AP 1001

TMI 1001-8

Three Mile Island Nuclear Station
Special Operating Procedure

Rev 3

SIDE 1

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

Unit No. 2

Date 5-27-99

NOTE: [illegible] AP 1001 should be followed when completing this form.

1. Title SOLID PLANT OPERATIONS

2. Purpose (Limited purpose of SOP)
PROVIDE [illegible] FOR MAINTAINING RCS SOLID. PROVIDE METHOD FOR [illegible] AND OPERATION A BUBBLE. (REV 3) REVISE PROCEDURE TO REFLECT NEW [illegible] FOR [illegible] PRESSURE AND TEMPERATURE FOR CURRENT PLANT CONDITIONS.

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

NRC

4. Generated by [illegible] Date 5-27-99

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

NRC [illegible] Approved – Shift Supervisor C.D. Hutchison 5-27-79

B&W T. Broadbelt Shift

Reviewed – List members of PORC contacted
R. Uhrig 5-27-79 per Telcon
I. Porter per Telcon 5-27-79
M.J. Ross per Telcon 5-27-79
T.E. Murley per Telcon 5-27-79
P.R. Newll per Telcon 5-27-79
J.J. Cooney per Telcon 5-27-79

[illegible] 5/27/79

Approved - Unit Superintendent

8. SOP is Cancelled

Shift Supervisor/Shift Foreman — Date

TMI-83 Rev 4001

SOLID PLANT OPERATIONS

1.0 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 EP-9 Loss of Makeup
2.6 Z-39 Natural Circulation Operation
2.7 EP-12 Loss of Instrumentation for RCS Pressure

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 pressure surge may be experienced due to bubble compression (especially at excessive fill rates), a sharp rise in pressure above saturation pressure of about 100 to 200 psi will be an indication of being solid.

3.3 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.

3.4 Closely monitor the natural circulation data collected for RCS parameters to ensure criteria established for satisfactory natural circulation continues to be met. (Refer to Reference 2.6.)

3.5 Carefully monitor pressure while heaters are energized when solid. (Refer to Reference 2.7 upon the loss of pressure indicator.)

3.6 Closely monitor makeup tank pressure and auxiliary building ventilation radiation monitors. Reduce letdown flow if makeup tank pressure exceeds 2 psig or a noticable rise in activity levels is indicated by any upward trend on the Auxiliary Building ventilation radiation monitors recorders, or an individual reading greater than ten (10) times the average value prior to commencing this procedure. Comply with the makeup tank addition rates established by J. G. Herbein.
NOTE: The response of the radiation monitor to an increase in makeup tank room activity will be delayed.

3.7 Observe the NDTT limits of Figure 2.

3.8 Prior to operation with this procedure with DHV-1 and DHV-2 open, caution should be taken to assure that RC pressure at the relief valve on the decay heat letdown line does not exceed it setpoint by monitoring the pressure gauge upstream of DHV-3.

3.8 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 $\geq$100.

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

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

4.1.6 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 pressurizer temperature. (This is for information only and not to be used as a limit.)

NOTE: 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. If pressure rises to within 500 psig of the maximum allowed pressure per NDTT curve (Figure 2), consider operation of RC-V-137 at the direction of the shift supervisor.

6.1.1 Establish makeup tank trace at 45 inches by adjusting letdown flow as necessary to achieve a constant level.

6.1.2 Complete Table A on attached data sheet 1.

6.1.3 Utilizing the combination of MU-V-17 and V-18 and/or MU-V5, slowly raise pressurizer level while reducing Makeup tank level at the rate of about one inch every three minutes. Operate pressurizer heaters as follows:

A. Initially leave control group as is at beginning of test. (Expect initial pressure rise approximately 15 psi/hr.)

B. When pressurizer pressure begins to decrease (drops 5 psi below highest previous pressure), energize backup heater bank.

C. Use the pressurizer heaters to maintain pressure within ± 25 psi of the saturation pressure corresponding to the initial pressurizer temperature.

D. Monitor and control the temperature of the pressurizer within a control band between the initial pressurizer temperature at which it was at prior to filling and 10° below that temperature (i.e., T initial $^{+0}_{-10^{\circ}F}$).

NOTE: 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 $10^{\circ}F$ of its initial temperature, raise pressurizer level in a series of small step changes allowing pressurizer temperature to return to within $10^{\circ}F$.

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

6.1.5 Refill the MU tank from the degassed source with appropriate boron addition to 45" in the MU tank. Complete Table B on data sheet 1 for each addition to the MU tank.

6.1.6 Monitor pressurizer temperature. Ensure it is within $10^{\circ}F$ of the initial temperature.

6.1.7 Repeat steps 6.1.3 - 6.1.6 until plant is solid. Indication of solid plant is when pressure increases rapidly approximately 100 to 200 psi above the saturation pressure correpsonding to the initial pressurizer temperature. Compare with pressures recorded in Table A on data sheet 1.

6.1.7.1 Maintain pressure between 100 and 200 psi above the saturation pressure corresponding to the initial pressurizer temperature recorded in Table A by adjusting makeup and letdown for a minimum of two hours after reaching a solid condition.

NOTE: When first taken solid (i.e., pressure sharply increases approximately 100 to 200 psi above initial pressure), the Pressurizer may contain a superheated, highly compressed steam bubble. This bubble will act as an ideal gas while superheated and will slowly (possibly 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.

6.1.7.2 Maintain pressurizer temperature in a band of plus 0^{o} to minus 10^{o} of the initial pressurizer temperature recorded in Table A.

6.1.7.3 If makeup tank level exceeds 45", divert to letdown the flow to the R.C. Bleed Tank at the direction of the Shift Supervisor. Lower makeup tank to below 45" and realign MU-V8 to the makeup tank.

6.1.7.4 Following the hold period specified in 6.1.7.1, slowly reduce pressure to 50 ($\pm$ 25) psi above the saturation pressure corresponding to the initial pressurizer temperature by carefully increasing letdown flow.

6.1.8 If it is desired to draw a bubble, go to steo 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 $\pm$ 5^{o}F for at least four hours prior to drawing bubble.

*The ordered pressure will be specified by R. C. Arnold or J. G. Herbein prior to initiation of this procedure.

6.2.2 While establishing pressurizer temperature, maintain pressure constant at 50 (± 25) psi 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 (approximately 30") to provide sufficient capacity to receive the flow from the pressurizer when the bubble is drawn.

6.2.3 If level is greater then 45" in the Makeup Tank after the stabilization period (Step 6.2.1 is complete, divert letdown at the direction of the shift supervisor to the R.C. Bleed Tank and makeup from the Makeup Tank to the Pressurizer as necessary to maintain pressure (compensating for leakage) until makeup tank level is less than 45".

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 maximum letdown flow condition.)

6.2.5 Verify Makeup Tank level is less than 45" and stabilized at a constant level. 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 pressurizer heaters to maintain pressurizer temperature ± 5°F at the saturation temperature corresponding to the ordered pressure.

6.2.8 Increase letdown to reduce RCS pressure to the saturation pressure for the temperature established in the pressurizer. Limit the pressure decrease to 5 psi/min.

NOTE: As pressure decreases, MU-V5 must be opened further to maintain the rate of pressure decrease.

6.2.9 Indication that a bubble has been formed will include a stabilization of the pressure while continuing to letdown to the makeup tank. Mark the makeup tank level trace at the point where pressure has been stabilized. Complete Table D. Return to normal pressure control using pressurizer heaters to maintain a band as specified by the shift supervisor.

6.2.10 Closely monitor Makeup Tank pressure and Auxiliary Building ventilation radiation monitors. Reduce letdown flow if Makeup Tank pressure exceeds 2 psig or a noticable rise in activity levels is indicated by any upward trend on the Auxiliary Building ventilation radiation monitors recorders, or an individual reading greater than ten (10) times the average value prior to commencing this procedure. Comply with the Makeup Tank addition rates established by J. C. Herbein. Adjust pressurizer heater input to maintain pressurizer RTD at the desired temperature ± 5°F.

NOTE: The response of the radiation monitor to an increase in Makeup Tank room activity will be delayed.

6.2.11 It is intended to draw a total of approximately 20 inches of Makeup Tank level from the pressurizer. When 20 inches of Makeup Tank level increase have been observed, adjust makeup and letdown to stabilize makeup tank level at a constant value. Also, stop drawing the bubble if either:

A. A noticeable increase in makeup tank level is not observed within 10 minutes or increasing letdown flow per step 6.2.7. This is an indication of an improper valve lineup, instrumentation failure or loss of letdown. Go to EP-5 to restore letdown flow or:

B. Pressurizer pressure is reduced to 25 psi below the ordered pressure. When pressure control has been re-established to within 25 psi or ordered pressure, complete the drawing of the bubble as noted above.

6.2.12 Stabilize Makeup Tank level. Operate pressurizer heaters as necessary to maintain ordered pressure ± 25 psi. Complete Table E.

6.2.13 Determine estimated pressurizer level as follows:

Utilize Tables C, D and E.

From Tables C & D determine the number of inches added to the makeup tank before the bubble was formed. (Table D value - Table C value) Determine total makeup tank addition from Tables C & E. (Table E value - Table C values.)

$$L_{Pzr} = 429 - 1.227\ K^{*}\ [\Delta L_{MUT\ TOTAL} - \Delta L_{MUT\ Before\ Bubble}] + (.042)\left(\begin{array}{c}\text{Leak Rate}\\(\text{gpm})\end{array}\right)\left(\begin{array}{c}\Delta\ \text{Time (min.)}\\\text{Since Bubble}\\\text{Formation was}\\\text{Started}\end{array}\right)$$

*K varies with pressurizer SAT temperature. See Data Sheet 2 for values.

6.2.14 Return to EP-21, substituting the level calculated above for L_{PzrTOF}. Re-establish new TOF values in EP-21 for T_{Pzr}, T_{ave}, L_{MUT} and A from Table E.

6.2.15 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. At the direction of the shift supervisor, reduce the level of the pressurizer to within the control band by either allowing system leakage to gradually bring level down or if sufficient volume remains, addition letdown to the makeup tank.

6.3 Solid Pressurizer Operation

During solid pressurizer operation, the pressurizer pressure shall be maintained at least 50 (± 25) psi above the lowest approved pressure for operation with a steam bubble per data sheet 3.**

6.3.1 Maintain pressure by balancing letdown flow with seal injection flow. Control pressure at 50 (± 25) psi above the saturation pressure corresponding to initial pressurizer temperature. 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 pressurizer temperature: (All three must be met)

1. At the saturation temperature corresponding to a pressure at least 100 psi above saturation pressure for the third hottest in-core thermocouple.

2. At least 50°F greater than the highest T_{μ}. (To insure pressurizer remains the hottest place in the RCS.)

3. At least 5°F below the saturation temperature corresponding to the pressurizer pressure (to prevent inadvertent reforming of the bubble).

4. As close as possible to the lowest approved pressurizer temperature for operation per data sheet 3.**

NOTE: 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 RTD's 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 thenew leak rate. Refer to EP-21, Loss of Pressurizer Level Indication.

6.3.4 Every 1/2 hour, record the data listed in Table F 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 equation 1 on data sheet 2.

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

**Data sheet 3 may be revised by R. C. Arnold or J. G. Herbein in agreement with overall plant status.

TABLE A	
Time	
Tc loop A	
Th loop A	
Pzr Temp	
MUT level	
RCS press 400	
RCS press (Pen)	
MUT press	

TABLE D	
Time	
Tc	
Th	
Pzr Temp	
MUT level	
RCS press 400	
RCS press(Pen)	
MUT press	

TABLE E	
Time	
Tc	
Th	
Pzr Temp	
MUT level	
RCS press 400	
RCS press(Pen)	
MUT press	

TABLE B				
Time	MUT Level Before Fill	MUT Level After Fill	Pzr Temp.	RCS Press

TABLE C		
Time		
Tc		
Th		
Pzr temp		
MUT level		
RCS press 400		
RCS press (Pen)		
MUT press		
Bank 1	On	Off
Bank 2	On	Off
Bank 3	On	Off
Bank 4	On	Off
Bank 5	On	Off
SCR % Cont		
Valve Setting		

DATA SHEET 2

TABLE F

Date / Time	MUT Level	Gallons Added by Totalizer During a Period	Tc_A	Th_A	Tave (Tc + Th) 2	Temp. Pzr.

Pzr Press	K
200	.850
300	.875
400	.897
500	.916
600	.935
700	.951
800	.970
900	.986
1000	1

Δ Time = Time End − Time Beginning ____ − ____ = ____ minutes

$\Delta L_{MUT} = L_{MUT\ End} - L_{MUT\ Beginning}$ ____ − ____ = ____ inches

ΔA = Gallons Added by Totalizer During Period = ____ gallons

ΔT_{ave} = Tave End − Tave Beginning ____ − ____ = ____ °F

$T_{Pzr} = T_{Pzr\ End} - T_{Pzr\ Beginning}$ ____ − ____ = ____ °F

Calculated Leak Rate This Period

____ GPM

EQ 1:

$$\text{Leak Rate} = \frac{24 \text{ gal/in}}{\Delta \text{ Time}} \left[(-1.227)(K)(\Delta L_{MUT}) + (.0393)(K)(A) + (1.5)(\Delta T_{ave}) + (.287)(K)(\Delta T_{Pzr})\right]$$

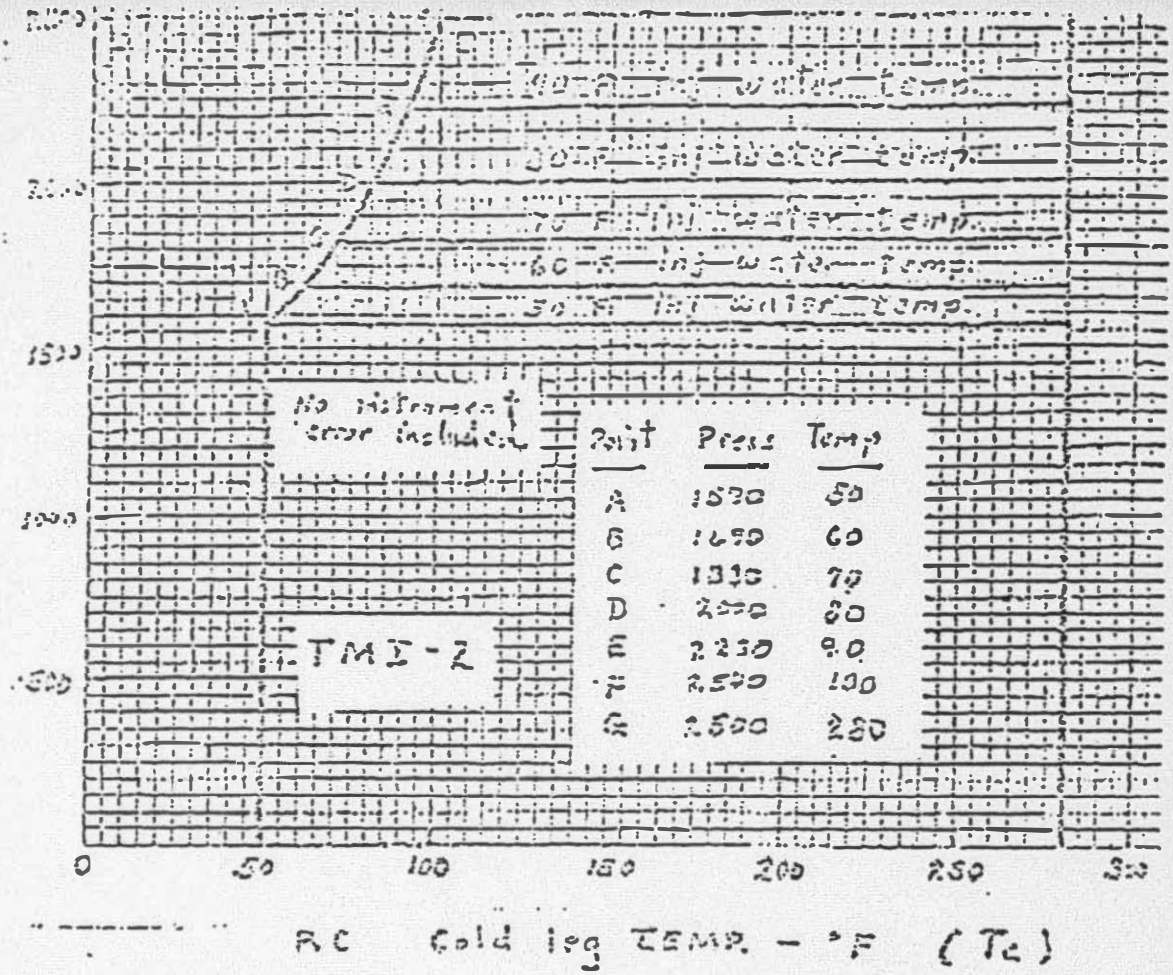
$$\text{Leak Rate} = \frac{24 \text{ gal/in}}{(\quad)} \left[(-1.227)(\quad)(\quad) + (.0393)(\quad)(\quad) + (1.5)(\quad) + (.287)(\quad)(\quad)\right]$$

1.5 max

INSTRUCTIONS: Determine Δ's between each 4 hour interval. Be sure to add all additions (A) listed for each interval. Use a new Data Sheet for each interval. Be sure to include proper sign convention for Δ's in Equation 1.

DATA SHEET 3

Date	Minimum Allowable Pressurizer Pressure	Minimum Allowable Pressurizer Temperature
5/27/79	275 psig	414.23°F



To compensate for instrument error, stay 50 psi below the pressure limits of the envelope.

ALLOWABLE OPERATING ENVELOPE FOR REACTOR

VESSEL NDT LIMITS

Prepared by [signature] 5-3-79

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

Approved by [signature]

Figure 2

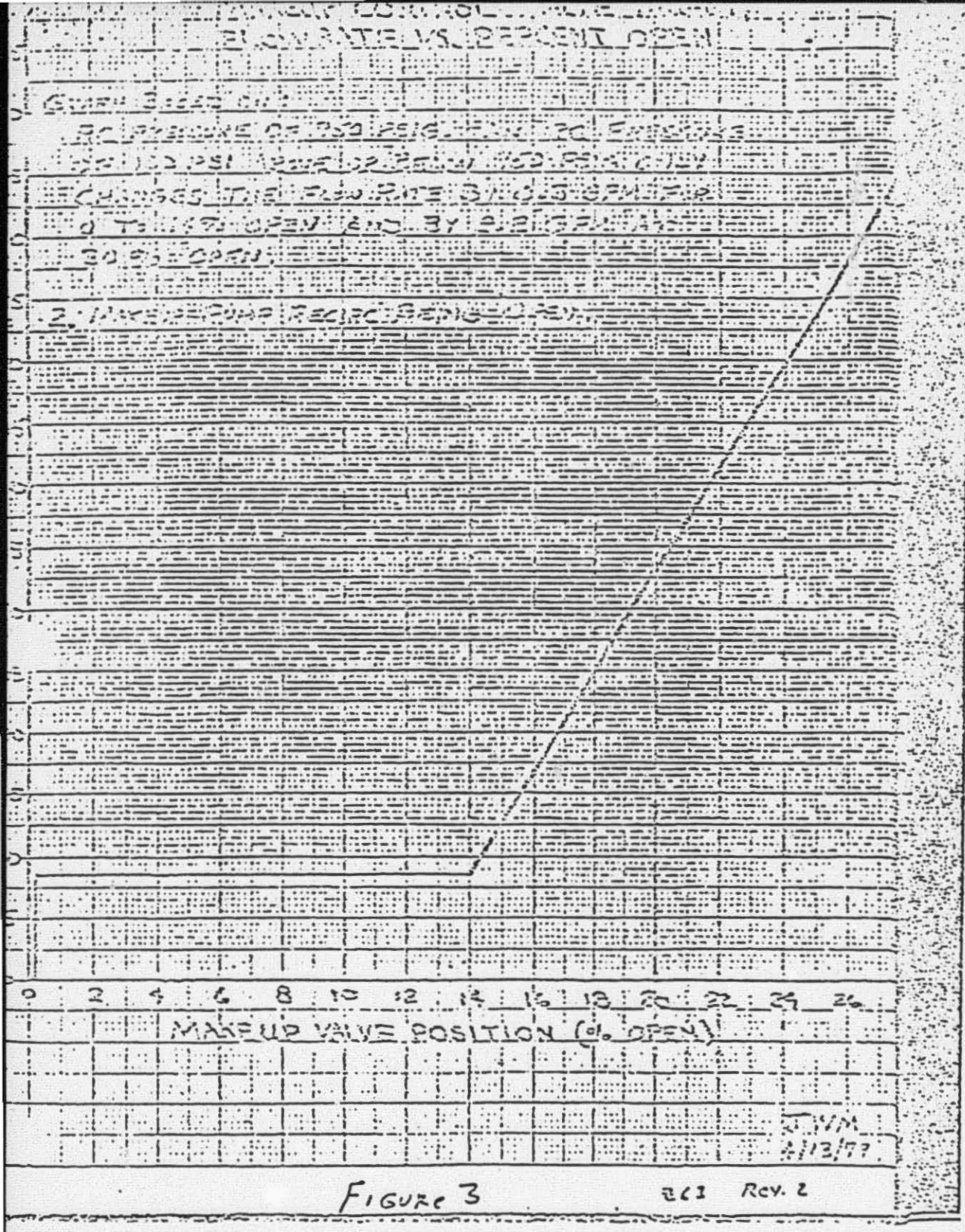


FIGURE 3 EC1 Rev. 2