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CALCULATION TITLE PAGE

Client	Florida Power Corporation	Page 1 of 9
Project	Review of Calculation of Allowable Makeup Tank Pressure vs. Level	Task No. 102-075
Title	Comparison of Calculated and Measured Pressures at Junction of Makeup Tank Surge Line and Pump Suction Pipe	Calculation No. 102075RCS01

Preparer/Date	Checker/Date	Reviewer/Date	Rev. No.
R.C. Landers, 4/8/96	S. Sethi, 4/8/96	David N. Stevens, 4/8/96	0
R.C. Landers, 4/22/96	D.Harrison 4/22/96	D.Harrison 4/22/96	1

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RECORD OF REVISIONS

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102075RCS01	R.C. Sanders	[signature]	1a

Revision	Description
0	Original Calculation
1	Revised to correct for fact that the 0.2 in H_2O in the BWST during testing was a vacuum and not a positive pressure. This correction has a negligable effect on the results.

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Purpose: The purpose of this calculation is to compare calculated and measured pressures at the junction of the makeup tank surge line and the pump suction line.

Approach: Reference (1) describes the model used for calculating the pressure at the junction of the makeup tank surge line and the pump suction. This model is used to calculate the allowable pressures in the makeup tank, Reference (2).

This calculation compares the pressures calculated using the Reference (1) model with pressures measured at the junction, Reference (3).

Results: The calculated pressures at the junction of the makeup tank surge line and the makeup pump suction line are less than the measured values obtained during testing. The lower calculated pressure means that the calculational technique predicts a higher pressure drop in the piping section between the BWST and the junction of the makeup tank surge line. The higher measured pressures confirm that there is, in fact, less pressure drop between the BWST and the makeup tank surge line junction than the pressure drop the calculational techniques would predict. Therefore, the test confirms that the calculational techniques used to evaluate pressure drop are conservative. This also means that the loss coefficient (K factors) used in the calculations are conservatively high.

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Analysis

See Figure 1 for nomenclature.

The pressure at the tie in point (point c) is

$$P_c = P_o + \rho\left[(E_b - E_c) - \frac{U_c^2}{2g} - H_L\right]$$

where, P_o = Pressure at surface at BWST
ρ = density at water in BWST
g = 32.2 ft/s²
E_b = elevation at water in BWST
E_c = elevation at point C = 104.50 ft
U_c = flow velocity in 6-inch pipe
H_L = head losses from BWST to point C.

$$H_L = \frac{1}{2g}\left(K_b U_b^2 + K_c U_c^2\right)$$

where, K_b = K-factor for 14-inch pipe run = 2.62, Ref. 1
K_c = K-factor for 6-inch pipe run = 11.33, Ref. 1
U_b = flow velocity in 14-inch pipe

$$P_c = P_o + \rho\left[(E_b - E_c) - \frac{1}{2g}\left[K_b U_b^2 + (K_c + 1)U_c^2\right]\right]$$

From Reference 3, during the test the BWST water temperature was about 88°F and the vacuum in the BWST was 0.2 in H_2O. At 88°F, ρ = 62.1 lb/ft³, Reference 4.

$$P_o = -(0.2'' H_2O)(62.1\ lb/ft^3)\left(\frac{1\ ft}{12\ in}\right)\left(\frac{1\ ft^2}{144\ in^2}\right) = -0.01\ psi$$

Several data points were measured. For this analysis, 4 data points will be selected for comparison [illegible] -alculated results. The 4 data points are [illegible]ized in Table 1.

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The flow velocity is given by

$$U = \frac{G}{A} = \frac{4G}{\pi D^2}$$

where, G - volumetric flow rate
D = pipe ID

For the 14-inch pipe, D = 1.1042 ft, Reference 1
For the 6-inch pipe, D = 0.5054 ft, Reference 1

$$U = \frac{4}{\pi} \frac{G\ (gal/min)}{(D^2)(ft^2)} \left(\frac{1\ ft^3}{7.4805\ gal}\right)\left(\frac{1\ min}{60\ sec}\right)$$

$$U = \begin{cases} 2.3262 \times 10^{-3}\, G & \text{for 14-inch pipe} \\ 1.1106 \times 10^{-2}\, G & \text{for 6-inch pipe} \end{cases}$$

$$P_c\ (psig) = -0.01 + \frac{62.1}{144}\left\{E_b - 104.90 - \frac{1}{2(32.2)}\left[2.62\,U_b^2 + 12.33\,U_c^2\right]\right\}$$

Calculated Values of P_c (P_{calc}) are given in Table 2.

The test gage is located 3.25 ft above the tie. Therefore, the measured pressure at the tie in is

$$P_{meas} = P_{gage} + (3.25\ ft)\left(62.1\ \frac{lb}{ft^3}\right)\left(\frac{1\ ft^2}{144\ in^2}\right)$$

$$P_{meas} = 1.40\,psi + P_{gage}$$

P_{meas} is given in Table 2.

Calculated and measured values at P_c are shown in Figure 2.

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Table 1
Makeup Tank Drawdown
Test Data
(Reference 3)

Time (minutes)	BWST Water El. (ft)	G_b, 14" flow (gpm)	G_c, 6" Flow (gpm)	Uncorrected Measured Pressure (psig)	Corrected Measured Pressure (psig) *
9	146.65	4760	204	14.8	16.20
12	146.52	4937	350	14.1	15.50
17	146.29	5022	442	13.3	14.70
26	145.79	5075	493	12.9	14.30

* Corrected for test gage elevation.

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Table 2
Pressures At Makeup Tank
Tie In To Pump Suction Line

Time (minutes)	U_c (ft/sec)	U_b (ft/sec)	P_{calc} (psig)	P_{meas} (psig)	$P_{meas} - P_{calc}$ psig/ft H_2O
9	2.27	11.07	15.59	16.20	0.61/1.41
12	3.89	11.48	14.55	15.50	0.95/2.20
17	4.91	11.68	13.63	14.70	1.07/2.48
26	5.48	11.80	12.88	14.30	1.42/3.29

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SCHEMATIC OF SYSTEM

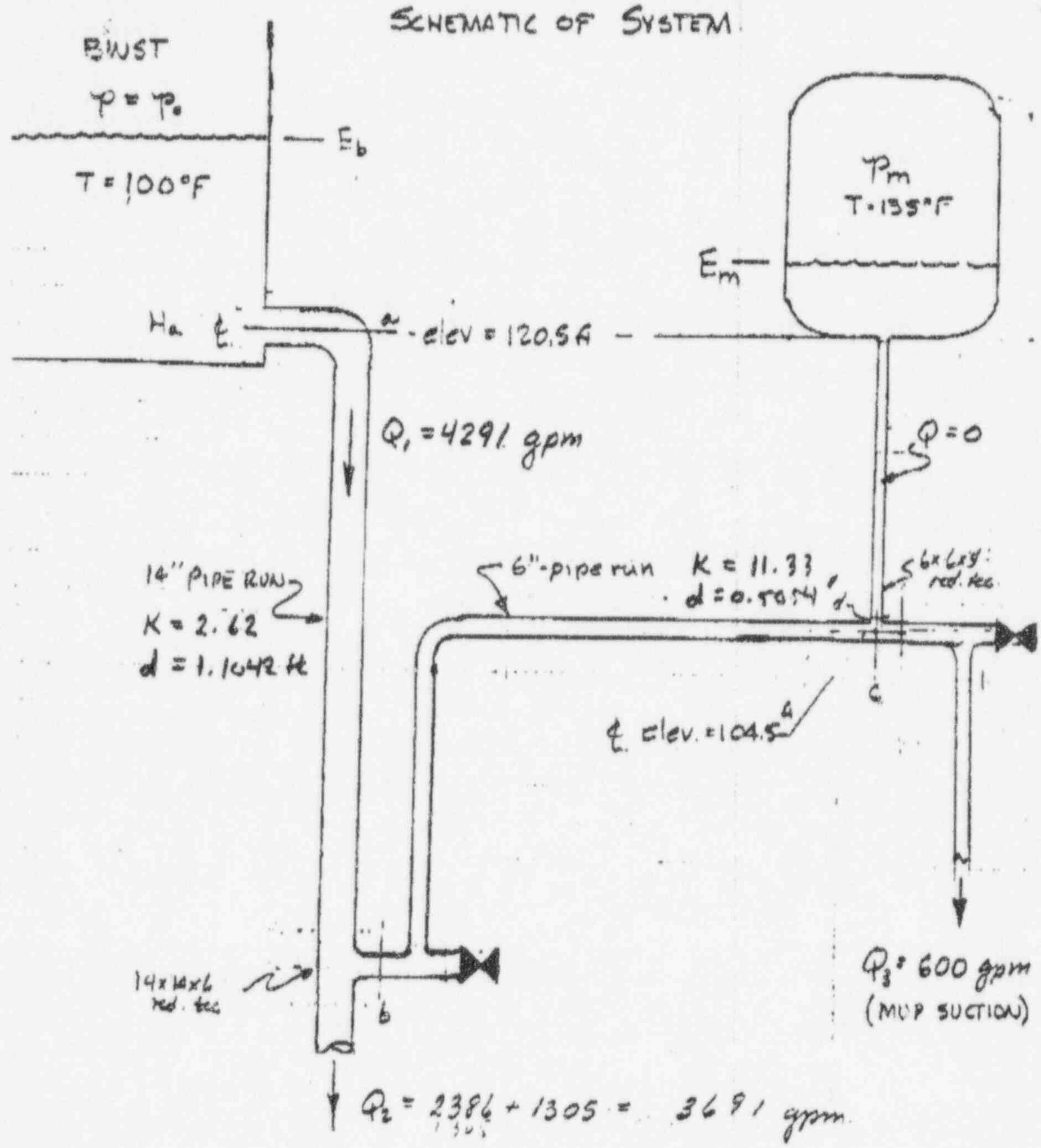

Figure 1
(From Reference 1)

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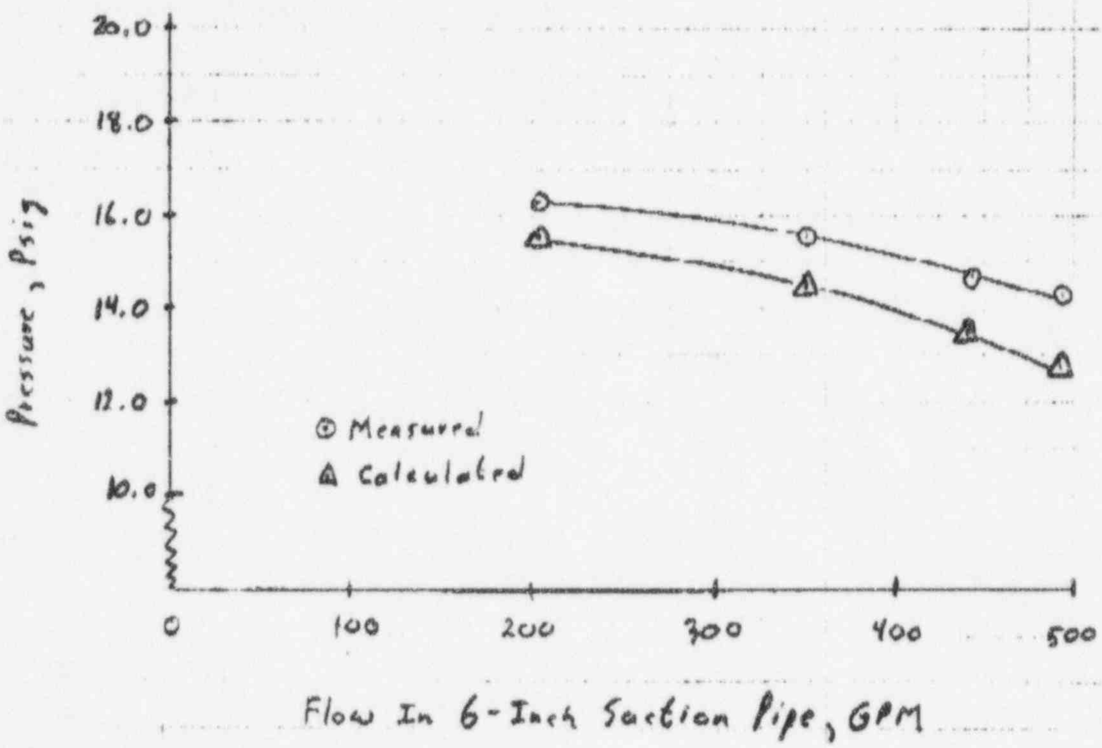

Figure 2

Pressure At Junction Between Makeup Tank Surge Line And Makeup Pump Suction Line

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References

1. MPR Calculation No. 102075 DHH02, Rev. 0, Head Loss in BWST to Makeup Pump Flow, January 1996.

2. MPR Calculation No. 102075 DHH01, Rev. 0, Maximum Allowable Makeup Tank Pressure, January 1996.

3. Fax from Florida Power Corporation (Paul Tanguay) to MPR Associates (Noman Cole) dated April 4, 1996.

4. El-Wakil, "Nuclear Heat Transport," International Text Book Company, 1971.