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WASHINGTON, D. C. 20036

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August 3, 1979

George Frampton, Esquire
NRC/TMI Special Inquiry Group
Nuclear Regulatory Commission
Washington, D.C. 20555

Dear George:

This will respond to the request for documents contained in the July 27, 1979 letter from Mitchell Rogovin to George F. Trowbridge. As noted during our telephone conversation of yesterday, all or most of the documents listed in your request are contained in the microfilm sets which have been forwarded to Kevin Cornell of your group by GPU Service Corp. pursuant to the letter of Robert L. Long dated June 18, 1979.

The microfilm locator numbers for some of the documents you requested are as follows:

File Code	Microfilm Locator Number
COR 0037	OPS-2 801.151
COR 0111	OPS-2 801.539
RCS 0001.01	OPS-2 819.2578

Copy of cvr letter + enclosures to Pickles!

Several of our microfilm files have been consolidated, resulting in new file codes. The old file code listed in your request for some of the documents, the new file code, and the microfilm locator numbers for those documents are as follows:

Old File Code	New File Code	Microfilm Locator No.
RTR 0002	RP 0003	OPS-2 811.004
COR 0221	RP 0001	OPS-2 806.277
RCO 0001.01	IT 0001.01	OPS-2 808.2656
RCO 0001.01	IT 0001.02	OPS-2 813.553
RCO 0001.01	IT 0001.02	OPS-2 819.768
RCO 0001.01	IT 0001.04	OPS-2 822.749
RCO 0001.01	IT 0001.04	OPS-2 822.894
RCO 0001.01	IT 0001.04	OPS-2 822.1031

The document bearing file code number RCS 0001 ("Reactor Coolant System Bubble Calculations") is being microfilmed at the present time. We are enclosing a hard copy of it with the identification number G/727-001.

Sincerely,

Mat

Matias F. Travieso-Diaz

MTD:bas

Enclosures

THE BABCOCK & WILCOX COMPANY
POWER GENERATION GROUP

DICK WILS-- OR GARY BROUGHTON

To: MR. DH ROY

From: LN BISHOP

BDS 442.3

Cust.

File No. or Ref.

Subj.: COMPOSITION OF GAS BUBBLE

Date: APRIL 1, 1979

This letter to cover one carbon and two typed pgs.

After review of the postulated sequence of events on March 28, we conclude that there is no significant amount of oxygen in the bubble. At the time of reactor trip a hydrogen over pressure was present in the primary system. This hydrogen over pressure would have remained until boiling occurred about 3 hours after the trip. During the period of boiling some small generation of oxygen probably occurred. Shortly thereafter, a metal-water reaction began, generating large amounts of hydrogen. The metal-water reaction produced most of the gas in the bubble. After the metal-water was quenched, the hydrogen in the bubble inhibited oxygen generation. This only during the short time of boiling was oxygen generated.

If we make the conservative assumption of boiling for 15 hours we calculate a oxygen production of 1100 SCF by radiolysis. In addition, there is a small contribution from air dissolved in the DWST. This DWST contribution is 198 SCF. The total oxygen, 1298 SCF, is 27 cubic feet at RCS pressure and temperature. If this small amount of oxygen had been present on the 28th, it is likely that radiolytic recombination would have removed the oxygen.

LNB:jws

mrb
DHR
4/1/79

DATE 4/8/79

TMI-2 RCS BUBBLE CALC SHEET

TIME 0120 AM PM

DATA TAKEN BY: MSL

RC PRESSURE (397) ~~(398)~~

P_1 = 629.1 PSIG = _____ PSIA

P_2 = 693.9 PSIG = _____ PSIA

ΔP = 64.8 PSI

RCS TEMP (394)

T_1 = 291.0 °F

T_2 = 290.8 °F

PRESSURIZER LEVEL (1682)

L_1 = 216.1 INCHES

L_2 = 213.3 INCHES

ΔL = 2.8 INCHES

PRESSURIZER TEMP (357) ~~(355)~~

T_1 = 504.0 °F

T_2 = 514.9 °F

MAKEUP TANK LEVEL (347)

L_1 = 90.2 INCHES

L_2 = 91.6 INCHES

ΔL = -1.4 INCHES

MAKEUP TANK TEMP (161 CONTROL BOARD METER)

T_1 = 94.5 °F

T_2 = 94.0 °F

$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ 2.8 × 2.515 = 7.04 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ -1.4 × 4.244 = -5.94 FT^3

ΔV_{TOTAL} = 1.1 FT^3

$V_1 = \frac{P_2 \Delta V_{tot}}{P_2 - P_1} =$ (X) / ( ) = _____ FT^3 @ P_1

$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) =$ 8.75 FT^3 @ 875 PSIA

DATE 4/8/79

TMI-2 RCS BUBBLE CALC SHEET

TIME 0120 AM/PM

DATA TAKEN BY: MSW

RC PRESSURE (~~398~~ 399)

P_1 = 629.1 PSIG = _____ PSIA

P_2 = 693.9 PSIG = _____ PSIA

ΔP = 64.8 PSI

RCS TEMP (394)

T_1 = 291.0 °F

T_2 = 280.8 °F

PRESSURIZER LEVEL (1682)

L_1 = 216.1 INCHES

L_2 = 213.3 INCHES

ΔL = 2.8 INCHES

PRESSURIZER TEMP (~~385~~ 386)

T_1 = 504.0 °F

T_2 = 514.9 °F

MAKEUP TANK LEVEL (347)

L_1 = 90.2 INCHES

L_2 = 91.6 INCHES

ΔL = -1.4 INCHES

MAKEUP TANK TEMP (CONTROL BOARD METER 161)

T_1 = 94.5 °F

T_2 = 94.0 °F

$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ 2.8 $\times$ 2.515 = 7.04 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ -1.4 $\times$ 4.244 = -5.94 FT^3

ΔV_{TOTAL} = 1.1 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(694 \times 1.1)}{(64.8)} = 11.78 \; FT^3 @ P_1$$

$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) =$ 8.5 FT^3 @ 875 PSIA.

RCS Bubble Calc. 4/8/74
0610 RSH

63	RCS	P_1	556.5	T_1	270.2
65		P_2	605.5	T_2	270.0
58		ΔP	49.0	ΔT	-.2
54					
52	PZR	L_1	229.5	T_1	492.8
47		L_2	228.4	T_2	501.5
43		ΔL	1.1		
54					
60	MUT	L_1	81.6	T_1	95.5
62		L_2	80.2	T_2	95.3
63		ΔL	1.4		
59					

$\Delta L' = \Delta L + \Delta T(2\%/^\circ) = 1.1 + (-.2)(2) = .7$

$\Delta V_{PZR} = \Delta L' \times \frac{.0204}{.0173} \times 3.2\ ft^3/in$

$= .7 \times 1.179 \times 3.2 = 2.18\ ft^3$.

$\Delta V_{MUT} = \Delta L \times 4.244 = 1.4 \times 4.244 = 5.94$

8.12

$V_1 = \frac{(605.5)(8.12)}{49} = 100.4\ ft^3$

-57.
89.

POOR ORIGINAL

4/8/79 0345

Bubble calculation data

	P_1				
50	603	RCS P	597.6	T avg	281.3
46	1		649.0 Δ 51.4		280.7
38	94	PZR	209.7	T avg	500.0
36	94		207.8		506.4
45	95		Δ 1.9		
56	90				
60	85	MUT L	94.6	T avg	93.8
56	83		95.4		94.0
53	90		Δ .8		
44	94				
44	04				
51	13				
2	05	PZR ΔV =	1.9 x 2.515 =		4.28
52	93	MUT ΔV =	.8 x 4.244 =		3.39
45	03				8.17
41	06				

$$V_1 = \frac{649(8.17)}{51.4} = 103.2$$

$$-166.6 \quad ft^3$$
$$+ \quad .6 \quad ft^3$$

RC Bubble Size Calcs

Data Taken: 0625/3-30-79
Broome

$L_1 = 356.2"$ $P_1 = 1065$ psig = 1080 psia

$L_2 = 352.3$ $P_2 = 1051$ psig = 1096 psia

$\Delta L = -3.9"$ $\Delta P = 16$ psi

$$V_1 = \frac{P_2 \Delta V}{P_1 - P_2}$$

$$\Delta V = 3.2 \frac{ft^3}{in} \times 3.9 \text{ in} = 12.48 \text{ ft}^3$$

$$V_1 = \frac{(1096)(12.48)}{16} = 854.88 \text{ ft}^3 \text{ @ } 1080 \text{ psia}$$

$$= 854.88 \times \frac{1080}{875} = 1055 \text{ ft}^3 \text{ @ } 875 \text{ psia}$$

Note: 3/31/79

I believe that there was little or no change in the MU Tank Level during these measurements. ∴ The calc below is based on zero MU Tank Level Change.

~~$\Delta V = (12.48)(0.626)$~~

$$\Delta V = -\frac{3.9}{16}(2.515) = -\frac{9.8 \text{ ft}^3}{\text{~~2+3812~~}}$$

$$V_1 = \frac{(1096)(9.8)}{16} = 671.3 \text{ ft}^3 \text{ @ } 1080 \text{ psia}$$

$$V_1 = 671.3 \left(\frac{1080}{875}\right) = 828.576 \text{ ft}^3 \text{ @ } 875 \text{ psia}$$

03/30/79 0730 AM

Seth 3/31/79

P_{Pzr}	MU TK
$L_1 = 360$	?
$L_2 = 390$	
$\Delta L = +30"$	

$P_1 = 1150$
$P_2 = 1035$ } assumed to be psia
$\Delta P = 115$

$\Delta V_{Pzr} = \pi(30)(2.515) = 75.45\ ft^3$

$V_1 = \frac{(1035)(75.45)}{115} = 679.1\ ft^3$ @ 1150 psia

$V_1 = \left(\frac{1150}{875}\right)(679.1) = 892.5\ ft^3$ @ 875 psia.

0730 AM
3/30/19

RGS Bubble Calculation

From recorders on control panel

360	1150	7:30 am 3/30
390	1035	

$\Delta L = 30"$ $\Delta P = 115$

$\Delta V = 30" \times \frac{3.2}{3.14} ft^3/in = \frac{96}{94} ft^3$

$V_1 = \frac{P_2 \Delta V}{P_1 - P_2}$ $V = \frac{1035 \left(\frac{96}{94} ft^3\right)}{115}$

$V_1 = \frac{864}{1035} ft^3$ @ 1150 psia

$V_1 = \frac{864}{875} \times 1150 = \frac{1156}{1157} ft^3$

@ 875 psig

RC Arnold

3/30/79

J. L. Moore

Primary Goals

1. Reduce Radiation Exposure
2. Minimize Off-Site Releases

3/30/79 1240/1340

$\Delta L_{pzr} = -22.1"$

$\Delta V_{pzr} = (-22.1)(2.515) = -55.58\ ft^3$

$\Delta L_{rm} = +15"$

$\Delta V_{rm} = (+15)(4.244) = +63.66$

$\Delta V_{TOT} = 8.08\ ft^3$

$V_1 = \frac{(1018)(8.08)}{32} = 257.\ ft^3$ @ 1050

$V_1 = (257)\frac{(1050)}{(875)} = 308\ ft^3$ @ 875

RCS Bubble calculation 3/30/79

Time	Pzr LVL Comp	Pzr LVL Recorder	WR Press Loop A Recorder	WR Press Loop A Indicator	Temp Loop B Comp	MU Tank — 50°F
1240	250.5"	25"	1100	1050	280.3	40"
1340	227.4 / 22.1	27.8" / 28	1065 / 35	1018 / 32	279.5	55 / 15"

MU Tank Volume Change

$15'' \times 30\ gal/in = 450\ gal$

$48\ ft^3/hr = 60\ ft^3 @ 80°F \times \frac{.022}{.0163} = 80.58\ ft^3$ at 550°F

Change in pzr volume =

$\frac{22.1}{28''} \times 3.2\ ft^3/in = 70.7\ ft^3 @ 555°F$

Increase in vol due to bubble expansion =

$-\Delta V_{pzr} + \Delta V_{MU\ Tank} = 81 - 70.7 = 10.3$

$V_1 = \frac{P_2 \Delta V}{P_1 - P_2} = \frac{(1018)(10.3)}{32} = 327.7\ ft^3 @ 1050$

$V_1 = 327.7\ ft^3 \left(\frac{1050}{575}\right) = 598.2\ ft^3$ @ time 1240

See Revised calcs 3/31/79 JPM

RCS Bubble Calc 3/30/79

	L pzr		P pzr		T		MU
	C	R	C	R	Pzr	Loop B	Tank
1445	214.5	215	1011	1050	552.3	278.9	47" → 37
1510	216.5	215	1053	1100	557.9	271.2	50" ← = 37...
	+ 2"		42 psi				ΔL = 8" 452 gal added ↓ 15"

$\Delta V_{Pzr} = 2'' \times$ ~~3.9~~ 3.2 ft^3/in = ~~7.8~~ 6.4 ft^3

* V_f @ 280°F = 0.0173 = RC Temp.

$\Delta V_{MU\ Tank}$ 8" X 4 ft^3/in = 32 ft^3 $\left(\frac{\text{0.0173 (~~.022~~)}}{.0163}\right)$ = ~~43.2~~ 33.96 ft^3

ΔV_{Total} = ~~39.8~~ ~~51~~ ft^3 ~~43.2~~ 33.96 − ~~7.8~~ 6.4 = ~~35.4~~ 27.56 ft^3

$V_1 = \frac{P_2 \Delta V}{P_2 - P_1}$ ~~1053 (51 ft³) / 42~~

Go Revised Calc 3/31/79 JPM

$= \frac{1053 (\text{~~35.4~~ 27.56 } ft^3)}{42\ psi}$ = ~~887.5~~ 691.0 ft^3 at ~~1053~~ 1011

$V_1 = \left(\text{~~887.5~~ 691}\right)\left(\frac{1011}{875}\right)$ = ~~1068~~ ~~1110~~ 798 ft^3 at 875 at time 1445

* ΔWater volume in MU Tank is interchanged with RC loop water rather than pressurizer level.

Therefore the ratio is $\left(\frac{0.0188}{0.0163}\right)$ rather than $\left(\frac{0.022}{0.0163}\right)$

Where V_f @ 285°F = 0.0173

V_f @ 1100 psia Sat = 0.022

JPM 3/31/79

5/31/79
Spm

3/30/79 1630/1735

$\Delta L_{Pzr} = {}^{+}0.2"$

$\Delta V_{Pzr} = {}^{+}(0.2)(2.515) = {}^{+}0.503\ ft^3$

$\Delta L_{mu} = -1.3"$

$\Delta V_{mu} = (-1.3)(4.244) = -5.517\ ft^3$

$\Delta V_{TOT} = 5.0142\ ft^3$

$V_1 = \frac{(1033)(5.0142)}{17} = 304.7$ @ 1050

$V_1 = 304.7\left(\frac{1050}{875}\right) = 365.6\ ft^3$

Bubble Calcs

3/31/79

8/30/79 1445/1510

ΔL PZR = +2"

$\Delta V_{PZR} = (2)(3.2 \frac{Ft^3}{in})(\frac{0.0173}{0.022}) = (6.4)(0.786) = +5.0 ft^3$ (0.786)

ΔL MU TK = −8"

$\Delta V_{MU} = -(8)(4 \frac{Ft^3}{in})(\frac{0.0173}{0.0163}) = -(32)(1.061) = -33.96 ft^3$ (1.061)

$\Delta V = -28.96 ft^3$

$V_1 = \frac{P_2 \Delta V}{P_2 - P_1} = \frac{(1053)(28.96)}{42} = 726 ft^3$ @ 1011 psia

$V_1 = (726)(\frac{1011}{875}) = 839 ft^3$ @ 875 psia

RCS Bubble Calc

	L_{Pzr} C	L_{Pzr} R	P_{Pzr} C	P_{Pzr} R	T Pzr	T RCS Loop D	MU Tank Level
1650	215.8	215	1050	1100	552.2	281.0	50"
1735	216.0	215	1058	1040	554.6	280.4	~~48.7"~~ ~~50.5~~
	.2"		17 psi				1.3"

$P_{Pzr}\ \Delta V = .2" \times 3.9\ ft^3/in = .64\ ft^3$

$MU\ \Delta V = 1.3" \times 4\ ft^3/in = 5.2\ ft^3 \times \left(\frac{1.025}{1.013}\right)^{1.35} = 7.04\ ft^3$

~~Tot. $\Delta V = 7.04\ ft^3$~~ $- 6.36$

$V_1 = \frac{P_2 \Delta V}{\Delta P} = \frac{1033\ (7.04\ ft^3)}{17\ psi} = 426.5\ @\ 1050$

$V = 426.5 \times \frac{1050}{875} = 511.8\ ft^3\ @\ 875$

See Revised Calc 3/31/99 JM

3/31/79

3/30/79 1745/1910

$\Delta L_{Pzr} = +0.2"$

$\Delta V_{Pzr} = (+0.2)(3.2)(0.786) = +0.2(2.515) = 0.503\ ft^3$

$\Delta L_{mu} = +1"$

$\Delta V_{mu} = (+1)(4)(1.061) = (+1)(4.244) = 4.244\ ft^3$

$\Delta V = 4.747\ ft^3$

$V_1 = \frac{(1005)(4.747)}{25} = 190.82\ ft^3 @ 1030\ psi$

$V_1 = (190.82)\left(\frac{1030}{875}\right) = 224.63\ ft^3 @ 875$

RCS Bubble Calc 3/30/79

	L_{pzr} Comp	P_{pzr} Comp	T Pzr	RCS	$L_{MU\ Tank}$
1745	215.8	1030	554.3	280.3	55"
1910	216.0	1005	551.4	279.9	56"
	+ .2"	25 psi		.4°	+ 1"

$\Delta Vol_{pzr} = .2" \times 3.2\ ft^3/in = .64\ ft^3$

$\Delta Vol_{MU} = 1" \times 4\ ft^3/in = 4\ ft^3 \times 1.35 = 5.4\ ft^3$

Total $\Delta Vol = 6.04\ ft^3$

$$V_1 = \frac{P_1 \Delta V}{\Delta P} = \frac{1005\,(6.04)}{25} = 242.8\ ft^3 \text{ @ } 1030\ psi$$

$$V_1 = 242.8\left(\frac{1030}{875}\right) = 327.8\ ft^3 \text{ @ } 875$$

See Revised Calc 3/31/79 JDM

3/30/79 1907/2030 3/31/79

$\Delta L\ P_{Zr} = 0$

$\Delta V\ P_{Zr} = 0$

$\Delta L\ Mn = 13.5''$

$\Delta V\ mn = (13.5 \times 4.244) = 57.294\ ft^3$

$\Delta V_{TOT} = 57.294$

$V_1 = \frac{(1043)(57.294)}{38} = 1572.5 @ 1005$

$V_1 = \frac{(1005)}{(875)}(1572.5) = 1804 @ 875$

RCS Bubble Calc 3/30/79

	L_{per}	L_{no}	P_{pzr}	T RCS	T PZR
1907	216.0	56"	1005	279.9	551.4
2030	216.0	43.5"	1043	279.4	556.5
	0	13.5"	38 psi		

$\Delta Vol = 13.5" \times 4\ ft^3/in = 54 \times 1.35 = 72.9\ ft^3$

$V_1 = \frac{1043\ (72.9)}{38} = 2000.9\ ft^3 = 2258\ ft^3$ @ 1005 psi @ 575°F

Lee Rossi/Calc
3/31/79

DATE _____

TMI-2 RCS BUBBLE CALC SHEET

TIME _____ AM PM

DATA TAKEN BY:

RC PRESSURE (398)

P_1 = ____ PSIG = _____ PSIA

P_2 = ____ PSIG = _____ PSIA

ΔP = _____ PSI

RCS TEMP (394)

T_1 = _____ °F

T_2 = _____ °F

PRESSURIZER LEVEL (1682)

L_1 = _____ INCHES

L_2 = _____ INCHES

ΔL = _____ INCHES

PRESSURIZER TEMP (405)

T_1 = _____ °F

T_2 = _____ °F

MAKEUP TANK LEVEL (347)

L_1 = _____ INCHES

L_2 = _____ INCHES

ΔL = _____ INCHES

MAKEUP TANK TEMP (CONTROL BOARD METER)

T_1 = _____ °F

T_2 = _____ °F

$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ _____ × 2.515 = _____ FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ _____ × 4.244 = _____ FT^3

ΔV_{TOTAL} = _____ FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(\quad X \quad)}{(\quad)} = \text{_____ } FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = \text{_____ } FT^3 @ 875 \text{ PSIG.}$$

RCS Bubble Calc Data Sheet

Time	Level (1432) P2R	Level (347) MUT	Pressure (394) RCS	Temp (394) RCS	Temp (405) P2R	[Control Board Meter] MUT

	ER		Ft3 @ 875 joule DP	
3/29	±0.71 1300	1839.3	95	DATA FROM J. FLOYD - SOURCES UNKNOWN
3/30	±6.06 0625	* 828.6	16	MU TK Δ LEVEL - BELIEVED TO BE ZERO IN.
	±0.84 0730	892.5	115	
	±1.827 0240	* 308	32	
	±1.948 1445	839	42	
	±7.715 1630	* 365.6	17	
	1745	* 224.6	25	
	1907	* 1806.0	38	
	~~0630~~	850	55	
3/31	1032	859.5	47	
	1351	879.4	92	
	1619	621.4	97	
	~~±351~~			
	1925	901		
	2030	765		

Jim
3/31/79

ERROR ANALYSIS FOR BUBBLE VOLUME CALCS

$$P_1 V_1 = P_2 V_2$$

$$V_2 = V_1 + \Delta V$$

$$P_1 V_1 = P_2 (V_1 + \Delta V)$$

~~$P_1 V_1 = P_2)($~~

$$P_1 V_1 = P_2 V_1 + P_2 \Delta V$$

$$V_1 (P_1 - P_2) = P_2 \Delta V$$

$$V_1 = \frac{P_2 \Delta V}{P_1 - P_2} = \frac{P_2 \Delta V}{\Delta P}$$

$$V_1 = \frac{P_2 \left[a (V_2 - V_1)_A \; b (V_2 - V_1)_B \right]}{P_2 - P_2}$$

Per Jim Flory 3/31/79

V_A = PRESSURIZER LEVEL	Computer Point	1682	0-400"	1% FS
V_B = MAKEUP TANK LEVEL	"	"	347	0-[illegible]"	1% FS
P = RC PRESSURE	"	"	398	0-2500 psig	1% FS

r = 2.515

Δb = 4.244

3/31/19

Assume Error Of Inst's = 1% of Range.

VARIABLE	RANGE	ESTIMATED UNCERTAINTY
P	~~3000~~ 2500	$E_P = E_{R1} =$ ~~30~~ 25
L_A	~~1000~~ 400 IN	$E_{LA} =$ ~~10~~ 4
L_B	100 IN	E_{LB} 1

a ~~α~~ = 2.515

b ~~β~~ = 4.244

$R_1 = \frac{P}{\text{~~A~~}}(P_1 - P_2)$

$R_2 = a(L_2 - L_1)_a$

$R_3 = b(L_2 - L_1)_b$

~~$R_5 = \frac{R_5[(R_2)(R_3)]}{(R_1)}$~~

$R_4 = P_2$

$R_5 = [R_2 + R_3]$

$R_6 = \frac{R_4 R_5}{R_1}$

~~$\left(\frac{E_R}{R_1}\right)_1^2$~~

$(E_R)_1 = \pm\left[(r_R)\frac{E_P}{P} + (r_R)\frac{E_P}{P}\right]$

$= \pm [r E_P + r E_P] =$ ~~$\pm[(E_P)(r+r)]$~~

$= \pm [2 r E_P]$

$(E_R)_2 = \pm \left[(P)\left(\frac{E_P}{P}\right) + P\left(\frac{E_P}{P}\right)\right] = \pm [2 E_P]$

~~$E_{R2} =$~~

$E_{R2} = \pm \left[(a/L_A)\left(\frac{E_{LA}}{L_A}\right) + (a/L_A)\left(\frac{E_{LA}}{L_A}\right)\right]$

$= \pm [2 a E_{LA}]$

$$E_{R3} = \pm \left[2b \; E_{LS} \right]$$

$$E_{R4} = (P)\left(\frac{E_P}{R}\right) = E_P$$

$$E_{R5} = \pm \left[E_{R2} + E_{R3} \right]$$

$$\frac{E_{R6}}{R_6} = \pm \left[\frac{E_{R4}}{R_4} + \frac{E_{R5}}{R_5} + \frac{E_{R1}}{R_1} \right]$$

$$E_{R_1} = \pm [2E_p] = \pm [2 \times \tfrac{25}{\cancel{36}}] = \pm [\tfrac{50}{\cancel{46}}]$$

$$E_{R2} = \pm [2a\, E_{L_A}] = \pm [(2)(2.515)(\tfrac{4}{\cancel{16}})] = \pm [\tfrac{20.12}{\cancel{32.18}}]$$

$$E_{R3} = \pm [2b\, E_{L_B}] = \pm [(2)(4.244)(1)] = \pm [8.488]$$

$$E_{R4} = \pm [E_p] = \pm [\tfrac{25}{\cancel{36}}]$$

$$E_{R5} = \pm [E_{R2} + E_{R3}] = \pm [\tfrac{20.12}{\cancel{32.18}} + 8.488] = \cancel{35.668}\ 28.608$$

$$\frac{E_{R6}}{R_6} = \pm \left[\frac{E_{R4}}{R_4} + \frac{E_{R5}}{R_5} + \frac{E_{R1}}{R_1} \right]$$

$R_4 = P_2$

$R_5 = (R_2 + R_3) = [a(L_2 - L_1)_A + b(L_2 - L_1)_B]$

$= [(2.515)(\Delta L)_A + (4.244)(\Delta L)_B]$

$R_1 = (P_1 - P_2)$

$$\frac{E_{R6}}{R_6} = \pm \left[\frac{\tfrac{25}{\cancel{36}}}{P_2} + \frac{\tfrac{28.608}{\cancel{32.668}}}{2.515(\Delta L)_A + 4.244(\Delta L_B)} + \frac{\tfrac{50}{\cancel{46}}}{(P_1 - P_2)} \right]$$

3/31/79
1551 hrs.

$$\frac{E_{R6}}{R_6} = \pm \left[\frac{\tfrac{25}{\cancel{36}}}{961} + \frac{\tfrac{28.608}{\cancel{32.668}}}{(2.515)(6.6) + (4.244)(12.8)} + \frac{\tfrac{50}{\cancel{46}}}{92} \right]$$

70.922

$$\frac{E_{R6}}{R_6} = \pm \left[\left(\frac{2.60 \times 10^{-2}}{\cancel{2.12 \times 10^{-2}}}\right) + \left(\frac{0.4034}{\cancel{0.5452}}\right) + \left(\frac{0.543}{\cancel{0.652}}\right) \right]$$

$$\frac{E_{R6}}{R_6} \quad \cancel{\pm 1.2286} \pm 0.973$$

ERROR ANALYSIS

$$\frac{E_{R_6}}{R_6} = \pm \left[\frac{25}{P_2} + \frac{28.608}{2.515(\Delta L_A) + 4.244(\Delta L_B)} + \frac{50}{(P_1 \cdot P_2)} \right]$$

ΔV_{TOT}

3/29/79 – 1300

$$\frac{E_{R_6}}{R_6} = \pm \left[\frac{25}{970} + \frac{28.608}{(2.515)(48) + (4.244)(14)} + \frac{50}{95} \right]$$

$$= \pm \left[(0.02577) + (0.1588) + (0.526) \right]$$

$$= \pm \left[0.7105 \right]$$

3/30/79 – 0625

$$\frac{E_{R_6}}{R_6} = \pm \left[\frac{25}{1096} + \frac{28.608}{(2.515)(3.9) + 0} + \frac{50}{16} \right]$$

$$= \pm \left[0.0228 + \frac{2.9164}{\cancel{2.9166}} + 3.125 \right]$$

$$= \pm 6.06$$

3/30/79 – 0730

$$\frac{E_{R_6}}{R_6} = \pm \left[\frac{25}{1035} + \frac{28.608}{(2.515)(30) + 0} + \frac{50}{115} \right]$$

$$= \pm \left[0.0242 + 0.379 + 0.435 \right]$$

$$= \pm 0.84$$

3/30/79 - 1240

$$\frac{E_{AL}}{R_L} = \pm \left[\frac{25}{1018} + \frac{28.608}{(2.515)(22.1) + (4.244)(15)} + \frac{50}{32} \right]$$

$$= \pm \left[0.0246 + 0.240 + 1.563 \right]$$

$$= \pm 1.8276$$

3/30/79 - 1445

$$\frac{E_{AL}}{R_L} = \pm \left[\frac{25}{1053} + \frac{28.608}{(2.515)(2) + (4.244)(8)} + \frac{50}{42} \right]$$

$$= \pm \left[0.0237 + 0.7338 + 1.1905 \right]$$

$$= \pm 1.948$$

3/30/79 - 1630

$$\frac{E_{AL}}{R_L} = \pm \left[\frac{25}{1080} + \frac{28.608}{(2.515)(0.2) + (4.244)(1.3)} + \frac{50}{17} \right]$$

$$= \pm \left[0.0231 + 4.752 + 2.94 \right]$$

$$= \pm 7.715$$

4/1/79 1211/1238

$$\frac{E_R}{R} = \pm\left[\frac{25}{1049} + \frac{28.608}{41.33} + \frac{50}{97}\right] = \pm\left[0.0238 + 0.692 + 0.515\right]$$

$$= \pm\left[1.23\right]$$

4/1/79 1044/1140

$$\frac{E_R}{R} = \pm\left[\frac{25}{1056} + \frac{28.608}{54.36} + \frac{50}{100}\right] = \pm\left[0.0237 + 0.526 + 0.5\right]$$

$$= \pm\left[1.076\right]$$

4/1/79 0946/1020

$$\frac{E_R}{R} = \pm\left[\frac{25}{1056} + \frac{28.608}{44.87} + \frac{50}{.03}\right] = \pm\left[0.0237 + 0.638 + 0.485\right]$$

$$= \pm\left[1.147\right]$$

4/1/79 0825/0903

$$\frac{E_R}{R} = \pm\left[\frac{25}{1050} + \frac{28.608}{44.5} + \frac{50}{105}\right] = \pm\left[0.0238 + 0.643 + 0.476\right]$$

$$= \pm\ 1.143$$

4/1/79 ~~0731~~ Shot

$$\frac{E_R}{R} = \pm\left[\frac{25}{1055} + \frac{28.608}{37.25} + \frac{50}{84}\right] = \pm\left[0.0237 + 0.768 + 0.595\right]$$

$$= \pm\ 1.387$$

TO: Jack Devine. 4/4/79.
0500

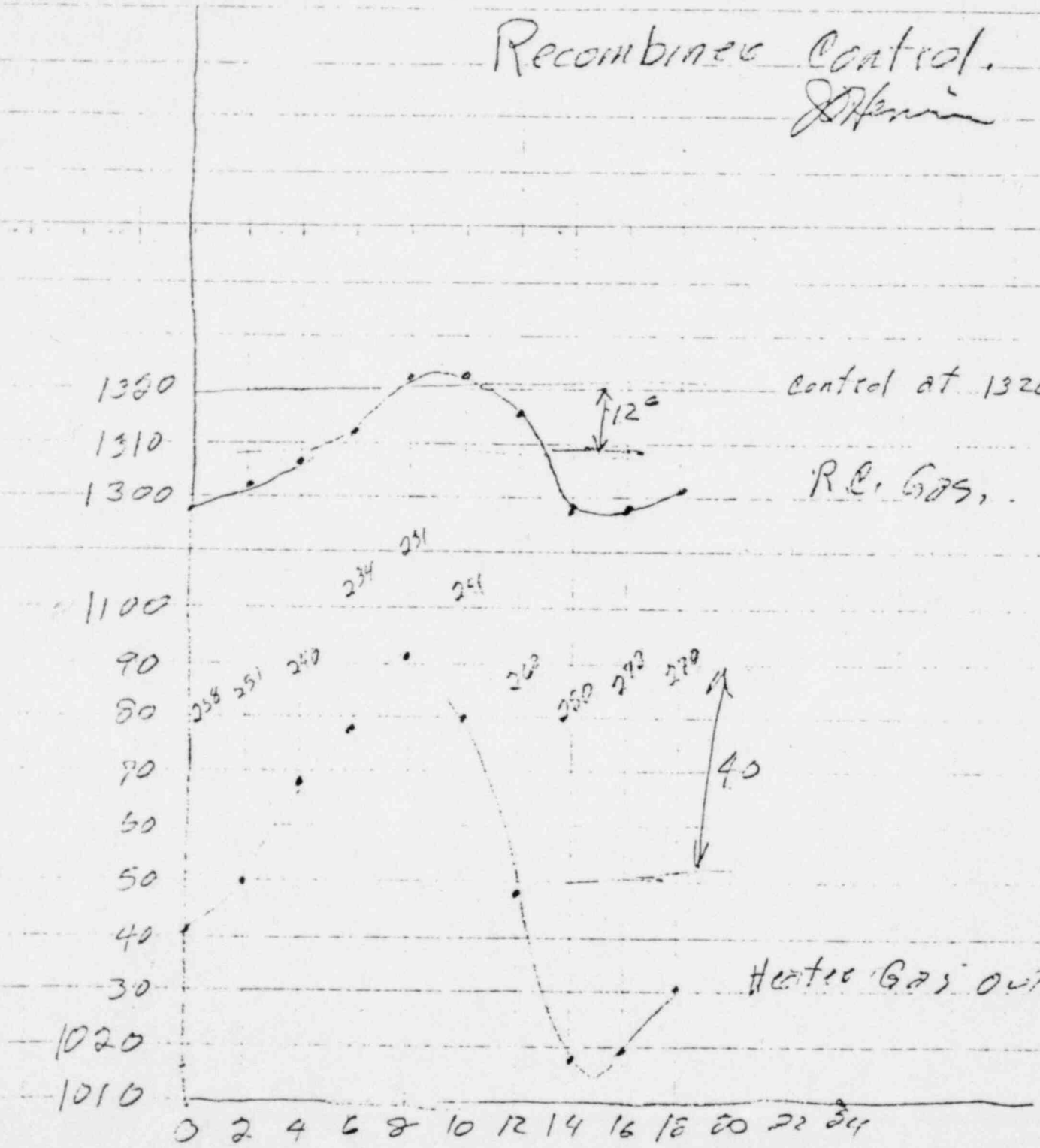
From: Jim Henrie. (509-942-9811 x 3397)
Home 509-946-2192

Subject: Work Summary.

Left Richland Wa., Sat., 3/31, 10:00
Arrived Harrisburg AP. Sun., 4/1, 11:00

1. Assigned by Dieckamp to recombiner problems. Advised in installation, checkout, safety & reliabilty considerations, review of start-up procedures, start-up, op. analysis, stability analysis, recommended corrections to improve stability. (Fig 1, 2, 3 & 4). Hydrogen analysis, error correction. (Fig 5). Analysis of H_2 removal from containment without consideration of H_2 generation. (Fig 6) Recommended operation of single recombiner.
2. Made gross evaluation of accident hydrogen burn on 3/28/79 at 13:50 (Fig 7) This is crude. Includes many assumptions and lacks good corrections for initial (unknown to me) conditions.
3. Worked on procedures and safety of transferring hydrogen from WDGT-1B. See Fig 8, Fig 9 (checklist), and Procedure Z-2.

Sorry no more time, Good Luck, Jim Henrie



~12:00

4/13/79

Fig 1

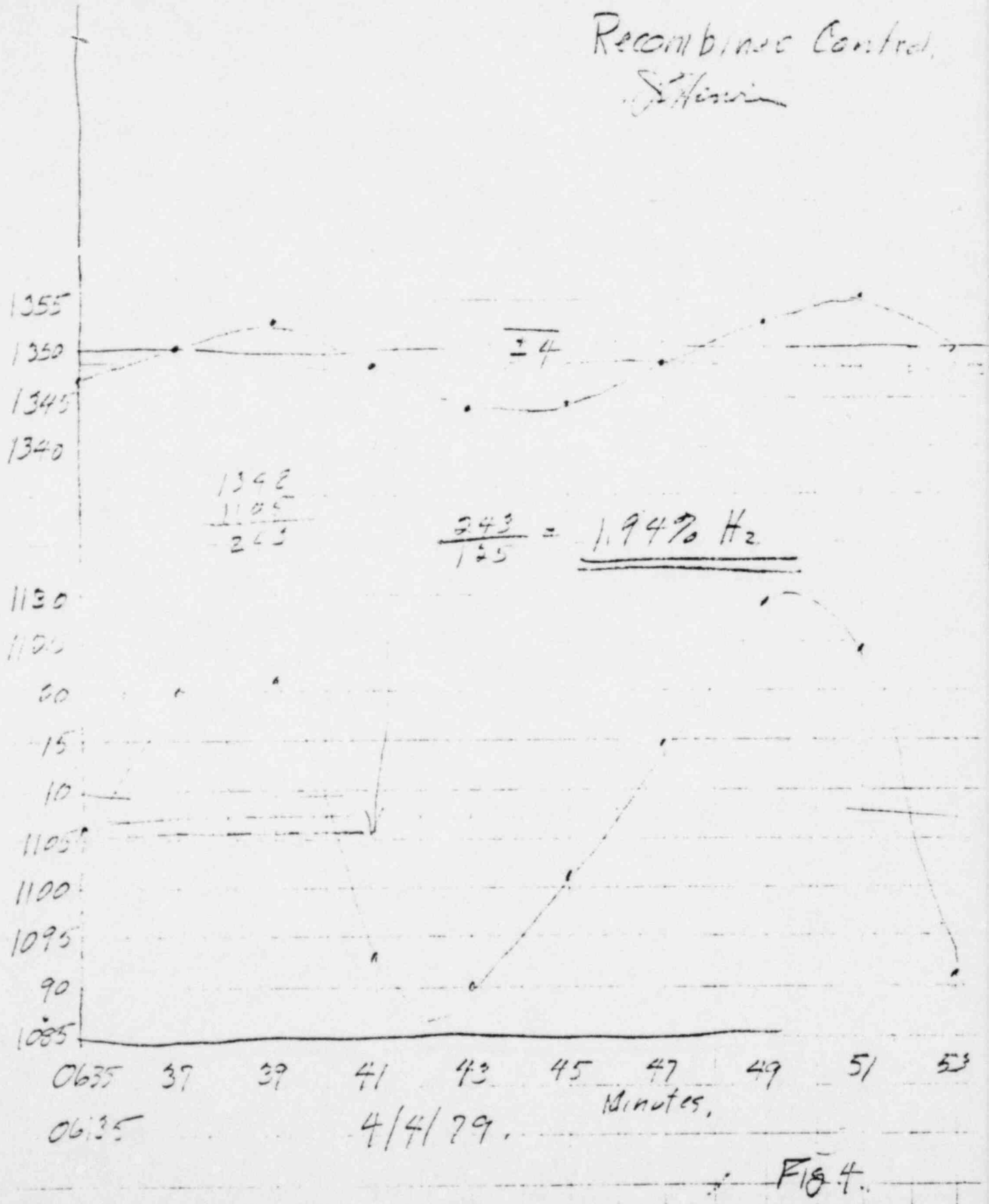
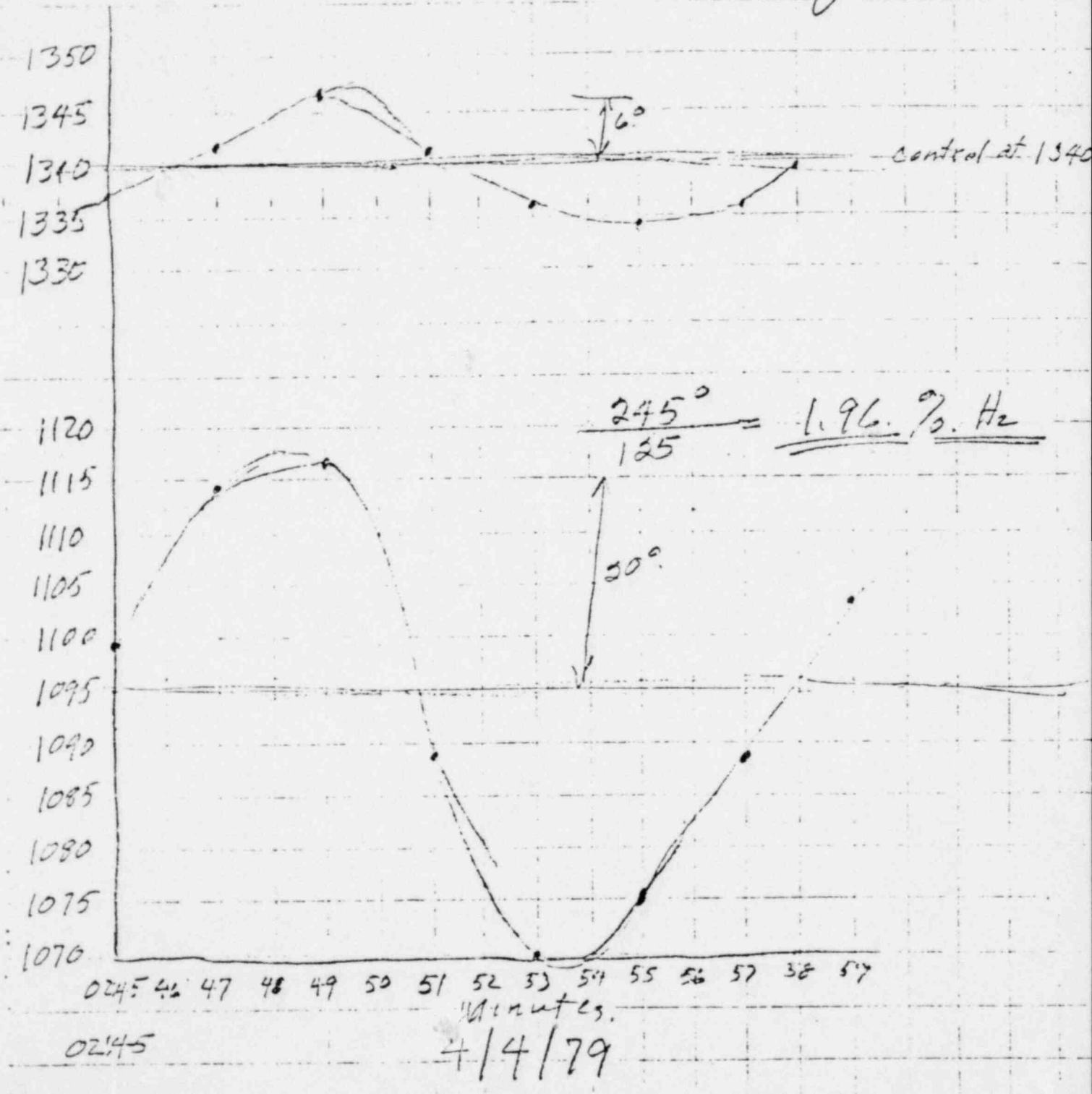

Recombiner Control
S. Hasin
1355
1350
1345
1340
1348
1105
243
243 / 125 = 1.94% H2
1130
1110
60
15
10
1105
1100
1095
90
1085
0635
37
39
41
43
45
47
49
51
53
Minutes.
0635
4/4/79.

Fig 4.

Recombiner Control

J. Henrie



$\frac{245°}{125} = 1.96\%\ H_2$

0245

4/4/79

Fig 2

J. Henrie

Date	Time	H_2	O_2	N_2	
	I Sam.				
Sat. 3/31	9:00	1.2	16.5		
	1500	1.9	21.2	76.9	
	2000	2.4			*
Sun 4/1	2045	2.2			*
	1000	2.0			
	1200	2.2	19	78.8	100.
	1330	2.0			
	1500	2.0	17.	78.6	
	1830	2.0			
	23:30	2.3	18.9	78.9	100.1 *
4/2	6:00	2.4	17.6	79.9	99.9 *
	10:30	2.1	18.4	79.5	1000
4/3	22:35	2.01	18.6	81.	101.01

- Sampling [illegible]
- [illegible]
- [illegible]
- [illegible]

* Same Operator.

~~Activity of containment atmosphere determined by a factor of 3 at source of this sample.~~

Fig 5.

944 4041 Unit 2 Control Room Dick Dubiel
mgr of chemists

Hydrogen Con centration 2.1%.

Cont. Volume 2,000,000 FT³. X2.1% = FT³ H = 42,000

Recombiner Flow 9.0 SCFM.

90 X 60 X 24 = 130,000 FT³/day. X 2.1% = 2,722 FT³ H/day

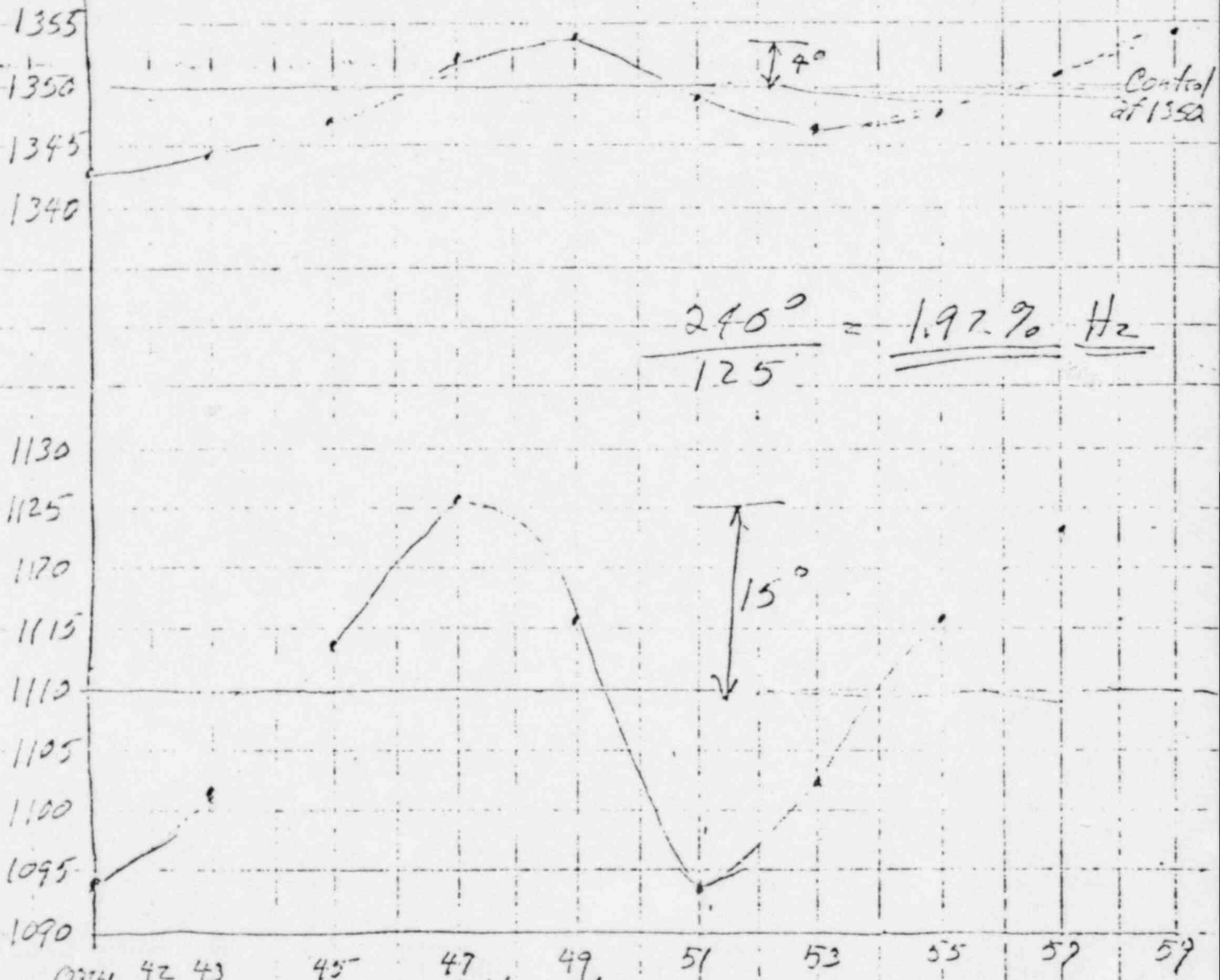
		H₂ (start)	Removed	H₂ end	%
Start 15'45,	4/2/79				
First day.	4/3	42.0K	2.1	39.9	1.96.
Second day.	4/4	39.3	2.5	36.8	1.84
Third day	4/5	36.8	2.4	34.4	1.72
Fourth "	4/6	34.4	2.2	32.2	1.61
	4/7	32.2	2.1	30.1	1.50
	4/8	30.1	1.9	28.2	1.41
	4/9	28.2	1.8	26.4	1.32
	4/10	26.4	1.7	24.7	1.24
	4/11	24.7	1.6	23.1	1.10
	4/12	23.1	1.4	21.7	1.04
	4/13	21.7	1.3	20.4	.97

Assume No Net H_2 input to Containment

Fig 6.

Gary Miller
Joe Logan, Plant Superintendent.
Jack Heabine V.P. Generation
Roetz
Diecking.

Recombiner Control



$$\frac{240°}{125} = \underline{\underline{1.92\%\ H_2}}$$

03:44

4/14/79

Fig 3

Analysis of hydrogen burn which appears to have occurred at about 13:50 on 3/28/79, Wednesday, about 9.8 hrs after start of incident.

Initial Conditions, Prior to burn, Pressure = 16 PSIA.
Humidity: Unknown. Temp: unknown.

Pressure spike increased to 42.6 PSIA in <1 minute,
reduced to 17.8 PSIA in ~10 minutes.
13.8 PSIA in 4½ hours.

Correlation of the 27 PSI spike with a 33.3 PSI spike observed in tests (AI-73-29, fig 12, attached) the hydrogen concentration was about $16 \times \frac{27}{33.3} = 13\%$.

Subsequent oxygen analysis showing ~18% O_2 suggests that less than 13% H_2 burned. Assume 10% H_2.

Inventories were about as follows:

	H_2	O_2	N_2
$O_2 = .21 \times 2 \times 10^6 \times \frac{530}{575} =$		386,400	
$N_2 = .79 \times 2 \times 10^6 \times .92 =$			1,454,000
H_2, metal/water reaction, 10% =	200,000		
Burn of H_2, 90% eff. =	-180,000	-90,000	
Radiolysis, first week. =	+20,000	+10,000	
Air Inleakage*, first week =		800	2,900
Total Inventory	40,000	307,200	1,454,900
% of total. (1,804,000) =	2.2%	17.0%	80.8%
Analysis of gas, 4/3, 02:35 =	2.0%	18.0%	81%

Pressure: $\frac{1,804,000}{2,000,000} \times \frac{460+84}{460+70} \times 14.7 = 13.6$ PSIA; Measured 13.4 PSIA.

* based on .2%/day, 5.6 PSI ΔP, corrected to 1 PSI ΔP. Fig 7.

$Q = .2\% \times 2 \times 10^6 \times \sqrt{\frac{1}{52}} \times 7 \text{ days} = 3,200 \text{ ft}^3$; $\times .21 = 800$; $\times .79 = 2,900$.

Reasonable correlation. 10% H_2 at time of burn appears to be reasonable.

J. O'Hern
4/4/79

Gas in WDGT-1B.

Volume 1937 FT^3
Pressure 86 PSIG.
Temperature 100°F.

$$\text{Volume} = 1937 \times \frac{86 + 14.7}{14.7} \times \frac{460 + 70}{460 + 100} = 12,605 \text{ SCF.}$$

(6.85 over 14.7; .95 = 530/560)

Reducing to 15 PSIG, Subtract 3,874

Net trans' $\times \frac{8.7}{2,000} = .449$ lbs. = 8,731 SCF

Max rate of 3 PSI/HR, $3/100 \times 12,605$/HR = 378 SCF/HR

$\frac{378}{60} = 6.3$ SCFM.

$\pi \left(\frac{.5}{2}\right)^2 = .04\pi$

$= .04\pi$

$\text{Velocity} = \frac{Q}{A} = \frac{6 \text{ FT}^3/\text{min} \quad 144 \text{ in}^2 \times 1 \text{ min}}{.04\pi \text{ in}^2 \times 117 \quad 60 \text{ sec}} = 115 \text{ FT/sec}$

Flowrate 6½#/min, 31 SCFM

31 SCFM X 60 M/HR = 1,860 SCFH. X 100 PSIG = 147 PSI/FT
12605 SCF 49 X rate max.

$\frac{31 \text{ CFM} \times 6 \text{ HR}}{6,000 \text{ CFM Total}} = .3\%$ Increase.

Location of exhaust line = 293'6"
207°38" Zero = South.

Needle Valve is 1½ needle, Velan, 150#, 200°F.
Need turns open to limit flow to 6.3 SCFM. Fig 8

1. Temp of T[illegible]. 100 to 200°F. Too hot to [illegible],

2. Calc gas.

3. Flowrate ~ 1, 50', 1/2" tubing,
calculate,

4. Pressure drop rate 375 l/hr.
Can do it only by [illegible] the throttle valve

5. Exit. detail. - No 1/2" nipple.

6. Assess failure modes.
a. operator errors - Dumps H_2, Alarms, Close Valve
Add precaution measures. (Tag Positions)
b. Equipment - Has been tested at 125% of max. measured,
Walk to see if O.K.

7. Consider Recombiner Running.

Mike 8. Check N_2 Source & Pressure.

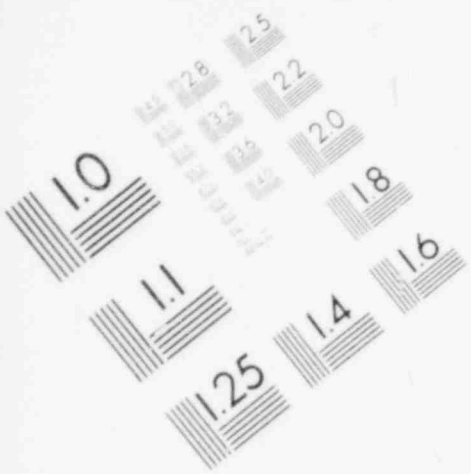
Jul 9. Check for equipment [illegible] R571C. Pen.

Jul 10. Valve position to limit flow to 4 to 8 SCFM.

11. Check Compressor logic. ~~[illegible] on if pump [illegible]~~

12. Consider flame arrestor. - Talk to Chemist

13. Consider H_2 Change total. .44% Fig 9



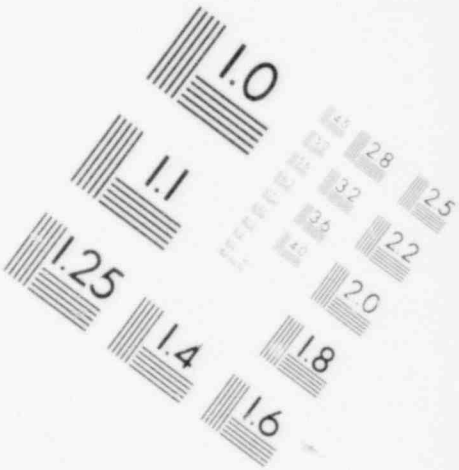
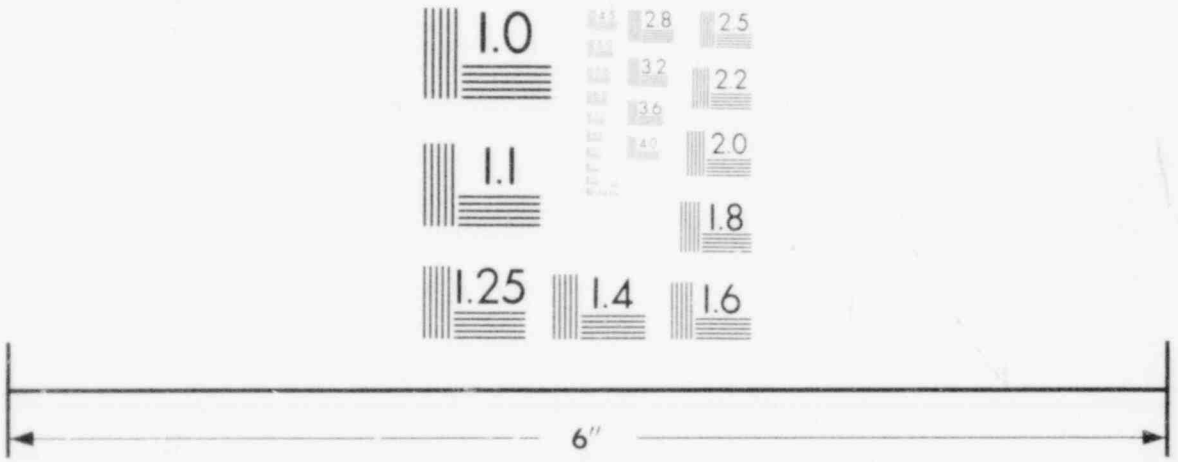
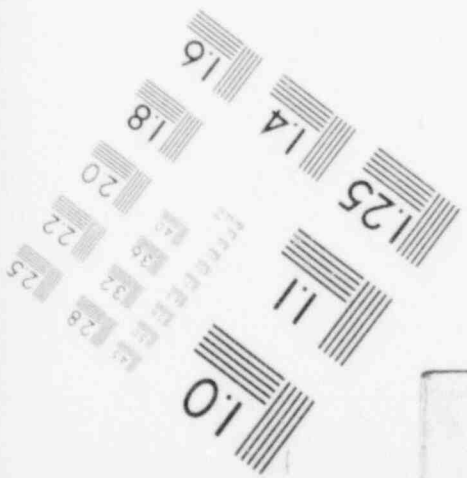
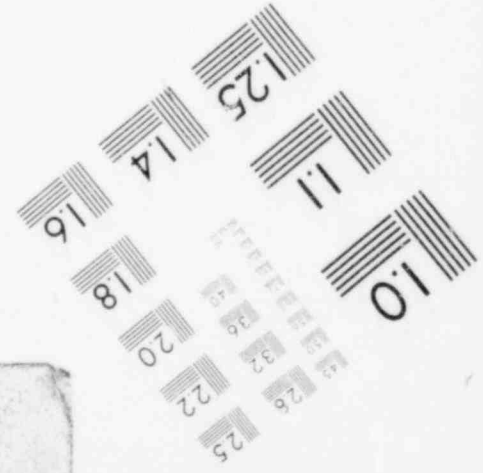


IMAGE EVALUATION
TEST TARGET (MT-3)



MICROCOPY RESOLUTION TEST CHART





AP 1001

Figure 1001-8

Three Mile Island Nuclear Station

Special Operating Procedure

SIDE 1

SOP No. Z-2 (From SOP Log Index)

NOTE: Instructions and guidelines in AP 1001 must be followed when completing this form.

Unit No. 2

Date 4-4-79

1. Title DISCHARGE OF WDG-T-1B TO REACTOR BLDG.

2. Purpose (Include purpose of SOP)

TO DISCHARGE WDG-T-1B TO REACTOR BLDG

3. Attach procedure to this form written according to the following format.

A. Limitations and Precautions

1. Nuclear Safety
2. Environmental Safety
3. Personnel Safety
4. Equipment Protection

SEE ATTACHED

B. Prerequisites

C. Procedure

4. Generated by Julien Abramowicz / Jim Aeric Date 4-4-79

5. Duration of SOP - Shall be no longer than 90 days from the effective date of the SOP or (a) or (b) below – whichever occurs first.

(a) SOP will be cancelled by incorporation into existing or new permanent procedure submitted by _____ ☐

(b) SOP is not valid after _____ ☐

(fill in circumstances which will result in SOP being cancelled)

6. (a) Is the procedure Nuclear Safety Related?

If "yes", complete Nuclear Safety Evaluation. (Side 2 of this Form) . . . . . Yes☐ No☐

(b) Does the procedure affect Environmental Protection?

If "yes", complete Environmental Evaluation. (Side 2 of this Form) . . . . . Yes☐ No☐

(c) Does the procedure affect radiation exposure to personnel? . . . . . Yes☐ No☐

NOTE: If all answers are "no", the change may be approved by the Shift Supervisor. If any questions are answered "yes", the change must be approved by the Unit Superintendent.

7. Review and Approval

Approved – Shift Supervisor _____ Date

Reviewed – List members of PORC contacted _____ Date

_____ Date

_____ Date

_____ Date

Approved - Unit Superintendent _____ Date

8. SOP is Cancelled

_____ _____

Shift Supervisor/Shift Foreman Date

SPECIAL OPERATION PROCEDURE

TMI-2 NUCLEAR STATION

DISCHARGE OF WDG-T-1B TO REACTOR BUILDING

1.0 CONDITIONS

1.1 PRIMARY SYSTEM

a) PRIMARY PRESSURE BETWEEN 1000 AND 1050 PSIG.

b) PRESSURIZER LEVEL BETWEEN 175 AND 210 IN. H_2O

c) PRIMARY PRESSURE/TEMPERATURE CONTROL USING PRESSURIZER HEATERS AND SPRAY.

d) ONE R.C. PUMP OPERATING.

1.2 SECONDARY SYSTEM

a) CONDENSER VACUUM BETWEEN 5 AND 29 IN. HG.

b) ONE OTSG STEAMING TO CONDENSER.

1.3 REACTOR BUILDING (RB.)

a) R. B. TEMPERATURE BETWEEN 50 AND 125°F.

b) R.B. HYDROGEN CONCENTRATIONS LESS THAN 4%.

2.0 PRECAUTIONS

2.1 DO NOT ALLOW THE WGD-T-1B PRESSURE TO DECREASE AT A RATE GRATER THAN 3 PSI/HR.

2.2 DO NOT ALLOW THE WGD-T-1B PRESSURE TO DECREASE BELOW 15 PSIG.

2.3 A FLAME ARRESTERS HAS BEEN INSTALLED TO PRECLUDE FLAME PROPAGATION.

2.4 THE SYSTEM IS GROUNDED.

3.0 PROCEDURE

3.1 VERIFY TEMPORARY VALVES T-V1 AND T-V2 ARE CLOSED.

3.2 HAVE CONTROL ROOM DEFEAT RMS INTERLOCKS ~~[illegible]~~ USING KEYLOCK SWITCHES FOR WDG-R-1485 WDG R-1485, WDG-R-1486 AND HP-R-219. -

3.3 VERIFY WDG-V-32 IS CLOSED.

3.4 VERIFY WDG-V-33 IS CLOSED.

3.5 VERIFY WDG-V-170 IS CLOSED.

3.6 VERIFY WDG-V-24 IS CLOSED.

3.7 VERIFY WDG-V-142A AND V-143A ARE CLOSED.

3.8 VERIFY WDG V-30A IS CLOSED.

3.9 VERIFY WDG V-143B IS OPEN.

3.10 VERIFY WDG-V-54B IS OPEN.

3.11 VERIFY WDG-V-188B IS CLOSED.

3.12 VERIFY T-V23 ~~[illegible]~~ IS CLOSED.

3.13 VERIFY ~~[illegible]~~ T-V7 IS OPEN AND V6 CLOSED

3.14 VERIFY WDG-V-30B IS CLOSED AT RADWASTE PANEL.

3.15 CLOSE SHUT WDG-V-26B AT RADWASTE PANEL TO ISOLATE COMPRESSOR

3.16 VERIFY WDG-V-142B IS CLOSED

3.17 OPEN BS-V-149.

3.18 OPEN WDG V-30B FROM RADWASTE PANEL

3.19 OPEN WDG-V-188B BY TURNING 1/2 TURN OR AS NECESSARY TO ACIEVE LESS THAN 3PSI PER HOUR DECREASE IN WASTE GAS DECAY TANK PRESSURE AT THE RADWASTE PANEL.

3.20 WHEN THE WASTE GAS DECAY TANK (WTG-T-1B) REACHES 15PSIG SECURE DISCHARGING BY CLOSING WDG-V-3CB AT RADWASTE PANEL.

3.21 CLOSE WDG-V-188B.

3.22 CLOSE WDG-V-54B.

3.23 CLOSE BS-V-149.

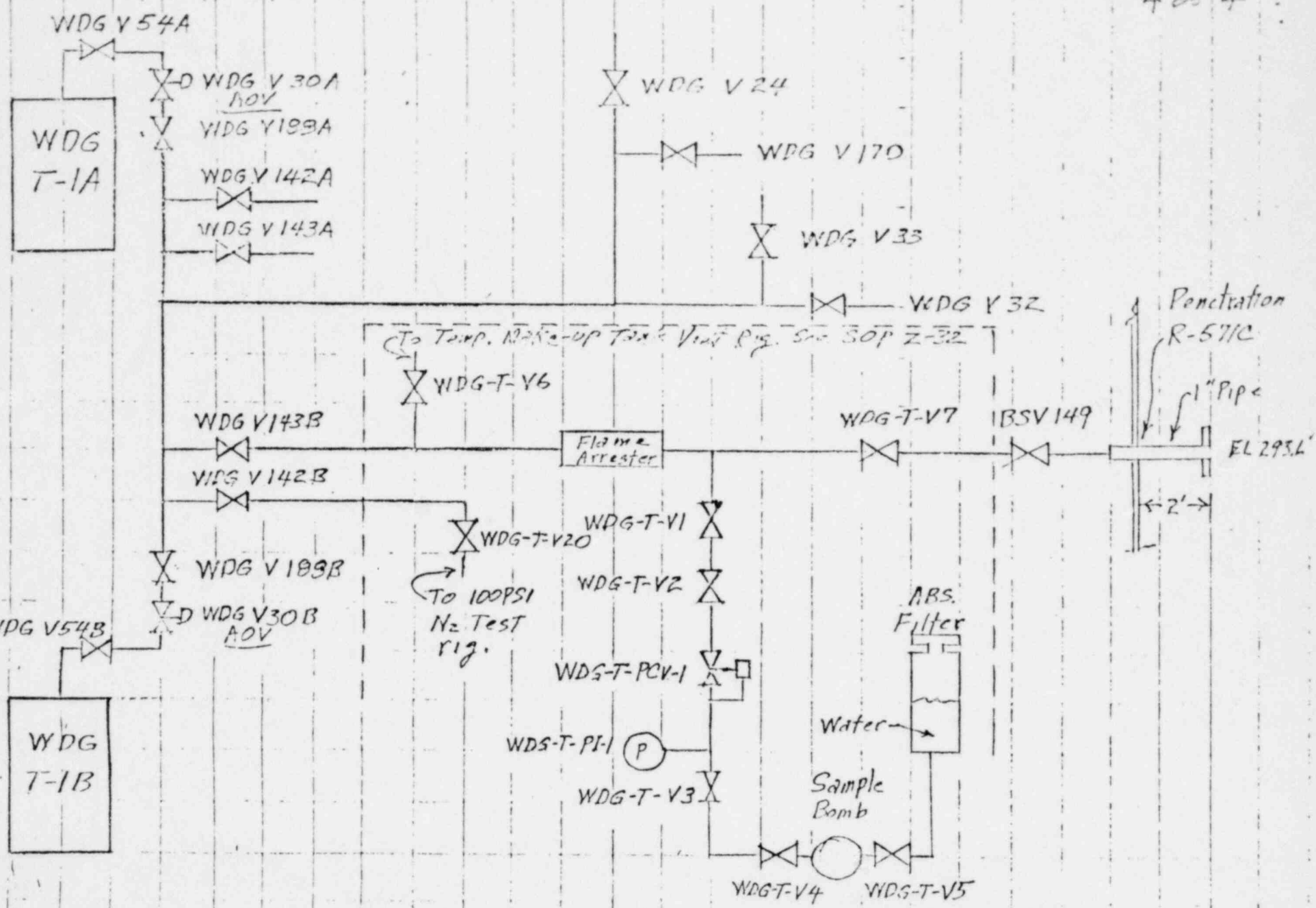
3.34 CLOSE WDG-V-143B

3.35 OPEN WDG-V-26B.

NOTES 1) ALL VALVES UNLESS OTHERWISE NOTED ARE WDG.

2) ALL VALVES OTHER THAN VALVES THAT ARE CYCLED SHOULD BE "DANGER" TAGGED.

3) VALVES THAT ARE INSTALLED AS PART OF THE TEMPORARY RIG SHOULD BE BRASS TAGGED.


WDG V54A
WDG T-1A
WDG V30A
AOV
WDG V199A
WDG V142A
WDG V143A
WDG V24
WDG V170
WDG V33
WDG V32
Penetration R-57C
1" Pipe
To Temp. Make-up Tank Vent Rig. See SOP Z-32
WDG-T-V6
WDG V143B
WDG V142B
Flame Arrester
WDG-T-V7
IBSV 149
EL 293.6'
2'
WDG-T-V1
WDG-T-V20
WDG V199B
WDG-T-V2
To 100PSI N2 Test rig.
WDG V30B
AOV
WDG V54B
ABS. Filter
WDG-T-PCV-1
Water
WDG T-1B
WDG-T-PI-1
P
WDG-T-V3
Sample Bomb
WDG-T-V4
WDG-T-V5

Circ Check of 4/2/79 6:50 ditto

1. $\frac{1063}{98}\left[\left\{3.178\left[\frac{.0172}{.02198}(202.9) - \frac{.0172}{.0205}(201.7)\right]^3 + \right.\right.$

$158.775 \quad 160.66$

-6.0541

$4.128\left(\frac{.0172}{.016052}\right)(46.1 - 49.8) - 6.166\times10^5\left[\right.$

-16.36

$-6.166\times10^5\left[9\times10^{-4}(278.5 - 278.8)\right] =$

-1.665

$-6.166\times10^5(-10^{-7})(1063 - 9.65)$

-6.04

$+6.166\times10^5(5.839\times10^{-7})(1063 - 9.65) =$

35.52

$\frac{1063}{98}\left[-6.0541 - 16.36 + 1.665 + 6.04 + 35.52\right]$

-225.8 ? Bubble

4/3/79 0200

$\frac{1063}{4.73 - 1.62}$

CALC,

③ $3.175 \left[\frac{.0172}{.0219} (202.5) - \frac{.0172}{.02159} (261.9) \right] = -5.736$

③ $4.128 \frac{.0172}{.016064} [53.1 - 54.3] = -5.3$

① $6.166 \times 10^5 (9 \times 10^{-4})(.3) = 1.665$

⑤ $6.166 \times 10^5 (-10^{-7})(90) = -5.5$

⑥ $6.166 \times 10^5 (5.434 \times 10^{-7})(90) = 32.4$

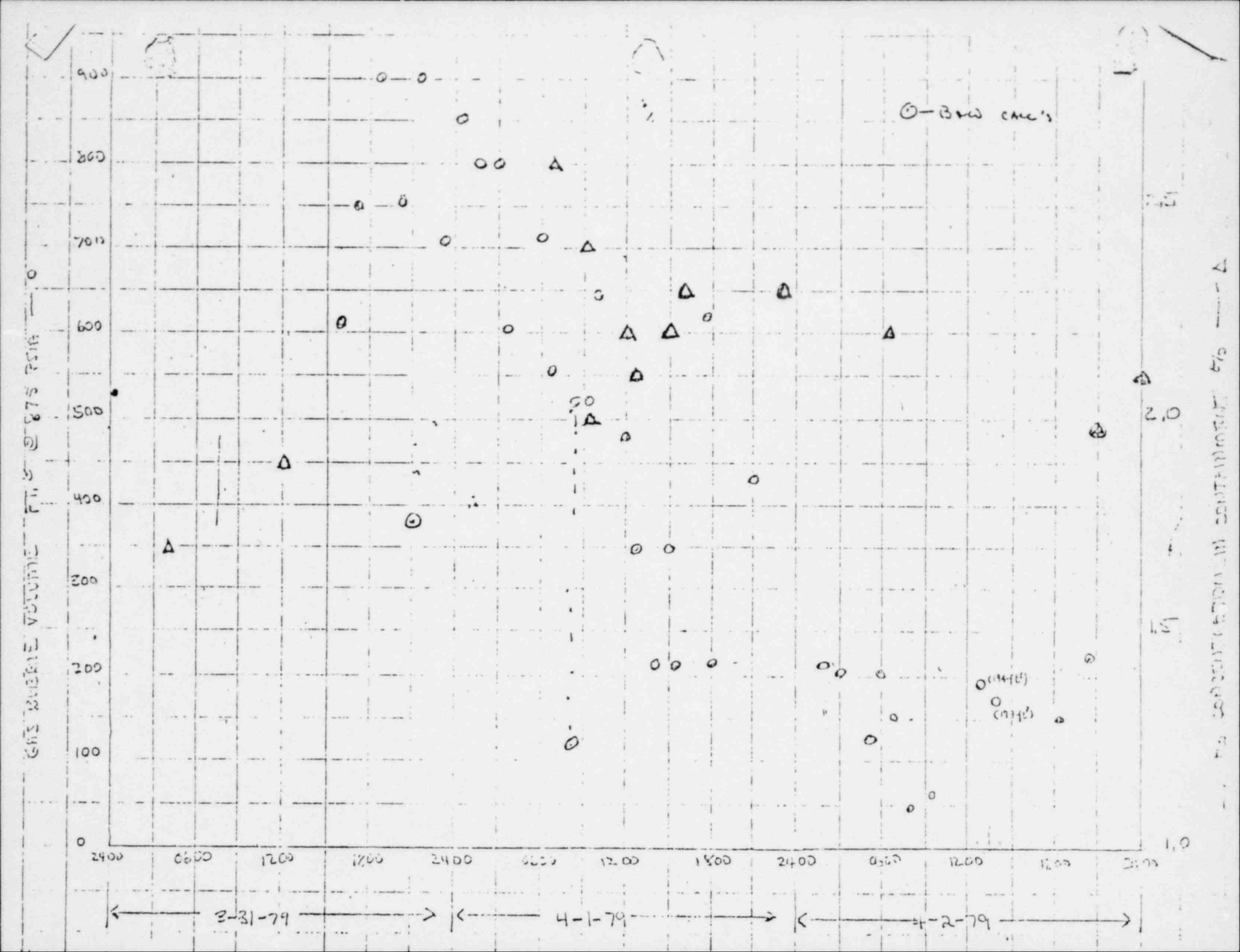
$V = -11.8 [-5.734 + (-5.3) - 1.665 - (-5.5) + 32.4]$

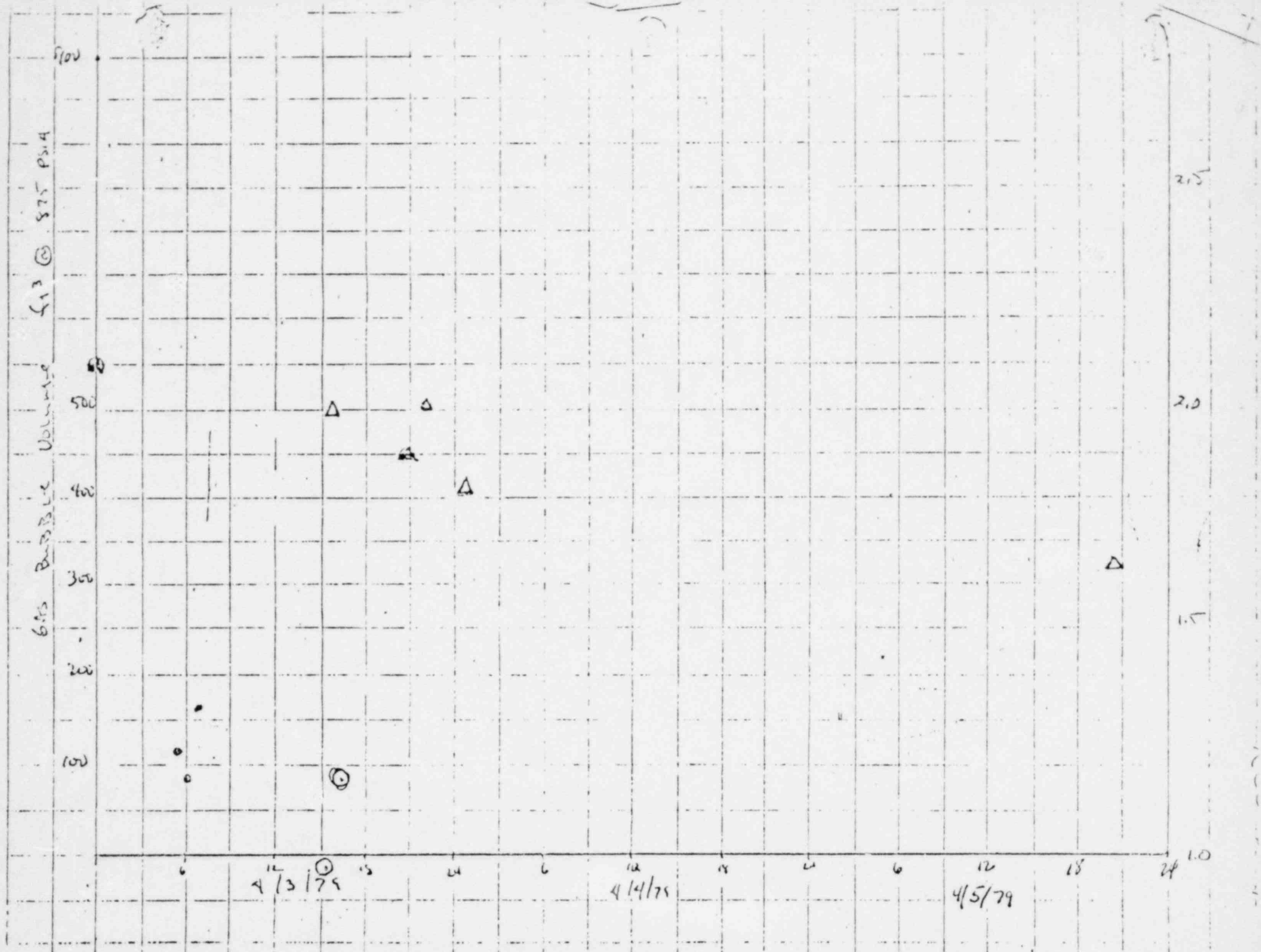
Volume $= 297 \text{ ft}^3$

gone

Check of 4/2/74 7:40 data

JJC 4/3/74 0200


⊙—BHP calc's
GAS STORAGE VOLUME FT³ @ 675 PSIA
900
800
700
600
500
400
300
200
100
0
2400
0600
1200
1800
2400
0600
1200
1800
2400
0600
1200
1800
3-31-79
4-1-79
4-2-79
2.0
1.0


600
500
400
300
200
100
2.5
2.0
1.5
1.0
6
12
18
24
4/3/79
4/4/79
4/5/79

4/8/79 0345

Bubble calculation data

	P_1				
8.	403	RCSP	597.6	Temp	271.3
46	1		649.0 Δ 51.4		270.7
38	94	PZR L	209.7	Temp	500.0
36	94		207.8		501.4
45	95		Δ 1.9		
56	90				
60	85	MVT L	94.6	Temp	93.8
54	83		95.4		94.0
53	90		Δ .8		
44	94				
44	04				
51	13				
12	05	PZR ΔV =	1.9 x 2.515 =		4.28
52	95	MVT ΔV =	.8 x 4.244 =		3.39
45	03				8.17
41	06				

$$V_1 = \frac{649(8.17)}{51.4} = 103.2$$

$$-166.6 \quad ft^3$$

$$+ .6 \quad ft^3$$

RCS Bubble Calc. 4/8/74
0610 PSH

63	RCS	P_1	556.5	T_1	210.2
65		P_2	605.5	T_2	210.0
58		ΔP	49.0	ΔT	-.2
54					
52	PZR	L_1	-29.5	T_1	492.8
47		L_2	224.4	T_2	501.5
43		ΔL	1.1		
54					
60	MUT	L_1	81.6	T_1	95.5
62		L_2	80.2	T_2	95.3
63		ΔL	1.4		
59					

$\Delta L' = \Delta L + \Delta T(2''/°F) = 1.1 + (-.2)(2) = .7$

$\Delta V_{PZR} = \Delta L' \times \frac{.0204}{.0173} \times 3.2\ ft^3/in$

$= .7 \times 1.179 \times 3.2 = 2.18\ ft^3$.

$\Delta V_{MUT} = \Delta L \times 4.244 = 1.4 \times 4.244 = 5.94$

8.12

54

01	97	$V_1 = \frac{(605.5)(8.12)}{49} = 100.4\ ft^3$	
11	11		
04	14		
6	16		
16	14	-57.	
1	10	89.	
91	06		
46	00		
10	99		
06	02		
3	04		

DATE 4/8/79

TIME 0120 AM PM

TMI-2 RCS BUBBLE CALC SHEET

DATA TAKEN BY: JSW

RC PRESSURE (397) (~~398~~)

P_1 = 629.1 PSIG = _____ PSIA

P_2 = 693.9 PSIG = _____ PSIA

ΔP = 64.8 PSI

RCS TEMP (394)

T_1 = 291.0 °F

T_2 = 280.8 °F

PRESSURIZER LEVEL (1682)

L_1 = 216.1 INCHES

L_2 = 213.3 INCHES

ΔL = 2.8 INCHES

PRESSURIZER TEMP (359, ~~455~~)

T_1 = 504.0 °F

T_2 = 514.9 °F

MAKEUP TANK LEVEL (347)

L_1 = 80.2 INCHES

L_2 = 81.6 INCHES

ΔL = -1.4 INCHES

MAKEUP TANK TEMP (161 CENTRAL BOARD MCC)

T_1 = 94.5 °F

T_2 = 94.0 °F

$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ 2.8 × 2.515 = 7.04 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ -1.4 × 4.244 = -5.94 FT^3

ΔV_{TOTAL} = 1.1 FT^3

$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(\quad X \quad)}{(\quad)} =$ _____ FT^3 @ P_1

$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) =$ 8.85 FT^3 @ 875 PSIA.

DATE 4/8/79

TMI-2 RCS BUBBLE CALC SHEET

TIME 0120 AM/PM

DATA TAKEN BY: BSW

RC PRESSURE (397)

P_1 = 629.1 PSIG = _____ PSIA

P_2 = 693.9 PSIG = _____ PSIA

ΔP = 64.8 PSI

RCS TEMP (394)

T_1 = 291.0 °F

T_2 = 280.8 °F

PRESSURIZER LEVEL (1682)

L_1 = 216.1 INCHES

L_2 = 213.3 INCHES

ΔL = 2.8 INCHES

PRESSURIZER TEMP (357)

T_1 = 504.0 °F

T_2 = 514.9 °F

MAKEUP TANK LEVEL (347)

L_1 = 80.2 INCHES

L_2 = 11.6 INCHES

ΔL = -1.4 INCHES

MAKEUP TANK TEMP (161) (CONTROL BOARD METER)

T_1 = 94.5 °F

T_2 = 94.0 °F

$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ 2.8 $\times$ 2.515 = 7.04 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ -1.4 $\times$ 4.244 = -5.94 FT^3

ΔV_{TOTAL} = 1.1 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(694 \times 1.1)}{(64.8)} = 11.78 \; FT^3 @ P_1$$

$V_{1(825)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) =$ 8.5 FT^3 @ 875 PSIA.

THE BABCOCK & WILCOX COMPANY
POWER GENERATION GROUP

DICK W
OR
GARY BROUGHT

To: MR DH ROY

MR BISHOP

Cust.

File No. or Ref.

Subj. COMPOSITION OF GAS BUBBLE

Date APRIL 1, 1979

After review of the postulated sequence of events on March 28, we conclude that there is no significant amount of oxygen in the bubble. At the time of reactor trip a hydrogen over pressure was present in the primary system. This hydrogen over pressure would have remained until boiling occurred about 3 hours after the trip. During the period of boiling some small generation of oxygen probably occurred. Shortly thereafter, a metal-water reaction began, generating large amounts of hydrogen. The metal-water reaction produced most of the gas in the bubble. After the metal-water was quenched, the hydrogen in the bubble inhibited oxygen generation. Thus only during the short time of boiling was oxygen generated.

If we make the conservative assumption of boiling for 15 hours we calculate a oxygen production of 1100 SCF by radiolysis. In addition, there is a small contribution from air dissolved in the RCST. This RCST contribution is 138 SCF. The total oxygen, 1238 SCF, is 27 cubic feet at RCS pressure and temperature. If this small amount of oxygen had been present on the 28th, it is highly that radiolytic recombination would have removed the oxygen.

RCS Bubble calculation error band analysis

Pzr level ± 1 inch → ΔL of 2" →

RVT level ± 1 inch → ΔL of 2"

$\Delta V_{PZR} = 2'' \times 2.515 = 5.03\ ft^3$

$\Delta V_{RVT} = 2'' \times 4.244 = 8.49\ ft^3$

Max ΔV due to error band = 13.52 ft³

RCS Pressure = ± 5 psi → ΔP of ± 10

Applying worst errors to calculation at 1000 psi and 100 ΔP for 80 ft³ H₂O

Nominal $V_1 = \frac{1000\ (80)}{100} = 800\ ft^3$

Error: $V_1 = \frac{1010\ (79.5)}{90} = 1049.2$

$V_1 = \frac{990\ (66.5)}{110} = 598.5$

Volume Error = +249 ft³

− 201.5 ft³

MAKEUP TO RCS

DATA FROM CONTROL ROOM LOG.

4/3/79
JRM

	Time	M-U (Y) (GAL)	(X) Δ Time	(XY)	(X^2)
3/30/79	0800	371	?		
	0815	300	15		
Missing Data? →	(1502	462	407) ?		
	1719	200	137		
	2036	300	197		
	2307	190	151		
	2347	300	40		
	~~2310~~	1752	947		

$\frac{1752 \text{ gal}}{947 \text{ min}} = 1.85$

Omit 1502 Data.

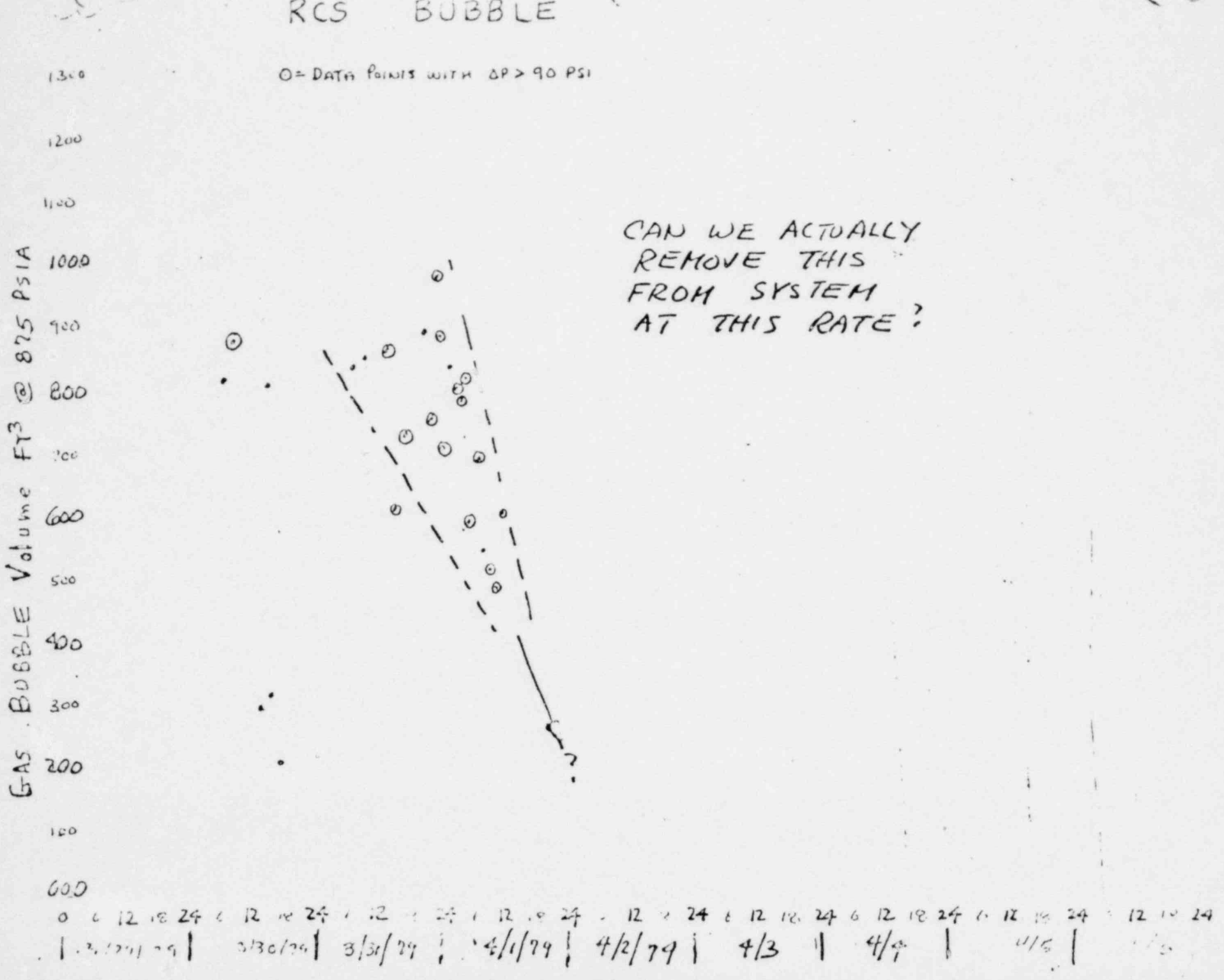
$\frac{1752-462}{947-407} = \frac{1290}{540} = 2.39$

3/31/79		Y	X	XY	X^2	
	0035	300	48	14400	2304	
Must be missing data JRM →	(0445	150	250 ~~205.75~~	37500	62500)	omit
	0547	150	62	9300	22500	
	0705	150	78	11700	6084	
	0830	566	85	48110	7225	
	1042	130	132	17160	17424	
	1120	900	38	34200	1444	
	1427	303	187	56661	34969	
	1530	413	63	26019	3969	
	1543	700	13	9100	169	
	1805	370	142	52540 ~~52540~~	20164	
	1820	370	15	5550	225	

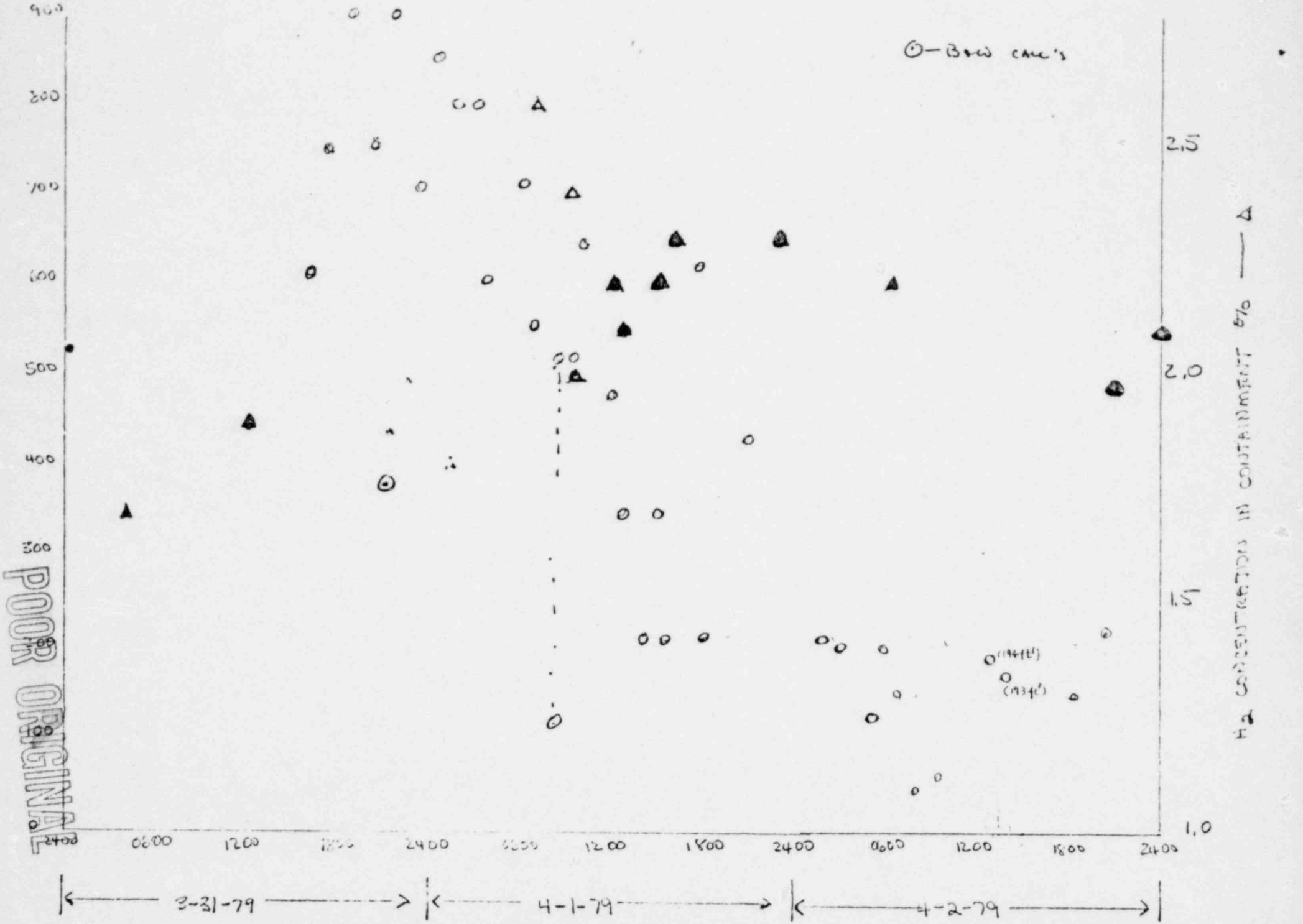
— CONT'D —

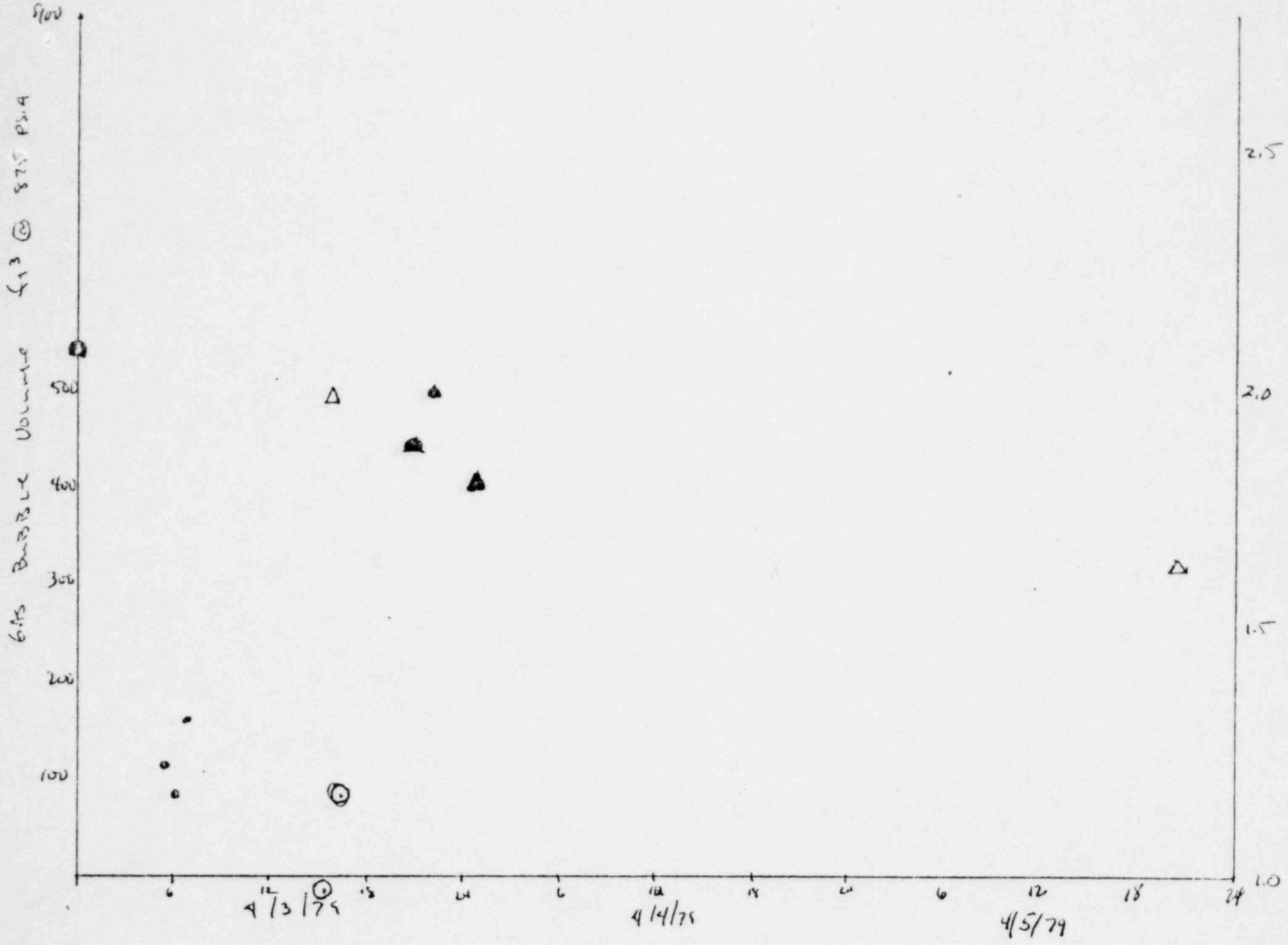
RCS BUBBLE

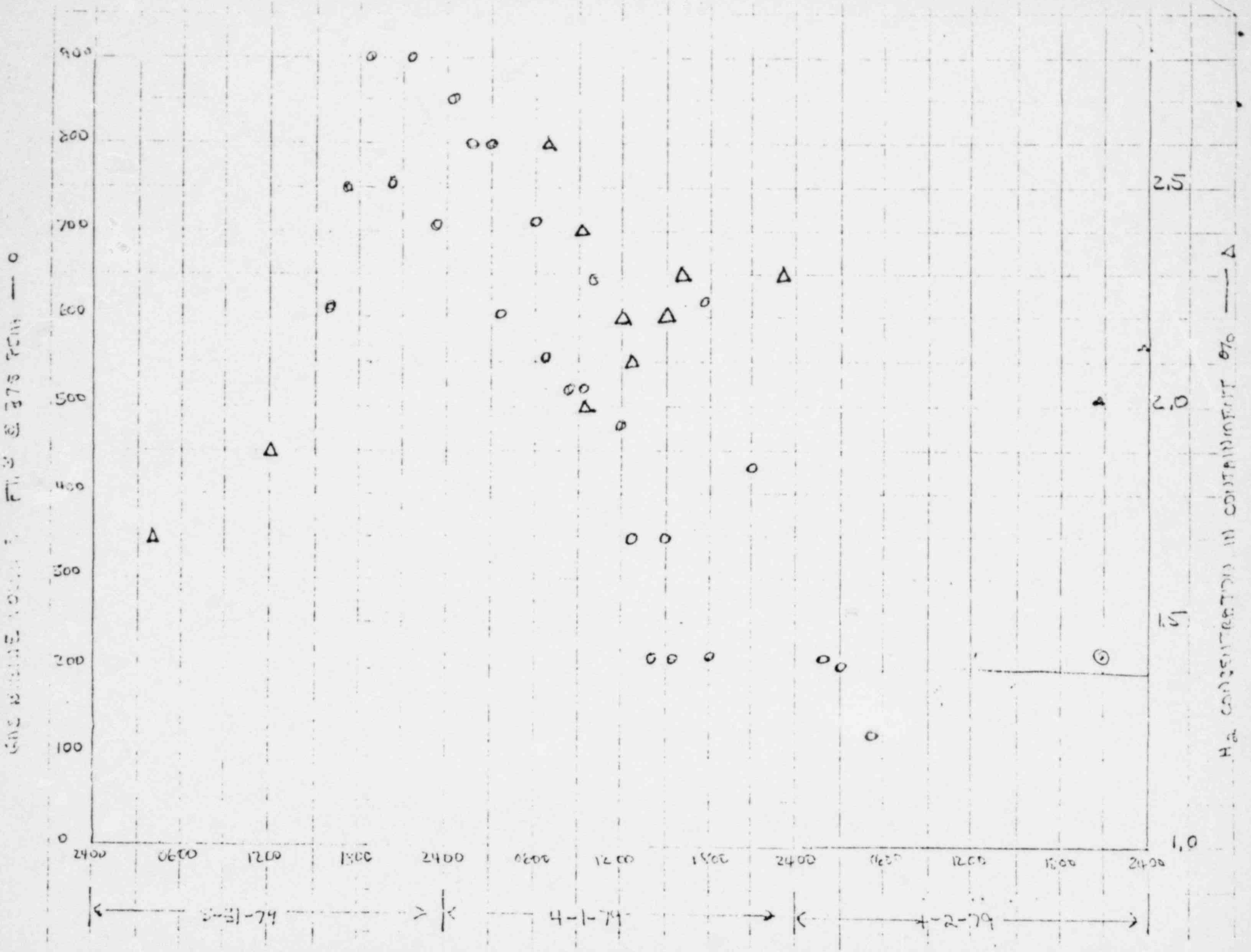
O = DATA POINTS WITH $\Delta P > 90$ PSI



CAN WE ACTUALLY REMOVE THIS FROM SYSTEM AT THIS RATE?


⊙—B&W cal's
2.5
2.0
1.5
1.0
900
800
700
600
500
400
300
200
100
0
2400
0600
1200
1800
2400
0600
1200
1800
2400
0600
1200
1800
2400
3-31-79
4-1-79
4-2-79
H2 CONCENTRATION IN CONTAINMENT %
POOR ORIGINAL


600
500
400
300
200
100
6 in Bubble Volume χ_{13} @ 875 psia
2.5
2.0
1.5
1.0
6
12
18
24
4/3/79
4/4/79
4/5/79


900
800
700
600
500
400
300
200
100
0
2.5
2.0
1.5
1.0
H_2 CONCENTRATION IN CONTAINMENT % — Δ
2400
0600
1200
1800
2400
1200
1800
2400
1200
1800
2400
3-31-79
4-1-79
4-2-79

USE OF 64 W ACCELEROMETER FOR BUBBLE SIZE CALC,

$= -11.8$

$\frac{1063}{973-1063}$

③ $3.178\left[\frac{.0172}{.0219}(202.5) - \frac{.0172}{.02157}(201.9)\right] = -5.738$

③ $4.128\ \frac{.0172}{.016064}\left[53.1 - 54.3\right] = -5.3$

① $6.166 \times 10^5 (9\times10^{-6})(.3) = 1.665$

⑤ $6.166\times10^5(-10^{-7})(90) = -5.5$

⑥ $6.166\times10^5(5.434\times10^{-7})(90) = 32.4$

$V = -11.8\left[-5.738 + (-5.3) - 1.665 - (-5.5) + 32.4\right]$

Volume $= 297.4$

gone

Check of 4/2/74 7:40 data

⇒

jfc 4/3/74 0200

One check of 4/2/79 6:50 data

1. $\frac{1063}{98}\left[\left\{3.178\left[\frac{.0172}{.02198}(202.9) - \frac{.0172}{.0205}(201.7)\right]\right\} + \right.$

$158.775 \quad - \quad 160.68$

-6.0541

$4.128\left(\frac{.0172}{.016052}\right)(46.1 - 49.4) - 6.166 \times 10^5 [$ [illegible] $($

-16.36

$-6.166 \times 10^5\left[9 \times 10^{-6}(278.5 - 278.8)\right] =$

-1.665

$-6.166 \times 10^5(-10^{-7})(1063 - 965)$

-6.04

$+ 6.166 \times 10^5 (5839 \times 10^{-7})(1063 - 965) =$

35.528

$\frac{1063}{98}\left[-6.0541 - 16.36 + 1.665 + 6.04 + 35.528\right]$

-225.8 ? Bubble gone

4/3/79 020

THE BABCOCK & WILCOX COMPANY
POWER GENERATION GROUP

Dick Wilson
NRC

To: DICK WILSON, MET ED OPERATIONS

From: D. W. BERGER, MANAGER, BSW OPERATIONS

BOS 660.5

Cust.

File No. or Ref.

Subj. REACTOR BUBBLE SIZE CALCULATION PACKAGE

Date APRIL 1, 1979

0153

This letter is never one contains and was issued only

ATTACHED ARE 12 PAGES OF THE CALCULATIONS FOR THE REACTOR BUBBLE.

OUR CALCULATIONS FROM DATA POINT 4 IS THAT THE BUBBLE HAS DISAPPEARED.

THIS IS SUBSTANTIATED BY NOISE MONITORING ON THE "B" LOOP PRESSURE TRANSMITTER.

STATISTICAL ANALYSIS LATER

D. W. BERGER

DWB/CW
ATTACHMENTS

NOTE: ALSO ATTACHED IS "REVIEW OF SODIUM SULFITE ADDITION ON RCS SYSTEM," DATED APRIL 1, 1979, 1 PAGE; AND 2) "COMPOSITION OF GAS BUBBLE," DATED APRIL 1, 1979, 1 PAGE.

LEE ROGERS - TRANSMIT THIS PACKAGE TO G. BROUGHTON

Babcock & Wilcox

4/1/79

Volume of Bubble Calculation

$$V_{Bubble} = \frac{P_2}{P_1 - P_2}\left[C_{PZR}\left(\frac{v_{f_2}^{RCS}}{v_{f_2}^{PZR}} L_2^{PZR} - \frac{v_{f_1}^{RCS}}{v_{f_1}^{PZR}} L_1^{PZR}\right) + C_{MWT}\left(\frac{v_f^{RCS}}{v_f^{MWT}}\right)\left(L_2^{MWT} - L_1^{MWT}\right) - M_{RCS}\left(\frac{\partial v^{RCS}}{\partial T^{RCS}}\right)\left(T_2^{RCS} - T_1^{RCS}\right) - M_{RCS}\left(\frac{\partial v^{RCS}}{\partial P^{RCS}}\right)\left(P_2 - P_1\right) + M_{RCS}\left(\frac{\partial S}{\partial P}\right)\left(P_2 - P_1\right)\right]$$

P_2 = RCS Press After Change

P_1 = RCS Press Before Change

C_{PZR} = Level to Volume Conversion for Pzr. = 3.173 ft^3/in

C_{MWT} = " " " " " MWT = 4.128 ft^3/in

v_f^{RCS} = Specific Volume of water at RCS temp, saturated steam tables

$v_{f_2}^{PZR}$ = " " " " " Pzr. " after change, saturated steam ta

$v_{f_1}^{PZR}$ = " " " " " " " " before " , " " "

v_f^{MWT} = " " " " " MWT " saturated steam tables

L_2^{PZR} = Level in pressurizer after change, inches

L_1^{PZR} = " " " " before " , "

L_2^{MWT} = " " relief tank after change, inches

L_1^{MWT} = " " " " " before " , "

$\frac{\partial v^{RCS}}{\partial T^{RCS}}$ = change in RCS specific vol per °F = 9.7×10^{-5} $ft^3/lbm\text{-}°F$

$\frac{\partial v^{RCS}}{\partial P^{RCS}}$ = Change in RCS specific volume per psid pressure = -10^{-7} $ft^3/lbm\text{-}psi$

$\frac{\partial S}{\partial P}$ = Change in solubility of H_2 per psid pressure = 5.839×10^{-7} $ft^3/lb_m\text{-}psi$

M_{RCS} = Mass of RCS = 5.166×10^5 lbs

Calc of Volume of Bubble from Data @ 1510 - 1650 sec, 4/1/79

	Time t_1	Time t_2
RCS Pressure	955 psia ✓	1065 psia ✓
Temp	280.9°F ✓	281.3°F ✓
PZR Level	216.8" ✓	208.3" ✓
Temp	545.9°F ✓	558.2°F ✓
MWT Level	53.3" ✓	50.6" ✓
Temp	75°F ✓	74°F ✓

① $\frac{P_2}{P_1 - P_2} = \frac{1055}{955 - 1065} = -\frac{1065}{110} = -9.682$ ✓

② $C_{vol}\left(\frac{\gamma_{f_2}^{RCS}}{\gamma_{f_2}^{PZR}} L_2^{PZR} - \frac{\gamma_{f_1}^{RCS}}{\gamma_{f_1}^{PZR}} L_1^{PZR}\right) = 3.178\left(\frac{.01720}{.03203}(208.3) - \frac{.01721}{.02163}(216.8)\right) = -31.122$ ✓

③ $C_{vol}\left(\frac{\gamma_2^{RCS}}{\gamma_2^{MWT}}\right)\left(L_2^{MWT} - L_1^{MWT}\right) = 4.128\left(\frac{.01721}{.01606}\right)(50.6 - 53.3) = -11.974$ ✓

④ $M_{RCS}\left(\frac{\partial v^{RCS}}{\partial T^{RCS}}\right)\left(T_2^{RCS} - T_1^{RCS}\right) = (5.145 \times 10^5)(9 \times 10^{-6})(281.3 - 280.9) = 2.220$ ✓

⑤ $M_{RCS}\left(\frac{\partial v^{RCS}}{\partial P^{RCS}}\right)\left(P_2 - P_1\right) = (5.156 \times 10^5)(-1.3 \times 10^{-7})(1065 - 955) = -6.783$ ✓

⑥ $M_{RCS}\left(\frac{\partial S}{\partial P}\right)\left(P_2 - P_1\right) = (5.116 \times 10^5)(5.339 \times 10^{-7})(1065 - 955) = 39.604$ ✓

$$V = \textcircled{1}\left[\textcircled{2} + \textcircled{3} - \textcircled{4} - \textcircled{5} + \textcircled{6}\right]$$

$$V = (-9.682)\left[(-31.122) + (-11.974) - (2.220) - (-6.783) + (39.604)\right]$$

$$V = (-9.682)\left[-31.122 - 11.974 - 2.220 + 6.783 + 39.604\right]$$

$$V = -10.660$$

Babcock & Wilcox

Calc. of Volume of Bubble from Data @ 2200 hrs, 3/28/79:

	Time t_1	Time t_2
RCS Pressure	955	1046
Temp	278.2°F	277.2°F
PZR Level	196"	192.2"
Temp	595.6°F	556.6°F
MUT Level	49.5"	33"
Temp	81°F	81°F

1) $\frac{P_2}{P_1 - P_2} = \frac{1046}{955 - 1046} = \frac{1046}{91} = -11.495$

2) $C_{comp}\left(\frac{V_{f_1}^{RCS}}{V_{f_1}^{PZR}} L_2^{PZR} - \frac{V_{f_1}^{RCS}}{V_{f_1}^{PZR}} L_1^{PZR}\right) = -3.173\left(\frac{.01719}{.02162}(192.2) - \frac{.01718}{.02196}(196)\right) = 1.65$

3) $C_{comp}\left(\frac{V_{f_1}^{RCS}}{V_{f_1}^{MUT}}\right)\left(L_2^{MUT} - L_1^{MUT}\right) = 4.128\left(\frac{.01718}{.01607}\right)\left(33 - 49.5\right) = -72.817$

4) $M_{RCS}\left(\frac{\partial V^{RCS}}{\partial T^{RCS}}\right)\left(T_2^{RCS} - T_1^{RCS}\right) = (6.166 \times 10^5)(9 \times 10^{-4})(277.2 - 278.2) = -2.775$

5) $M_{RCS}\left(\frac{\partial V^{RCS}}{\partial P^{RCS}}\right)\left(P_2 - P_1\right) = (6.166 \times 10^5)(-10^{-7})(955 - 1046) = -5.611$

6) $M_{RCS}\left(\frac{\partial S}{\partial P}\right)(P_2 - P_1) = (6.166 \times 10^5)(5.839 \times 10^{-7})(955 - 1046) = +32.763$

$$V = ① [② + ③ - ④ - ⑤ + ⑥]$$

$$V = (-11.495)\left[\left(\frac{-1.65}{-12.577}\right) + (-72.817) - (2.775) - (-5.611) + (+32.763)\right]$$

$$V = (-11.495)\left[-12.577 - 72.817 + 2.775 + 5.611 + 32.763\right]$$

$$V = (-11.495)\left[\frac{-32.327}{-49.067}\right] = \frac{533.}{564.52} \text{ ft}^3$$

0425 @ 4/1/79

		t_1	t_2
RCS	P	957	1055
	Temp	280	279.4
PZR	Level	195.1	192.7
	Temp	545.7	557.9
MUT	Level	53.3	39.6
	Temp	72	70

① $\frac{P_2}{P_1 - P_2} = \frac{1055}{957 - 1055} = -10.765$ ✓ ✓

② $C_{PZR}\left(\frac{v_{f_2}^{RCS}}{v_{f_2}^{PZR}} L_2^{PZR} - \frac{v_{f_1}^{RCS}}{v_{f_1}^{PZR}} L_1^{PZR}\right) = 3.178\left(\frac{.01719}{.02280}(195.1) - \frac{.01720}{.02163}(192.7)\right) = -14.53$

③ $C_{MUT}\left(\frac{v_f^{RCS}}{v_f^{MUT}}\right)\left(L_2^{MUT} - L_1^{MUT}\right) = 4.128\left(\frac{.01720}{.01605 2}\right)(39.5 - 53.3) = -60.578$

④ $M_{RCS}\left(\frac{\partial v}{\partial T}\right)^{RCS}\left(T_2^{RCS} - T_1^{RCS}\right) = 6.164 \times 10^5 (9 \times 10^{-4})(279.4 - 280) = -3.33$

⑤ $M_{RCS}\left(\frac{\partial v}{\partial P}\right)^{RCS}\left(P_2 - P_1\right) = 6.164 \times 10^5 (-10^{-7})(1055 - 957) = -6.043$ ~~-37.26~~

⑥ $M_{RCS}\left(\frac{\partial S}{\partial P}\right)\left(P_2 - P_1\right) = 6.164 \times 10^5 (5.839 \times 10^{-7})(1055 - 957) = 35.28$ ~~217.56~~

$V = ① [② + ③ - ④ - ⑤ + ⑥] = (-10.765)[-0.742] = 328.4 ft^3$

-30.425

.01721 .01720

0830 4/1

RCS temp 280.5 $v_{f2}^{RCS} = .01720$ ft³/lb

press 1050 P_2

$P_2 = 1050$ v_2^{RCS} .01720

$P_1 = 945$ v_1^{RCS} .01721

T_2

T_1

pressurizer

T_1 544.6 $v_{f1}^{PZR} = .02159$ L_1^{PZR} 201.2

T_2 557.1 $v_{f2}^{PZR} = .02198$ L_2^{PZR} 192.6

makeup tank

L_1^{MT} 50.7

T 76.5 $v_f^{MT} = .016064$

L_2^{MT} 45.3

(1) $\dfrac{P_2}{P_1 - P_2} = \dfrac{1050}{945-1050} = -10.0$

(2) $C_{PZR}\left(\dfrac{v_{f2}^{RCS}}{v_{f2}^{PZR}} L_2^{PZR} - \dfrac{v_{f1}^{RCS}}{v_{f1}^{PZR}} L_1^{PZR}\right) = 3.173\left(\dfrac{.01720}{.02198}(192.6) - \dfrac{.01720}{.02159}(201.2)\right) = -30.47$ ~~-32.4~~

(3) $C_{MT}\left(\dfrac{v_f^{RCS}}{v_f^{MT}}\right)\left(L_2^{MT} - L_1^{MT}\right) = 4.128\left(\dfrac{.01720}{.016064}\right)\left(45.3 - 50.7\right) = -23.868$

(4) $M_{RCS}\left(\dfrac{\gamma v^{RCS}}{\gamma T^{RCS}}\right)\left(T_2^{RCS} - T_1^{RCS}\right) = (6.166 \times 10^5)(9 \times 10^{-6})(280.5 - 280.5) = 0$

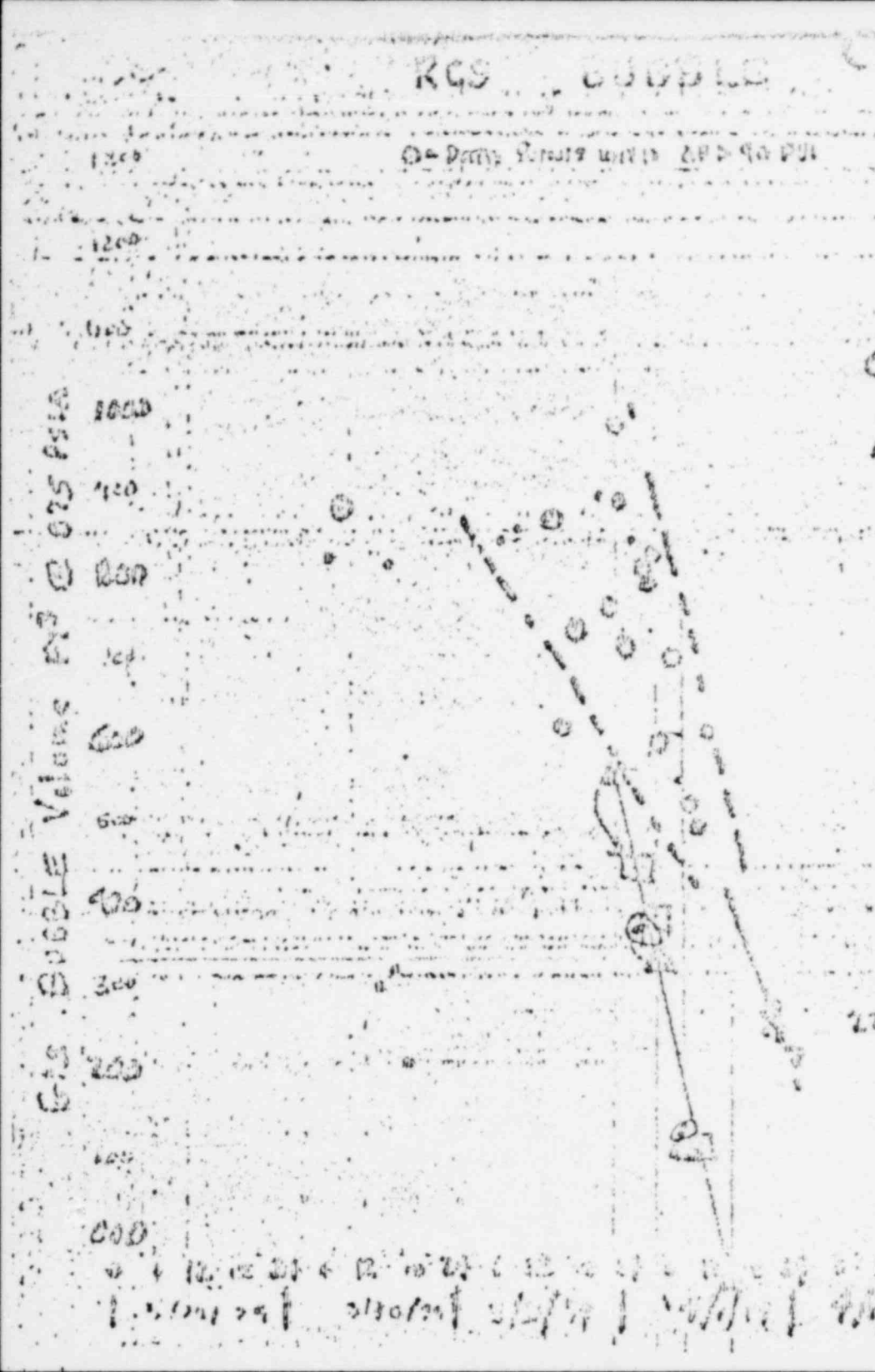
(5) $M_{RCS}\left(\dfrac{\gamma v^{RCS}}{\gamma P^{RCS}}\right)\left(P_2 - P_1\right) = (6.166 \times 10^5)(-10^{-7})(1050 - 945) = -6.474$

(6) $M_{RCS}\left(\dfrac{\gamma S}{\gamma P}\right)\left(P_2 - P_1\right) = (6.166 \times 10^5)(5.839 \times 10^{-7})(1050 - 945) =$ ~~38.151~~ 37.497 ~~37.497~~ 37.80

$v = (1)\left[(2) + (3) - (4) - (5) + (6)\right]$

$V = -10\left[-32.426 + (-23.868) - 0 - (-6.474) + \text{~~38.151~~ } 37.497\right]$

$V = -10\left[-9.369\right] =$ ~~93.69~~ 103.23 ft³



(118)

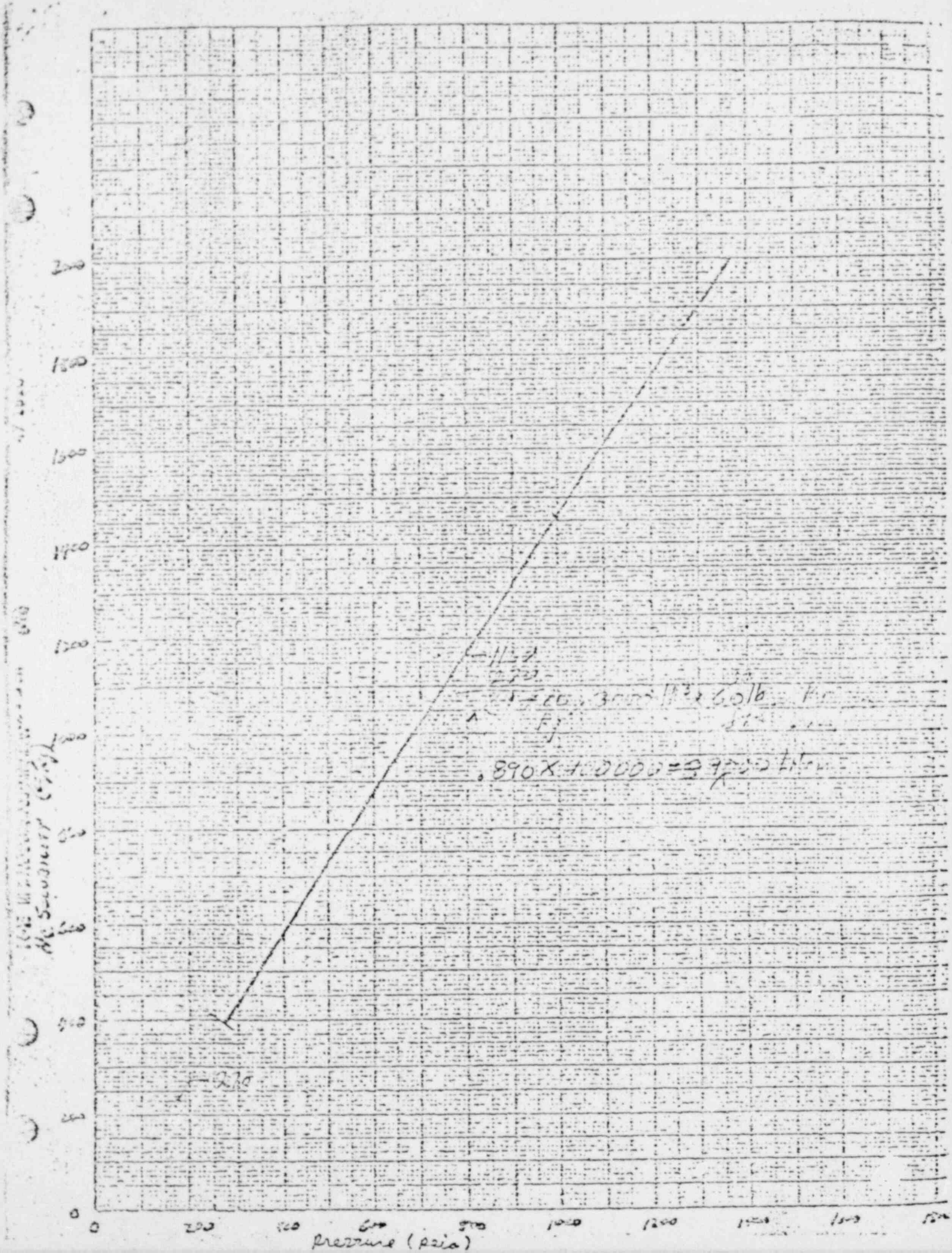
Received 4/1/74

CAN WE ACTUALLY REMOVE THIS FROM SYSTEM AT THIS RATE?

12.4

224.5 @ 1120

Δ B+W Recalculated Data


Pressure (psia)

Rate of Change of Solubility as a Function of Pressure

$T = 280°F = 137.8°C$

Conc (cc/kg)	Conc (scf/lb)	Conc (cc/lb)*	Press Atm	Press (P
400	6.41×10^{-3}	1.54×10^{-4}	13.6	273
600	9.64×10^{-3}	2.39×10^{-4}	21.9	410
800	—	3.15×10^{-4}	37.2	547
1000	—	3.98×10^{-4}	46.5	684
1200	—	4.78×10^{-4}	55.8	820
1400	—	5.57×10^{-4}	65.1	957
1500				
1600	—	6.37×10^{-4}	74.4	1094
1800	—	7.16×10^{-4}	83.7	1230
2000	0.032	7.96×10^{-4}	93.0	(367

$$\text{Conc}\left(\frac{scf}{lb}\right) = \text{Conc}\left(\frac{cc}{kg}\right) \times \frac{0.1604\ ft^3/lb}{28{,}317\ cc/ft^3}$$

$$\text{Conc}\left(\frac{cc}{lb}\right) = \text{Conc}\left(\frac{cc}{kg}\right) \times \frac{0.4536\ kg/lb}{28{,}317\ cc/ft^3} \times \frac{14.7\ psia}{820\ psia} \times \frac{T_2}{T_1}$$

$$-\frac{dc}{dP} \simeq -\left(\frac{C_2 - C_1}{P_2 - P_1}\right) = -\left(\frac{5.57 \times 10^{-4} - 4.78 \times 10^{-4}}{957 - 820}\right) = -5.765 \times 10^{-9}\ \left(\frac{cc/lb}{psi}\right)$$

* Reference Conditions 875 psia & 280°F

TMI-2 RCS BUBBLE CALC SHEET   TIME 2355

Jim Moore   DATA TAKEN BY: [illegible]

RC PRESSURE (393)

P_1 = ____ PSIG = 959 PSIA

P_2 = ____ PSIG = 1057 PSIA

ΔP = 99 PSI

RCS TEMP

T_1 = 278.4 °F

T_2 = 279.6 °F

PRESSURIZER LEVEL (1482)

L_1 = 197.0 inches

L_2 = 137.6 inches

ΔL = 60 inches

PRESSURIZER TEMP (405)

T_1 = 546.5 °F

T_2 = 557.4 °F

MAKEUP TANK LEVEL (343)

L_1 = 52 inches

L_2 = 40.5 inches

ΔL = 11.5 inches

MAKEUP TANK TEMP

T_1 = 81 °F

T_2 = 79 °F

$\Delta V_{PZR} = \Delta L \times 2.515$ = 50 × 2.515 = [illegible] ft³

$\Delta V_{MUT} = \Delta L \times 4.2??$ = 11.5 × 4.2?? = 49.5 ft³

ΔV_{TOTAL} = 11.38 ft³

$V_1 = \frac{P_2 \Delta V}{P_2 - P_1}$ = (1057 × 11.38) / (99) = 155.34 ft³ @ P_1

$V_{(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right)$ = ~~[illegible]~~ 1??.5 ft³ @ 875 psia

2353 Repressurization
0018 Time 25 min
[illegible] 2353
[illegible] 2018

[illegible]

TMI-2 RCS BUBBLE CALC SHEET

TIME — (6-25 0425 PM)

DATA TAKEN BY: GTF

RC PRESSURE (592)

P_1 = ______ PSIG = 957 PSIA

P_2 = ______ PSIG = 1055 PSIA

ΔP = 98 PSI

RCS TEMP (504)

T_1 = 280 °F

T_2 = 279.4 °F

PRESSURIZER LEVEL (1692)

L_1 = 195.1 INCHES

L_2 = 192.7 INCHES

ΔL = 2.4 INCHES

PRESSURIZER TEMP (405)

T_1 = 545.7 °F

T_2 = 557.9 °F

MAKEUP TANK LEVEL (342)

L_1 = 52.3 INCHES

L_2 = 37.6 INCHES

ΔL = 13.7 INCHES

MAKEUP TANK TEMP (SOURCE)

T_1 = 72 °F

T_2 = 70 °F

ΔV_{PZR} = ΔL x 2.515 = 2.4 x 2.515 = 6.04 FT³

ΔV_{MUT} = ΔL x 4.24 = 13.7 x 4.24 = 58 FT³

ΔV_{TOTAL} = 64.2 FT³

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1055 \times \quad)}{(98)} = 690.9 \text{ FT}^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 835.1 \text{ FT}^3 @ 875 \text{ PSIA}$$

S 0403

S 0435

Repressurization Time
Start 0403 Stop 0435
Δt = 32

TMI-2 RCS Bubble Calc Sheet

Time 0925/0935 hrs

Data Taken By: [illegible]

RC Pressure (343)

P_1 = ____ PSIG = 945 PSIA

P_2 = ____ PSIG = 1050 PSIA

ΔP = 105 PSI

RCS Temp (3??)

T_1 = 280.5 °F

T_2 = 280.5 °F

Pressurizer Level (1682)

L_1 = 201.3 inches

L_2 = 193.6 inches

ΔL = 8.? inches

Pressurizer Temp (405)

T_1 = 544.6 °F

T_2 = 557.? °F

Makeup Tank Level (347)

L_1 = 50.7 inches

L_2 = 45.3 inches

ΔL = 5.4 inches

Makeup Tank Temp (Senior Reactor Operator)

T_1 = 78.? °F

T_2 = 78 °F

ΔV_{PZR} = ΔL × 2.515 = 8.? × 2.515 = 21.13 ft³

ΔV_{MUT} = ΔL × 5.24 = 5.4 × 4.?? = 2?.?? ft³

ΔV_{NET} = 44.5 ft³

$$V_1 = \frac{P_2 \Delta V_{NET}}{P_2 - P_1} = \frac{(1050)(44.5)}{(105)} = 445.5 \text{ ft}^3 @ P_1$$

$$V_{1(275)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{275}\right) = \text{~~445.5~~ } 5?46 \text{ ft}^3 @ 275 \text{ psia}$$

TMI-2 RCS Bubble Calc Sheet

Date 4-1-(?)
Time 1510-1550 pm

Data Taken By: [illegible]

RC Pressure (338)

P_1 = ______ psig = 955 psia

P_2 = ______ psig = 1065 psia

ΔP = 110 psi

RCS Temp

T_1 = 280.9 °F

T_2 = 284.3 °F

Pressurizer Level (1682)

L_1 = 216.8 inches

L_2 = 208.3 inches

ΔL = -8.5 inches

Pressurizer Temp (455)

T_1 = 545.7 °F

T_2 = 558.2 °F

Makeup Tank Level (347)

L_1 = 53.3 inches

L_2 = 50.6 inches

ΔL = -2.7 inches

Makeup Tank Temp

T_1 = [illegible] °F

T_2 = [illegible] °F

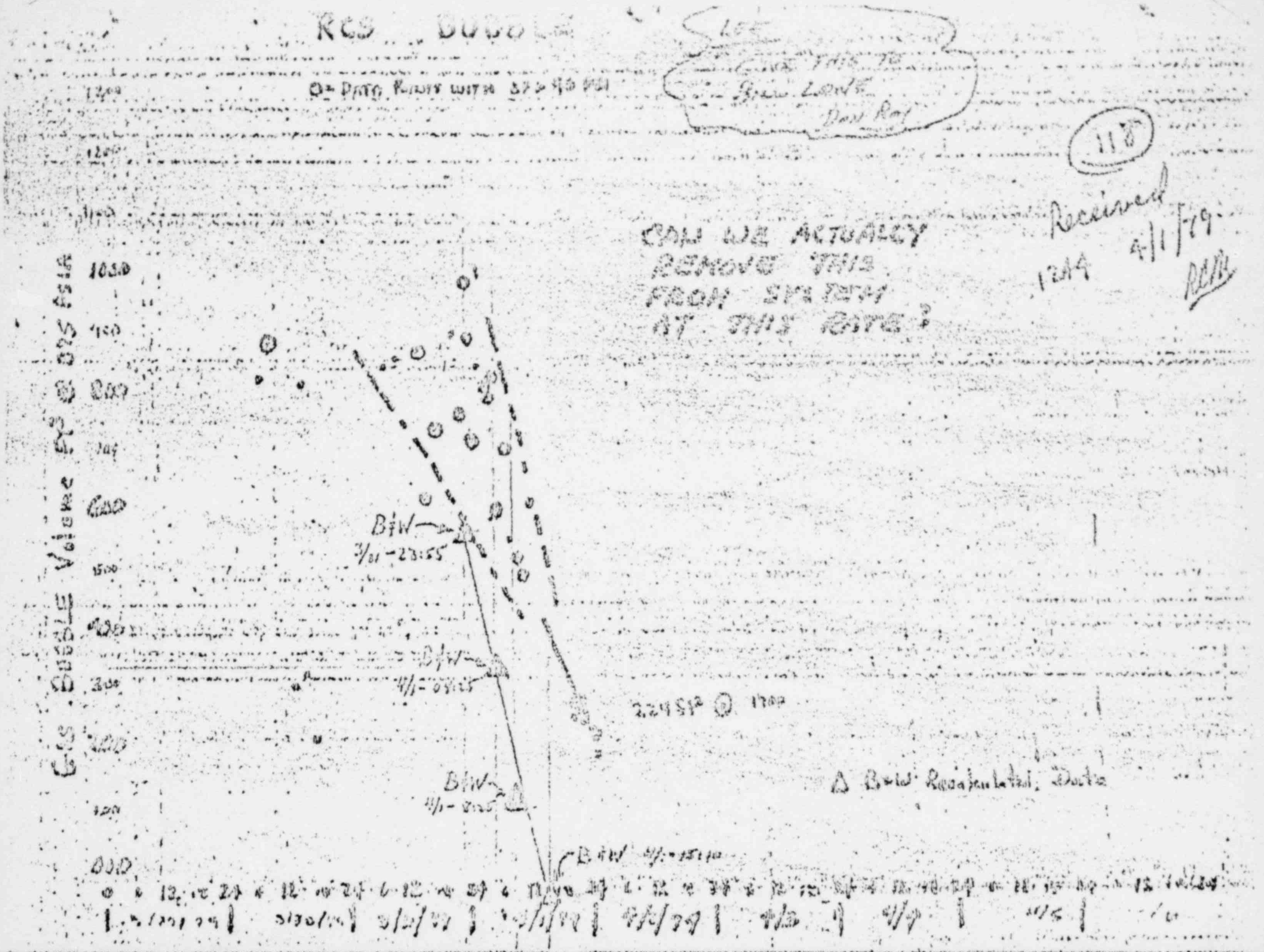
$\Delta V_{PZR} = \Delta L \times 2.515$ = 8.5 × 2.515 = 21.38 ft³

$\Delta V_{MUT} = \Delta L \times 4.24$ = 2.7 × 4.24 = 11.46 ft³

ΔV_{total} = 32.84 ft³

$$V_1 = \frac{P_2 \Delta V_T}{P_2 - P_1} = \frac{(1065)(32.84)}{(110)} = 317 \text{ ft}^3 @ P_1$$

$$V_1(875) = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 347 \text{ ft}^3 @ 875 \text{ psia}$$


RCS BUBBLE
O = DATA POINTS WITH 875 → 950 PSI
GIVE THIS TO
Gene Lowe
Dan Ray
118
Received 4/1/79
1244
RCM
CAN WE ACTUALLY
REMOVE THIS
FROM SYSTEM
AT THIS RATE?
Bubble Volume ft³ @ 875 psia
B&W — 3/31 - 23:55
B&W — 4/1 - 05:25
B&W — 4/1 - 08:25
B&W 4/1 - 15:10
2245P @ 1300
Δ B&W Recalculated Data
3/30/79
3/31/79
4/1/79
4/2/79
4/3
4/4
4/5

MEMO from:

G. P. MILLER

BUBBLE SIZE 4-2-79

211 FT.^{3} @ 2:15 AM

205 FT.^{3} @ 3:15 AM

130 FT.^{3} @ 5:00 AM

Babcock & Wilcox

D. A. NITTI
4/1/79

Volume of Bubble Calculation

Adjust to approximately 1875 psia.

$$V_{Bubble} = \frac{P_2}{P_1 - P_2}\left[C_{PZR}\left(\frac{\nu_f}{\nu_{f_2}^{PZR}} L_2^{PZR} - \frac{\nu_f^{RCS}}{\nu_{f_1}^{PZR}} L_1^{PZR}\right) + C_{MUT}\left(\frac{\nu_f}{\nu_f^{MUT}}\right)\left(L_2^{MUT} - L_1^{MUT}\right) - M_{RCS}\left(\frac{\partial \nu^{RCS}}{\partial T^{RCS}}\right)\left(T_2^{RCS} - T_1^{RCS}\right) - M_{RCS}\left(\frac{\partial \nu^{RCS}}{\partial P^{RCS}}\right)\left(P_2 - P_1\right) + M_{RCS}\left(\frac{\partial S}{\partial P}\right)\left(P_2 - P_1\right)\right]$$

P_2 = RC Sys Press After Change

P_1 = RC Sys Press Before Change

C_{PZR} = Level to Volume Conversion for PZR = 3.178 ft³/in

C_{MUT} = " " " " " MUT = 4.128 ft³/in

ν_f^{RCS} = Specific Volume of water at RCS temp, superheated steam tables

$\nu_{f_2}^{PZR}$ = " " " " " PZR " after change, saturated steam tables

$\nu_{f_1}^{PZR}$ = " " " " " " " " before " , " " "

ν_f^{MUT} = " " " " " " MUT " , saturated steam tables

L_2^{PZR} = Level in pressurizer after change, inches

L_1^{PZR} = " " " before " , "

L_2^{MUT} = " " makeup tank after change, inches

L_1^{MUT} = " " " " before " , "

$\frac{\partial \nu^{RCS}}{\partial T^{RCS}}$ = change in RCS specific vol. per °F = 9 x 10⁻⁵ ft³/lbm-°F

$\frac{\partial \nu^{RCS}}{\partial P^{RCS}}$ = Change in RCS specific volume per pound pressure = -1 x 10⁻⁷ ft³/lbm-psi

$\frac{\partial S}{\partial P}$ = Change in solubility of H_2 per pound pressure = 5.839 x 10⁻⁷ ft³/lbm-psi

M_{RCS} = Mass of RCS = 5.166 x 10⁺⁵ lbs

R25-0001

O = DATA POINTS WITH ΔP > 90 PSI

⊕ = DATA TAKEN WITH DECREASING PRESSURE.

RCS BUBBLE

O = DATA TAKEN WITH $\Delta P > 40$ PSI

ϕ = DATA TAKEN WITH DECREASING PRESSURE.

4/2/79 OSC
Patrick 15.4

Make Up Tank Makeup Data from Operators Log

3/28	3/29	3/30	3/31	4/1	4/2
1720 Dust @ 26½'	Dust 20.5' @ 0615	0100 371	0033 300	0125 460	0150 -455
1900 Dust @ 24'		0115 300	0315 Started degas pmp	0445 450	0360 455
1820 23'		1502 462	0445 150	1041 301	0445 455
1847 22'		1719 200	0547 150	1200 446	0630 455
1953 22'		1853 Start filling Dust Level @ 15.5'	0705 150	1306 400	0723 455
		2036 300	0737 Stopped Degas	1508 456	0853 455
		2307 190	0830 546	1650 505	1310 436
		2347 300	1042 150	1805 456	1458 671
		2310 Started per Vent	1120 900	1900 455	1658 455
		2353 Start per Survey	1427 303	2145 454	1828 455
		Total Makeup 2123	1530 413	2118 454	
			1543 100	2225 455	
			1705 370	0112 470	
			1920 370	0127 470	
			2000 470	0325 470	
			2120 450	0435 470	
			2228 470	0645 470	
			2330 470		
			Total 5762	Total 8553	

16438

From Alarm Data on day of accident — One RB Sump Pump on (3) for 31 min
Other " " " " for 28 min

4/1/79
Sem

AVG MAKEUP FLOW TO MAKEUP TANK

Calculate Average rate of makeup to Makeup Tank for comparison with the Calculated rate of decrease in bubble size. The first data is for makeup is from 0730 to 0825. This is for the depressurization half of the cycle. The pressurization half of this cycle started at about 0700. Therfore the rate will be Calculated on the basis of Time = 0 @ 0700.

Date	Time of Make-up To MU Tk	Gal Added (× 1/7.481)	Ft³ Added at 70°F (× 1.075)	Ft³ Added at 280°F	Total Ft³/Added	Total Time (HR) from 0700 4/1/79	Makeup Rate Ft³/HR @ 280°F
4/1/79	0730-0825	460	61.5	66	66	1.42	46
	0903-0945	400	53.47	57.5	123.5	2.75	44.9
	1020-1041	301	40.24	43.25	166.8	3.68	45.3
	1140-1200	446	59.62	64.1	230.9	5.00	46.2
	1238-1306	400	57.46	61.8	292.7	6:10	48.0
	-1506	456	60.95	65.52	358.2	8.10	44.2 ~~25.47~~
	1650	505	67.5	72.567	430.8	9.83	43.83
	505	456	60.95	65.52	496.3	11.01	45.08
	1900	455	60.82	65.38	561.68	12.40	46.8
	2015	454	60.69	65.24	626.92	13.25	47.31
	2120	455	60.82	65.38	692.3	14.33	
	2225	455	60.82	65.38	757.68	15.41	
	2347	455	60.82	65.38	823.06	16.77	
	~~0151~~						

- See Next page

0150 455

0300 455

0445 455

0630 455

0723 455

0853 455

4/1/79 4/2
2347 → 0853 Avg = 30.9

Ft3 @ 875' joint

			ΔP	
3/29	1300	1839.3	95	DATA FROM J. FLOYD – SOURCES UNKNOWN
3/30	0625	* 828.6	16	MU TK Δ LEVEL – BELIEVED TO BE ZERO IN.
	0730	892.5	115	
	1240	* 358	32	
	1445	839	42	
	1630	* 365.6	17	
	1745	* 224.6	25	
	1907	* 1806.0	38	
	0630	850	55	
3/31	1032	859.5	47	
	1351	879.4	92	

~~1351~~

TLC

493 - 544

DATE 4/3/79

TMI-2 RCS BUBBLE CALC SHEET

TIME 1604 - 1634 AM PM

DATA TAKEN BY: TSC

RC PRESSURE (398)

P_1 = _____ PSIG = 949 PSIA

P_2 = _____ PSIG = 1050 PSIA

ΔP = 101 PSI

RCS TEMP (394)

T_1 = 280.2 °F

T_2 = 290.7 °F

PRESSURIZER LEVEL (1682)

L_1 = 193.5 INCHES

L_2 = 186.7 INCHES

ΔL = -3.2 INCHES

PRESSURIZER TEMP (~~385~~ 351)

T_1 = 546.2 °F

T_2 = 557.4 °F

MAKEUP TANK LEVEL (347)

L_1 = 45.0 INCHES

L_2 = 41.4 INCHES

ΔL = 3.6 INCITES

MAKEUP TANK TEMP (CONTROL BOARD METER)

T_1 = 74 °F

T_2 = 74 °F

$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ -3.2 × 2.515 = -8.05 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ 3.6 × 4.244 = 15.28 FT^3

ΔV_{TOTAL} = 7.23 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1050 \times 7.23)}{(101)} = 75.2 \ FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 81.5 \ FT^3 @ 875 \text{ PSIA}$$

DATE 4/3/79

TMI-2 RCS BUBBLE CALC SHEET

TIME 1525 AM PM

DATA TAKEN BY: PSL

RC PRESSURE (398)

P_1 = _____ PSIG = 958 PSIA

P_2 = _____ PSIG = 1056 PSIA

ΔP = 98 PSI

RCS TEMP (394)

T_1 = 277.6 °F v_f = .01722

T_2 = 280.0 °F v_f = .017246

$v_{1\&2}$ = .017264

Δv = 1.8×10^{-5} ft^3/lb

PRESSURIZER LEVEL (1682)

L_1 = 182.3 INCHES

L_2 = 187.5 INCHES

ΔL = -5.2 INCHES

PRESSURIZER TEMP (~~413~~ 384)

T_1 = 547.7 °F

T_2 = 554.6 °F

MAKEUP TANK LEVEL (347)

L_1 = 50.2 INCHES

L_2 = 47.4 INCHES

ΔL = 2.8 INCHES

MAKEUP TANK TEMP (CONTROL BOARD METER)

T_1 = 75 °F

T_2 = 75 °F

$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ -5.2 × 2.515 = -13.07 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ 2.8 × 4.244 = 11.88 FT^3

ΔV_{TOTAL} = -1.19 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1056)(-1.19)}{(98)} = -12.8 \text{ } FT^3 @ P_1$$

$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right)$ = -14.0 FT^3 @ 875 PSIG

Babcock & Wilcox

TMI-2 RC GAS BUBBLE CALCS

D. Moore
3/31/79

$$V_1 = \frac{P_2\left[a\,(L_2-L_1)_A + b\,(L_2-L_1)_B\right]}{P_1 - P_2}$$

P = RC System Pressure – Computer point 398

L_A = Pressurizer Level – " " 1682

L_B = Makeup Tank Level – " " 347

Subscripts

1 – Initial Data Point
2 – Final Data Point
A – Pressurizer
B – Makeup Tank

To Convert P2R ΔV to equivalent ΔV at RC Temp.

$$a = \left(3.2\ \frac{ft^3}{IN}\right)\left(\frac{0.0173}{0.0122}\right) = 2.515$$

where v_f for RC TEMP = 0.0173
v_f for PRESSURIZER TEMP = 0.0163

To Convert MUTK ΔV to equivalent ΔV at RC TEMP

$$b = \left(4\ \frac{ft^3}{IN}\right)\left(\frac{0.0173}{0.0163}\right) = 4.244$$

where v_f for RC Temp = 0.0173
v_f for Makeup Tank Temp = 0.0163

DATE 4/3/79

TMI-2 RCS BUBBLE CALC SHEET

TIME 56:20 - 645 (AM/PM)

DATA TAKEN BY: JHL

RC PRESSURE (398)

P_1 = 962 PSIG = 977 PSIA

P_2 = 1035 PSIG = 1050 PSIA

ΔP = 73 PSI

RCS TEMP (394)

T_1 = 280.1 °F

T_2 = 280.2 °F

PRESSURIZER LEVEL (1682)

L_1 = 201.3 INCHES

L_2 = 205.2 INCHES

ΔL = -3.9 INCHES

PRESSURIZER TEMP (~~405~~ 355)

T_1 = 547.4 °F

T_2 = 556.6 °F

MAKEUP TANK LEVEL (347)

L_1 = 52.5 INCHES

L_2 = 47.8 INCHES

ΔL = 4.7 INCHES

MAKEUP TANK TEMP (CONTROL BOARD METER)

T_1 = 70 °F

T_2 = 70 °F

$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ 3.9 × 2.515 = -9.8 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ 4.7 × 4.244 = 19.9 FT^3

ΔV_{TOTAL} = 10.14 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1050 \times 10.14)}{(73)} = 145.8 \text{ } FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_{1977}}{875}\right) = 162.8 \text{ } FT^3 @ 875 \text{ PSIG}$$

DATE 4/13/79

TMI-2 RCS BUBBLE CALC SHEET

TIME 5:37 – 6:02 (AM) PM

DATA TAKEN BY: Joel

RC PRESSURE (398)

P_1 = 960 PSIG = 975 PSIA

P_2 = 1061 PSIG = 1076 PSIA

ΔP = 101 PSI

RCS TEMP (394)

T_1 = 280.0 °F

T_2 = 280.1 °F

PRESSURIZER LEVEL (1682)

L_1 = 201.8 INCHES

L_2 = 205.9 INCHES

ΔL = -4.1 INCHES

PRESSURIZER TEMP (389 ~~405~~)

T_1 = 548.0 °F

T_2 = 558.1 °F

MAKEUP TANK LEVEL (347)

L_1 = 45.4 INCHES

L_2 = 41.2 INCHES

ΔL = 4.2 INCHES

MAKEUP TANK TEMP (CONTROL BOARD METER)

T_1 = 68 °F

T_2 = 68 °F

$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ -4.1 × 2.515 = -10.31 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ 4.2 × 4.244 = 17.82 FT^3

ΔV_{TOTAL} = 7.513 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1076 \times 7.513)}{(101)} = 80.04 \text{ } FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 89.19 \text{ } FT^3 @ 875 \text{ PSIA}$$

DATE 4/3/79

TMI-2 RCS BUBBLE CALC SHEET

TIME 4:53 – 5:23 AM PM

DATA TAKEN BY: JT

RC PRESSURE (398)

P_1 = 941 PSIG = 956 PSIA

P_2 = 1055 PSIG = 1070 PSIA

ΔP = 114 PSI

RCS TEMP (394)

T_1 = 279.7 °F

T_2 = 240.0 °F

PRESSURIZER LEVEL (1682)

L_1 = 201.5 INCHES

L_2 = 206.7 INCHES

ΔL = -5.2 INCHES

PRESSURIZER TEMP (389 / 405)

T_1 = 546.2 °F

T_2 = 558.8 °F

MAKEUP TANK LEVEL (347)

L_1 = 53.8 INCHES

L_2 = 48.0 INCHES

ΔL = 5.8 INCHES

MAKEUP TANK TEMP (CONTROL BOARD METER)

T_1 = 69 °F

T_2 = 69 °F

$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ -5.2 × 2.515 = -13.08 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ 5.8 × 4.244 = 24.61 FT^3

ΔV_{TOTAL} = 11.53 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1070 \times 11.53)}{(114)} = 10825 \text{ FT}^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 11813 \text{ FT}^3 @ 875 \text{ PSIG}$$

DATE 4/2/79

TMI-2 RCS BUBBLE CALC SHEET

TIME 2025 AM PM

DATA TAKEN BY: PSL

RC PRESSURE (398)

P_1 = _____ PSIG = 964 PSIA

P_2 = _____ PSIG = 1062 PSIA

ΔP = 98 PSI

RCS TEMP (394)

T_1 = 275.8 °F

T_2 = 275.9 °F

PRESSURIZER LEVEL (1682)

L_1 = 204.0 INCHES

L_2 = 202.7 INCHES

ΔL = 1.3 INCHES

PRESSURIZER TEMP (405)

T_1 = 546.8 °F

T_2 = 559.1 °F

MAKEUP TANK LEVEL (347)

L_1 = 52.8 INCHES

L_2 = 49.2 INCHES

ΔL = 3.6 INCITES

MAKEUP TANK TEMP (CONTROL BOARD METER)

T_1 = 72 °F

T_2 = 72 °F

$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ 1.3 × 2.515 = 3.30 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ 3.6 × 4.244 = 15.28 FT^3

ΔV_{TOTAL} = 18.5 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1062 \times 18.5)}{(98)} = 201.0 \text{ } FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 22.5 \text{ } FT^3 @ 875 \text{ PSIG}$$

TMI-2 RCS Bubble Calc Sheet

DATE 4/2/79

TIME 1803 AM PM

DATA TAKEN BY: PSL

RC PRESSURE (398)

P_1 = ____ PSIG = 976 PSIA

P_2 = ____ PSIG = 1063 PSIA

ΔP = 87 PSI

RCS TEMP (394)

T_1 = 275.9 °F

T_2 = 275.5 °F

PRESSURIZER LEVEL (1682)

L_1 = 201.9 INCHES

L_2 = 202.8 INCHES

ΔL = -.9 INCHES

PRESSURIZER TEMP (389 / 405)

T_1 = 553.1 °F

T_2 = 559.5 °F

MAKEUP TANK LEVEL (347)

L_1 = 41.5 INCHES

L_2 = 38.4 INCHES

ΔL = 3.1 INCITES

MAKEUP TANK TEMP (CONTROL BOARD METER)

T_1 = 72 °F

T_2 = 72 °F

$\Delta V_{RC} = \Delta L \cdot 2.515 =$ -.9 × 2.515 = -2.26 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ 3.1 × 4.244 = 13.16 FT^3

ΔV_{TOTAL} = 10.9 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1063 \times 10.9)}{(87)} = 133.1 \; FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 148.5 \; FT^3 @ 875 \text{ PSIG}$$

48 54
55 57
65 55
61

DATE 4/2

TIME 1600-1650 AM PM

TMI-2 RCS BUBBLE CALC SHEET

DATA TAKEN BY: PSW

RC PRESSURE (398)

P_1 = _____ PSIG = 960 PSIA

P_2 = _____ PSIG = 1045 PSIA

ΔP = 85 PSI

RCS TEMP (394)

T_1 = 277.6 °F

T_2 = 278.0 °F

PRESSURIZER LEVEL (1682)

L_1 = 209.5 INCHES

L_2 = 213.5 INCHES

ΔL = -4.0 INCHES

PRESSURIZER TEMP (405)

T_1 = 548.1 °F

T_2 = 557.1 °F

MAKEUP TANK LEVEL (347)

L_1 = 46.3 INCHES

L_2 = 43.1 INCHES

ΔL = 3.2 INCITES

MAKEUP TANK TEMP (CONTROL BOARD METER)

T_1 = 76 °F

T_2 = 76 °F

$\Delta V_{PZR} = \Delta L \cdot 2.515 = -4.0 \times 2.515 = 10.06$ FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 = 3.2 \times 4.244 = 13.58$ FT^3

$\Delta V_{TOTAL} = 3.52$ FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1045 \times 3.52)}{(85)} = 43.3 \text{ } FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 47.5 \text{ } FT^3 @ 875 \text{ PSIA}$$

TMI-2 RCS Bubble Calc Sheet

DATE 4/7/79

TIME 1515 PM

DATA TAKEN BY: [illegible]

RC Pressure (398)

P_1 = _____ PSIG = 942 PSIA

P_2 = _____ PSIG = 1063 PSIA

ΔP = 121 PSI

RCS Temp (394)

T_1 = 228.4 °F

T_2 = 228.5 °F

Pressurizer Level (1682)

L_1 = 206.4 INCHES

L_2 = 204.0 INCHES

ΔL = 2.4 INCHES

Pressurizer Temp (405)

T_1 = 545.1 °F

T_2 = 558 °F

Makeup Tank Level (347)

L_1 = 47.4 INCHES

L_2 = 44.5 INCHES

ΔL = 2.9 INCITES

Makeup Tank Temp (Control Board Meter)

T_1 = 78 °F

T_2 = 78 °F

$\Delta V_{PZR} = \Delta L \cdot 2.515 = 2.4 \times 2.515 = 6.04$ FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 = 2.9 \times 4.244 = 12.31$ FT^3

$\Delta V_{TOTAL} = 18.35$ FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1063 \times 18.35)}{(121)} = 161.2 \text{ } FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 173.5 \text{ } FT^3 @ 875 \text{ PSIA}$$

DATE 4/2/79

TIME 1225 - 1305 ~~1345 - 1425~~ AM PM

TMI-2 RCS BUBBLE CALC SHEET

DATA TAKEN BY: [illegible]

RC PRESSURE (398)

P_1 = _____ PSIG = 936 PSIA

P_2 = _____ PSIG = 1056 PSIA

ΔP = 120 PSI

RCS TEMP (394)

T_1 = 280.1 °F

T_2 = 280.1 °F

PRESSURIZER LEVEL (1682)

L_1 = 208.3 INCHES

L_2 = 207.6 INCHES

ΔL = ~~[illegible]~~ .7 INCHES

PRESSURIZER TEMP (~~405~~ 389)

T_1 = 547.5 °F

T_2 = 557.9 °F

MAKEUP TANK LEVEL (347)

L_1 = 45.5 INCHES

L_2 = 41.6 INCHES

ΔL = 3.9 INCITES

MAKEUP TANK TEMP (CONTROL BOARD METER)

T_1 = 74° °F

T_2 = 75 °F

$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ .7 $\times$ 2.515 = 1.76 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ 3.9 $\times$ 4.244 = 16.55 FT^3

ΔV_{TOTAL} = 18.3 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1056 \times 18.3)}{(120)} = 161.1 \text{ FT}^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 194.5 \text{ FT}^3 @ 875 \text{ PSIG}.$$

TMI-2 RCS BUBBLE CALC SHEET

DATE 4/2/79

TIME ~~0944~~ / 1208 AM PM

DATA TAKEN BY: JAF

RC PRESSURE (398)

P_1 = ____ PSIG = 942 PSIA

P_2 = ____ PSIG = 1036 PSIA

ΔP = 78 PSI

RCS TEMP (394)

T_1 = 280.1 °F

T_2 = 280.1 °F

PRESSURIZER LEVEL (1682)

*L_1 = 206.4 INCHES

L_2 = 211.3 INCHES

ΔL = .8 INCHES

PRESSURIZER TEMP (389 ~~385~~)

T_1 = 5~~1~~75.1 °F

T_2 = 558.00 °F

MAKEUP TANK LEVEL (347)

L_1 = 47.6 INCHES

L_2 = 45.8 INCHES

ΔL = 4.6 INCHES

MAKEUP TANK TEMP (CONTROL BOARD METER)

T_1 = 78° °F

T_2 = 76° °F

$\Delta V_{RC} = \Delta L \cdot 2.515 =$ .8 × 2.515 = 2.01 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ 4.6 × 4.244 = 19.52 FT^3

$\Delta V_{TOTAL} =$ ~~21.53~~ 17.5 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1036 \times (\text{~~21.53~~ } 17.5))}{(78)} = \text{~~285~~ } 175 \text{ } FT^3 @ P_1$$

L-7

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = \text{~~3356~~ } 208.17 \text{ } FT^3 @ 875 \text{ PSIA}$$

DATE / TIME 4/11/77 / 2205

Rc Pressure	1030 2250
Rc TEMP	277.1
PZR TEMP	350 550.
RCP RUNNING	1A
Rc make up Tank Level	49.8
letdown to. make up TK	2
S/GA level	35
S/GA press	30
S/GB level	94
S/GB press	24
Cond Vac.	24
Cont Temp	84-90
Cont press	-.9

Cont H2	2.37%
PZR level	201.8
Bubble size	198.5 (11:00p)

Plant status.

Keep 4 hrs

TMI-2 RCS Bubble Calc Sheet

DATE 4/2/79
TIME ~0850/0929 AM FM
DATA TAKEN BY:
TF

RC Pressure (398)

P_1 = 950 PSIG = 965 PSIA
P_2 = ____ PSIG = 1056 PSIA
ΔP = 106 PSI

RCS Temp (394)

T_1 = 279.9 °F
T_2 = 278.5 °F

Pressurizer Level (1682)

L_1 = 201.7 INCHES
L_2 = 202.9 INCHES
ΔL = + 1.2 INCHES

Pressurizer Temp (389 ~~405~~)

T_1 = 546.4 °F
T_2 = 558.1 °F

Makeup Tank Level (347)

L_1 = 47.9 INCHES
L_2 = 48.5 INCHES
ΔL = + 0.6 INCHES

Makeup Tank Temp (Control Board Meter)

T_1 = 75 °F
T_2 = 76 °F

$\Delta V_{RC} = \Delta L \cdot 2.515 =$ + 1.2 × 2.515 = 3.02 FT^3
$\Delta V_{MUT} = \Delta L \times 4.244 =$ + 0.6 × 4.244 = 2.55 FT^3
ΔV_{TOTAL} = 5.57 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1056 \times 5.57)}{(106)} = 55.49 \; FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 60 \; FT^3 @ 875 \text{ PSIG.}$$

Start 0850
Stop 0929

TMI-2 RCS BUBBLE CALC SHEET

DATE 4/2/79

TIME 7:40 AM PM

DATA TAKEN BY: [signature]

RC PRESSURE (398)

P_1 = 958 PSIG = 973 PSIA

P_2 = 1048 PSIG = 1063 PSIA

ΔP = 90 PSI

RCS TEMP (394)

T_1 = 279.4 °F

T_2 = ~~279.1~~ °F

PRESSURIZER LEVEL (1682)

L_1 = 201.9 INCHES

L_2 = 202.5 INCHES

ΔL = -.6 INCHES

PRESSURIZER TEMP (389 ~~405~~)

T_1 = 548.5 °F

T_2 = 548 °F

MAKEUP TANK LEVEL (347)

L_1 = 40.3 INCHES

L_2 = 53.1 INCHES

ΔL = 1.2 INCHES

MAKEUP TANK TEMP (CONTROL BOARD METER)

T_1 = 72 °F

T_2 = 72 °F

$\Delta V_{RCS} = \Delta L \cdot 2.515 =$ -.6 × 2.515 = 1.51 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ 1.2 × 4.244 = 5.09 FT^3

ΔV_{TOTAL} = 3.583 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1063 \times 3.583)}{(90)} = 42.3 \text{ } FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 47.07 \text{ } FT^3 @ 875 \text{ PSIA}$$

TMI-2 RCS BUBBLE CALC SHEET

DATE 4/2/79

TIME 6:50 AM/FM

DATA TAKEN BY: [signature]

RC PRESSURE (398)

P_1 = ~~777~~ 750 PSIG = 965 PSIA

P_2 = .1048 PSIG = 1063 PSIA

ΔP = 98 PSI

RCS TEMP (394)

T_1 = 277.8 °F

T_2 = 278.5 °F

PRESSURIZER LEVEL (1682)

L_1 = ~~206.1~~ 201.7 INCHES

L_2 = 202.9 INCHES

ΔL_{1-2} = -1.2 INCHES

PRESSURIZER TEMP (~~660~~ 389)

T_1 = 546 °F

T_2 = 558.5 °F

MAKEUP TANK LEVEL (347)

L_1 = ~~36~~ 49.8 INCHES

L_2 = 46.1 INCHES

ΔL_{1-2} = 3.7 INCHES

MAKEUP TANK TEMP (CONTROL BOARD METER)

T_1 = 71 °F

T_2 = 71 °F

$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ 1.2 × 2.515 = -3.02 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ 3.7 × 4.244 = 15.703 FT^3

ΔV_{TOTAL} = 12.6848 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1063 \times 12.685)}{(98)} = 137.6 \; FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 151.7 \; FT^3 @ 875 \text{ PSIG}.$$

TMI-2 RCS Bubble Calc Sheet

DATE 4/2/79

TIME 5:50 (AM) PM

DATA TAKEN BY:

RC PRESSURE (398)

P_1 = 977 PSIG = 992 PSIA

P_2 = 1059 PSIG = 1074 PSIA

ΔP = 92 PSI

RCS TEMP (394)

T_1 = 278.5 °F

T_2 = 278.2 °F

PRESSURIZER LEVEL (1682)

L_1 = 203.3 INCHES

L_2 = 201.6 INCHES

ΔL = 1.7 INCHES

PRESSURIZER TEMP (389)

T_1 = 549.8 °F

T_2 = 558.6 °F

MAKEUP TANK LEVEL (347)

L_1 = 48.9 INCHES

L_2 = 46.4 INCHES

ΔL = 2.5 INCHES

MAKEUP TANK TEMP (CONTROL BOARD METER)

T_1 = 72 °F

T_2 = 75 °F

$\Delta V_{RC} = \Delta L \cdot 2.515 =$ 1.7 × 2.515 = 4.15 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ 2.5 × 4.244 = 10.61 FT^3

ΔV_{TOTAL} = 15.36 FT^3

$$V_1 = \frac{P_2 \Delta V_{tot}}{P_2 - P_1} = \frac{(1074 \times 15.36)}{(92)} = 179 \; FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_{1492}}{875}\right) = 203.3 \; FT^3 @ 875 \text{ PSIA}.$$

DATE 4/2/79

TIME 5:00 AM PM

TMI-2 RCS BUBBLE CALC SHEET

DATA TAKEN BY: JL

RC PRESSURE (398)

P_1 = 960 PSIG = 975 PSIA

P_2 = 1060 PSIG = 1075 PSIA

ΔP = 100 PSI

RCS TEMP (394)

T_1 = 277.7 °F

T_2 = 279.4 °F

PRESSURIZER LEVEL (1682)

L_1 = 217.6 INCHES

L_2 = 215.8 INCHES

ΔL = 1.8 INCHES

PRESSURIZER TEMP (389 ~~405~~)

T_1 = 548.6 °F

T_2 = 559.6 °F

MAKEUP TANK LEVEL (347)

L_1 = 39.3 INCHES

L_2 = 52.8 INCHES

ΔL = 1.5 INCHES

MAKEUP TANK TEMP (CONTROL BOARD METER)

T_1 = 73 °F

T_2 = 75 °F

$\Delta V_{RCS} = \Delta L \cdot 2.515 =$ 1.8 × 2.515 = 4.527 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ 1.5 × 4.244 = 6.366 FT^3

$\Delta V_{TOTAL} =$ 10.89 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1075 \times 10.89)}{(100)} = 117 \text{ } FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 130.7 \text{ } FT^3 @ 875 \text{ PSIA}$$

DATE 4/2/79

TMI-2 RCS BUBBLE CALC SHEET

TIME 4:15 AM/PM

DATA TAKEN BY: JK

RC PRESSURE (398)

P_1 = 869 PSIG = 884 PSIA

P_2 = 1055 PSIG = 1070 PSIA

ΔP = 186 PSI

RCS TEMP (394)

T_1 = 276.4 °F

T_2 = 277.7 °F

PRESSURIZER LEVEL (1682)

L_1 = 231.7 INCHES

L_2 = 223.8 INCHES

ΔL = 7.9 INCHES

PRESSURIZER TEMP (389 ~~405~~)

T_1 = 534.6 °F

T_2 = 558.1 °F

MAKEUP TANK LEVEL (347)

L_1 = 48.0 INCHES

L_2 = 42.4 INCHES

ΔL = 5.6 INCHES

MAKEUP TANK TEMP (CONTROL BOARD METER)

T_1 = 77 °F

T_2 = 74 °F

$\Delta V_{RCS} = \Delta L \cdot 2.515 =$ 7.9 × 2.515 = 19.8 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ 5.6 × 4.244 = 23.76 FT^3

ΔV_{TOTAL} = 43.56 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1070 \times 43.56)}{(186)} = 250.6 \ FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 253.2 \ FT^3 @ 875 \text{ PSIA}$$

TMI-2 RCS Bubble Calc Sheet

DATE 4/2/79

TIME 3:15 (AM) PM

DATA TAKEN BY: JL

RC Pressure (398)

P_1 = 956 PSIG = 971 PSIA

P_2 = 1025 PSIG = 1040 PSIA

ΔP = 69 PSI

RCS Temp (394)

T_1 = 275.6 °F

T_2 = 275.5 °F

Pressurizer Level (1682)

L_1 = 201.5 INCHES

L_2 = 202.5 INCHES

ΔL = 1 INCHES

Pressurizer Temp (389 ~~405~~)

T_1 = 547.2 °F

T_2 = 554.7 °F

Makeup Tank Level (347)

L_1 = 54.4 INCHES

L_2 = 52.1 INCHES

ΔL = 2.3 INCITES

Makeup Tank Temp (Control Board Meter)

T_1 = 70 °F

T_2 = 75 °F

$\Delta V_{RC} = \Delta L \cdot 2.515 =$ 1 × 2.515 = 2.515 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ 2.3 × 4.244 = 9.76 FT^3

$\Delta V_{TOTAL} =$ 12.27 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1040 \times 12.27)}{(69)} = 185 \; FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 205.3 \; FT^3 @ 875 \text{ PSIA}.$$

TMI-2 RCS BUBBLE CALC SHEET

DATE 4/2/79

TIME 2.15 AM/PM

DATA TAKEN BY: [signature]

RC PRESSURE (398)

P_1 = 945 PSIG = 960 PSIA

P_2 = 1056 PSIG = 1073 PSIA

ΔP = 113 PSI

RCS TEMP (394)

T_1 = 276.1 °F

T_2 = 276.4 °F

PRESSURIZER LEVEL (1682)

L_1 = 210.8 INCHES

L_2 = 201.6 INCHES

ΔL = 9.2 INCHES

PRESSURIZER TEMP (384 ~~405~~)

T_1 = 546.6 °F

T_2 = 558.7 °F

MAKEUP TANK LEVEL (347)

L_1 = 47.0 (57) INCHES

L_2 = 49.3 INCHES

ΔL = 10.3 INCITES

MAKEUP TANK TEMP (CONTROL BOARD METER)

T_1 = 69 °F

T_2 = 72 °F

$\Delta V_{RCS} = \Delta L \cdot 2.515 =$ 9.2 × 2.515 = 23.1 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ 10.3 × 4.244 = 43.7 FT^3

ΔV_{TOTAL} = 20.6 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1056 \times 20.6)}{(113)} = 192.6 \; FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 211.3 \; FT^3 @ 875 \text{ PSIA}.$$

DATE 4/2/79

TIME 1:28 AM PM

TMI-2 RCS BUBBLE CALC SHEET

DATA TAKEN BY: JC

Dave while Vetter

RC PRESSURE (398)

P_1 = 1054 PSIG = 1071 PSIA

P_2 = 971 PSIG = 984 PSIA

ΔP = 85 PSI

RCS TEMP (394)

T_1 = 276.4 °F

T_2 = 275.7 °F

PRESSURIZER LEVEL (1682)

L_1 = 201.6 INCHES

L_2 = 201.7 INCHES

ΔL = -.1 INCHES

PRESSURIZER TEMP (389 ~~405~~)

T_1 = 558.7 °F

T_2 = 549.0 °F

MAKEUP TANK LEVEL (347)

L_1 = 49.3 INCHES

L_2 = 40.2 INCHES

ΔL = 9.1 INCHES

MAKEUP TANK TEMP (CONTROL BOARD METER)

T_1 = 72 °F

T_2 = 70 °F

$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ -.1 × 2.515 = -.2515 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ 9.1 × 4.244 = 38.6 FT^3

ΔV_{TOTAL} = 38.3 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(984 \times 38.3)}{(\ 85\ )} = 444.3 \ FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 543 \ FT^3 @ 875 \text{ PSIA}.$$

Dave while Vetter

DATE 4/1/79 / 4/2/79

TMI-2 RCS BUBBLE CALC SHEET

TIME 0020 (AM/PM)

DATA TAKEN BY: JK

RC PRESSURE (398) 968

P_1 = 953 PSIG = ~~970~~ PSIA

P_2 = 1018 PSIG = 1073 PSIA

ΔP = 105 PSI

RCS TEMP (394)

T_1 = 270.5 °F

T_2 = 276.6 °F

PRESSURIZER LEVEL (1682)

L_1 = 220.0 INCHES

L_2 = 217.5 INCHES

ΔL = 2.5 INCHES

PRESSURIZER TEMP (405) 389

T_1 = 545.7 °F

T_2 = 559.3 °F

MAKEUP TANK LEVEL (347)

L_1 = ~~45.7~~ 53.0 INCHES

L_2 = 50.0 INCHES

ΔL = 3.0 INCHES

MAKEUP TANK TEMP (CONTROL BOARD METER)

T_1 = ~~72~~ 72 °F

T_2 = 70 °F

$\Delta V_{RCS} = \Delta L \cdot 2.515 =$ 2.5 × 2.515 = 6.2875 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ 3 × 4.244 = 12.732 FT^3

ΔV_{TOTAL} = 19.0195 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1073)(19.0195)}{(105)} = 194.36 \ FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 215.01 \ FT^3 @ 875 \text{ PSIG}.$$

DATE 4/11

TIME 10:55 AM/PM

TMI-2 RCS BUBBLE CALC SHEET

DATA TAKEN BY: JC

RC PRESSURE (398)

P_1 = 945 PSIG = 960 PSIA

P_2 = 1045 PSIG = 1060 PSIA

ΔP = 1000 PSI

RCS TEMP (394)

T_1 = 272.8 °F

T_2 = 274.0 °F

PRESSURIZER LEVEL (1682)

L_1 = 201.4 INCHES

L_2 = 201.7 INCHES

ΔL = .3 INCHES

PRESSURIZER TEMP (389 ~~405~~)

T_1 = 545 °F

T_2 = 557.3 °F

MAKEUP TANK LEVEL (347)

L_1 = 53.6 INCHES

L_2 = 47.4 INCHES

ΔL = -4.2 INCHES

MAKEUP TANK TEMP (CONTROL BOARD METER)

T_1 = 78 °F

T_2 = 76 °F

ΔV_{RC} = $\Delta L \times 2.515$ = .3 × 2.515 = .755 FT^3

ΔV_{MUT} = $\Delta L \times 4.244$ = 4.2 × 4.244 = 17.825 FT^3

ΔV_{TOTAL} = 17.07 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1060 \times 17.07)}{(1000)} = 180.942 \text{ } FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 198.5 \text{ } FT^3 @ 875 \text{ PSIA}.$$

DATE 4/01/79

TMI-2 RCS BUBBLE CALC SHEET

TIME 1910 - 2000 AM PM

DATA TAKEN BY: JPM

RC PRESSURE (398)

P_1 = _____ PSIG = ~~954~~ 954 Avg PSIA

P_2 = _____ PSIG = 1058 Avg PSIA

ΔP = 104 PSI

RCS TEMP (394)

T_1 = 278.2 °F

T_2 = 278.8 °F

PRESSURIZER LEVEL (1682)

L_1 = 201.7 INCHES

L_2 = 201.0 INCHES

ΔL = -0.7 INCHES

PRESSURIZER TEMP (389 ~~405~~)

T_1 = 547 °F

T_2 = 559.1 °F

MAKEUP TANK LEVEL (347)

L_1 = 51.2 INCHES

L_2 = 42.3 INCHES

ΔL = -8.9 INCHES

MAKEUP TANK TEMP (CONTROL BOARD METER)

T_1 = 78. °F

T_2 = 75 °F

$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ -0.7 $\times$ 2.515 = 1.76 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ -8.9 $\times$ 4.244 = 37.77 FT^3

ΔV_{TOTAL} = 39.53 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1058 \times 39.53)}{(104)} = 402 \text{ } FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 438 \text{ } FT^3 @ 875 \text{ PSIG}$$

DATE 4-01-79

TMI-2 RCS BUBBLE CALC SHEET

TIME 1758 - 1847 AM PM

DATA TAKEN BY: _____

RC PRESSURE (398)

P_1 = _____ PSIG = 955 PSIA

P_2 = _____ PSIG = 1053.6 PSIA

ΔP = 98.6 PSI

RCS TEMP (394)

T_1 = 279.4 °F

T_2 = 278.6 °F

PRESSURIZER LEVEL (1682)

L_1 = 201.3 INCHES

L_2 = 201.3 INCHES

ΔL = 0 INCHES

PRESSURIZER TEMP (389, 405)

T_1 = 558 °F

T_2 = 558.9 °F

MAKEUP TANK LEVEL (347)

L_1 = 47.1 INCHES

L_2 = 42.6 INCHES

ΔL = 4.5 INCHES

MAKEUP TANK TEMP (CONTROL BOARD METER)

T_1 = 78 °F

T_2 = 78 °F

$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ 0 $\times$ 2.515 = 0 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ 4.5 $\times$ 4.244 = 19.1 FT^3

ΔV_{TOTAL} = 19.1 FT^3

$$V_1 = \frac{P_2 \Delta V_{tot}}{P_2 - P_1} = \frac{(1053.6 \times 19.1)}{(98.6)} = 204 \text{ } FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 222.73 \text{ } FT^3 @ 875 \text{ PSIG}$$

DATE 4-01-79

TMI-2 RCS BUBBLE CALC SHEET

TIME 1710 – 1800 AM PM

DATA TAKEN BY: _____

RC PRESSURE (398)

P_1 = _____ PSIG = 972 PSIA

P_2 = _____ PSIG = 1050 PSIA

ΔP = 78 PSI

RCS TEMP (394)

T_1 = 280.1 °F

T_2 = 279.7 °F

PRESSURIZER LEVEL (1682)

L_1 = 201.4 INCHES

L_2 = 201.2 INCHES

ΔL = -0.2 INCHES

PRESSURIZER TEMP (389 ~~405~~)

T_1 = 548.1 °F

T_2 = 557.8 °F

MAKEUP TANK LEVEL (347)

L_1 = 50.0 INCHES

L_2 = 40.1 INCHES

ΔL = ~~9.9~~ 9.9 INCHES

MAKEUP TANK TEMP (CONTROL BOARD METER)

T_1 = 78 °F

T_2 = 78 °F

$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ 0.2 × 2.515 = 0.503 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ 9.9 × 4.244 = 42.02 FT^3

ΔV_{TOTAL} = 42.52 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1050 \times 42.52)}{(78)} = 572.4 \; FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 635 \; FT^3 @ 875 \text{ PSIA}$$

DATE 4-01-79

TMI-2 RCS BUBBLE CALC SHEET

TIME ~1645 AM PM

DATA TAKEN BY: _____

RC PRESSURE (398)

P_1 = _____ PSIG = 962 PSIA

P_2 = _____ PSIG = 1064 PSIA

ΔP = 102 PSI

RCS TEMP (394)

T_1 = 280.7 °F

T_2 = 280.5 °F

PRESSURIZER LEVEL (1682)

L_1 = 201.1 INCHES

L_2 = 201.1 INCHES

ΔL = 0 INCHES

PRESSURIZER TEMP (389 / 405)

T_1 = 548.4 °F

T_2 = 558.6 °F

MAKEUP TANK LEVEL (347)

L_1 = 45.6 INCHES

L_2 = 41.0 INCHES

ΔL = 4.6 INCHES

MAKEUP TANK TEMP (CONTROL BOARD METER)

T_1 = 75. °F

T_2 = 78 °F

$\Delta V_{PZR} = \Delta L \times 2.515 = 0 \times 2.515 = 0$ FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 = 4.6 \times 4.244 = 19.52$ FT^3

$\Delta V_{TOTAL} = 19.52$ FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1064 \times 19.52)}{(102)} = 203.6 \text{ } FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 223.8 \text{ } FT^3 @ 875 \text{ PSIA}$$

TMI-2 RCS Bubble Calc Sheet

TIME 1510-1550 AM PM

DATA TAKEN BY: John

RC PRESSURE (398)

P_1 = _____ PSIG = 955 PSIA

P_2 = _____ PSIG = 1065 PSIA

ΔP = 110 PSI

RCS TEMP (394)

T_1 = 280.9 °F

T_2 = 281.3 °F

PRESSURIZER LEVEL (1682)

L_1 = 216.8 INCHES

L_2 = 208.3 INCHES

ΔL = -8.5 INCHES

PRESSURIZER TEMP (389 ~~405~~)

T_1 = 545.9 °F

T_2 = 558.2 °F

MAKEUP TANK LEVEL (347)

L_1 = 53.3 INCHES

L_2 = 50.6 INCHES

ΔL = -2.7 INCHES

MAKEUP TANK TEMP (CONTROL BOARD METER)

T_1 = 75°F °F

T_2 = 74°F °F

$\Delta V_{PZR} = \Delta L \times 2.515 = 8.5 \times 2.515 = 21.38$ FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 = 2.7 \times 4.244 = 11.46$ FT^3

$\Delta V_{TOTAL} = 32.84$ FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1065 \times 32.84)}{(110)} = 317 \text{ } FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 347 \text{ } FT^3 @ 875 \text{ PSIA}$$

DATE 04-01-79

TMI-2 RCS BUBBLE CALC SHEET

TIME 1456 - 1505 AM PM

DATA TAKEN BY: JHL

RC PRESSURE (398)

P_1 = 1055 PSIG = 1055 PSIA

P_2 = _____ PSIG = 962 PSIA (456)

ΔP = 93 PSI

RCS TEMP (394)

T_1 = 280.5 °F

T_2 = 280.7 °F

PRESSURIZER LEVEL (1682)

L_1 = 201.8 INCHES

L_2 = 210.5 (214.5 / 215.2) INCHES

ΔL = +8.7 INCHES

PRESSURIZER TEMP (384) (405)

T_1 = 557.9 °F

T_2 = 547.0 °F

MAKEUP TANK LEVEL (347)

L_1 = 42.8 INCHES

L_2 = 42.3 INCHES

ΔL = −0.5 INCHES

MAKEUP TANK TEMP (CONTROL BOARD METER)

T_1 = 75 °F

T_2 = 75 °F

$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ +8.7 × 2.515 = +21.88 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ −0.5 × 4.244 = −2.122 FT^3

$\Delta V_{TOTAL} =$ 19.758 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(962 \times 19.758)}{(93)} = 204 \text{ } FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 224 \text{ } FT^3 @ 875 \text{ PSIA}$$

NOTE! THIS DATA WAS TAKEN DURING A FAIRLY RAPID DEPRESSURIZATION

DATE 4/1/79

TMI-2 RCS BUBBLE CALC SHEET

TIME 1211/1238 AM PM

DATA TAKEN BY: J. Thorne

RC PRESSURE (398)

P_1 = _____ PSIG = 952 PSIA

P_2 = _____ PSIG = 1049 PSIA

ΔP = 97 PSI

RCS TEMP (394)

T_1 = 279.8 °F

T_2 = 279.7 °F

PRESSURIZER LEVEL (1682)

L_1 = 196.0 INCHES

L_2 = 192.[illegible] INCHES

ΔL = -3.1 INCHES

PRESSURIZER TEMP (389 ~~395~~)

T_1 = 545.7 °F

T_2 = 557.2 °F

MAKEUP TANK LEVEL (347)

L_1 = 51.6 INCHES

L_2 = 43.7 INCHES

ΔL = -7.9 INCHES

MAKEUP TANK TEMP (CONTROL BOARD METER)

T_1 = 75. °F

T_2 = 77 °F

$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ 3.1 × 2.515 = 7.8 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ 7.9 × 4.244 = 33.53 FT^3

ΔV_{TOTAL} = 41.33 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1049)(41.33)}{(97)} = 447 \; FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 486 \; FT^3 @ 875 \text{ PSIG}$$

Confirming Calc on
4/11/79 1238 DATA

① $\frac{1049}{952. - 1049} = -10.814$

② $3.178\left[\frac{.0172}{.02199}(192.9) - \frac{.0172}{.02159}(196.0)\right] = -16.73$

③ $4.128\left(\frac{.0172}{.016064}\right)(-51.6 + 43.7) = -34.91$

④ $(6.166 \times 10^{-5})(9 \times 10^{-4})\left(\frac{1}{2}279.8 + 279.7\right) = -.55$

⑤ $(6.166 \times 10^{-5})(-10^{-7})(9.7) =$

⑥ $6.166 \times 10^{-5}(5.839 \times 10^{-7})(97) =$

① $[2 + 3 - 4 - 5 + 6] =$

$-10.8[-16.73 - \cancel{34.91} + [55] + [-5.98] + \cancel{34.91}]$

110 ft

TMI-2 RCS Bubble Calc Sheet

DATE 04/01/79

TIME 1044/1140 AM PM

DATA TAKEN BY: J. Johnson

RC Pressure (398)

P_1 = _____ PSIG = 956 PSIA

P_2 = _____ PSIG = 1056 PSIA

ΔP = 100 PSI

RCS Temp (394)

T_1 = 280 °F

T_2 = 279.8 °F

Pressurizer Level (1682)

L_1 = 196.8 INCHES

L_2 = 192.4 INCHES

ΔL = -4.4 INCHES

Pressurizer Temp (389 ~~405~~)

T_1 = 546.2 °F

T_2 = 557.9 °F

Makeup Tank Level (347)

L_1 = 52.6 INCHES

L_2 = 42.4 INCHES

ΔL = -10.2 INCHES

Makeup Tank Temp (Control Board Meter)

T_1 = 79 °F

T_2 = 77 °F

$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ -4.4 × 2.515 = 11.07 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ -10.2 × 4.244 = 43.29 FT^3

ΔV_{TOTAL} = 54.36 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1056 \times 54.36)}{(100)} = 574 \text{ } FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 627 \text{ } FT^3 @ 875 \text{ PSIG}$$

DATE 4/11/79

TMI-2 RCS BUBBLE CALC SHEET

TIME 1305-1355 AM PM

DATA TAKEN BY: J.P. Moore

RC PRESSURE (398)

P_1 = _____ PSIG = 967 PSIA

P_2 = _____ PSIG = 1040 PSIA

ΔP = 73 PSI

RCS TEMP (394)

T_1 = 279.8 °F

T_2 = 279.6 °F

PRESSURIZER LEVEL (1682)

L_1 = 194.3 INCHES

L_2 = 195.6 INCHES

ΔL = +1.3 INCHES

PRESSURIZER TEMP (405)

T_1 = 547.3 °F

T_2 = 558.5 °F

MAKEUP TANK LEVEL (347)

L_1 = 53.2 INCHES

L_2 = 47.3 INCHES

ΔL = -5.9 INCHES

MAKEUP TANK TEMP (CONTROL BOARD METER)

T_1 = 78 °F

T_2 = 78 °F

$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ +1.3 × 2.515 = +3.27 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ -5.9 × 4.244 = -25.04 FT^3

ΔV_{TOTAL} = -21.77 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1040)(21.77)}{(73)} = 310 \text{ } FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 343 \text{ } FT^3 @ 875 \text{ PSIA}$$

NOTE: ADDED 400 gal Makeup After The above data was taken.

TMI-2 RCS Bubble Calc Sheet

DATE 04/01/79

TIME 0946/1020 AM PM

DATA TAKEN BY: J. Moore

RC Pressure (398)

P_1 = _____ PSIG = 953 PSIA

P_2 = _____ PSIG = 1056 PSIA

ΔP = 103 PSI

RCS Temp (394)

T_1 = 280.2 °F

T_2 = 280.2 °F

Pressurizer Level (1682)

L_1 = 196.5 INCHES

L_2 = 193 INCHES

ΔL = -3.5 INCHES

Pressurizer Temp (389)

T_1 = 545.3 °F

T_2 = 552.9 °F

Makeup Tank Level (347)

L_1 = 53.4 INCHES

L_2 = 44.9 INCHES

ΔL = -8.5 INCHES

Makeup Tank Temp (Control Board Meter)

T_1 = 78 °F

T_2 = 79 °F

$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ 3.5 × 2.515 = 8.80 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ 8.5 × 4.244 = 36.07 FT^3

ΔV_{TOTAL} = 44.87 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1056 \times 44.87)}{(103)} = 460 \; FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 501 \; FT^3 @ 875 \text{ PSIA}$$

DATE 4.11.79

TMI-2 RCS BUBBLE CALC SHEET

TIME 0825/0903 (AM/PM)

DATA TAKEN BY: [illegible]

RC PRESSURE (398)

P_1 = _____ PSIG = 945 PSIA

P_2 = _____ PSIG = 1050 PSIA

ΔP = 105 PSI

RCS TEMP (394)

T_1 = 280.5 °F

T_2 = 280.5 °F

3.84

PRESSURIZER LEVEL (1682)

L_1 = 201.2 INCHES

L_2 = 192.6 INCHES

ΔL = 8.6 INCHES

PRESSURIZER TEMP (~~405~~)

T_1 = 544.6 °F

T_2 = 557.1 °F

MAKEUP TANK LEVEL (347)

L_1 = 50.7 INCHES

L_2 = 45.3 INCHES

ΔL = 5.4 INCHES

MAKEUP TANK TEMP (CONTROL BOARD METER)

T_1 = 78 °F

T_2 = 75 °F

CANCELLED

$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ 8.6 × 2.515 = 21.63 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ 5.4 × 4.244 = 22.92 FT^3

$\Delta V_{TOTAL} =$ 44.5 FT^3

$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1050 \times 44.5)}{(105)} =$ 445.5 FT^3 @ P_1

$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) =$ ~~445.5~~ 534.6 FT^3 @ 875 PSIA.

TMI-2 RCS Bubble Calc Sheet

DATE 4/1/79

TIME ~0731 AM/PM

DATA TAKEN BY: [illegible]

RC Pressure (398)

P_1 = _____ PSIG = 971 PSIA

P_2 = _____ PSIG = 1055 PSIA

ΔP = 84 PSI

RCS Temp (394)

T_1 = 280.1 °F

T_2 = 280.1 °F

Pressurizer Level (1682)

L_1 = 196.0 INCHES

L_2 = 193.0 INCHES

ΔL = 3.0 INCHES

Pressurizer Temp (405)

T_1 = 545.9 °F

T_2 = 557.7 °F

Makeup Tank Level (347)

L_1 = 49.1 INCHES

L_2 = 42.1 INCHES

ΔL = 7.0 INCHES

Makeup Tank Temp (Control Board Meter)

T_1 = 73. °F

T_2 = 73 °F

$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ 3.0 × 2.515 = 7.54 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ 7.0 × 4.244 = 29.71 FT^3

ΔV_{TOTAL} = 37.25 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1055 \times 37.25)}{(84)} = 467 \text{ } FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 564 \text{ } FT^3 @ 875 \text{ PSIA}$$

Repressurize Time 23xx

Start 0731 Stop 0754

3.6 psi/min

TMI-2 RCS Bubble Calc Sheet

DATE 4/1/79

TIME 0620 (AM) PM

DATA TAKEN BY: JAF

RC Pressure (398)

P_1 = _____ PSIG = 960 PSIA

P_2 = _____ PSIG = ~~1053~~ PSIA

ΔP = 93 PSI

RCS Temp (394) 1069

T_1 = 280.6 °F

T_2 = _____ °F

Pressurizer Level (1682)

L_1 = 200.6 INCHES

L_2 = 192.7 INCHES

ΔL = 7.9 INCHES

Pressurizer Temp (405)

T_1 = ~~557.1~~ °F 545.9

T_2 = 551.9 °F

Makeup Tank Level (347)

L_1 = 46.1 INCHES

L_2 = 39.1 INCHES

ΔL = 7.0 INCHES

Makeup Tank Temp (CONTROL BOARD METER)

T_1 = 72.0 °F = 5

T_2 = 70° °F 53

$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ 7.9 × 2.515 = 19.9 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ 7.0 × 4.244 = 32.4 FT^3

$\Delta V_{TOTAL} =$ 52.144 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1053 \times 52.14)}{(93)} = 590 \text{ } FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 710 \text{ } FT^3 @ 875 \text{ PSIA}$$

944 - 4411

Repressurization Time

Start 0620 Stop 0655

2.67 psi/min

TMI-2 RCS Bubble Calc Sheet

DATE 4/1/77 ✓

TIME 4:55 (AM) PM

DATA TAKEN BY: [illegible]

RC PRESSURE (398) 92½

P_1 = _____ PSIG = 446 PSIA

P_2 = _____ PSIG = 1056 PSIA

ΔP = 130 PSI

RCS TEMP (394)

T_1 = 279.4 °F

T_2 = 280.5 °F

PRESSURIZER LEVEL (1682)

L_1 = 209.9 INCHES

L_2 = ~~[illegible]~~ 200.1 INCHES

ΔL = 9.8 INCHES

PRESSURIZER TEMP (405)

T_1 = 543.2 °F

T_2 = 558 °F

MAKEUP TANK LEVEL (347)

L_1 = 559 INCHES

L_2 = 50.1 INCHES

ΔL = 8.8 INCHES

MAKEUP TANK TEMP (CONTROL BOARD METER)

T_1 = 78 °F

T_2 = 72 °F

$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ 9.8 × 2.515 = 24.6 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ 8.8 × 4.244 = 37.3 FT^3

ΔV_{TOTAL} = 61.9 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1056)(61.9)}{(130)} = 502.8 \text{ } FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 605.8 \text{ } FT^3 @ 875 \text{ PSIA}$$

0500

0544

Repressurization Time 44m.

Start 0455 Stop 0539

~~[illegible]~~ 130 PSI

44 min

DATE 4/1/19

TIME ~~0415~~ 0425 AM PM

DATA TAKEN BY: MF

TMI-2 RCS BUBBLE CALC SHEET

RC PRESSURE (098)

P_1 = _____ PSIG = 957 PSIA

P_2 = _____ PSIG = 1055 PSIA

ΔP = 98 PSI

RCS TEMP (394)

T_1 = 280 °F

T_2 = 279.4 °F

PRESSURIZER LEVEL (1682)

L_1 = 195.1 INCHES

L_2 = 192.7 INCHES

ΔL = 2.4 INCHES

PRESSURIZER TEMP (~~405~~ 389)

T_1 = 545.7 °F

T_2 = 557.9 °F

MAKEUP TANK LEVEL (347)

L_1 = 53.3 INCHES

L_2 = 39.6 INCHES

ΔL = 13.7 INCHES

MAKEUP TANK TEMP (CONTROL BOARD METER)

T_1 = 72 °F

T_2 = 70 °F

$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ 2.4 × 2.515 = 6.04 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ 1.37 × 4.244 = 58 FT^3

ΔV_{TOTAL} = 64.2 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1055 \times \quad)}{(98)} = 696.9 \text{ FT}^3 @ P_1$$

$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) =$ 833.1 FT^3 @ 875 PSIG.

S 0403

S 0425

Repressurization Time 22m

Start 0403 Stop 0425

$\frac{\Delta P}{m} = \frac{98}{22 \text{ m}}$

TMI-2 RCS Bubble Calc Sheet

DATE 9/11/79

TIME 0321 (AM) PM

DATA TAKEN BY: MF

RC Pressure (398)

P_1 = ~~914~~ PSIG = 91.0 PSIA

P_2 = _____ PSIG = 1058 PSIA

ΔP = 98 PSI

RCS Temp (394)

T_1 = 279.9 °F

T_2 = 280.1 °F

Pressurizer Level (1682)

L_1 = 199.3 INCHES

L_2 = 192.3 INCHES

ΔL = 7.0 INCHES

Pressurizer Temp (3:9 ~~405~~)

T_1 = 546.3 °F

T_2 = 558.4 °F

Makeup Tank Level (347)

L_1 = 47.5 INCHES

L_2 = 37.2 INCHES

ΔL = 10.3 INCHES

Makeup Tank Temp (Control Board Meter)

T_1 = 72 °F

T_2 = _____ °F

$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ 70 × 2.515 = 176 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ 10.3 × 4.244 = 43.7 FT^3

ΔV_{TOTAL} = 61.3 FT^3

$$V_1 = \frac{P_2 \Delta V_{tot}}{P_2 - P_1} = \frac{(1058 \times 61.3)}{(98)} = 661.9 \text{ } FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) =$$ 606.3 FT^3 @ 875 PSIA.

S 0253

S 0321

Repressurization Time ~~0253 - 0321~~ 28 min

Start 0253

Stop 0321

Δ11 min

DATE 4/1/79

TIME 0104/ AM PM

DATA TAKEN BY: SAF

TMI-2 RCS BUBBLE CALC SHEET

1.00

RC PRESSURE (398)

P_1 = _____ PSIG = 958 PSIA

P_2 = _____ PSIG = 1008 PSIA

ΔP = 50 PSI

RCS TEMP (394)

T_1 = 279.4 °F (*)

T_2 = _____ °F

PRESSURIZER LEVEL (1682)

L_1 = 193 INCHES

L_2 = 191.9 INCHES

ΔL = 1.1 INCHES

PRESSURIZER TEMP (405)

T_1 = 546.1 °F (*)

T_2 = _____ °F

MAKEUP TANK LEVEL (347)

L_1 = 41.8 INCHES

L_2 = 33.4 INCHES

ΔL = 8.4 INCHES

MAKEUP TANK TEMP (CONTROL BOARD METER)

T_1 = 78 °F

T_2 = _____ °F (*)

$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ 1.1 × 2.515 = 2.77 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ 8.4 × 4.244 = 35.65 FT^3

ΔV_{TOTAL} = 38.42 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1008 \times 38.42)}{(50)} = 774.6 \ FT^3 @ P_1$$

$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) =$ 848.1 (*) FT^3 @ 875 PSIA.

(*) Note: MUT refilled so test period cut short (data not in procedure)

@ 33.4	1008	191.9	RC pressurization Time N4 (*)	1:23 Add ~~450~~ 465	774.6 / 41.4 / 1057 / 38.42

TMI-2 RCS Bubble Calc Sheet

DATE 4/1/79

TIME 0200/0230 (AM/PM)

DATA TAKEN BY: DNF

RC Pressure (398)

P_1 = ~~956~~ PSIG = 956 PSIA

P_2 = ~~1050~~ PSIG = 1050 PSIA

ΔP = 94 PSI

RCS Temp (394)

T_1 = 279.5 °F

T_2 = 279.3 °F

Pressurizer Level (1682)

L_1 = 196.2 INCHES

L_2 = 192.2 INCHES

ΔL = 4.0 INCHES

Pressurizer Temp (405)

T_1 = 545.6 °F

T_2 = 557.0 °F

Makeup Tank Level (347)

L_1 = 59.9 INCHES

L_2 = 47.9 INCHES

ΔL = 12.0 INCHES

Makeup Tank Temp (Control Board Meter)

T_1 = 73° °F

T_2 = 75° °F

$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ 4 × 2.515 = 10.1 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ 12 × 4.244 = 50.9 FT^3

ΔV_{TOTAL} = 61.0 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1050 \times 61.0)}{(94)} = 681.7 \text{ } FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 818.03 \text{ } FT^3 @ 875 \text{ PSIG}.$$

5/0205
0225

Repressurization Time Start 0205 Stop 0225

Δt
min

DATE 3/31 ✓

TMI-2 RCS BUBBLE CALC SHEET

TIME 2355 AM PM

DATA TAKEN BY: KH

RC PRESSURE (398)

P_1 = _____ PSIG = 958 PSIA

P_2 = _____ PSIG = 1057 PSIA

ΔP = 99 PSI

RCS TEMP (394)

T_1 = 278.4 °F

T_2 = 279.6 °F

PRESSURIZER LEVEL (1682)

L_1 = 197.0 INCHES

L_2 = 192.0 INCHES

ΔL = 5.0 INCHES

PRESSURIZER TEMP (405) 389

T_1 = 546.5 °F

T_2 = 557.8 °F

MAKEUP TANK LEVEL (347)

L_1 = 52.1 INCHES

L_2 = 40.6 INCHES

ΔL = 11.5 INCHES

MAKEUP TANK TEMP (CONTROL BOARD METER)

T_1 = 81 °F

T_2 = 79 °F

$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ 50 × 2.515 = 12.6 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ 11.5 × 4.244 = 48.8 FT^3

$\Delta V_{TOTAL} =$ 61.38 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1057 \times 61.38)}{(99)} = 655.34 \text{ } FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = \text{~~655.34~~ } 717.13 \text{ } FT^3 @ 875 \text{ PSIA}$$

2353
0018

2353 Repressurization
0018 Time 25 min
Start 2353
Stop 0018

DATE 3/31

TIME 2245 AM PM

DATA TAKEN BY: RSW

TMI-2 RCS BUBBLE CALC SHEET

RC PRESSURE (398)

P_1 = _____ PSIG = 955 PSIA

P_2 = _____ PSIG = 1050 PSIA

ΔP = 95 PSI

RCS TEMP (394)

T_1 = 277.6 °F

T_2 = 277.1 °F

PRESSURIZER LEVEL (1682)

L_1 = 196.4 INCHES

L_2 = 192.4 INCHES

ΔL = 4.0 INCHES

PRESSURIZER TEMP (405)

T_1 = 545.6 °F

T_2 = 556.9 °F

MAKEUP TANK LEVEL (347)

L_1 = 50.1 INCHES

L_2 = 35.0 INCHES

ΔL = 15.1 INCITES

MAKEUP TANK TEMP (CONTROL BOARD METER)

T_1 = 81. °F

T_2 = 81 °F

$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ 4.0 × 2.515 = 10.06 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ 15.1 × 4.244 = 64.09 FT^3

$\Delta V_{TOTAL} =$ 74.14 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1050 \times 74.14)}{(95)} = 819.4 \; FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 894.4 \; FT^3 @ 875 \text{ PSIG}$$

DATE 5/31

TIME 2139 AM PM

DATA TAKEN BY: [illegible]

TMI-2 RCS BUBBLE CALC SHEET

RC PRESSURE (398)

P_1 = _____ PSIG = 955 PSIA

P_2 = _____ PSIG = 1046 PSIA

ΔP = 91 PSI

RCS TEMP (394)

T_1 = 278.2 °F

T_2 = 277.7 °F

PRESSURIZER LEVEL (1682)

L_1 = 196.0 INCHES

L_2 = 192.2 INCHES

ΔL = 3.8 INCHES

PRESSURIZER TEMP (405)

T_1 = 545.6 °F

T_2 = 556.6 °F

MAKEUP TANK LEVEL (347)

L_1 = 49.5 INCHES

L_2 = 33.0 INCHES

ΔL = 16.5 INCHES

MAKEUP TANK TEMP (CONTROL BOARD METER)

T_1 = 81. °F

T_2 = 81 °F

$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ 3.8 × 2.515 = 9.56 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ 16.5 × 4.244 = 70.03 FT^3

ΔV_{TOTAL} = 79.6 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1046 \times 79.6)}{(91)} = 914.8 \text{ FT}^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 998.5 \text{ FT}^3 @ 875 \text{ PSIA}$$

DATE 3/31

TIME 2030 AM PM

TMI-2 RCS BUBBLE CALC SHEET

DATA TAKEN BY: JSL

RC PRESSURE (398)

P_1 = _____ PSIG = 953 PSIA

P_2 = _____ PSIG = 1053 PSIA

ΔP = 100 PSI

RCS TEMP (394)

T_1 = 278.7 °F

T_2 = 278.3 °F

PRESSURIZER LEVEL (1682)

L_1 = 193.9 INCHES

L_2 = 191.0 INCHES

ΔL = 2.9 INCHES

PRESSURIZER TEMP (405)

T_1 = 545.6 °F

T_2 = 557.4 °F

MAKEUP TANK LEVEL (347)

L_1 = 48.4 INCHES

L_2 = 34.4 INCHES

ΔL = 14.0 INCHES

MAKEUP TANK TEMP (CONTAIN. BOARD METER)

T_1 = 81 °F

T_2 = 81 °F

$\Delta V_{PZR} = \Delta L \cdot 2.515 = 2.9 \times 2.515 = 7.29$ FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 = 14.0 \times 4.244 = 59.42$ FT^3

$\Delta V_{TOTAL} = 66.7$ FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1053 \times 66.7)}{(100)} = 702.5 \text{ } FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 765.1 \text{ } FT^3 @ 875 \text{ PSIG.}$$

TMI-2 RCS Bubble Calc Sheet

DATE 5/31

TIME 1925 AM / PM

DATA TAKEN BY: PSW

RC Pressure (398)

P_1 = _____ PSIG = 966 PSIA

P_2 = _____ PSIG = 1049 PSIA

ΔP = 83 PSI

RCS Temp (394)

T_1 = 278.3 °F

T_2 = 278.3 °F

Pressurizer Level (1682)

L_1 = 205.2 INCHES

L_2 = 191.0 INCHES

ΔL = 14.2 INCHES

Pressurizer Temp (405)

T_1 = 547.1 °F

T_2 = 556.8 °F

Makeup Tank Level (347)

L_1 = 41.8 INCHES

L_2 = 35.0 INCHES

ΔL = 6.8 INCHES

Makeup Tank Temp (Control Board Meter)

T_1 = 82 °F

T_2 = 82 °F

$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ 14.2 × 2.515 = ~~35.713~~ ~~28.85~~ FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ 6.8 × 4.244 = 28.85 FT^3

64.57

ΔV_{TOTAL} = ~~57.77~~ FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1049 \times \overset{64.57}{\cancel{57.77}})}{(83)} = \overset{816.1}{\cancel{729.5}}\ FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = \overset{901.0}{\cancel{805.3}}\ FT^3 @ 875\ PSIA.$$

TMI-2 RCS Bubble Calc Sheet

DATE 3/31

TIME 1735 AM PM

DATA TAKEN BY: PSW

RC Pressure (398)

P_1 = _____ PSIG = 946 PSIA

P_2 = _____ PSIG = 1046 PSIA

ΔP = 100 PSI

RCS Temp (394)

T_1 = 279.4 °F

T_2 = 279.1 °F

Pressurizer Level (1682)

L_1 = 201.0 INCHES

L_2 = 191.6 INCHES

ΔL = 9.4 INCHES

Pressurizer Temp (405)

T_1 = 545.0 °F

T_2 = 556.7 °F

Makeup Tank Level (347)

L_1 = 46.9 INCHES

L_2 = 37.0 INCHES

ΔL = 9.9 INCHES

Makeup Tank Temp (Control Board Recorder)

T_1 = 81 °F

T_2 = 81 °F

$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ 9.4 × 2.515 = 23.64 FT^3

$\Delta V_{MUT} = \Delta L \times 4.244 =$ 9.9 × 4.244 = 42.0 FT^3

ΔV_{TOTAL} = 65.64 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1046 \times 65.64)}{(100)} = 686.6 \text{ } FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 742.3 \text{ } FT^3 @ 875 \text{ PSIA}$$

DATE [illegible]

TMI-2 RCS Bubble Calc Sheet

TIME 1619 AM PM

DATA TAKEN BY: PSL

Checked JJM 3/31/79

RC Pressure (398)

P_1 = _____ PSIG = 949 PSIA

P_2 = _____ PSIG = 1046 PSIA

ΔP = 97 PSI

RCS Temp (394)

T_1 = 278.3 °F

T_2 = 279.2 °F

Pressurizer Level (1682)

L_1 = 197.3 INCHES

L_2 = 191.7 INCHES

ΔL = 5.6 INCHES

Pressurizer Temp (405)

T_1 = 544.9 °F

T_2 = 556.7 °F

Makeup Tank Level (347)

L_1 = 42.2 INCHES

L_2 = 33.0 INCHES

ΔL = 9.2 INCITES

Makeup Tank Temp (Control Board Meter)

T_1 = ____ °F

T_2 = ____ °F

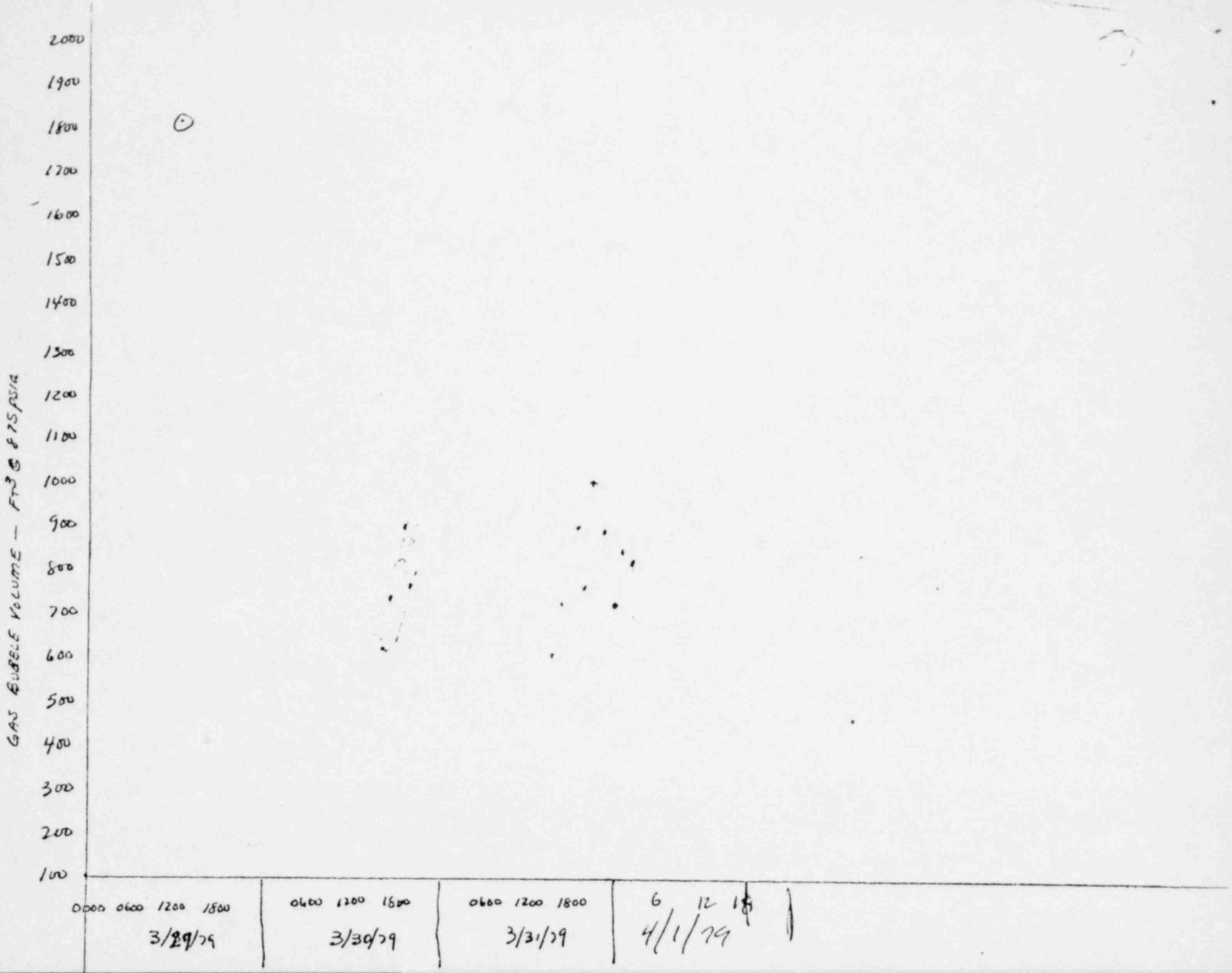
$\Delta V_{PZR} = \Delta L \cdot 2.515 =$ 5.6 × 2.515 = 14.08 FT^3

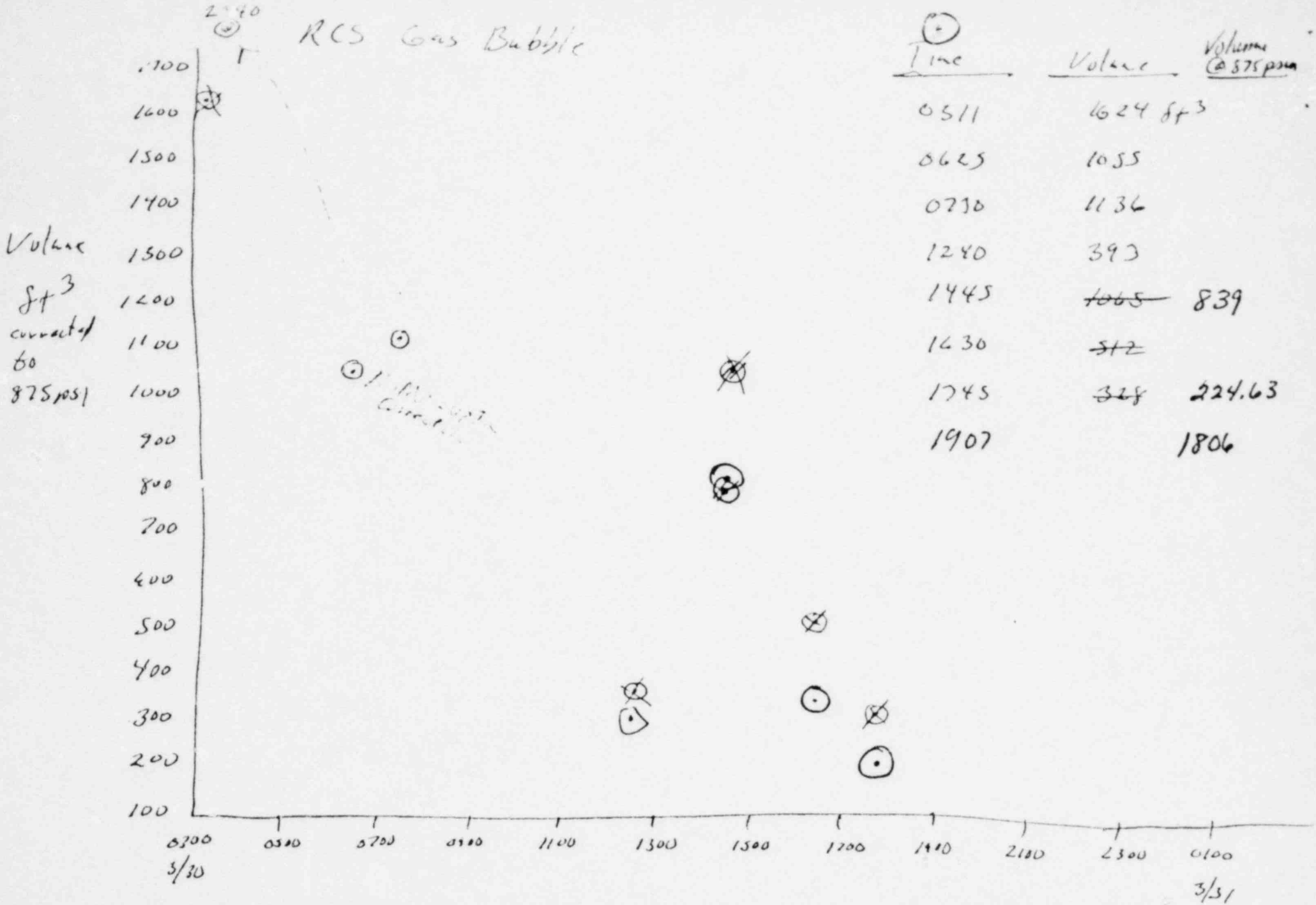
$\Delta V_{MUT} = \Delta L \times 4.244 =$ 9.2 × 4.244 = 39.04 FT^3

$\Delta V_{TOTAL} =$ 53.13 FT^3

$$V_1 = \frac{P_2 \Delta V_{TOT}}{P_2 - P_1} = \frac{(1046)(53.13)}{(97)} = 572.9 \; FT^3 @ P_1$$

$$V_{1(875)} = (V_1 \text{ at } P_1)\left(\frac{P_1}{875}\right) = 621.4 \; FT^3 @ 875 \text{ PSIG.}$$


GAS BUBBLE VOLUME — FT³ @ 75 PSIA
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0000 0600 1200 1800
3/29/79
0600 1200 1800
3/30/79
0600 1200 1800
3/31/79
6 12 18
4/1/79



Time	Volume	Volume @ 875 psia
0511	1624 ft³	
0625	1055	
0730	1136	
1240	393	
1445	~~1065~~	839
1630	~~512~~	
1745	~~328~~	224.63
1907		1806

point 347

Time	Pressure	Level		Temp		Flow	
	Pzr	Pzr	MU Tank	RCS	Pzr	Letdown	Seal
1907	1005	216.0	56	279.9	551.4	—	19
1909	1005	216.0	56	279.9	551.4	—	19
1911	1005	215.7	54	279.9	551.4	—	19
1913	1006	215.8	54	279.8	551.6	—	19
2017	1029	215.0	47 4	279.5 ~~291.4~~	554.5	—	19
2020	1031	215.4	46"	279.4	555.1	—	19
2029	1043	215.8	44"	279.4	556.5	—	19
2030	1043	214.0	43.5"	279.4	556.5	—	19
2031	1042	214.2	43.5	279.4	556.4	—	19
			Left				
	1017						
	1070	215.6	44.5	281.2 ~~280~~	553.7		

3/31/79 0630

Jpm 3/31/79

	Pzr	MU
L_1	215.8 ~~Not Recorded!~~	41.8
L_2	233.1	41.0
ΔL	+17.3"	ΔL = -0.8"

P_1 = 1038
P_2 = 983
ΔP = 55 psi
} assumed to be prior Jpm

$\Delta V_{pzr} = +(17.3)(2.515) = 43.51\ ft^3$

$\Delta V_{mv} = -(0.8)(4.244) = 3.4\ ft^3$

NOTE
Original Calcs ~~made~~ used difference between these volumes, indicating that one ~~zone~~ volume ~~increased~~ and the other decreased — Can't be confirmed, since data ~~wasn't~~ recorded. OK - See Raw Data Jpm

$\Delta V_{total} = 43.51 - 3.4 = 40.11\ ft^3$

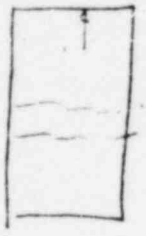
$V_1 = \frac{(983)(40.11)}{55} = 716.9\ ft^3$ @ 1038 psi

$V_1 = (716.9)\left(\frac{1038}{875}\right) = 850\ ft^3$ @ 875 psi

$P_1 =$ 1038 psia $T_1 =$ 280.4 6630

$P_2 =$ 983 psia 3/31

$P_1 V_1 = P_2 V_2$



$= P_2(V_1 + \Delta V)$

.8 in x 4 ft^3/in 3.2 cu ft MLT

12.3 in x 3.2 ft 55. cu ft.

55 - 3.2 = 51.8 cu ft

$\frac{1038}{(55)}$ 51.8 cu ft = ΔV = 177 cu ft.

$\frac{1}{T}$

cu ft

$\frac{1038}{675}$ 177 = 1098.3 cu ft @ 675 $\frac{ft}{s^2}$

Questions from Croneberger

1. H_2 Recombiner when will it be ready

2. H_2 Concentration & Activity in ~~70R~~ Gas Decay Tank

3. Gas Decay Tank line disch. filter is ~~[illegible]~~ plugged dirt or activity can someone get close to it?

4. Portable Rad. Monitors for Rad waste gas tanks

Tag nos.

Tag nos.		Elev.
HP-R-223	Spent Fuel Area	347'-6"
-224	Aux. Bldg.	280'-6"

2303 03 — 0630 3/31

					1025	1032
[illegible]	RCS T	280.4	280.3	280.3	279.7	279.8
	Pzr cc	215.8	233.1	[illegible]	190.7	187.0
[illegible]	Pzr T	554.2	547.1	541.1	549.9	550.8
[illegible]	M/U level	41.8	41.0	41.2	39.1	37.0
398	RCS Pr	1023	967.	[illegible]	988	975
	M/U TK T	76°	77°	77	79	79

3/31/79 1032/1039

3/31/79

Pzr	MU	Prem	
L_1 = 187.0	39.0	P_1 = 995 psi	} assumed to be same
L_2 = 201.9	39.0	P_2 = 948 psi	
ΔL = +14.9"	ΔL = 0	ΔP = 47 psi	

$$\Delta V = \pi(14.9)(2.515) = 374.735 \text{ ft}^3$$

$$V_1 = \frac{(948)(374.735)}{(47)} = 755.85 \text{ ft}^3 @ 995 \text{ psi}$$

$$V_1 = (755.85)\left(\frac{995}{875}\right) = 859.5 \text{ ft}^3 @ 875 \text{ psi}$$

3/31/79
1351

RCS Bubble Calc 3/31/79 1351 P. Walsh.

	L_{pzr}	P_{RCS}	T_{RCS}	T_{feed}	L_{MUT}
1351	197.4	954	279.7	538.6	45.9
~~1352~~	~~196.2~~	~~941~~	~~279.8~~	~~534.6~~	~~45.9~~
1425	190.8	1046	280.0	538.6	33.1
	6.6	92			12.8"

$\Delta Vol_{pzr} = 6.6'' \times 3.2\ ft^3/in = 21.1$ Correction to RCS temp $\frac{.0173}{.022} = 16.6\ ft^3$

$\Delta Vol_{MUT} = 12.8 \times 4\ ft^3/in = 51.2$ $\frac{.0173}{.0163} = 54.3\ ft^3$

$\Delta V_{Total} = 70.94\ ft^3$

$\Delta P = 92$ psi

$$V_1 = \frac{\rho_2 \Delta V}{\Delta P} = \frac{1046(70.94)}{92} = 806.6\ ft^3 \quad @\ 954$$

$$V_1 = 806.6\left(\frac{954}{875}\right) = 879.4\ ft^3$$

$\Delta V_{pzr} = -(6.6)(2.515) = -16.6$

$\Delta V_{MUT} = -(12.8)(4.244) = -54.3$

ΔV Total $= -70.9$

$$V_1 = \frac{(1046)(70.9)}{92} = 806.6$$

Check

RCS Bubble Calculation 3/31/79

Time	Level		Pressure	Temp		
	Pzr	MUT	Pzr	RCS	Pzr	MUT
1032	187.0	39.0	995	279.8	550.8	79
1039	201.9	39.0	948	280.2	544.5	80
	ΔL 14.9"	0	47 psi			

$$\Delta V = 14.9'' \times 3.2\ ft^3/in = 47.68\ ft^3$$

$$V_1 = \frac{P_2 \Delta V}{\Delta P} = \frac{948\ (47.68)}{47} = 961.7 \text{ @ } 995 \text{ psi}$$

$$V_1 = 961.7 \times \frac{995}{875} = 1093.6 \text{ psi @ } 875$$

See Revised Calcs 3/31/79 JWM

3/31/79
Jam

About 1300 3/29/79 Per J. Lloyd

Pzr	MUTK	
$L_1 = 373$	$L_1 = 52''$	$P_1 = 875$ psia
$L_2 = 325$	$L_2 = 38''$	$P_2 = 970$ psia
$\Delta L = -48''$	$\Delta L = 14''$	$\Delta P = 95$ psi

$\Delta L_{Pzr} = -48''$ $\quad \Delta V_{Pzr} = (-48)(2.518)(4.244) = -120.72$

$\Delta L_{MU} = -14''$ $\quad \Delta V_{MU} = (-14)(4.244) = -59.416$

$\Delta V_{TOT} = -180.136$

$$V_1 = \frac{P_2 \Delta V}{P_1 - P_2} = \frac{(970)(180.136)}{95} = 1839.3 \text{ ft}^3$$

RC System

Size of Hydrogen Gas Bubble Outside the Pressurizer

T=0311

3/30/79

Temp was about 280°F at this time per Gen. Hough

Data taken about 14 hrs ago

$L_1 = 373''$

$L_2 = 325''$

$\Delta L = 48''$

$P_1 = 860$ psig $= 875$ psia

$P_2 = 955$ psig $= 970$ psia

$\Delta P = 95$ psi

Trans ~ 1300 3/29/79

Pressurizer Capacitance $= 3.2\ ft^3/in.$

$\Delta V = 48 \times 3.2 = 153.6$

$P_1 V_1 = P_2 V_2$

$V_2 = V_1 + \Delta V$

$P_1 V_1 = P_2 (V_1 + \Delta V)$

$P_1 V_1 = P_2 V_1 + P_2 \Delta V$

$V_1 (P_1 - P_2) = P_2 \Delta V$

$\Delta V_{total} = 153.6\ ft^3$

$\Delta V_{RV\ Tank} = 54\ ft^3 \times 1.35$

$= 75.6\ ft^3$

Total ΔV = 229.2

$V_1 = \dfrac{P_2 \Delta V}{P_1 - P_2}$

$V_1 = \dfrac{153.6 \times 970}{95} = 1568\ ft^3$

$2340.3\ ft^3$

See Next

Volume of head = $800\ ft^3$ per B&W

RV diameter = 14 ft.

The MU Tank level dropped during this time period

3/29/79
[initials]

MU Tank ΔVolume

L_1 52"
L_2 38"
ΔL = 14"

$\frac{\Delta V}{\Delta L} = 30$ gal/inch

14 × 30 = 420 gal / 7.481 gal/ft³ = 56 ft³

V_1 = 1568 ft³ + 56 ft³
= 1624 ft³

Total Volume Above RV Nozzles = 5855 ft³

Rec'd from B&W 0325 3/30/79

This includes total volume of RV head, RC Loops, Pressurizer etc above the Rtr Coolant Loops.

RV outlet plenum	158	
" upper "	411	
" " Head	560	
	1129	ft³

Doesn't include CRDM volume