AP 1001

Figure 1001-8

NRC

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

Three Mile Island Nuclear Station

Special Operating Procedure

(REV 0)

SIDE 1

SOP No. Z-63 (From SOP Log Index)

Unit No. TMI-2

Date 5/4/79

1. Title Solid Plant Operations

2. Purpose (include purpose of SOP)

To provide methods for:
1. Taking the RCS pressurizer solid. 2. Drawing a bubble. 3. Solid pressurizer/plant operation.

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
   - B. Prerequisites
   - C. Procedure

Attached

4. Generated by Tech Support Procedures Group Date 5/4/79

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 [signature] 5-5-79 Date

Reviewed — List members of PORC contacted

NRC [signature] 1710 5/4/79 — R P Warren 5/4/79 — R. S. [signature] 5/4/79 Date

68W B. D. [signature] 5/4/79 — [signature] 5/4/79 Date

NRA [signature] 5-5-79 — RW Bensel 5/4/79

Approved — Unit Superintendent — [signature] 5/4/79 Date

8. SOP is Cancelled

______ Shift Supervisor/Shift Foreman ______ Date

.0 Purpose

1.1 To provide a method for taking the RCS pressurizer solid.

1.2 To provide a method for drawing a bubble.

1.3 To provide a method for solid pressurizer operation.

2.0 References

2.1 EP-5 Loss of Letdown

2.2 EP-21 Total Loss of Pressurizer Level Indication

2.3 EP-34 Loss of Natural Circulation

2.4 B&W transmittal #W248 of 4/13/79

2.5 EP9 Loss of Makeup

3.0 Precautions and Limits

3.1 This procedure temporarily precludes performance of EP-21.

3.2 Carefully monitor pressurizer pressure while raising level. While a 50 psig surge may be experienced due to bubble compression, a sharp rise in pressure above saturation pressure of about 200 psig will be an indication of being solid. When solid, pressurizer pressure will change by ~ 33 psi for every 10 gallons added to the RCS.

3.3 Raising pressurizer level will affect the temperature compensation. Should LT-3 be operating during this evolution, its output may be affected. Disregard this behavior.

3:4 Monitor temperature indication downstream of primary pressure relief valves prior to raising level and following solid condition to determine if any significant change in leakage has been made as a result of going solid.

3.5 Closely monitor the natural circulation data collected for RCS parameters to ensure criteria established for satisfactory natural circulation continues to be met.

3.6 Carefully monitor pressure while heaters are engergized when solid.

3.7 Closely monitor Makeup Tank pressure and Makeup Tank Room radiation monitors. Reduce letdown flow if Makeup Tank pressure exceeds 2 psig or a noticeable rise in activity levels is determined on the radiation monitor.

3.3 Observe the NOTT limits of Figure 2.

3.9 If RCS pressure rises above the Safety Features Actuation System reset point, a limited Safety Injection Actuation could be initiated when pressure is again reduced.

4.0 Prerequisites

4.1 Initial Conditions

4.1.1 RCS pressure control in manual with pressurizer heaters operating.

4.1.2 Natural circulation on OTSG "A" or "B" or both.

4.1.3 Best estimated pressurizer level > 100".

4.1.4 Degassed makeup water available for blending to makeup tank.

4.1.5 High Pressure Safety Injection System ~~actuation~~ components shall be defeated such that automatic or manual initiation is not possible. Initiation may violate NOTT limits or cause other RCS pressure boundary failures. (with exception of running makeup pump)

4.1.6 Low Pressure Safety Injection System shall be available for automatic or manual actuation to prevent total depressurization accidents.

4.1.7 MU-V8 aligned to MU Tank.

5.0 Special Equipment

5.1 None

6.0 Method

6.1 Taking Pressurizer Solid

NOTE: The pressurizer fill rate of about one inch of MU Tank level every three minutes is selected to utilize approximately 500 KW of pressurizer heaters for the 10 gpm if added to the pressurizer. Fill rates should not exceed about 15 gpm to preserve an adequate heater reserve to control T_{SAT} in the pressurizer.

NOTE 2: If an overpressure condition is experienced attempt to lower pressure by:

1. Closing MU-V-17 and MU-V-18 to isolate normal makeup, and if necessary;

2. Opening MU-V-5 to increase letdown and if necessary;

3. Closing MU-V-32 and MU-V-378 to isolate RCP seal injection and, if necessary;

4. Operation of RC-V-137.

6.1.1 Establish MU Tank level at 50 inches from a degassed makeup source (i.e., demineralized water and boric acid storage tank).

6.1.2 Stabilize makeup tank trace at 50 inches by adjusting letdown flow (MU-V5) as necessary. Complete Table A on attached data sheet 1.

6.1.3 Utilizing the combination of MU-V17 and V18 and/or MU-V5, slowly raise pressurizer level while reducing Makeup tank level at the rate of about one inch every 3 minutes. Operate pressurizer heaters as follows:

a. Leave control group (group 13, bank 1) as is at beginning of test.
(expect initial pressure rise $\sim$15 psi/hr)

b. When pressurizer pressure begins to decrease (drops 5 psi below highest previous pressure) energize back up heater bank.

c. Try to hold pressure constant with heaters.

- Hold up pressure with heaters,
  except: if T_{PZR} drops to $10^{o}F$ below initial temp. turn on more heaters (T_{min}, PZR = $10^{o}F$ below initial pressurizer temp)

If it is impossible to maintain this temperature with all heaters energized, reduce the rate at which the pressurizer is being filled until this criteria can be met. If not possible to maintain temperature within $10^{o}F$ of its initial temperature, raise pressurizer level in a series of small step changes allowing pressurizer temperature to return to within $10^{o}F$. Figure 1 is a typical acceptable operating range.

6.1.4 When MU tank level reaches ~30", secure raising pressurizer level.

6.1.5 Refill the MU Tank from the degassed source with appropriate boron addition to 50" in the MU Tank.

6.1.6 Monitor pressurizer temperature. Ensure it is within 10°F of the initial temperature. Complete table B on data sheet 1.

6.1.7 Repeat steps 6.1.3 - 6.1.4 until plant is solid. Indication of solid plant is when pressure increases rapidly ~ 200 psig above the saturation pressure which existed at the start of the fill procedure. Compare with pressures recorded in Table A on data sheet 1.

6.1.7.1 After first pressure rise to + 200 psi, (where filling stopped), let pressurizer soak for a minimum of two (2) hours with T_{PZR} = Constant at initial value. Then resume charging at ~ 10 gpm until a second + 200 psi pressure is again reached. When the second 200 psi rise over initial pressure from Table A is reached, the pressurizer should be assumed solid.

NOTE: When solid the RCS pressure will change approximately 33 psi for every 10 gallons added.

6.1.8 Once solid, secure filling the pressurizer by shutting MU-V17 and MU-V18. Maintain RCS pressure at the initial pressure + 200 psig by operating MU-V5 to vary letdown as necessary. Complete table C on data sheet 1 as soon as pressure is 200 psig above initial pressure. It should be noted that as pressurizer temperature slowly returns to its initial temperature, letdown will be required. If Makeup Tank level reaches 50" while the pressurizer is heating back to the initial temperature, divert to the Bleed Tanks.

6.1.9 If it is desired to draw a bubble, go to step 6.2.

If it is desired to remain solid, go to step 6.3.

6.2 DRAWING A BUBBLE IN THE PRESSURIZER

6.2.1 Operate pressurizer heaters as necessary to establish the bulk fluid temperature in the pressurizer at the saturation temperature for the ordered pressure when the bubble is drawn. Maintain this temperature ± 5°F for at least 4 hours prior to drawing bubble.

6.2.2 While establishing pressurizer temperature, maintain pressure constant at 200 psig above the desired pressure when the bubble is drawn by varying letdown flow to the M/U Tank.

NOTE: During this period, makeup from the makeup tank may be required to compensate for leakage. If possible, MU tank level should be maintained in the low end of its control band (≈ 30") to provide sufficient capacity to receive the flow from the pressurizer when the bubble is drawn.

6.2.3 If level is greater than 50" in the Makeup Tank after the stabilization period (Step 6.2.1 is complete, divert letdown to the R. C. Bleed Tank and make up from the Makeup Tank to the Pressurizer as necessary to maintain pressure (compensating for leakage) until makeup tank level is less than 50".

6.2.4 Place both Waste Gas Compressors in manual run immediately prior to commencing drawing the bubble. (This ensures maximum venting capacity to Makeup Tank to preclude spurious release during max. letdown flow condition.)

6.2.5 Verify Makeup Tank level is less than 50" and stabilized. Complete Table C on data sheet 1.

6.2.6 Check MU-V-8 aligned to the M/U Tank and not to the Bleed Tank.

6.2.7 Energize all heaters. Commence drawing the bubble by increasing letdown utilizing MU-V-5. Modulate MU-V-5 as necessary to maintain the pressure at which the bubble is to be formed. Report time _____.

NOTE: If maximum letdown is not sufficient to keep pressure from rising, secure heaters as necessary to regain pressure control while continuing to letdown. T_{sat} in the pressurizer should not exceed the desired T_{sat} by more than $5^{o}F$.

6.2.8 Closely monitor Makeup Tank pressure and Makeup Tank room radiation monitors. Reduce letdown if tank pressure exceeds 2 psig or a noticeable rise in activity level is determined on the radiation monitor. If letdown flow must be reduced, adjust pressurizer heater input to maintain pressurizer RTD at the desired $T_{sat} \pm 5^{o}F$.

6.2.9 It is intended to draw approximately 40 inches of Makeup Tank level from the pressurizer. When 40 inches of Make Up Tank level increase have been observed return heaters and MU-V-5 to the conditions recorded in Table C to stop drawing the bubble. Also stop drawing the bubble if either:

a. A noticeable increase in makeup tank level is not observed within 10 minutes of increasing letdown flow per step 6.2.7. This is an indicating of loss of letdown. Go to EP-5 to restore letdown flow or;

b. Pressure is reduced to 100 psi below P_{sat} in the pressurizer. When pressure control has been reestablished to within 100 psi of ordered pressure, complete the drawing of the bubble as noted above.

6.2.10 Stabilize Makeup Tank level. Operate pressurizer heaters as necessary to maintain desired pressure ± 50 psig. Complete Table D.

6.2.11 Determine estimated pressurizer level as follows:

From Table C and D calculate change in makeup tank level since step 6.2.7 was commenced.

Prz level = 429" - 1.227" (Δ MUT level)

6.2.12 Plot pressurizer level and recommence EP-21 tracking method.

NOTE: The final level in the pressurizer may be above the control band of EP-21. Reduce the level of the pressurizer to the level required by not adjusting for system leakage for the necessary period of time.

6.3 SOLID PRESSURIZER OPERATION:

NOTE: When first taken solid (i.e. pressure sharply increased to 200 psig above initial saturation pressure) the Pressurizer may contain a superheated, highly compressed steam bubble. This bubble will act as an ideal gas while superheater and will slowly (possibily over several hours) collapse due to cooling through ambient losses and leakage. This shrinkage will be seen as an abnormally large amount of makeup required to maintain pressure at PSAT + 200 psig.

Maintain a plot of the Makeup Tank volume added to the RCS vs time to determine when the bubble has collapsed. Plot should level out when bubble is gone.

6.3.1 Maintain pressure by balancing letdown flow with seal injection flow. Control pressure between initial PSAT (see table A) and + 200 psig. Use MU-V-5 to control letdown flow.

NOTE: This procedure will reduce letdown flow to a minimum. Ensure intermediate cooling is secured to letdown coolers prior to reducing flow to prevent precipitation. Do not exceed 150°F in the Makeup Tank. If letdown is lost go to EP-5, Loss of Letdown.

6.3.2 Maintain the Pressurizer temperature at least $50^{o}F$ greater than Th to ensure the pressurizer remains the hottest place in the RCS and at least 20^{o} below TSAT to prevent inadvertant reforming of the bubble.

NOTE 1: For every $1^{o}F$ change in T_{ave}, RCS pressure will increase by 110 psig.

For every 10 gals added to the RCS, pressure should change by 33 psig.

NOTE 2: If low level in the Pressurizer causes Loss of Natural Circulation, go to EP-34 Loss of Natural Circulation.

6.3.3 Hourly monitor the RTDs on the outlet of the Pressurizer relief valves (computer points 402, 403 and 404. A 10 degree increase in any one of these temperatures is indication of a change in leakage rate through these valves. New leakage calculations will be needed to determine the new leak rate . Refer to EP-21 Loss of Pressurizer Level Indication.

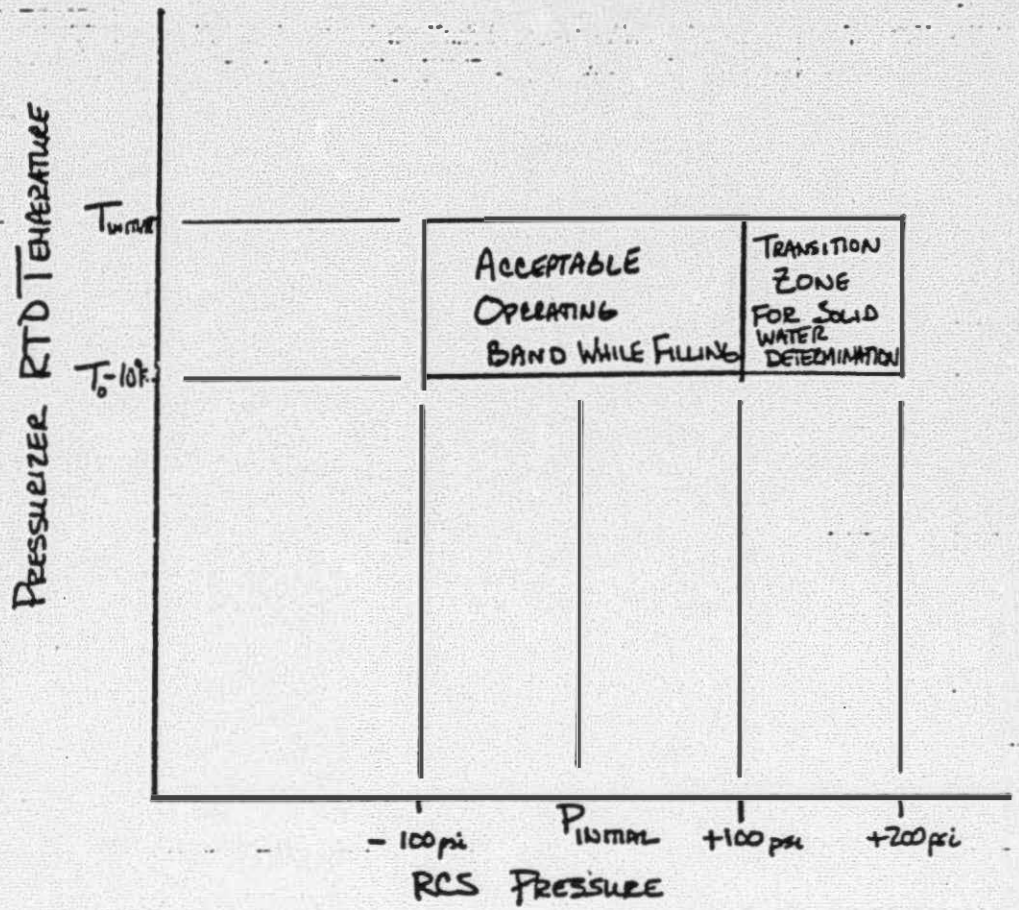
6.3.4 Every 1/2 hour record the data listed in Table E on Data Sheet 2.

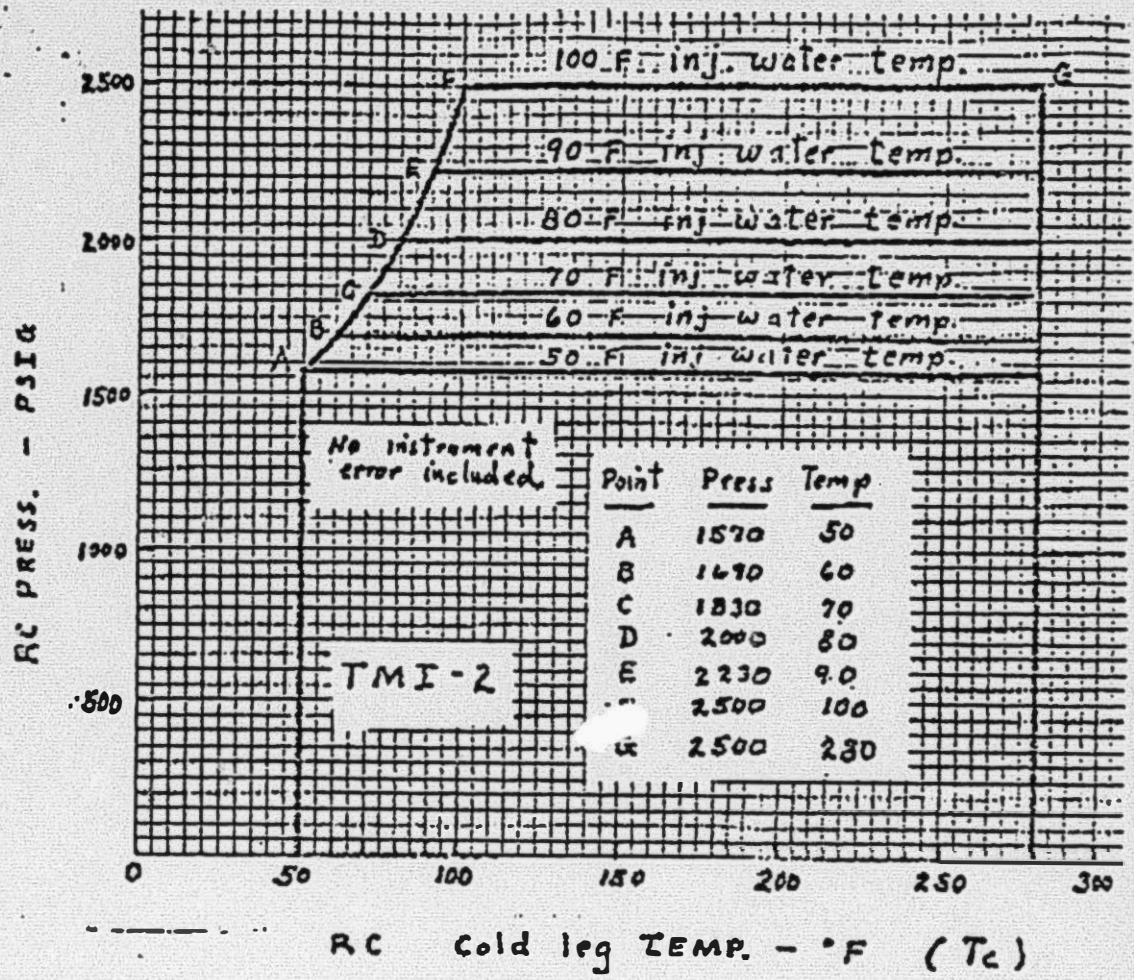
6.3.5 Every 4 hours perform a mass balance on the system to determine if any change in leakage rate can be detected. Utilize Data Sheet 2.

6.3.6 If makeup pumps are lost or seal injection is secured, go to EP-9.

FIGURE 1

TYPICAL OPERATING AREA
FOR USE WITH Z-63 SECT. 6.1
TRANSITION TO SOLID OPERATIONS





ALLOWABLE OPERATING ENVELOPE FOR REACTOR VESSEL HDT LIMITS

Prepared by B.B. Newton 5-3-79

Reviewed by C.E. Harris 5-3-79

Approved by Gordon Williams

Figure 2

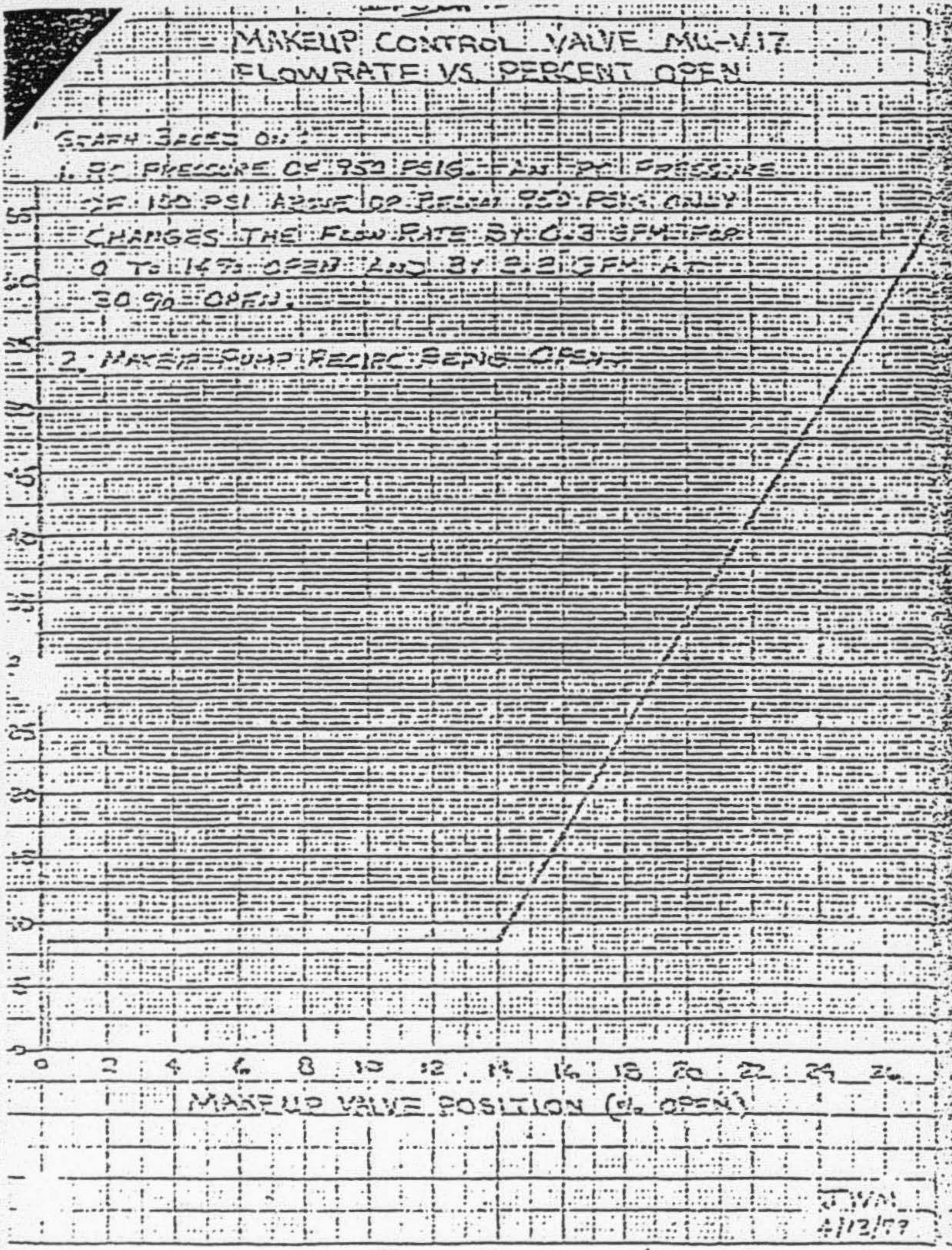

MAKEUP CONTROL VALVE MU-V17
FLOWRATE VS PERCENT OPEN
GRAPH BASED ON:
1. RC PRESSURE OF 950 PSIG. AN RC PRESSURE OF 100 PSI ABOVE OR BELOW 950 PSIG ONLY CHANGES THE FLOW RATE BY 0.3 GPM FOR 0 TO 14% OPEN AND BY 2.2 GPM AT 30% OPEN.
2. MAKEUP PUMP RECIRC BEING OPEN
0 2 4 6 8 10 12 14 16 18 20 22 24 26
MAKEUP VALVE POSITION (% OPEN)
4/12/77

Fig. 3

Z-63 Rev 0

Data Sheet 1

table A	
Tc loop A	
Th loop A	
Prz Temp	
MUT level	
RCS Press 398	
RCS Press 399	
RCS Press	
MUT Press	

table B				
Time	MUT Level Before Fill	MUT Level After Fill	Prz Temp	RCS Press

table C		
Tc		
Th		
Prz Temp		
MUT level		
RCS Press 398		
RCS Press 399		
RCS Press		
MUT Press		
Bank 1	on	off
Bank 2	on	off
Bank 3	on	off
Bank 4	on	off
Bank 5	on	off
SCR % Cont		
mu 5 setting %		

table D	
Tc	
Th	
Prz Temp	
MUT Level	
RCS Press 398	
RCS Press 399	
MUT Press	

863 Bevo

DATA SHEET 2

Time	MUT Level	Gallons added by totalizer during period	T_{c_A}	T_{h_A}	Tave $\left(\frac{T_c+T_h}{2}\right)$	Temp Prz	
		A					

Mass Balance: Make up Rate $= 30.8 \left[\frac{-\Delta L \text{ MUT} + 1.22 \times \Delta T_{ave} + .234 \quad \Delta T_{Prz} + .043 A}{\Delta \text{ Time}} \right]$

Instructions: Determine Δ's between each 4 hour interval. Be sure to add all additions (A) listed for each interval. Draw a line under the data used calculation. Restart data sheet every 4 hours.