pc Req'd for NPSHA of 29 feet* (psia)	*Margin* (feet)
		Values below plotted on Figure 6 ⇓			*Values below plotted on Figure 6* ⇓					*Values below plotted on Figure 6* ⇓	*Values below plotted on Figure 7* ⇓
101.84	0.028	124.7	61.63	1.929	15.732	32.25	12.5	2.40	42.3	10.02	13.3
201.84	0.056	126.6	61.60	2.030	15.877	32.37	12.5	2.40	42.5	10.11	13.5
401.84	0.112	128.9	61.56	2.159	16.060	32.52	12.5	2.40	42.6	10.24	13.6
603.62	0.168	135.6	61.44	2.578	16.637	32.95	12.5	2.40	43.1	10.64	14.1
1003.62	0.279	143.8	61.31	3.184	17.435	33.47	12.5	2.40	43.6	11.23	14.6
2005.66	0.557	154.2	61.10	4.123	18.616	34.16	12.5	2.40	44.3	12.14	15.3
2786.91	0.774	159.1	61.01	4.644	19.248	34.47	12.5	2.40	44.6	12.65	15.6
3568.16	0.991	162.7	60.94	5.057	19.743	34.70	12.5	2.40	44.8	13.06	15.8
4349.41	1.208	165.4	60.88	5.388	20.133	34.88	12.5	2.40	45.0	13.38	16.0
5130.66	1.425	167.4	60.85	5.648	20.437	35.00	12.5	2.40	45.1	13.63	16.1
5911.91	1.642	169.1	60.82	5.870	20.695	35.10	12.5	2.40	45.2	13.85	16.2
6693.16	1.859	170.7	60.77	6.093	20.951	35.21	12.5	2.40	45.3	14.07	16.3
10447.91	2.902	174.8	60.68	6.690	21.627	35.44	12.5	2.40	45.5	14.66	16.5
19633.66	5.454	177.6	60.63	7.126	22.080	35.52	12.5	2.40	45.6	15.08	16.6
28998.41	8.055	176.7	60.65	6.981	21.867	35.34	12.5	2.40	45.4	14.94	16.4
38913.91	10.809	174.1	60.70	6.586	21.360	35.05	12.5	2.40	45.1	14.55	16.1
49139.91	13.650	170.4	60.78	6.051	20.687	34.67	12.5	2.40	44.8	14.03	15.8
59757.16	16.599	166.4	60.87	5.518	20.009	34.28	12.5	2.40	44.4	13.51	15.4
70590.16	19.608	162.6	60.95	5.045	19.395	33.91	12.5	2.40	44.0	13.04	15.0
81643.66	22.679	159.2	61.01	4.655	18.876	33.56	12.5	2.40	43.7	12.66	14.7
92860.66	25.795	156.2	61.06	4.332	18.433	33.25	12.5	2.40	43.4	12.35	14.4
104289.91	28.969	153.5	61.11	4.054	18.043	32.96	12.5	2.40	43.1	12.07	14.1
116030.91	32.231	150.9	61.17	3.802	17.682	32.67	12.5	2.40	42.8	11.83	13.8

Table 22 - Updated Analysis - Containment Pressure for Core Spray Pump NPSHR at 5%/Day Leakage Rate- 75°F Seawater Temperature

		F14.5-10	*Lookup*	*Lookup*	*Eq. 19*	*Eq. 21*			*Eq. 22*	*Eq. 23*	*Eq. 24*
Time (secs)	*Time* (hours)	*Tp* (°F)	*ρ* (lbm/ft³)	*Pvp* (psia)	P_C (psia)	*Pgas* (feet)	*Hz* (feet)	*Hsl* (feet)	*NPSHA* (feet)	P_c *Req'd for NPSHA of 29 feet* (psia)	*Margin* (feet)
127890.66	35.525	148.4	61.22	3.577	17.352	32.40	12.5	2.40	42.5	11.61	13.5
139876.91	38.855	146.1	61.26	3.375	17.051	32.15	12.5	2.40	42.2	11.42	13.2
151928.91	42.202	144.0	61.31	3.200	16.783	31.90	12.5	2.40	42.0	11.25	13.0
164009.41	45.558	142.1	61.34	3.052	16.550	31.69	12.5	2.40	41.8	11.10	12.8
172800	48.000	140.8	61.36	2.951	16.389	31.54	12.5	2.40	41.6	11.00	12.6
259200	72.000	130.3	61.54	2.243	15.167	30.24	12.5	2.40	40.3	10.32	11.3
328600	91.278	126.0	61.61	1.994	14.696	29.69	12.5	2.40	39.8	10.08	10.8
329600	91.556	125.9	61.61	1.991	14.696	29.69	12.5	2.40	39.8	10.08	10.8
330600	91.833	125.8	61.61	1.987	14.696	29.70	12.5	2.40	39.8	10.07	10.8
331600	92.111	125.8	61.61	1.984	14.696	29.71	12.5	2.40	39.8	10.07	10.8
332600	92.389	125.7	61.62	1.981	14.696	29.72	12.5	2.40	39.8	10.07	10.8
333600	92.667	125.7	61.62	1.978	14.696	29.72	12.5	2.40	39.8	10.06	10.8
334600	92.944	125.6	61.62	1.975	14.696	29.73	12.5	2.40	39.8	10.06	10.8
335600	93.222	125.5	61.62	1.971	14.696	29.74	12.5	2.40	39.8	10.06	10.8
336600	93.500	125.5	61.62	1.968	14.696	29.74	12.5	2.40	39.8	10.06	10.8
337600	93.778	125.4	61.62	1.965	14.696	29.75	12.5	2.40	39.9	10.05	10.9
338600	94.056	125.3	61.62	1.962	14.696	29.76	12.5	2.40	39.9	10.05	10.9
339600	94.333	125.3	61.62	1.958	14.696	29.77	12.5	2.40	39.9	10.05	10.9
340600	94.611	125.2	61.62	1.955	14.696	29.77	12.5	2.40	39.9	10.04	10.9
341600	94.889	125.2	61.62	1.952	14.696	29.78	12.5	2.40	39.9	10.04	10.9
342600	95.167	125.1	61.63	1.949	14.696	29.79	12.5	2.40	39.9	10.04	10.9
343600	95.444	125.0	61.63	1.945	14.696	29.79	12.5	2.40	39.9	10.03	10.9
344600	95.722	125.0	61.63	1.942	14.696	29.80	12.5	2.40	39.9	10.03	10.9
345600	96.000	124.9	61.63	1.939	14.696	29.81	12.5	2.40	39.9	10.03	10.9
432000	120.000	120.6	61.70	1.723	14.696	30.28	12.5	2.40	40.4	9.82	11.4
518400	144.000	117.9	61.73	1.597	14.696	30.56	12.5	2.40	40.7	9.70	11.7
604800	168.000	115.9	61.77	1.510	14.696	30.74	12.5	2.40	40.8	9.62	11.8

Table 22 - Updated Analysis - Containment Pressure for Core Spray Pump NPSHR at 5%/Day Leakage Rate- 75°F Seawater Temperature

		F14.5-10	*Lookup*	*Lookup*	*Eq. 19*	*Eq. 21*			*Eq. 22*	*Eq. 23*	*Eq. 24*
Time (secs)	*Time* (hours)	*Tp* (°F)	*ρ* (lbm/ft^3)	*Pvp* (psia)	P_C (psia)	*Pgas* (feet)	*Hz* (feet)	*Hsl* (feet)	*NPSHA* (feet)	P_c *Req'd for NPSHA of 29 feet* (psia)	*Margin* (feet)
613440	170.400	115.7	61.77	1.501	14.696	30.76	12.5	2.40	40.9	9.61	11.9
622080	172.800	115.5	61.77	1.493	14.696	30.78	12.5	2.40	40.9	9.60	11.9
630720	175.200	115.3	61.78	1.484	14.696	30.80	12.5	2.40	40.9	9.59	11.9
639360	177.600	115.1	61.78	1.475	14.696	30.82	12.5	2.40	40.9	9.58	11.9
648000	180.000	114.9	61.78	1.467	14.696	30.83	12.5	2.40	40.9	9.58	11.9
656640	182.400	114.7	61.78	1.459	14.696	30.85	12.5	2.40	41.0	9.57	12.0
665280	184.800	114.5	61.79	1.451	14.696	30.87	12.5	2.40	41.0	9.56	12.0
673920	187.200	114.3	61.79	1.443	14.696	30.88	12.5	2.40	41.0	9.55	12.0
682560	189.600	114.1	61.79	1.435	14.696	30.90	12.5	2.40	41.0	9.55	12.0
691200	192.000	113.9	61.80	1.427	14.696	30.92	12.5	2.40	41.0	9.54	12.0
777600	216.000	111.9	61.83	1.348	14.696	31.09	12.5	2.40	41.2	9.46	12.2
864000	240.000	110.0	61.86	1.276	14.696	31.24	12.5	2.40	41.3	9.39	12.3
950400	264.000	108.8	61.88	1.232	14.696	31.33	12.5	2.40	41.4	9.35	12.4

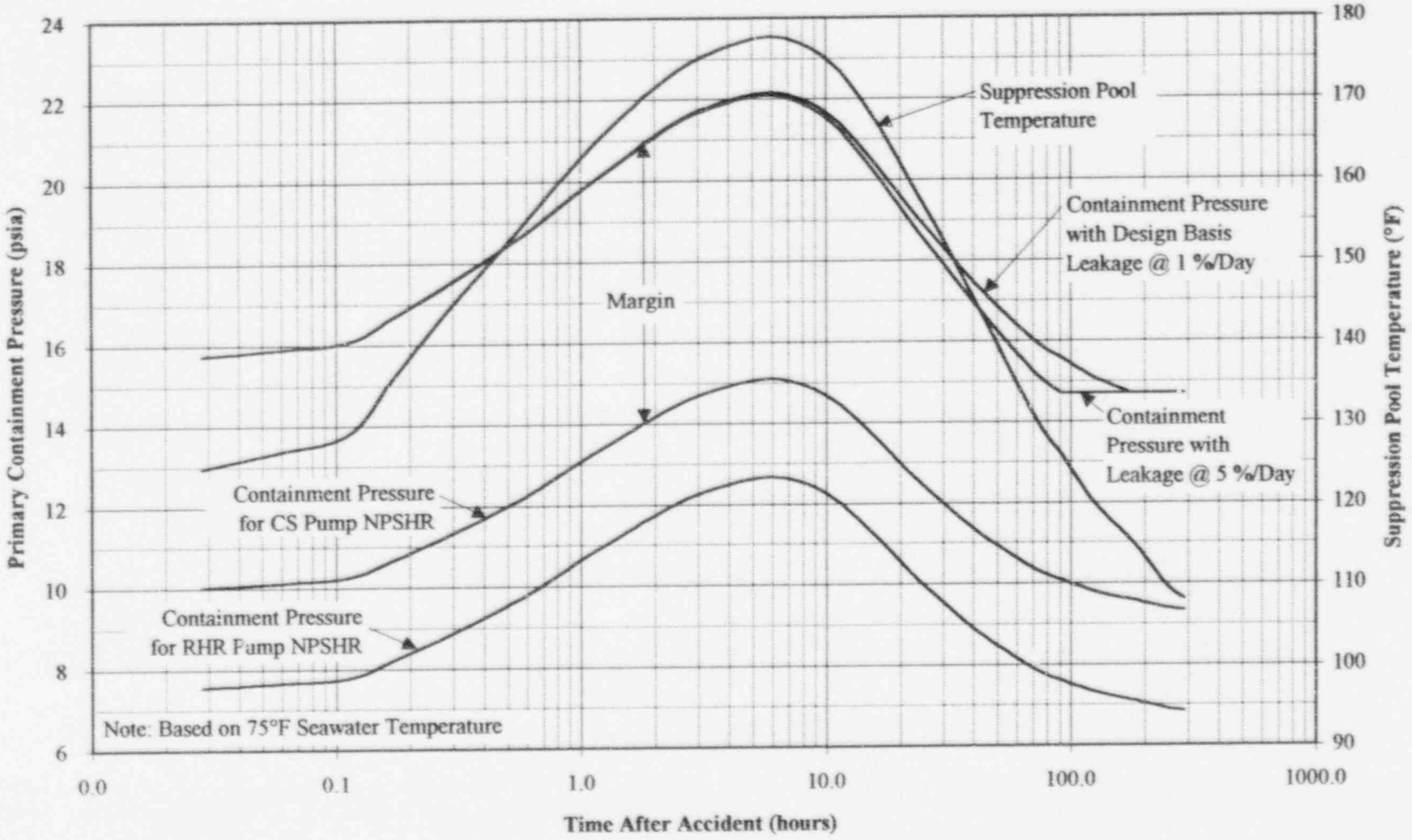


Figure 14.5-XX NPSH Availability for RHR and Core Spray System

Figure 6

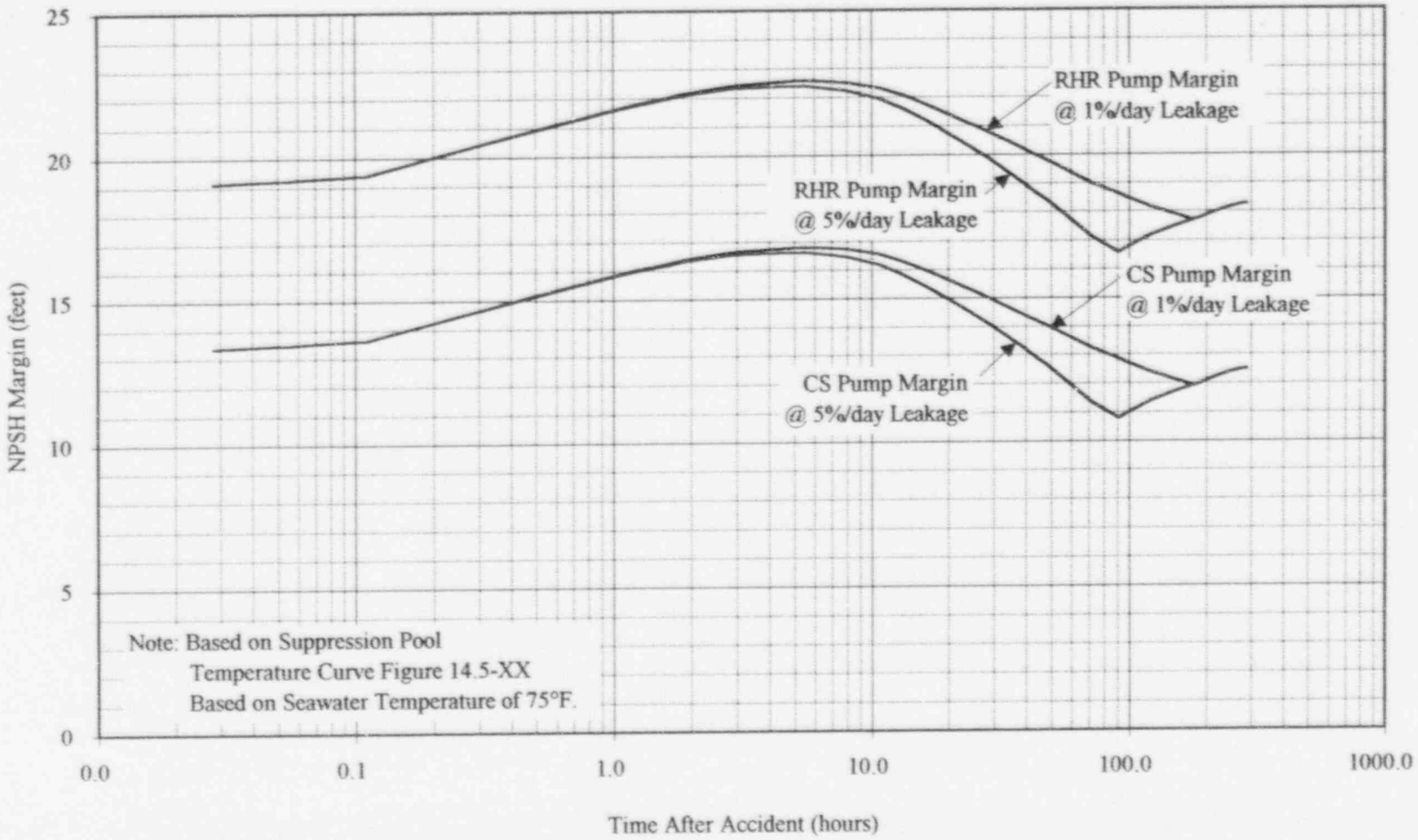


Figure 14.5-XX NPSH Margin for RHR and Core Spray System After a DBA-LOCA

Figure 7

This table contains calculated values of NPSHA and NPSHR for RHR and CS pumps as presented on FSAR Figure 14.5-9. Containment leakage is not considered in this calculation (i.e., containment leakage is assumed equal to zero).

Table 23 - ECCS Pump NPSHA Over a Range of Pool Temperatures and Zero Containment Leakage

Core Spray Pump

	Eq. 27	Lookup	Eq. 19	*Eq. 21*			Eq. 22	
Suppression Pool Chamber Pool Temperature (°F)	*Tp (°R)*	*Pvp (psia)*	*0% Leakage Pc (psia)*	*Pgas (feet)*	*Hz (feet)*	*Hsl (feet)*	*NPSHA (feet)*	*CS NPSHR (feet)*
								Values below plotted on Figure 6 ⇓
130	590.0	2.225	16.153	32.589	12.5	2.40	42.69	29
140	600.0	2.889	17.054	33.236	12.5	2.40	43.34	29
150	610.0	3.721	18.122	33.890	12.5	2.40	43.99	29
160	620.0	4.746	19.382	34.555	12.5	2.40	44.65	29
170	630.0	5.995	20.868	35.228	12.5	2.40	45.33	29
180	640.0	7.511	22.620	35.914	12.5	2.40	46.01	29
190	650.0	9.340	24.685	36.620	12.5	2.40	46.72	29

RHR Pump

	Eq. 27	Lookup	Eq. 19	*Eq. 21*			Eq. 22	
Suppression Pool Chamber Pool Temperature (°F)	*Tp (°R)*	*Pvp (psia)*	*0% Leakage Pc (psia)*	*Pgas (feet)*	*Hz (feet)*	*Hsl (feet)*	*NPSHA (feet)*	*RHR NPSHR (feet)*
							Values below plotted on Figure 6 ⇓	*Values below plotted on Figure 6 ⇓*
130	590.0	2.225	16.153	32.589	12.5	2.63	42.46	23
140	600.0	2.889	17.054	33.236	12.5	2.63	43.11	23
150	610.0	3.721	18.122	33.890	12.5	2.63	43.76	23
160	620.0	4.746	19.382	34.555	12.5	2.63	44.42	23
170	630.0	5.995	20.868	35.228	12.5	2.63	45.10	23
180	640.0	7.511	22.620	35.914	12.5	2.63	45.78	23
190	650.0	9.340	24.685	36.620	12.5	2.63	46.49	23

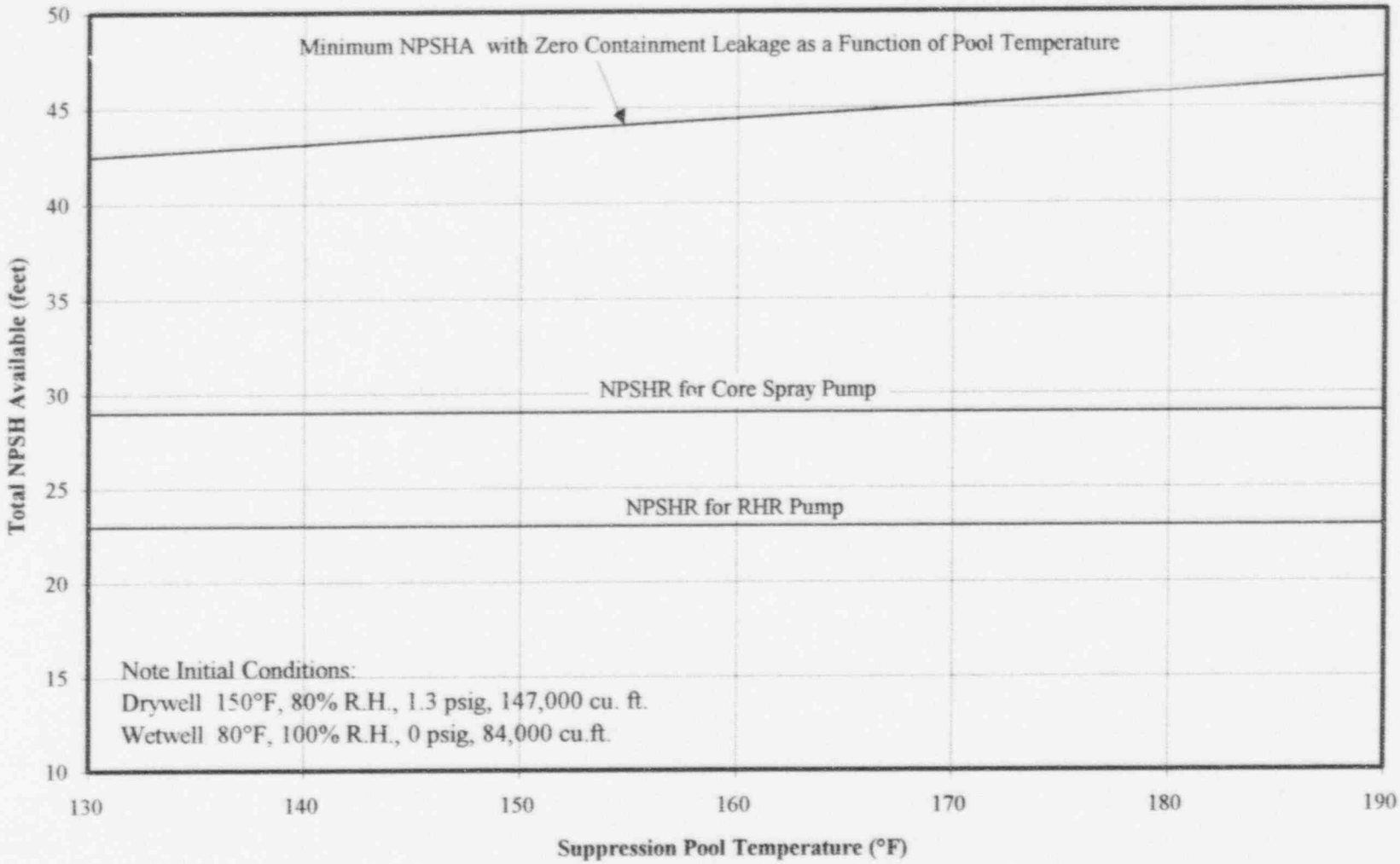


Figure 14.5-9 NPSH Availability for RHR and Core Spray System

Figure 8

Section 5.0 References

1. FSAR Section 4.8, Residual Heat Removal System.
2. FSAR Section 6.4, Core Spray System.
3. General Electric Report GE-NE-B13-01805-11, "Effects of Fiberglass Insulation Debris on Pilgrim ECCS Pump Performance", January 1996 (SUDDS/RF #96-02 Rev. 0).
4. GE Report GE-NE-523-A044-0595.
5. Bingham Pump Curve No. 27956 and 27763 (Core Spray Pumps)
6. Bingham Pump Curve No. 28457, 28167, 28168, and 28169 (RHR Pumps)
7. Crane Technical Paper No. 410, Crane Co., New York, N.Y., 1981.
8. Brater & King, *Handbook of Hydraulics*, Sixth Edition, McGraw-Hill, New York, NY, 1976.
9. General Electric Report GE-NE-523-A044-0595, "PNPS Decay Heat Removal Capability", May 1995 (SUDDS/RF #95-127 Rev. 1).
10. FSAR Section 14.5, Postulated Design Basis Accidents.
11. General Electric Report NEDC-31852P Rev. 1, "PNPS SAFER/GESTR-LOCA Loss-of-Coolant Accident Analysis", 1992.
12. BECo Calculation N110, Rev. 0, "OPL-4 (ECCS Parameters) for SAFER/GESTR-LOCA Analysis for PNPS".
13. SUDDS/RF #84-59, "Procurement of RHR & Core Spray Strainers".
14. M108C-DSB, Rev. E1, "Suction Strainers Data Sheet"
15. M108C-1, Rev. E1, "Core Spray & RHR Strainer"
16. M100-51-7, "Core Spray System Suction Piping to Core Spray Pump P-215A"
17. M100-54, Rev. E2, "Core Spray System Core Spray Line Rerouting Assembly"
18. M100-256-4, Rev. E2, "Core Spray Critical Piping, S.E. Quadrant Below Elev. 23'-0"
19. M100-52-6, Rev. E2, "Core Spray System Suction Piping to Core Spray Pump P-215B"
20. M100-265-4, Rev. E2, "Core Spray Critical Piping, N.W Quadrant Below Elev. 23'-0"
21. M100-251-4, Rev. E1, "RHR Nuclear Piping S.E. Quadrant Below Elev. 23'-0"
22. M100-43-7, Rev. E1, "RHR Nuclear Piping, S.E. Quadrant Below Elev. 23'-0"
23. M100-47-8, Rev. E1, "RHR Nuclear Piping, NW Quadrant Below Elev. 23'-0"

24. M100-266-3, "RHR Nuclear Piping, N.W. Quadrant Below Elev. 23'-0"

25. M100-262-4, Rev. E1, "RHR Nuclear Piping, N.W. Quadrant Below Elev. 23'-0"

26. M100-42-9, Rev. E1, "RHR Nuclear Piping S.E. Quadrant Below Elev. 23'-0"

27. M100-252-4, Rev. E1, "RHR Nuclear Piping, S.E. Quadrant Below Elev. 23'-0"

28. M100-47-6, Rev. E1, "RHR Nuclear Piping, N.W. Quadrant Below Elev. 23'-0"

29. M100-263-3, Rev. E1, "RHR Nuclear Piping, N.W. Quadrant Below Elev. 23'-0"

30. M100-264-6, Rev. E1, "RHR Nuclear Piping, N.W. Quadrant Below Elev. 23'-0"

31. Amendment 9 to License Application Filed June 30, 1967 (Docket No. 50-293), 03/11/68.

32. Amendment 24 to License Application (Docket No. 50-293).

33. FSAR:
    a) Table 5.2-1 Primary Containment System Principal Design Parameters and Characteristics
    b) Section 14.5.3.1.2 Containment Response
    c) Section 14.5.3.1.3 Core Standby Cooling System Pump Net Positive Suction Head
    d) FSAR Figure 14.5-7 Loss of Coolant Accident Suppression Pool Temperature Response
    e) FSAR Table 14.5-1 Loss of Coolant Accident Primary Containment Response Summary

34. Technical Specifications for Pilgrim Nuclear Power Station:
    a) Minimum water volume per LCO 3.7.A.1.a.
    b) Maximum water volume per LCO 3.7.A.1.b.
    c) Maximum suppression pool temperature during normal continuous power operation per LCO 3.7.A.1.c.
    d) Minimum differential pressure between drywell and suppression chamber per LCO 3.7.A.1.i.
    e) Allowable suppression chamber water level range per LCO 3.7.A.1.m.
    f) Maximum containment leakage rate per surveillance requirement 4.7.A.2.a.

35. BECo Calculation S&SA91, "Containment and Decay Heat Removal Analysis Inputs", Rev. E0
    a) Section 5.2 "Calculation of Initial Suppression Chamber Free Airspace Volume"
    "Calculation of Initial Suppression Chamber Pool Volume at HWL per TS 3.7.A.1.m."

36. GE Specification, 22A5756, Containment Data, Rev. 3, February 1982.

37. General Electric Report GE-NE-T23-00732-01, "Containment Heat Removal Analysis", March 1996, (SUDDS/RF96-05).

Section 5.0 **References cont'd**

38. "SSW Analysis Transmittal for Pilgrim Nuclear Power Station," GE letter from E.G. Thacker to F. Mogolesko, February 9, 1996 with Attachments, (SUDDS/RF96-05).

Section 6.0 **Attachments**

Attachment 1 = Independent Verification Statement Record (3 pages)

CALC M-662 REV. E1
ATTACHMENT 1
Page 82 of 84

INDEPENDENT DESIGN VERIFICATION RECORD (IDVR)

I. Instructions to independent personnel

Design Documents: M662 (Document No.) E1 (Rev.) CALC. (Document Title)

_____ (Document No.) _____ (Rev.) _____ (Document Title)

Design verification should be done in accordance with ANSI N45.2.11, Section 6, as amended by Reg. Guide 1.64, Rev. 1.

Verification Methods to be used:

✓ Design review
_____ Alternate or simplified calculations
_____ Qualification Testing

Document(s) "Q" Level:

✓ Q
_____ FP-Q
_____ Non-Q

Special Instructions:

Thomas White J.
T.F. WHITE / Div. Manager — 2-29-96 / Date

II. Verification Documentation:

Method Used:

✓ Design review (attach any documentation)
_____ Alternate or simplified calculations (Attach calculations)
_____ Qualification testing (Attach Test Report)

Design Document Acceptable: YES ✓ NO _____

If not acceptable, give reasons or provide comments on Exhibit 3.06-B:

Independent Design Verification check completed by

(Signature): Thom M. Hauck — Independent Reviewer — 3/20/96 / Date

Acknowledgment of verification: Thomas White J. — Division Manager — 3/25/96 / Date

III. Resolution of comments:
Comments resolved (See Exhibit 3.06-B):

P.D. Hariji — Cognizant Engineer — 3-20-96 / Date

Action taken makes design document acceptable

Thom M. Hauck — Independent Reviewer — 3/20/96 / Date

Calculation - Independent Verification Statement Record

Calculation # M662, Revision # E1 has been independently verified by the following method(s), as noted below:

Mark each item yes, no or not applicable (N/A) and initial each item checked by you.

Design Review ☒ including verification that:

- ✓ Design inputs were correctly selected and included in the calculation.
- ✓ Assumptions are adequately described and are reasonable.
- N/A Input or assumptions requiring confirmation are identified, and if any exist, the calculation has been identified as "Preliminary" and a "Finalization Due Date" has been specified.
- N/A Design requirements from applicable codes, standards and regulatory documents are identified and reflected in the design.
- N/A Applicable construction and operating experience was considered in the design.
- ✓ The calculation number has been properly obtained and entered.
- ✓ An appropriate design method or computer code was used.
- ✓ A mathematical check has been performed.
- ✓ The output is reasonable compared to the input.

Alternate Calculation ☐ including verification of asterisked items noted above. The alternate calculation (pages) is attached.

Qualification Testing ☐ for design feature including verification of asterisked items noted above and the following:

- The test was performed in accordance with written test procedures.
- Most adverse design conditions were used in the test.
- Scaling laws were established and verified and error analyses were performed, if applicable.
- Test acceptance criteria were clearly related to the design calculation.
- Test results (documented in) were reviewed by the calculation Preparer or other cognizant engineer.

Independent Reviewer Comments: See Attached Sheet

/S/ Thom M. Hanks 3/20/96
Independent Reviewer /Date

Preparer concurrence with findings and comment resolution

/S/ P.D. Hariji 3-20-96
Preparer or Other Cognizant Engineer

Note: Exhibit 3.06-B (Sheet 3 of 3) may to used for additional comments by IV as a part of the Independent Verification for calculations.

COMMENTS	RESOLUTION
1) Section 2.0 - States "The RHR and Core Spray Pumps are provided adequate NPSH under design conditions at the peak pool temperature with the initial wetwell pressure of 0.5psig" where as Section 4 Inputs Table 8 says initial Wetwell Pressure of 0psig. Explain the difference.	THE CONTAINMENT PRESSURES IN TABLE 8 ARE 1.3PSIG DRYWELL AND 0 PSIG WETWELL. WHEN THESE EQUALIZE, THE RESULT IS 0.5 PSIG IN CONTAINMENT. A NEW SECTION 3.C.5 WAS ADDED TO CALCULATE THIS AND EXPLAIN THAT AFTER A REACTOR BLOWDOWN THE DRYWELL AND WETWELL EQUALIZE PRESSURE.
2) Also for the 75°F Seawater Temperature case, the required containment pressure for CS pump NPSH exceeds 14.7 psia. Should we state we don't need to meet Reg. Guide 1.1 and this is acceptable.	REG. GUIDE 1.1 IS NOT PART OF THE PNPS LICENSING OR DESIGN BASIS. HOWEVER, THE REG. GUIDE STATES ADEQUATE NPSH BE PROVIDED ASSUMING "NO INCREASE IN CONTAINMENT PRESSURE FROM THAT PRESENT PRIOR TO POSTULATED LOSS OF COOLANT ACCIDENTS". THE NOMINAL DESIGN CONDITION, I.E., WITHOUT DEBRIS CLOGGING EFFECTS, MEETS THIS CRITERIA AT A 178°F POOL TEMPERATURE WITH THE 0.5 PSIG CONTAINMENT PRESSURE THAT EXISTS DUE TO INITIAL MASS AS SHOWN IN NEW SECTION 3.C.5.