A.' 1001

ire 1001-8

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

Three Mile Island Nuclear Station

Special Operating Procedure

NRC

SIDE 1

SOP No. EP-21 Rev. 6 (From SOP Log Index)

Unit No. 2

Date 5/9/79

1. Title LOSS OF PRESSURIZER LEVEL INDICATION

2. Purpose (include purpose of SOP) The intent of this procedure is to track pressurizer level after a loss of normal level indication utilizing an empirically derived relationship between Make Up Tank level, pressurizer level, and RCS leakage. Periodic checks and updates will be made utilizing the test equipment installed on the pressurizer water space sample line and pressurizer temperature (RTD) voltage output to determine actual level.

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 TSPG Date 5/9/79

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 RP Warren 5/9/79

NRC [illegible] 5/11/79 GK [illegible] 5/9/79 RW Bensel 5-9-79 Date

B&W BD Hu[illegible] 5/9/79 M. [illegible] 5-9-79 Date

[illegible] HWG [illegible] 5-10-79 J[illegible] 5/9/79 Date

Approved - Unit Superintendent

8. SOP is Cancelled

______ Shift Supervisor/Shift Foreman ______ Date

LOSS OF PRESSURIZER LEVEL INDICATION

PURPOSE

The intent of this procedure is to track pressurizer level after a loss of normal level indication utilizing an empirically derived relationship between Make Up Tank level, pressurizer level, and RCS leakage. Periodic checks and updates will be made utilizing the test equipment installed on the pressurizer water space sample line and pressurizer temperature (RTD) voltage output to determine actual level.

1.0 INITIAL CONDITIONS

1.1 Pressurizer level is being maintained in a band of 375 ±25 inches.

1.2 RCS pressure is being maintained between 300 and 1000 with a bubble in the pressurizer.

1.3 The pressurizer temperature transmitter selector switch on the control panel must be CAUTION tagged to require Shift-Supervisor permission to operate. After any readings taken on TT-1 the switch must be selected to TT-2. This will allow TT-2 to read out on the pen recorder and provide TT-1 as the point monitored by the computer.

1.4 Pressurizer heater interlocks disabled to prevent level failure from causing loss of heaters.

1.5 Temperature of RCS is between 160° and 280°F.

1.6 RC-V2, RC-2 and RC-V137 shut.

1.7 MUV 8 is aligned to the make-up tank.

2.0 SYMPTOMS

2.1 Failed pressurizer level indication. Level instrument should fail to midscale, but may fail high or low.

2.2 Pressurizer level annunciator sounds.

2.3 Pressurizer level steady with changing plant parameters.

3.0 IMMEDIATE ACTION (First 5 Min.)

3.1 Do not secure spray if already initiated.

3.2 Do not alter pressurizer heater alignment.

3.3 Shut or check shut MUV 17 and 18. (With a loss of indication it will be necessary to go to shut on MUV 18 regardless of assumed position.)

3.4 Check shut pressurizer vent valve RC V137 and relief valve block valve RC V2.

3.5 Check MU V-8 aligned to the make-up tank and not to the bleed tank.

3.6 Record the last valid pressurizer level from the pen recorder prior to malfunction of the instrument.

3.7 Start a summary Group including points 389, 1682, 398, 399, 394, 400, and 341 trending at 1 min. intervals. Secure trending the Group Summary at the direction of the shift supervisor.

3.8 Record the data listed in data sheet 1.

4.0 LONG-TERM ACTIONS (After 5 Min.)

4.1 Maintain ordered RCS pressure $\pm$ 50 psig. DO NOT EXCEED 1000 psig.

4.2 DO NOT VENT THE PRESSURIZER.

4.3 Maintain constant reactor coolant temperature during first 4 hours following loss of all pressurizer level indication. Subsequent shrink due to cooldown must be compensated for by periodic additions per section 5.4.

4.4 Maintain MU-V8 aligned to the makeup tank. If diversion to the RC Bleed tank is necessary, obtain permission from the shift supervisor to reposition MU-V8. Note the level in the RC Bleed Tank before and after MU-V8 is operated. Convert this level change to gallons. Enter on data sheet 3.

4.5 Maintain pressurizer level utilizing the method outlined herein.

4.5.1 Every 2 hours calculate the pressurizer level using data sheet 3. Utilize the best estimate of leakage rate as listed in data sheet 5.

4.5.2 Plot the value obtained from 4.5.1 on a pressurizer level vs. time trend plot.

4.5.3 Control level within the band of 375 $\pm$25 inches.

4.5.4 Periodic additions must be made to compensate for leakage in the RCS. Minimize the number of additions by utilizing the full range of the control band.

A. The change in pressurizer level resulting from an addition from the MUT can be calculated as follows:

$$\Delta L_{PZR} = + 1.227K (\Delta L_{MUT})$$

where $\Delta L_{PZR} = L_{Desired} - L_{CALC}$

$$\Delta L_{MUT} = L_{MUT\ Before\ Addition\ to\ RCS} - L_{MUT\ After\ Addition\ to\ RCS}$$

K = Function of pressurizer saturation temperature. See data sheet 3 for value.

So as an example: required control band 350-400 level calculated per data sheet 3 = 352, pressure = 900 psig.

Calculate amount to be pumped out of makeup tank and into RCS as follows:

$$\Delta L_{pzr} = 1.227(K)(\Delta L_{MUT}) \text{ so } \frac{\Delta L_{pzr.}}{1.227K} = \Delta L_{MUT}$$

$$\Delta L_{pzr.} = \underset{\text{Desired}}{400} - \underset{\text{Calc.}}{352} = 48 \text{ inches}$$

K = .986 (for 900 psig) from Data Sheet 3

$$\Delta L_{MUT} = \frac{48}{(1.227)(.986)} = 40 \text{ inches}$$

So to raise pressurizer level to top of band, i.e., 400", pump 40 inches out of makeup tank to RCS.

CAUTION: 1. DO NOT fill makeup tank from other than letdown while making RCS addition.

2. DO NOT lower makeup tank level to less than 20" while makeup pumps are running.

4.5.5 Refill the makeup tank as necessary to a level within the control band specified by the shift supervisor. Makeup tank has a capacity of 30.8 gal/in.

4.6 Maintain a record of additions to the M/U Tank by completing data sheet 2. Use the totalizer (if available) as the means of determining actual gallons added to the makeup tank.

4.7 Between RCS addition, at least every 8 hours determine pressurizer level utilizing the DVM method as outlined below. This method measures the pressure exerted on the water space sample tap in the wall of the pressurizer and the saturation temperature of the bulk fluid in the pressurizer. The pressure on the water space sample tap includes saturation pressure + the height of water in the pressurizer. The saturation temperature of the bulk fluid is converted to saturation pressure in the pressurizer. By taking the difference in these two pressures (PSAT + ΔH - PSAT) a ΔP is determined which can be directly correlated to pressurizer level (ΔH) using the curve of Figure 1. This measurement is highly sensitive to equilibrium conditions within the pressurizer and is used as an additional information point as to actual pressurizer level. No action is required based on the magnitude of this value.

4.8 Between additions, at least once every 8 hours determine pressurizer level utilizing the following DVM method.

4.8.1 Stabilize pressure ±50 psig within the pressure band specified by the shift supervisor. Maintain pressure and heater input as constant as possible during the five minutes of data collection.

4.8.2 Check CA V3 and CA V10 open.

4.8.3 Compare the output of the digital voltmeter (DVM) monitoring pressurizer water space pressure with the indicated RCS pressure on the installed plant instrumentation.

Conversion: [(DVM Voltage) (137.5)] - 275 psig = Pressure

NOTE: If a primary sample has been drawn since the last level determination, there is a potential for an improper valve lineup. If erroneous indication is noted in step 4.8.3 above, re-verify the valve lineup per Z-107 to ensure the pressurizer pressure transmitter has been put in service. If valve lineup is correct, contact the I&C shop to trouble shoot the transmitter and/or the digital voltmeter.

4.8.4 Station a man to read the pressurizer bulk fluid RTD as read on the digital voltmeter installed on the output of the linear bridge. (Cable Spreading Rm.).

4.8.5 Establish communication between the man reading the pressurizer water space pressure and the man reading the DVM on the pressurizer temperature output.

4.8.6 Simultaneously read and record the DVM readout at both stations on Data Sheet 4. Repeat this process five times at 1 minute intervals.

4.8.7 Calculate level per equation on data sheet 4. Average the five readings and plot this value as a * on the pressurizer level plot established per 4.5.2.

4.9 As determined by the shift supervisor, the plant will be periodically taken solid per Z-63 and mass balance performed to determine actual pressurizer level before and after the bubble is redrawn. In addition, while solid, an accurate leak rate can be determined using Z-63.

4.9.1 Following redrawing the bubble per Z-63, reset the pressurizer level vs. time plot to the level determined in Z-63 as follows: On Data Sheet 3, enter the time of failure (TOF) values for the following items as recorded on Table E of Z-63: (T_{ave}), (L_{MUT}), and (T_{pzr}).

4.9.2 Restart the cumulative values of A (gallons added to the makeup tank) and Δtime since the time at which Table E was completed.

4.9.3 Inplace of pressurizer level at time of failure ($L_{pzr\ TOF}$) insert the level calculated in Z-63.

4.9.4 Enter the new leak rate (calculated in Z-63) into Data Sheet 5. Utilize the new value as "ℓ" to calculate L_{pzr} per Data Sheet 3. Inform shift supervisor of the new leak rate.

4.9.5 Continue to plot new level. Annotate on plot the date and time or the new point per Z-63 control level per Section 4.5

4.10 Loss of pressurizer level (high or low).

4.10.1 LOW level.

A. Indication.

Rapid superheating of pressurizer steam volume as indicated by sudden increase in pressurizer temperature RTD readout.

A deviation from the null value being trended on the low level brush recorder in the control room.

B. Immediate Action.

(1) Secure all pressurizer heaters.

(2) Open or check open MU-V18, Close MU-V5. Using MU-V17 raise pressurizer level by pumping 20 inches out of the makeup tank at a rate of 1 inch a minute or until the value trended on the low level brush recorder returns to its initial value, whichever occurs first. MONITOR RCS Pressure.

NOTE: This rate of addition may increase pressure at higher pressurizer levels due to bubble compression or taking the plant solid. EXTREME CAUTION must be exercised when raising level. DO NOT EXCEED PSAT + 200 psig.

(3) Allow plant to stabilize.

(4) If brush recorder has returned to normal, re-energize heaters and return to normal level control. Closely monitor pressurizer temperature.

(5) If brush recorder has not returned to normal, slowly increase pressurizer level in by pumping 5 inch increments out of the makeup tank while carefully monitoring pressurizer temperature and pressure.

(a) When an additional 30 inches out of the makeup tank have been added, or the brush recorder returns to its initial value, stabilize MUT level.

(b) Re-energize pressurizer heaters in the lower bank (BK1,2,3) first to regain normal pressure control. Closely monitor pressurizer temperature for an indication of abnormal temperature response.

(c) Trouble shoot the low level brush recorder to determine its operability.

(d) If no obvious reason can be found for the decrease, consideration should be given to taking the pressurizer solid per Z-63. If a loss of pressure control is experienced concurrent with these indications, proceed to Section 4 of EP-33 utilizing the LPI pumps.

4.10.1 High pressurizer level

A. Indicated by increasing RCS pressure (greater than PSAT). This indication only occurs if for existing PZR temperatures the pressurizer is near solid.

(1) Take manual control of MU-V17 (if being used) and maintain the existing makeup flow rate. Use MU-V5 for pressure control.

(2) Shut/check shut RC-V1, RC-V2, and RC-V137.

(3) Secure all pressurizer heaters, record the RCS pressure and mark the pressure recorder chart.

(4) Proceed to Z-63.

DATA SHEET 1

EP-21 5/8/79 Rev. 6

	Values at Time of Failure (TOF)
Console Pen Recorder MCS Pressure	
Console Pen Recorder PRZ Temperature	
Console Pen Recorder Th	
Console Pen Recorder Tc	
Console Pen Recorder MU Tank Level	
Console MU Tank Temperature	
Console MU Tank Press	
OSTG Operating Range A Level	
OSTG Operating Range B Level	
OSTG A Temperature	
OSTG B Temperature	
Upper Cavity Press RCP1A	
RCP1B	
RCP2A	
RCP2B	
Seal Leakage	
RCP 1A	
RCP 2A	
RCP 1B	
RCP 2B	
Seal Injection	
RCP 1A	
RCP 2A	
RCP 1B	
2B	

DATA SHEET 2

EP-21 5/8/79 Rev. 6

RECORD OF ADDITIONS TO MU TANK

(Use Totalizer)

TIME/ DATE	TOTALIZED FLOW TO MAKEUP TANK (gal.)	CUMULATIVE TOTALIZED FLOW TO MU TK SINCE TOF (gal.)	INITIAL

DATA SHEET 3

PRZ LEVEL CALCULATION

ITEM

1. L= (PRZ TOF taken from value recorded on data sheet 1) = _____ inches.
2. ΔT_{ave} = (RCS T_{ave} _____ °F - (RCS T_{ave} @ TOF) _____ °F = _____ °F.
3. K = See table PZR Pressure vs. K below = _____.
4. Δ L MUT = (MUT per recorder level) _____ inches - (MUT level @ TOF) _____ inches = _____ inches.
5. A = (Total additions to MUT since TOF from Data Sheet 2) = _____ gal.
6. Δ T PZR = (temp. PRZ) _____ °F - (temp. PRZ @ TOF) _____ °F = _____ °F.
7. ℓ = leakage RCS = _____ GPM.
8. Δ Time = (present time - TOF) = _____ hours.

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

EQUATION

*L_{PZR} = (item 1) + 1.5 (item 2) - 1.227 (item 3)(item 4) + .0398 (item 3)(item 5) + .287 (item 3)(item 6) - 2.5 (item 7)(item 8). = _____ inches.

*L_{PZR} = L + 1.5 T_{ave} - 1.227K(ΔL MUT) + .0398K(A) + .287K (Δ T PZR) - 2.5ℓ(time) = _____ inches.

*L_{PZR} = ( )in. + 1.5 ( )°F - 1.227 ( )( ) inches + .0398 ( )( ) gal. + .287(X)°F - 2.5 ( )gpm( )hours = _____ inches.

*record and plot

DATA SHEET

Time	Water Space Pressure		Pressurizer Temperature			ΔP
	DVM (Volts)	Psig Fm Eq 1	DVM (Volts)	Temp. Fm Eq 2	PSAT (Psia)	Fm Eq 3
					Average	

Eq 1 Water Space Pressure (psig) = (137.5)(Volts) -275

Eq 2 Pressurizer Temperature (^{o}F) = $\frac{(101\ (\text{Volts}))}{20}$ 700

Eq 3 ΔP(psig) = Water Space Pressure + 14.7 - PSAT

To determine PSAT - interpolate in the steam tables to the right for the temperature calculated in equation 2 as follows:

1. Determine pressurizer temperature from equation 2.
2. Find the nearest temperatures (high and low) in the steam tables to the right.
3. Determine the difference in the two nearest temperatures and their corresponding saturation pressures.
4. Determine the difference between pressurizer temperature for equation 2 and the nearest low temperature.
5. Divide the temperature difference calculated in 4 by the temperature difference in 3 and multiply by the difference in pressure calculated in 4.

$$\frac{\Delta TOF\ (4)}{\Delta TOF\ (3)} \times \Delta P(4)$$

6. Add the product to the pressure associated with the lower temperature noted in 2.

STEAM TABLES

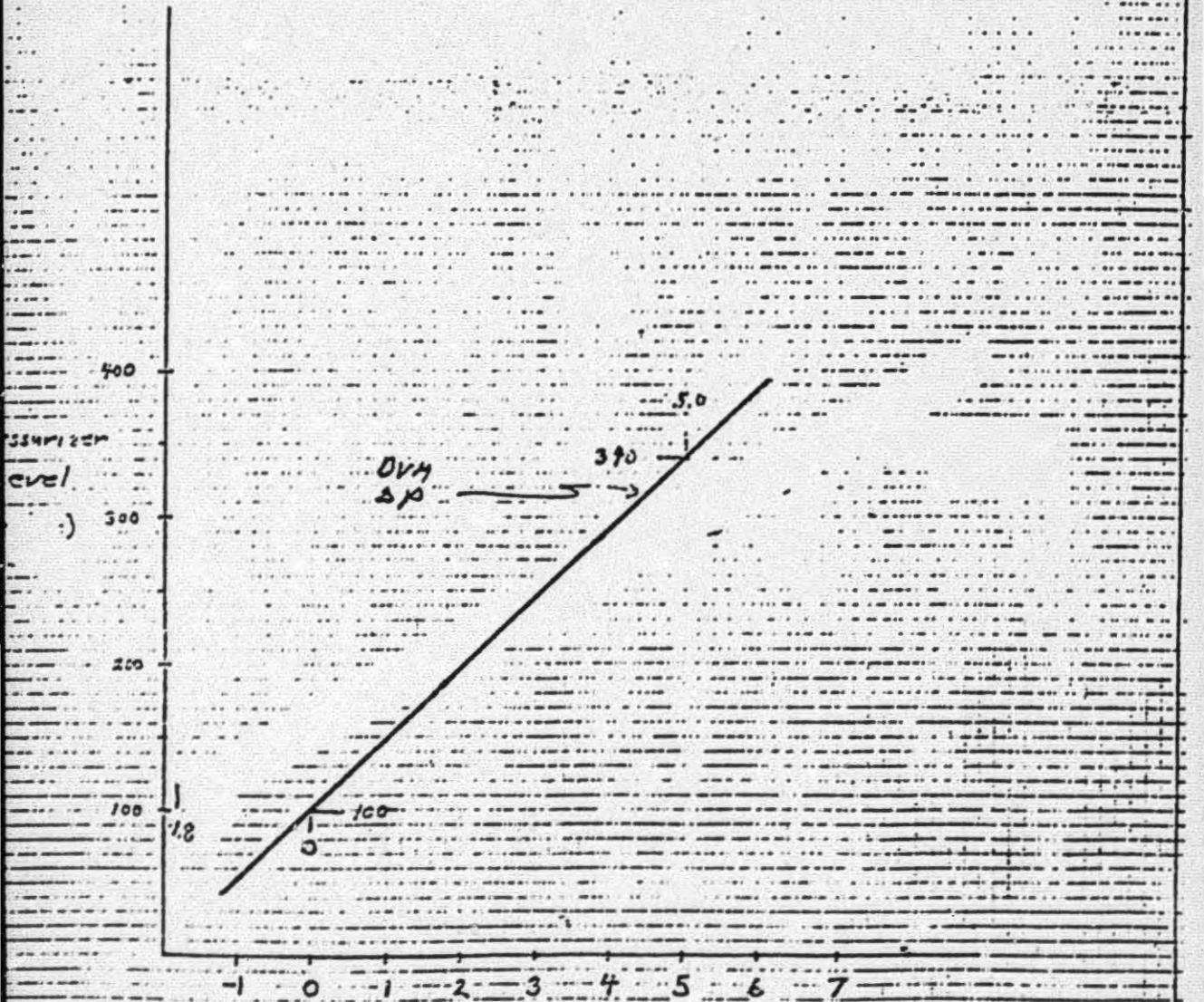
DATA SHEET 5

RECORD OF BEST ESTIMATE LEAKRATE TO BE USED IN EQUATION 1 ON DATA SHEET 3

LEAKRATE (GPM)	TO BE USED AFTER TIME/DATE	SIGNATURE (Shift Supervisor)

Figure 1

Pressurizer Level as calculated from Pressurizer Water Space Pressure Measurement



$$\Delta PSI = P_{measured} - P_{sat}$$

$P_{measured}$ = Water Space DVM