NSID

1463W:42/040284

NSID-EIS-84-07

VESSEL LEVEL MONITOR SYSTEM

SCALING CALCULATIONS

FOR

PNJ/SALEM UNIT #2

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1.0 INTRODUCTION

The purpose of this document is to explain the derivation of the plant specific values for the Vessel Level Monitor (VLM) System at PNJ/Salem Unit #2.

2.0 SENSOR ENGINEERING UNIT CONVERSION (TABLE 1)

The sensor engineering unit conversion data converts the volts measured at the input to engineering units (°F, PSI). The equation to represent this conversion is:

(1) Engineering Units (°F, PSI) = $A + B(V) + C(V)^2 + D(V)^3 + E(V)^4$

A. RTD Engineering Unit Conversion Data for Impulse Line RTD's is a polynomial representing the RTD's resistance-temperature relationship at a constant current. For PNJ, the manufacturer's resistance-temperature curve for the RTD's was used to derive the following polynomial: See equation (2).

(2) Temperature (°F) = $-411.19 + 4270.6V + 1518.7V^2 + 971.87V^3$

Comparing with Equation (1):

A = -411.19
B = 4270.6
C = 1518.7
D = 971.87
E = 0.0

B. DP Cell Engineering Unit Conversion Data
A linear relationship between Volts and PSI is used to derive the following equations representing DP engineering unit conversion. For PNJ, the DP sensor's specification sheets at a temperature of 60°F and a resistance of 50 ohms were used, with the following results:

i. Upper Range Sensor (DP1)

Upper Range Empty (cold)	Upper Range Full (cold)
180.625 INWC	17.625 INWC
-6.5205 PSI	-0.6362 PSI
4 mA	20 mA
0.2V	1V

(3) Pressure (PSI) = -7.9916 + 7.3534V

Comparing with Equation (1): A = -7.9916
B = 7.3534

ii. Full Range Sensor (DP2)

Vessel Empty (cold)	Vessel Full (cold)
512.875 INWC	17.625 INWC
-18.515 PSI	-0.6363 PSI
4 mA	20 mA
0.2V	1.0V

(4) Pressure (PSI) = -22.984 + 22.348V

Comparing with Equation (1): A = -22.984
B = 22.348

iii. Dynamic Head Sensor (DP3)

Vessel Empty (cold)	Vessel Full (cold, pumps on)
512.875 INWC	1072 INWC
-18.515 PSI	38.699 PSI
4 mA	20 mA
0.2V	1.0V

(5) Pressure (PSI) = -32.811 + 71.518

Comparing with Equation (1): A = -32.819
B = 71.518

C. Reactor Coolant Wide-Range Temperature Engineering Conversion Data
A linear relationship between Volts and °F is used to derive an equation representing THOT 1 and THOT 2 engineering unit conversion. For PNJ, the THOT 1 and THOT 2 specification sheets were used, with the following results:

0	700°F
1.0	5.0V

(6) Temperature (°F) = -175.0 + 175.0V

Comparing with Equation (1): A = 175.0
B = 175.0

D. Reactor Coolant Wide-Range Pressure Engineering Unit Conversion
A linear relationship between Volts and PSIA is used to derive an equation representing PRESS engineering conversion. For PNJ, the PRESS specification sheets were used, with the following results:

0	3000 PSIG
14.7	3014.7 PSIA
1.0	5.0V

(7) Pressure (PSIA) = -735.3 + 750.0V

Comparing with Equation (1): A = -735.3
B = 750.0

Table 1 is a summary of these calculations.

3.0 SENSOR OFF-SCALE HIGH AND LOW SETPOINTS (TABLE 2)

The off-scale high and low setpoints are the range of the sensor in engineering units.

(8) A = Off-scale low setpoint = lower end of E.U range
B = Off-scale high setpoint = upper end of E.U. range

A. RTD Setpoints

The water density function used for the impulse line water density at PNJ was valid from 50 to 420°F.

Comparing with relationship (8):

(9) A = 50
B = 420

B. DP Cell Setpoints

i. Upper Range Sensor (DP1)

The Upper Range Sensor (DP1) at PNJ was valid from -6.5205 to -0.6362 PSI.

Comparing with relationship (8):

(10) A = -6.5205
B = -0.6362

ii. Full Range Sensor (DP2)

The Full Range Sensor (DP2) at PNJ was valid from -18.515 to -0.6363 PSI.

Comparing with relationship (8):

(11) A = -18.515
B = -0.6363

iii. Dynamic Head Sensor (DP3)

The Dynamic Head Sensor (DP3) at PNJ was valid from -18.515 to 38.699 PSI (see Figure 2).

Comparing with relationship (8):

(12) A = -18.515
B = 38.699

Reactor Coolant Wide-Range Setpoints

The Reactor Coolant Wide-Range temperature sensors (THOT 1, THOT 2) were valid from 0 to 700°F

Comparing with relationship (8):

(13) A = 0.0
B = 700.0

Reactor Coolant Wide-Range Pressure Setpoints

The Reactor Coolant Wide-Range Pressure sensor (PRESS) was valid from 14.7 to 3014.7 PSIA.

Comparing with relationship (8):

(14) A = 14.7
B = 3014.7

Table 2 is a summary of these calculations.

4.0 ALARM SETPOINTS (TABLE 3)

Entering alarm setpoints are not recommended by Westinghouse, and at PNJ alarm setpoints were not used. This feature was cancelled by choosing setpoints at the lower limit of the VLM range. The lower limit of the range was -99%.

Table 3 is a summary of this.

5.0 NORMAL LEVEL READINGS (TABLE 4)

The following is an explanation of normal (expected) level readings as a function of the number of pumps running. These normal readings are given on the VLM remote display as an operator aid.

A. Upper Range Sensor (DP1)

The scaling for the upper range instrument will result in a normal indication of 103% level when vessel and standpipe are completely filled. When a reactor coolant pump is started in a loop with a RVLIS hot leg connection, that RVLIS upper range indication will indicate offscale low (< 60%), and "INVALID" will appear on the remote display status column. If the pump is not running in the loop with a RVLIS connection, but other pumps are started, the upper range indication will increase slightly due to small pressure drops in the hot leg and vessel internals, resulting in the following indications:

Pump Running	Upper Range Indication
0	103%
1	103 - 104%
2	104 - 105%
3	107 - 108%
4	< 60% (INVALID)

B. Full Range Sensor (DP2)

For the Full Range Sensor, the normal value is 104% (vessel and standpipe full) for 0 pumps on. When the first reactor coolant pump is started, the Full Range indication will increase to about 120% or to the limit value if set lower. Additional pump startups will cause (or maintain) an offscale high indication. This condition will remain until RCS pumps are shut down, or until a high void condition in the vessel with RCS pumps running causes a reduced pressure drop bring the indication back onscale.

C. Dynamic Head Sensor (DP3)

For the dynamic head sensor, the normal readings are a function of the number of pumps running. This information is obtained during cycling under hot conditions or calculated using pump characteristics and pressure drops. At PNJ, the following normal readings were obtained during heatup.

0 pumps	34%	1 pump	38%
2 pumps	50%	3 pumps	71%
4 pumps	100%		

Table 4 is a summary of these results.

6.0 PERCENT LEVEL SCALE CALIBRATION DATA (TABLE 5)

The VLM calculates the following:

1. Vessel level, in feet, above the hot leg elevation for upper range (DP1).
2. Vessel level, in feet above the bottom of the vessel for full range (DP2).
3. Measured Dynamic Head (DP3). Has a scale of 0-1.

These are converted to percent using the following equation:

(15) $\% = A + B(X)$

A. Vessel Level in Feet Above the Hot Leg Elevation for Upper Range (DP1)

For this case, equation (15) becomes:

(16) % = (%) below hot leg elevation +
X(ft) above (hot leg elevation) % above hot leg elevation (above hot leg elevation) (ft)

where:

$$\text{\% below hot leg elevation} = \text{(ft) below hot leg elevation} \; \frac{(100(\%))}{\text{height (ft) of RV}}$$

$$\text{\% above hot leg elevation} = \text{(ft) below hot leg elevation} \; \frac{(100(\%))}{\text{height (ft) of RV}}$$

For PNJ, equation (16) became:

$$\% = \left([27.6875]\left[\frac{100}{41.2708}\right]\right) + (X)\,\frac{\left([14.521]\left[\frac{100}{41.2708}\right]\right)}{14.521}$$

(16) $\% = 67.0874 + 2.4230X$

Comparing with Equation (15): $A = 67.0874$
$B = 2.4230$

B. Vessel Level in Feet Above the Bottom of the Vessel for Full Range. For this case, equation (15 becomes 17)

17 $\% = \left(X\text{(ft) above RVB}\right)\left(\frac{100\%}{\text{height (Ft) of RV}}\right)$

For PNJ, the Reactor Vessel Water Level Installation Schematic was used. Equation (17) becomes:

$$\% = (X)\left(\frac{100}{41.2708}\right)$$

Comparing with Equation (15): $A = 0.0$
$B = 2.4230$

C. Measured Dynamic Head (DP3)

The 0-1 scale is converted to 0-100%. For PNJ, a linear equation representing this was:

(18) % = 100X

Comparing wih equation (15): A = 0.0
B = 100.0

Table 5 is a summary of these equations.

7.0 READOUT LIMIT VALUES (TABLE 6)

It is recommended that the hard limits for DP1 be 60 to 120%, DP2 be 0 to 120% and DP3 be 0 to 120%. These limits are set sufficiently beyond the normal indication so that malfunctions causing an abnormal indication can be detected. For example, a sensing line failure would result in an off-scale indication and would be detected if the limit value for the indicator is set at a value greater than the normal value. The NRC considers this capability to be important for indicating and diagnosing malfunctions which could otherwise be undetected or introduce uncertainties during an accident.

Table 6 is a summary of this.

8.0 DYNAMIC HEAD PUMP PERFORMANCE CURVE (TABLE 7)

The dynamic head level sensor (DP3) is compared with pump performance curves. These curves are represented by fourth-order polynomials. One polynomial gives pump performance as a function of reactor coolant temperature and the other gives pump performance as a function of primary pressure. This polynomial is represented by the equation:

$$(21)\ DP\ \left(\frac{PSIA}{°F}\right) = A + B\left(\frac{P}{T}\right) + C\left(\frac{P}{T}\right)^2 + D\left(\frac{P}{T}\right)^3 + E\left(\frac{P}{T}\right)^4$$

The polynomial giving pump performance as a function of reactor coolant temperature is acquired by using a least-squares polynomial fitting procedure on a curve obtained either during plant heat-up with all pumps running or calculated using pump characteristics and pressure drops. The polynomial giving pump performance as a function of primary pressure is acquired by using a least-squares polynomial fitting procedure on the curve represented by Equation (21) and converting to saturation pressure (in PSIA) using steam tables.

For PNJ, the curve used in this document was obtained from data taken during heat up with all pumps running. (See Figure 1)

Fitting a polynomial to this curve gave:

$$(22)\ DP(°F) = 22.79 + 3.755 \times 10^{-1}V - 2.115 \times 10^{-3}V^2 + 4.337 \times 10^{-6}V^3 - 3.128 \times 10^{-9}V^4$$

Converting this curve to saturation pressure (PSIA) and fitting a polynomial (see Figure 2) gave:

FOR <45 PSIA

$$(23)\ DP(PSIA) = 12.27 + 2.1908V - 14.492 \times 10^{-2}V^2 - 3.7535 \times 10^{-3}V^3 + 3.427 \times 10^{-5}V^4$$

FOR (45 -3000 PSIA)

$$DP(PSIA) = 36.67 - 17.267 \times 10^{-3}V + 7.0661 \times 10^{-6}V^2 - 1.457 \times 10^{-9}V^3 + 1.275 \times 10^{-13}V^4$$

Comparing these two equations with (21):

DP(°F)	DP(PSIA) [< 45 PSIA]	DP(PSIA) [45 -3000 PSIA]
A = 22.79	A = 12.27	A = 36.67
B = -3.755×10^{-1}	B = 2.1908	B = -17.267×10^{-3}
C = -2.115×10^{-3}	C = -14.492×10^{-2}	C = 7.066×10^{-6}
D = 4.337×10^{-6}	D = 3.753×10^{-3}	D = -1.457×10^{-9}
E = -3.128×10^{-9}	E = 3.427×10^{-5}	E = 1.275×10^{-13}

Table 7 is a summary of these results.

9.0 IMPULSE LINE VERTICAL LENGTHS (TABLE 8)

Vertical lengths of each DP RTD cell combination are entered to correct the measured DP's for weight of water in the impulse line.

$$DP_J \text{ corrected} = DP_J \text{ measured} + H_{iJ}\, P_{H2O}\,(Ti)$$

Where:

DP_J corrected = the DP corrected for impulse line water weight for the J^{th} transducer (1 = Upper Range, 2 = Full Range, 3 = Dynamic Head).

DP_J measured = the DP measured by the J^{th} sensor.

H_{ij} = the height of the impulse line (in feet) connected to the J^{th} DP cell whose temperature is measured by the i^{th} RTD. Note the H_{ij} can be negative, zero or positive. If H_{ij} is positive, the weight of water is added to the measured DP. If it is zero, that RTD does not measure the temperature of an impulse line connected to the particular DP cell. If it is negative, the weight of water is subtracted from the measured DP.

P_{H2O} (%i) = the density of the water at the temperature Ti (lb/ft^3).

Figure 3 shows how the polarity of the vertical lengths is determined. Each DP cell uses the same diagram. DP2 and DP3 should read the same and have the same impulse line heights. The overall height of the reactor vessel is needed for DP1 and DP2. This height normally is from the hot leg tap point to the top of the standpipe from the vessel top up to the highest point that would drain off water if the vessel were to empty for DP1 and from the bottom of the vessel up to the same tap point for DP2.

For PNJ, the Reactor Vessel Water Level Installation Schematic Drawing was used to obtain these heights.

Table 8 presents a summary of these results.

10.0 CALIBRATION OF ANALOG INPUTS (TABLE 9, TABLE 10)

Analog inputs are calibrated by inputting a voltage into the unit and storing the A/D converter reading that corresponds to the calibration point. Normally, the calibration potentiometers on the input board do not have to be adjusted. The zeroes on all ranges are calibrated first, the full-scale second. The calibration tools should have an accuracy of at least 0.05% and preferably 0.01%. The 0-1V and 0-10V ranges should be calibrated carefully, while the 0-20mV and 0-100mV ranges can be calculated crudely since they normally are not used in the VLM. Calibration accuracy is determined by the designer and presented in Tables 9 and 10.

APPENDIX A

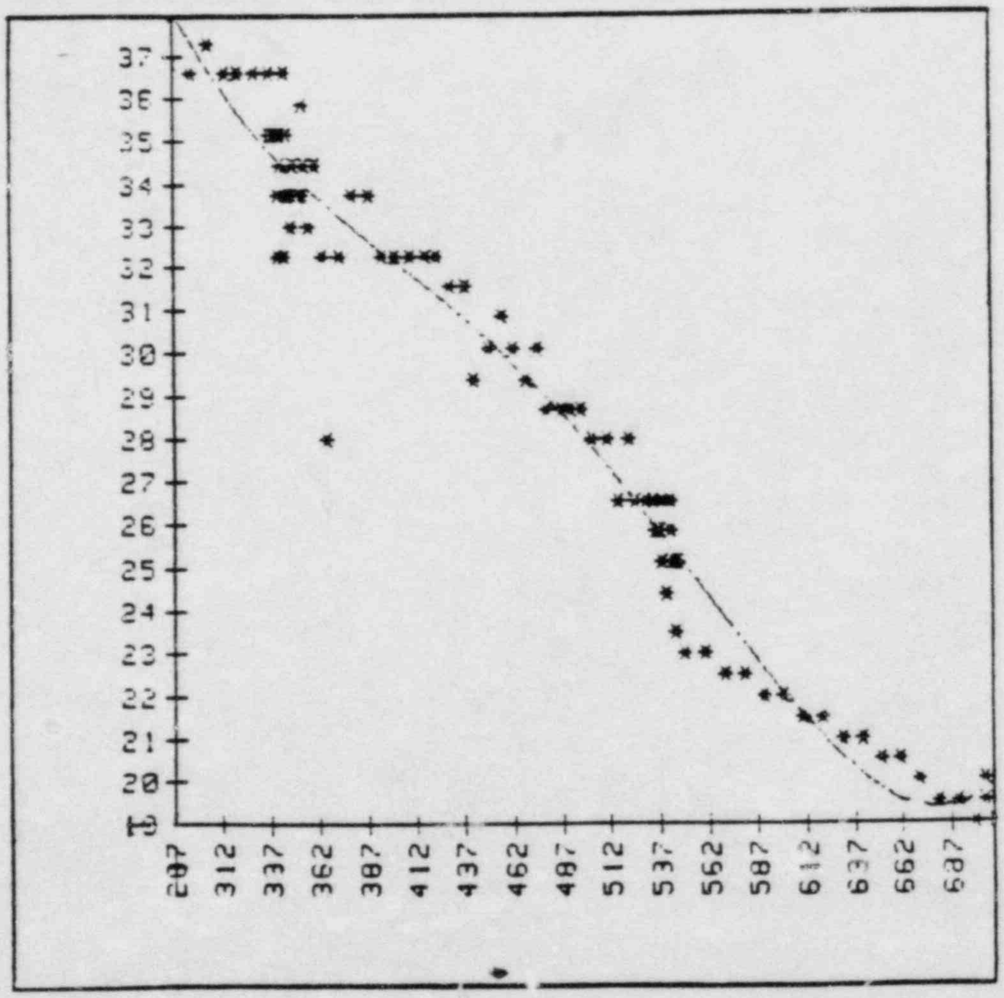
FIGURES 1-3

DYNAMIC HEAD PUMP PERFORMANCE CURVES

FIGURE 1

TEMPERATURE - Dp^3

FOURTH ORDER POLYNOMIAL IN THE FORM OF:
Y=A(4)*X 4+A(3)*X 3+A(2)*X 2+A(1)*X 1+A(0)
Coefficients:
A(0)=22.7977
A(1)=.375538
A(2)=-.00211523
A(3)=.00000433763
A(4)=-3.12855000000E-09



POLYNOMIAL

FIGURE 2

PRESSURE - DP3
(0--45 PSIA)

```
FOURTH ORDER POLYNOMIAL IN THE FORM OF:
Y=A(4)*X 4+A(3)*X 3+A(2)*X 2+A(1)*X 1+A(0)
Coefficients:
    A(0)=12.2782652
    A(1)=2.1908788
    A(2)=-.14492446
    A(3)=.0037535509
    A(4)=-.000034277314
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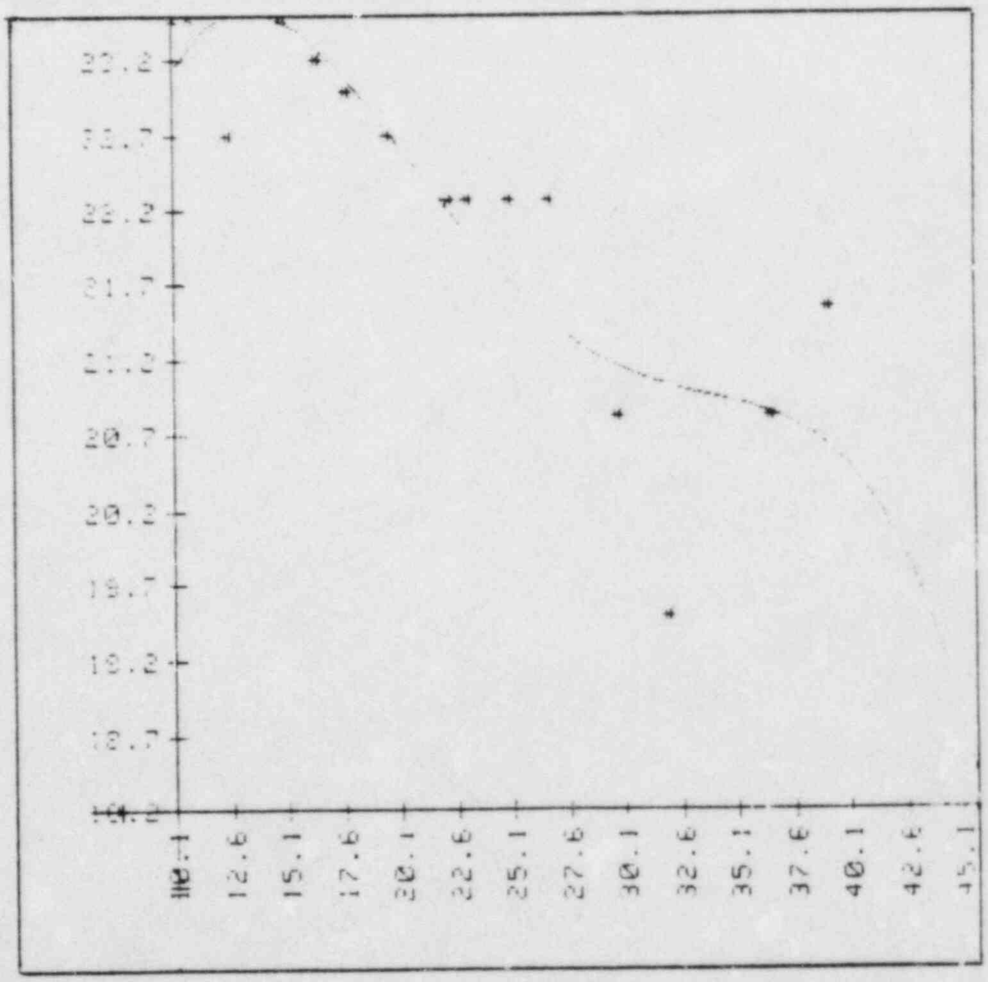


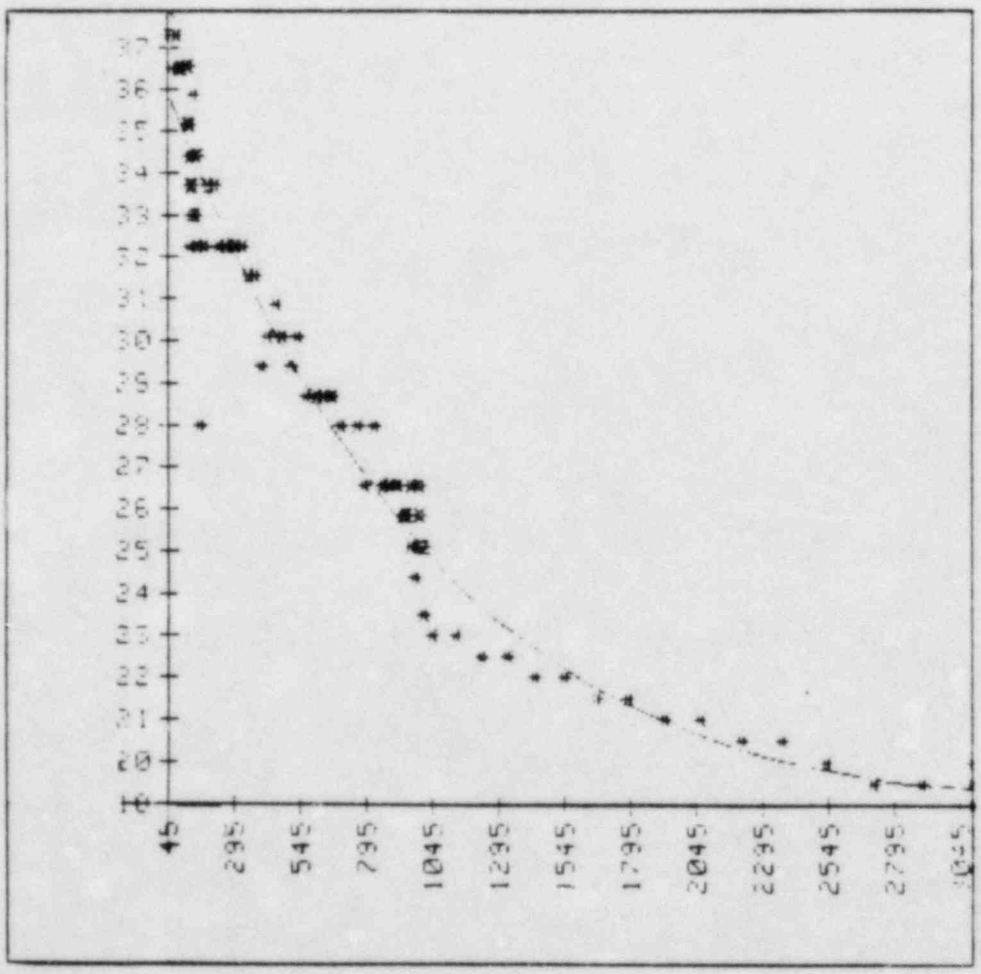
POLYNOMIAL

FIGURE 2A

PRESSURE - DP3

(45-3000 PSIA)

FOURTH ORDER POLYNOMIAL IN THE FORM OF:
Y=A(4)*X 4+A(3)*X 3+A(2)*X 2+A(1)*X 1+A(0)
Coefficients:
A(0)=36.67565806
A(1)=-.01726775482
A(2)=7.06615970000E-06
A(3)=-1.45764319000E-09
A(4)=1.27576400000E-13



POLYNOMIAL

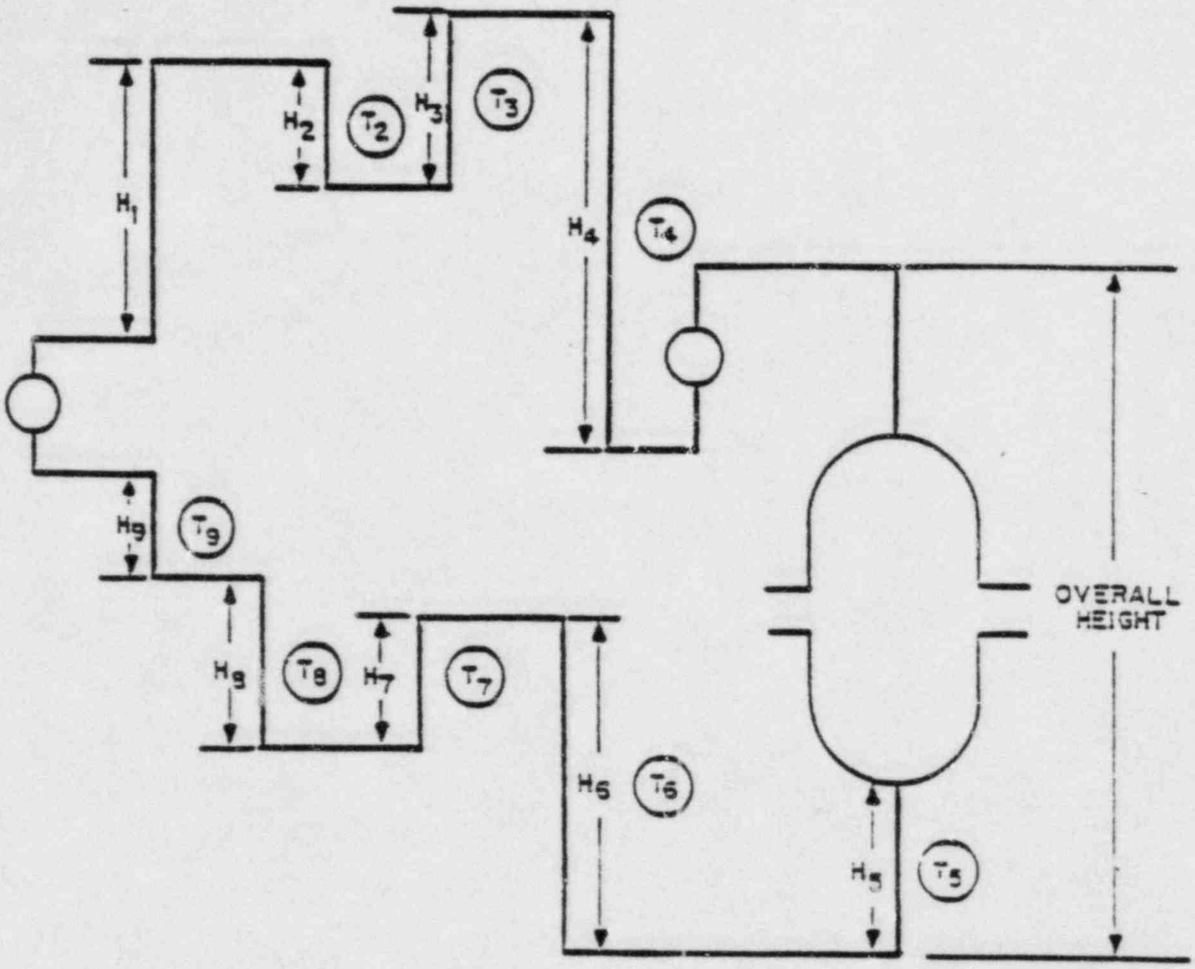


FIGURE 3

* Notice that it is not necessarily the case that the RTDs will be in the same order, but the loop direction should remain constant throughout the analysis. When the elevation increases this usually determines a positive height.

H_1 POSITIVE	H_6 POSITIVE
H_2 NEGATIVE	H_7 NEGATIVE
H_3 POSITIVE	H_8 POSITIVE
H_4 NEGATIVE	H_9 POSITIVE
H_5 NEGATIVE	

APPENDIX B

TABLES 1-10

SETPOINTS AND CALIBRATION DATA

TABLE 1

SENSOR ENGINEERING UNIT CONVERSION DATA

TABLE 1
SENSOR ENGINEERING UNIT CONVERSION DATA

Function	Variable	Sensor	Sensor Tag	A	B	C	D	E
14	1	RTD1	TE1313,TE1323	-4.112E+02	4.271E+03	1.519E+03	9.719E+02	0.000E+00
14	2	RTD2	TE1317,TE1328	-4.112E+02	4.271E+03	1.519E+03	9.719E+02	0.000E+00
14	3	RTD3	TE1315,TE1325	-4.112E+02	4.271E+03	1.519E+03	9.719E+02	0.000E+00
14	4	RTD4	TE1316,TE1326	-4.112E+02	4.271E+03	1.519E+03	9.719E+02	0.000E+00
14	5	RTD5	TE1314,TE1329	-4.112E+02	4.271E+03	1.519E+03	9.719E+02	0.000E+00
14	6	RTD6	TE1319,TE1324	-4.112E+02	4.271E+03	1.519E+03	9.719E+02	0.000E+00
14	7	RTD7	TE1318,TE1327	-4.112E+02	4.271E+03	1.519E+03	9.719E+02	0.000E+00
14	8	RTD8	TA3831,TA3836	-4.112E+02	4.271E+03	1.519E+03	9.719E+02	0.000E+00
14	9	RTD9	N.A.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
14	10	RTD10	N.A.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
14	11	RTD11	N.A.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
14	12	RTD12	N.A.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
14	13	RTD13	N.A.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
14	14	RTD14	N.A.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
14	15	RTD15	N.A.	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
14	16	DP1	LT1310,LT1320	-7.992E+00	7.353E+00	0.000E+00	0.000E+00	0.000E+00
14	17	DP2	LT1311,LT1321	-2.298E+01	2.235E+01	0.000E+00	0.000E+00	0.000E+00
14	18	DP3	LT1312,LT1322	-3.282E+01	7.152E+01	0.000E+00	0.000E+00	0.000E+00
14	19	THOT1	TE413,TE433	-1.750E+02	1.750E+02	0.000E+00	0.000E+00	0.000E+00
14	20	THOT2	TE423,TE443	-1.750E+02	1.750E+02	0.000E+00	0.000E+00	0.000E+00
14	21	PRESS	PT403,PT405	-7.353E+02	7.500E+02	0.000E+00	0.000E+00	0.000E+00

TABLE 2

SENSOR OFF-SCALE HIGH AND LOW SETPOINTS

TABLE 2
SENSOR OFF-SCALE HIGH AND LOW SETPOINTS

Function	Variable	Sensor Name	Sensor Tag	LO	HI
10	1	RTD1	TE1313, TE1323	5.000E+01	4.200E+02
10	2	RTD2	TE1317, TE1328	5.000E+01	4.200E+02
10	3	RTD3	TE1315, TE1325	5.000E+01	4.200E+02
10	4	RTD4	TE1316, TE1326	5.000E+01	4.200E+02
10	5	RTD5	TE1314, TE1329	5.000E+01	4.200E+02
10	6	RTD6	TE1319, TE1324	5.000E+01	4.200E+02
10	7	RTD7	TE1318, TE1327	5.000E+01	4.200E+02
10	8	RTD8	TA3831, TA3836	5.000E+01	4.200E+02
10	9	RTD9	N.A.	0.000E+00	0.000E+00
10	10	RTD10	N.A.	0.000E+00	0.000E+00
10	11	RTD11	N.A.	0.000E+00	0.000E+00
10	12	RTD12	N.A.	0.000E+00	0.000E+00
10	13	RTD13	N.A.	0.000E+00	0.000E+00
10	14	RTD14	N.A.	0.000E+00	0.000E+00
10	15	RTD15	N.A.	0.000E+00	0.000E+00
10	16	DP1	LT1310, LT1320	-6.521E+00	-6.362E-01
10	17	DP2	LT1311, LT1321	-1.852E+01	-6.363E-01
10	18	DP3	LT1312, LT1322	-1.852E+01	3.870E+01
10	19	THOT1	TE413, TE433	0.000E+00	7.000E+02
10	20	THOT2	TE423, TE443	0.000E+00	7.000E+02
10	21	PRESS	PT403, PT405	1.470E+01	3.015E+03

TABLE 3

ALARM SETPOINTS

TABLE 3
ALARM SETPOINTS

Function	Alarm	} Pumps running	DP1	DP2	DP3	DP4
11	Alarm	0	-9.900E+01	-9.900E+01	-9.900E+01	-99
11	Alarm	1	-9.900E+01	-9.900E+01	-9.900E+01	-99
11	Alarm	2	-9.900E+01	-9.900E+01	-9.900E+01	-99
11	Alarm	3	-9.900E+01	-9.900E+01	-9.900E+01	-99
11	Alarm	4	-9.900E+01	-9.900E+01	-9.900E+01	-99

TABLE 4

NORMAL LEVEL READINGS

TABLE 4
NORMAL LEVEL READINGS

Function	Pump Condition	DP1	DP2	DP3	DP4
7	0	1.030E+02	1.040E+02	3.100E+01	0.0
7	1	1.040E+02	1.200E+02	3.800E+01	0.0
7	2	1.050E+02	1.200E+02	5.000E+01	0.0
7	3	1.070E+02	1.200E+02	7.100E+01	0.0
7	4	6.000E+01	1.200E+02	1.000E+02	0.0

TABLE 5

PERCENT LEVEL SCALE CALIBRATION DATA

TABLE 5
PERCENT LEVEL SCALE CALIBRATION DATA

Function	Coefficient	DP1	DP2	DP3	DP4
8	A	6.709E+01	0.000E+00	0.000E+00	0.0
8	B	2.423E+00	2.423E+00	1.000E+02	0.0

TABLE 6

READOUT LIMIT VALUES

TABLE 6
READOUT LIMIT VALUES

Function	Limit	DP1	DP2	DP3	DP4
9	Lo	6.000E+01	0.000E+00	0.000E+00	0.0
9	Hi	1.200E+02	1.200E+02	1.200E+02	0.0

TABLE 7

FLOW HEAD PUMP PERFORMANCE CURVE

TABLE 7
FLOW HEAD PUMP PERFORMANCE CURVE

Function	Range	Press/Temp	A	B	C	D	E
13	LOW	PRESS	1.228E+01	2.191E+00	-1.449E-01	3.754E-03	-3.428E-05
13	HI	PRESS	3.668E+01	-1.727E-02	7.066E-06	-1.458E-09	1.276E-13
13	LOW	TEMP	2.280E+01	3.755E-01	-2.115E-03	4.338E-06	-3.129E-09
13	HI	TEMP	2.280E+01	3.755E-01	-2.115E-03	4.338E-06	-3.129E-09

Function 12

SETPOINT P: 4.500E+01
SETPOINT T: 0.000E+00

TABLE 8

IMPULSE LINE VERTICAL LENGTHS
TRAIN A

Function	Variable	Sensor Name	Sensor Tag	DP1	DP2	DP3	DP4
6	1	RTD1	TE1313	0.000E+00	-1.104E+01	-1.104E+01	0.0
6	2	RTD2	TE1317	0.000E+00	-1.258E+01	-1.258E+01	0.0
6	3	RTD3	TE1315	-1.858E+01	-1.858E+01	-1.858E+01	0.0
6	4	RTD4	TE1316	1.928E+01	1.928E+01	1.928E+01	0.0
6	5	RTD5	TE1314	1.622E+01	1.622E+01	1.622E+01	0.0
6	6	RTD6	TE1319	-2.479E+00	0.000E+00	0.000E+00	0.0
6	7	RTD7	TE1318	0.000E+00	4.592E+01	4.592E+01	0.0
6	8	RTD8	TA3831	0.000E+00	3.542E+00	3.542E+00	0.0
6	9	RTD9	N.A.	0	0	0	0.0
6	10	RTD10	N.A.	0	0	0	0.0
6	11	RTD11	N.A.	0	0	0	0.0
6	12	RTD12	N.A.	0	0	0	0.0
6	13	RTD13	N.A.	0	0	0	0.0
6	14	RTD14	N.A.	0	0	0	0.0
6	15	RTD15	N.A.	0	0	0	0.0
6	16	DP1	LT1310,LT1320	Overall Height		1.444E+01	
6	17	DP2	LT1311,LT1321	Overall Height		4.275E+01	

IMPULSE LINE VERTICAL LENGTHS
TRAIN B

Function	Variable	Sensor Name	Sensor Tag	DP1	DP2	DP3	DP4
6	1	RTD1	TE1323	0.000E+00	-1.104E+01	-1.104E+01	0.0
6	2	RTD2	TE1328	0.000E+00	4.592E+01	4.592E+01	0.0
6	3	RTD3	TE1325	-2.479E+00	0.000E+00	0.000E+00	0.0
6	4	RTD4	TE1326	-1.858E+01	-1.858E+01	-1.858E+01	0.0
6	5	RTD5	TE1329	1.928E+01	1.928E+01	1.928E+01	0.0
6	6	RTD6	TE1324	1.622E+01	1.622E+01	1.622E+01	0.0
6	7	RTD7	TE1327	0.000E+00	-1.258E+01	-1.258E+01	0.0
6	8	RTD8	TA3836	0.000E+00	3.542E+00	3.542E+00	0.0
6	9	RTD9	N.A.	0	0	0	0.0
6	10	RTD10	N.A.	0	0	0	0.0
6	11	RTD11	N.A.	0	0	0	0.0
6	12	RTD12	N.A.	0	0	0	0.0
6	13	RTD13	N.A.	0	0	0	0.0
6	14	RTD14	N.A.	0	0	0	0.0
6	15	RTD15	N.A.	0	0	0	0.0
6	16	DP1	LT1310,LT1320	Overall Height		1.444E+01	
6	17	DP2	LT1311,LT1321	Overall Height		4.275E+01	

TABLE 9

CALIBRATION OF ANALOG INPUTS - ZERO SETTING

TABLE 9
CALIBRATION OF ANALOG INPUTS - ZERO SETTING

Function	Variable	Sensor Name	Sensor Tag	Range							
				0-20 mV		0-100 mV		0-1 V		0-10 V	
				Zero Expect	Zero Actual	Zero Expect	Zero Actual	Zero Expect	Zero Actual	Zero Expect	Zero Actual
15	1	RTD1	TE1313,TE1323	)000(100		)000&(100		)001&(050		)001&(050	
15	2	RTD2	TE1317,TE1328	)000(100		)000&(100		)001&(050		)001&(050	
15	3	RTD3	TE1315,TE1325	)000(100		)000&(100		)001&(050		)001&(050	
15	4	RTD4	TE1316,TE1326	)000(100		)000&(100		)001&(050		)001&(050	
15	5	RTD5	TE1314,TE1329	)000(100		)000&(100		)001&(050		)001&(050	
15	6	RTD6	TE1319,TE1324	)000(100		)000&(100		)001&(050		)001&(050	
15	7	RTD7	TE1318,TE1327	)000(100		)000&(100		)001&(050		)001&(050	
15	8	RTD8	TA3831,TA3836	)000(100		)000&(100		)001&(050		)001&(050	
15	9	RTD9	N.A.	)000(100		)000&(100		)001&(050		)001&(050	
15	10	RTD10	N.A.	)000(100		)000&(100		)001&(050		)001&(050	
15	11	RTD11	N.A.	)000(100		)000&(100		)001&(050		)001&(050	
15	12	RTD12	N.A.	)000(100		)000&(100		)001&(050		)001&(050	
15	13	RTD13	N.A.	)000(100		)000&(100		)001&(050		)001&(050	
15	14	RTD14	N.A.	)000(100		)000&(100		)001&(050		)001&(050	
15	15	RTD15	N.A.	)000(100		)000&(100		)001&(050		)001&(050	
15	16	DP1	LT1310,LT1320	)000(100		)000&(100		)001&(050		)001&(050	
15	17	DP2	LT1311,LT1321	)000(100		)000&(100		)001&(050		)001&(050	
15	18	DP3	LT1312,LT1322	)000(100		)000&(100		)001&(050		)001&(050	
15	19	THOT1	TE413,TE433	)000(100		)000&(100		)001&(050		)001&(050	
15	20	THOT2	TE423,TE443	)000(100		)000&(100		)001&(050		)001&(050	
15	21	PRESS	PT403,PT405	)000(100		)000&(100		)001&(050		)001&(050	

TABLE 10

CALIBRATION OF ANALOG INPUTS - FULL SCALE SETTING

TABLE 10

CALIBRATION OF ANALOG INPUTS - FULL SCALE SETTING

Function	Variable	Sensor Name	Sensor Tag	Range: 0-20 mV F.S. Expect	0-20 mV F.S. Actual	0-100 mV F.S. Expect	0-100 mV F.S. Actual	0-1 V F.S. Expect	0-1 V F.S. Actual	0-10 V F.S. Expect	0-10 V F.S. Actual
15	1	RTD1	TE1313,TE1323	)F00(FFF		)F00&(FFF		)F40&(FFE		)F40&(FFE	
15	2	RTD2	TE1317,TE1328	)F00(FFF		)F00&(FFF		)F40&(FFE		)F40&(FFE	
15	3	RTD3	TE1315,TE1325	)F00(FFF		)F00&(FFF		)F40&(FFE		)F40&(FFE	
15	4	RTD4	TE1316,TE1326	)F00(FFF		)F00&(FFF		)F40&(FFE		)F40&(FFE	
15	5	RTD5	TE1314,TE1329	)F00(FFF		)F00&(FFF		)F40&(FFE		)F40&(FFE	
15	6	RTD6	TE1319,TE1324	)F00(FFF		)F00&(FFF		)F40&(FFE		)F40&(FFE	
15	7	RTD7	TE1318,TE1327	)F00(FFF		)F00&(FFF		)F40&(FFE		)F40&(FFE	
15	8	RTD8	TA3831,TA3836	)F00(FFF		)F00&(FFF		)F40&(FFE		)F40&(FFE	
15	9	RTD9	N.A.	)F00(FFF		)F00&(FFF		)F40&(FFE		)F40&(FFE	
15	10	RTD10	N.A.	)F00(FFF		)F00&(FFF		)F40&(FFE		)F40&(FFE	
15	11	RTD11	N.A.	)F00(FFF		)F00&(FFF		)F40&(FFE		)F40&(FFE	
15	12	RTD12	N.A.	)F00(FFF		)F00&(FFF		)F40&(FFE		)F40&(FFE	
15	13	RTD13	N.A.	)F00(FFF		)F00&(FFF		)F40&(FFE		)F40&(FFE	
15	14	RTD14	N.A.	)F00(FFF		)F00&(FFF		)F40&(FFE		)F40&(FFE	
15	15	RTD15	N.A.	)F00(FFF		)F00&(FFF		)F40&(FFE		)F40&(FFE	
15	16	DP1	LT1310,LT1320	)F00(FFF		)F00&(FFF		)F40&(FFE		)F40&(FFE	
15	17	DP2	LT1311,LT1321	)F00(FFF		)F00&(FFF		)F40&(FFE		)F40&(FFE	
15	18	DP3	LT1312,LT1322	)F00(FFF		)F00&(FFF		)F40&(FFE		)F40&(FFE	
15	19	THOT1	TE413,TE433	)F00(FFF		)F00&(FFF		)F40&(FFE		)F40&(FFE	
15	20	THOT2	TE423,TE443	)F00(FFF		)F00&(FFF		)F40&(FFE		)F40&(FFE	
15	21	PRESS	PT403,PT405	)F00(FFF		)F00&(FFF		)F40&(FFE		)F40&(FFE	