ATTACHMENT III

Consumers Power Company
Palisades Plant
Docket 50-255

LTOP - HEAT ADDITION PRESSURE OVERSHOOT
(EA-NL-89-14-1)

September 22, 1989

30 Pages

TSP0889-0101-MD01-NL04

DESIGN REVIEW SIGNOFF

EA: A-NL-89-14-1

UFI: 950*42*40*01

TITLE: LTOP - HEAT ADDITION PRESSURE OVERSHOOT

PURPOSE: DETERMINE THE EFFECT ON PCS PRESSURE WHEN FORCED CIRCULATION IS INITIATED WITH THE S/G SECONDARY AT A HIGHER TEMERATURE THAN THE PCS. THE ANALYSIS IS PERFORMED ASSUMING THE NEW REPLACEMENT PORV'S ARE INSTALLED AND THE VARIABLE LTOP SETPOINT IS IN SERVICE.

PROCEDURE UTILIZED: RETRAN ANALYSIS DESCRIBED WITHIN.

SIMILARITIES WITH PREVIOUS DESIGNS: N/A

SUMMARY OF RESULTS: A SET OF REQUIREMENTS FOR PRIMARY COOLANT PUMP OPERABILITY WITH A SECONDAY TO PRIMARY ΔT IS DETERMINED (SEE SECTION 4.0)

SPECIAL MEDIA ATTACHED (DRAWINGS, MICROFICHE, ETC)

___ NO ✓ YES - LIST OF ATTACHMENTS INCLUDED

FSAR UPDATE REQUIRED: ✓ NO ___ YES UPDATE ATTACHED ___ OR

UPDATE ASSIGNED TO: ______________________

REQUIRED COMPLETION DATE: ________

R.J. Gerling / 9/14/89 — PREPARED BY / Date

[signature] / 9/19/89 — PREPARER APPROVED BY / Date

T.C. Duffy / 9/18/89 — REVIEWED BY / Date

[signature] / 9/19/89 — REVIEWER APPROVED BY / Date

[signature] / 9/19/89 — REPORT APPROVED BY / Date

Consumers Power
POWERING MICHIGAN'S PROGRESS

NUCLEAR OPERATIONS DEPARTMENT
Document Review Sheet

Document Title	Document Number	Revision	Revision Number	Page
EA-A-NL-89-14			0	Page 1 of 2

Item Number	Page and/or Section Number	Comments	Response or Resolution
1.	Pg. 1-x (1.1 2nd ¶)	THE OVERPRESSURE R.V. (RV 3164) IS SET TO OPEN AT 300 PSIG (315 psia) IT WONT ~~BE~~ ALWAYS LIMIT THE SYSTEM PRESSURE TO 315 psia.	Reworded to say the valve is set to try to limit pressure to 315 psia.
2.	Pg 1-x ~~under~~	THERE IS A DISCUSSION IN JAM 85-019 (ATTACHED) ABOUT WHAT THE ACTUAL LIMIT ON THE SDC PRESSURE IS, THIS MIGHT ENABLE A ΔT PRIM to SECONDARY WITH SDC AVAILABLE UNDER CERTAIN CONDITIONS IF SO DESIRED.	See the response to comment 6.
3.	Pg. 2-x	ONCE YOU START REVERSE HEAT TRANSFER (SECONDARY → PRIMARY), WHAT IS REMOVING THE DECAY HEAT FROM THE PCS? SHOULD THE D.H. BE RAMPED BACK UP TO SOME REASONABLE VALUE? ESPECIALLY WHEN PCS IS ABOVE 250°F AND SDC IS DEFINELY NOT AVAILABLE.	Decay heat removal is assumed to be taking place by either SDC or one SG, before the pump is started. SDC is not applicable and one SG will still remove D.H. after pump start, see pgs. 2-3
4.	Pg. 3-x 1st ¶	The PROPOSED VARIABLE LTOP SETPOINT CURVE WAS CHANGED (LOWER BY 6 TO 9 PSI DUE TO COMMENTS ON REVIEW.) CHECK THE EFFECT ON THIS EA.	Since Appendix G values are unchanged, the slightly lower setpoint curve results in a slight conservatism for this analysis.

Reviewer	Organization	Date	Review Coordinator	Date	Document Sponsor	Date
T.C. DUFFY	Rx ENG.	8/25/89				

Form 3110 1 82

1.0 OBJECTIVES

An analysis is performed for the Palisades Plant to determine the effect on PCS pressure when forced circulation is initiated with the SG secondary at a higher temperature than the PCS. The analysis is performed assuming the new replacement PORVs are installed and the PCS conditions are such that the proposed variable Low Temperature Overpressure Protection (LTOP) setpoint is in service. The analysis calculates the pressure overshoot beyond the LTOP trip setpoint for several initial PCS conditions to form a basis for procedural guidance with respect to primary coolant pump (PCP) operability, when a primary to secondary temperature difference exists. The analysis is also designed to protect against the possibility of an inadvertant pump start with a primary to secondary delta T. This analysis is performed in response to A-NL-89-14.

1.1 Background

Current plant Technical Specifications prohibit starting a PCP if the SG secondary water temperature is higher than the PCS temperature and the LTOP System is in service (Reference 1). This is to preclude overpressurizing the PCS due to reverse heat transfer from the SG when the pump is started, before PCS pressure control can be regained. With the replacement of the current PORVs with larger, higher capacity valves the possibility exists for removing (or relaxing) this restriction. However, the proposed variable LTOP setpoint will reduce margin to the Appendix G pressure limits by raising the trip setpoint at certain PCS temperatures in order to take advantage of the greater relief capacity of the new PORVS (as they affect other overpressure concerns). Therefore, in order to relax the PCP start requirement, both the capability of the new PORVs and the proposed variable LTOP setpoint must be considered.

It should also be noted that a further restriction will exist if the Shutdown Cooling (SDC) System is in service. The overpressure relief valve on the SDC System piping is set to try to limit pressure to 315 psia (Reference 2). The floor of the variable LTOP setpoint will be 326 psia, therefore, a SG to PCS temperature difference of zero degrees will have to be maintained.

2.0 ANALYSIS INPUT & METHODOLOGY

The RETRAN-02 MOD 5.0 computer code is used in this analysis to calculate the PCS pressure response (Reference 3). A model is developed from the Palisades M24-0SG C7R0 base model (see Figure 1 and Reference 4) to simulate the scenario described earlier. The changes made to develop this new base model (labeled the PAL RETRAN LTOP MODEL) are as follows:

1. The normalized power dependent non-conducting heat exchanger in the referenced base model is changed to a flow and temperature dependent non-conducting heat exchanger. This type of heat exchanger model requires a heat transfer coefficient be specified by the user (see Attachment 1 for the calculation of this coefficient). This heat exchanger allows the user to specify the secondary temperature as a function of time. The heat transfer is then calculated knowing the heat transfer coefficient, the primary to secondary temperature difference and the flow through the heat exchanger.

2. The SDC System or SGs are assumed to be removing all decay heat. Therefore, a minimal decay heat power is initially specified to allow an easy initialization. This power is then ramped to zero in the first 5 seconds.

3. The new PORV data is incorporated into this model (see Attachment 2). This analysis assumes only one valve is available for pressure relief. This assumption covers single failure criteria as well as allows for the possibility of normal maintenance of one valve when the LTOP System is in service.

4. The PCPs are modeled as being off initially and a 10 second ramp to full speed is incorporated into the base model pump data (Attachment 3).

The PAL RETRAN LTOP MODEL is maintained and controlled on the Reactor Engineering Dept. VM8 IBM computer under ID RJGERLIN. The files containing the model data are named LTOP DATA A1 and LTOP1 DATA A1.

The base model is initialized without steady state initialization (SSI), assuming solid, stagnant conditions at 300 psia and 120 F. A converged solution is more easily obtained without SSI when there is no initial flow. The boundary conditions used are similar for all cases performed. The secondary temperature is ramped to produce a 100 F delta-T over the first 40 seconds of the simulation. At 40 seconds the 1A PCP is started and ramped to full speed in 10 seconds. PZR heaters are also turned on at 40 seconds to add a slight amount of conservatism to the calculations. The simulations are performed for differing lengths of time depending on the particular case being analyzed. It should be noted that the backpressure on the PORV is held at 100 psig, the approximate pressure at which the rupture disk will fail for the quench tank, in order to insure a slight conservatism in the PORV flow.

The cases performed for this analysis are as follows:

Case 1 - Initial PCS Pressure = 300 psia, Temperature = 120 F
SG Temperature = 220 F
PORV Trip Setpoint = 326 psia

Case 2 - Initial PCS Pressure = 300 psia, Temperature = 170 F
SG Temperature = 260 F
PORV Trip Setpoint = 326 psia

Case 2A - Initial PCS Pressure = 300 psia, Temperature = 170 F
SG Temperature = 190 F
PORV Trip Setpoint = 326 psia

Case 3 - Initial PCS Pressure = 300 psia, Temperature = 210 F
SG Temperature = 310 F
PORV Trip Setpoint = 326 psia

Case 4 - Initial PCS Pressure = 300 psia, Temperature = 250 F
SG Temperature = 350 F
PORV Trip Setpoint = 326 psia

Case 5 - Initial PCS Pressure = 875 psia, Temperature = 350 F
SG Temperature = 450 F
PORV Trip Setpoint = 885 psia

Case 6 - Initial PCS Pressure = 2060 psia, Temperature = 418 F
SG A Temperature = 518 F, SG B = 418 F
PORV Trip Setpoint = 2062 psia
1A PCP Started

The initial PCS conditions chosen for each case are from data points along the proposed variable LTOP setpoint curve developed in Reference 5. For Cases 2, 4 and 5 the data points coincide with a change in heatup (or cooldown) rate. These points will therefore result in the smallest margin to the Appendix G limit, at those particular heatup rates. The pressure rise and overshoot as predicted in each case is compared to the Appendix G limit as calculated in Attachment 4 as well as the overshoot calculated for inadvertant HPSI and charging pump starts in Reference 5.

Case 6 addresses the Steam Generator Tube Rupture (SGTR) accident. At temperatures above SDC System operability (~350 F), the SGTR is considered to be the only scenario in which a SG to PCS temperature difference should exist. Deliberate operator actions are taken to isolate the affected SG (which then remains hot, if PCPs are off), thus creating the delta-T. Without this type of action by the operators (even if it wasn't the result of a SGTR) a temperature difference between the primary and the secondary cannot be created until SDC is in service. The overshoot is calculated for the case where the PCP is started in the same loop as the hot SG. It should be noted that this case is modeled assuming an initial zero degree ΔT in the cold SG loop (decay heat is essentially set to zero in the model). In reality, a delta T (primary to secondary) large enough to remove the decay heat would be present in this SG. When the PCP is started, heat will be transferred from the hot SG to the PCS and, in turn, some of this heat (above and beyond the decay heat) will be transferred back through the cold SG to the secondary. The modeling approach results in the same heat transfer mechanism since this transfer is based on the relative change in PCS temperatures.

3.0 ASSUMPTIONS

The following assumptions are made to perform the calculations in this analysis.

1. The plant is in a steady state condition at the initiation of the event - all PCS heat being generated is also being removed.

2. One PORV is available. This assumption is necessary to satisfy single failure criteria. The PORV opening time is given in Attachment 2. A total stroke time of 2.10 seconds is used from the September 12, 1989 transmittal from MPR Associates.

3. The PCS is assumed to be solid at the initiation of the event for all cases.

4. The backpressure on the PORV is maximized to minimize flow when the valve is not in a choked flow condition.

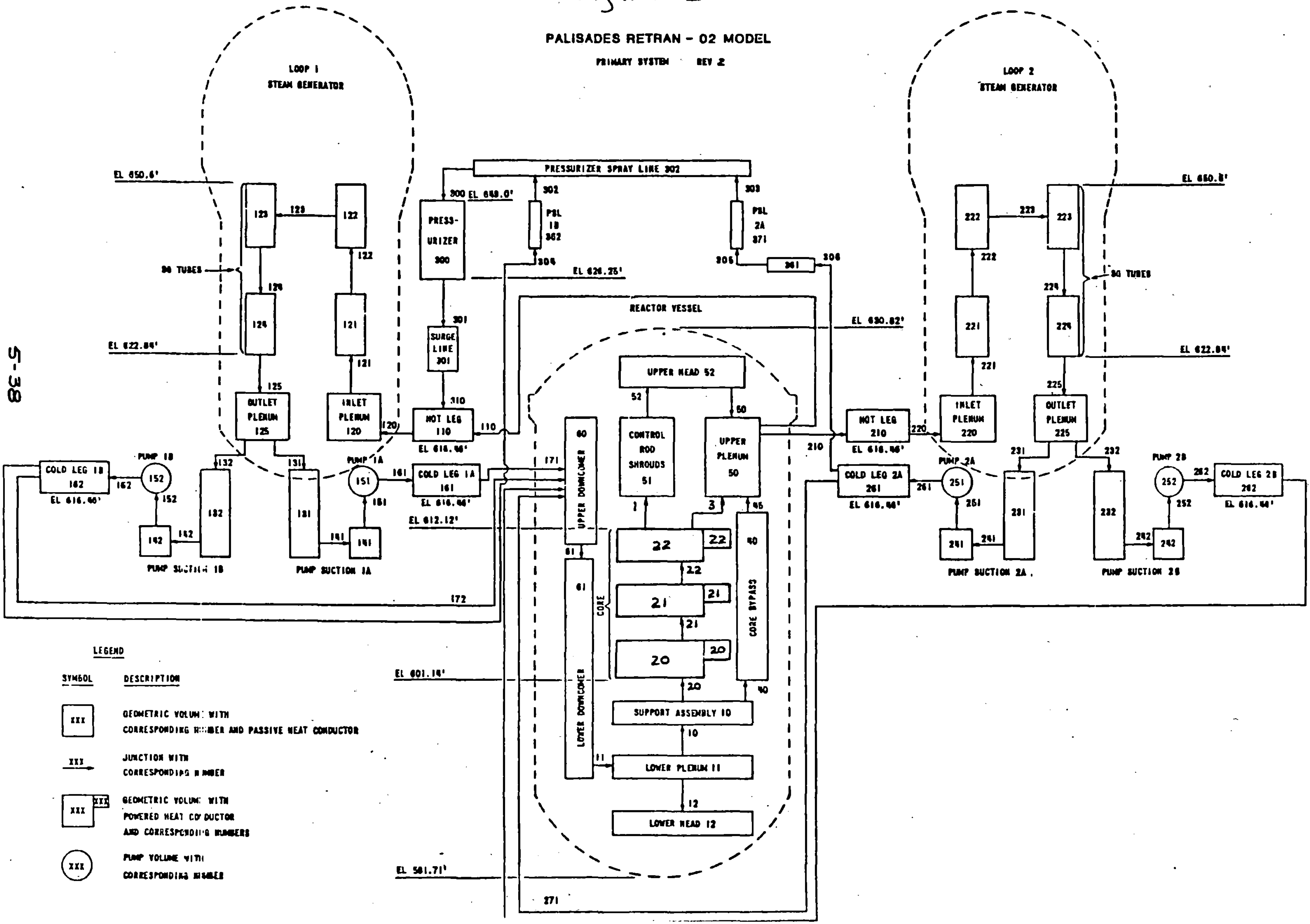
5. PZR heaters are assumed to be on at the initiation of the event to maximize the pressure increase.

6. The PZR is assumed to be saturated for all cases to maximize the pressure increase.

Figure 1

PALISADES RETRAN - 02 MODEL

PRIMARY SYSTEM REV 2



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4.0 ANALYSIS RESULTS

The results of the individual cases are presented in the table below and microfiche of all the RETRAN runs are included with the EA.

Table of Results

Case #	PCS to SG ΔT (F)	T pcs (F)	PORV stpt. (psia)	Peak Press. (psia)	Appendix G Limit (psia)
1	100	120	326	386	401.7
2	100	170	326	413	389.7
2A	20	170	326	377	389.7
3	100	210	326	437	458.7
4	100	250	326	420	536.7
5	100	350	885	963	1099.7
6	100	418	2062	2189	2216

5.0 SUMMARY & CONCLUSIONS

Only one of the cases analyzed, Case 2, shows the peak pressure exceeding the Appendix G pressure limit. Case 2, and its associated initial temperature of 170 F, is analyzed at the point where the cooldown rate changes from 20 to 40 F/hr. The margin to the pressure limit is significantly reduced at this point, making the 100 F ΔT impossible. By reducing the temperature differential to 20 F (as in Case 2A), acceptable results are achieved.

Case 6 is analyzed at the temperature corresponding to the point at which the PORV setpoint would be the closest to the maximum nominal operating pressure of 2060 psia. This occurs at 418 F and the Appendix G limit is 2216 psia. Beyond 418 F, up to the 430 F termination point, the PORV setpoint continues up (to 2200 psia) while the nominal PCS pressure remains at 2060 psia. This leaves significant margin to the setpoint, thus reducing the overshoot. The Appendix G limit also continues up, beyond 2500 psia.

The Case 6 results indicate that a PCP can be started (in either loop, since the overshoot would be greater in the case analyzed) with as much as a 100 F Delta T between secondary and primary. It should be noted that for Case 6 the PZR is assumed solid initially, like all the other cases analyzed. In all probability there would be a steam bubble present at these conditions, thus reducing or eliminating any possible pressure overshoot.

The results of this analysis support the following conclusions:

1. When the SDC System is in operation, the SG water temperature cannot be higher than the PCS cold leg temperature when starting a PCP.

2. When the SDC System is not in operation, the SG can be 100 F hotter than the PCS cold leg between 120 F and 170 F and between 210 F and 350 F. The SG can be no hotter than 20 F above the PCS cold leg temperature between 170 F and 210 F.

3. Under accident conditions such as the SGTR event and with the PCS temperature between 350 F and 430 F: a PCP can be started in either loop with as much as a 100 F ΔT.

6.0 REFERENCES

1. Palisades Technical Specifications, Section 3.1.8.
2. Palisades Instrument Index, M-311, Sht. 31-1.
3. RETRAN-02 - A Program for Transient Thermal-Hydraulic Analysis of Complex Fluid Flow Systems, EPRI-NP-1850-CCM, May 1981.
4. Palisades RETRAN Model, Vol. I-III, A & TA Section, CPCo.
5. EA-FC-809-13, Pressure Response Effects on VLTOP With Replacement PORVs, August, 1989.

Attachment 1

SG Heat Transfer Coefficient Calculations

SG Heat Transfer Coefficient Calculations for Use in RETRAN Non-Conducting heat Exchanger Models.

Typical PCS Conditions Following Shutdown are used, data taken from Palisades Long-Term Cooldown RETRAN Analysis, SCG-434-85, Energy Inc., November 26, 1985.

$Q_{core} = 25.3$ MWt $= 8.634131 \times 10^{7}$ Btu/hr

$Q_{pump\ heat} = 4.98608 \times 10^{7}$ Btu/hr (4 pumps)

$W = 34,258$ lbm/sec.

$T_{pcs} = 435\ ^{\circ}F \qquad T_{sg} = 429\ ^{\circ}F$

From RETRAN Vol. 1: Theory and Numerics, pg VI-50, the governing equation for the flow and temperature dependent non-conducting heat exchanger is

$$Q_o = W_o h_c (T_{pcs} - T_{sg})$$

$$h_c = Q_o\left(\frac{1}{W_o}\right)\left(\frac{1}{T_{pcs} - T_{sg}}\right)$$

$$\therefore h_c = 1.3620211 \times 10^{8}\left(\frac{1}{34,258}\right)\left(\frac{1}{435-429}\right) = \underline{\underline{662.63}}\ \frac{\text{Btu-s}}{\text{hr-°F-lbm}}$$

The coefficient calculated here represents the maximum expected value based on actual plant data. The RETRAN non-conducting heat exchanger model will calculate the PCS heat transfer by simply scaling the above equation depending on the flowrate and the temperature difference as a function of time.

Attachment 2

Palisades Replacement PORV Data

Replacement PORV Data

Water Release Data (test date 7/20/89)

Average Open/Close times

OPen 1.61 sec. + 0.340 sec. (signal process + pilot)
+ 0.200 sec. (pressure signal process)
+ 0.540 sec.

Close 4.18 sec. + 0.184 sec. (signal process + pilot)
+ 0.200 Sec (pressure signal process)
+ 0.384 sec.

Full open area = 5.7732 in^2 (0.04009 ft^2)
nominal 4 in. valve

Average C_v = 219.4

Replacement PORV water flow

from test data on 7/6/89
Average $C_v = 219.4$

$$C_v = \frac{29.9\, d^2}{\sqrt{K}} \quad \text{where} \quad K = \frac{894\, d^4}{C_v^2}$$ (Crane Tech. Paper 410, pg A-31)

$$K = \frac{894\,(4^4)}{(219.4)^2} = 4.75$$

Modified Darcy Formula

$$W = 1891\, Y d^2 \sqrt{\frac{\Delta P}{K v}} = \text{lbm/hr}$$ (Crane pg 3-4)

$$\frac{\Delta P}{P_1'} = \frac{310 - 114.7}{310} = 0.630$$ $Y = 0.71$ (Crane pg A-22 for $k = 1.3$)

$$\Delta P = .630\,(310) = 195.3$$

$v = .01894 \frac{ft^3}{lbm}$ @ 420°F (sat. @ 310 psia, 1967 steam tables)

$$W = (1891)(.71)(16)\sqrt{\frac{195.3}{(4.75)(.01894)}} = 1{,}000{,}885 \text{ lbm/hr}$$

$$= \underline{278 \text{ lbm/s}}$$

RETRAN predicts $\underline{279}$ lbm/s (ave. max) Case 1 using 2.0 for K_f and 1.0 for contraction coeff.
∴ This is used as is throughout the analysis.

Target Rock Corporation, 1966E Broadhollow Rd., P.O. Box V, Farmingdale, N.Y. 11735-0917/Phone: (516) 293-3800

SUBSIDIARY CURTISS WRIGHT CORPORATION

C9576

July 26, 1989

Mr. J.L. Topper, Project Engineer
CONSUMERS POWER COMPANY
1945 West Parnall Road
Jackson, Michigan 49201

Reference: P.O. #2003-4152-(Q)
GWO 8304/FC 791
Palisades Plant
TRC Project 88RR

Subject: Non-Conformance - IPS #3686-451 - Test Valve, Body S/N 258

Dear Mr. Topper:

Target Rock Corporation herewith submits the subject non-conformance (In-Process Status Sheet, attached):

Description of Non-Conformance: Specification SP-MP-8304-002(Q) Design Data Sheets #1 and #2 require that the valve opening and closing times are 0.2 sec. minimum/2.0 sec. maximum (pages DDS-3 and DDS-7). The valve was tested with both steam (saturated at 2500 psig) and water (455 psig and 388° F). For both water and steam tests the valve actuated within the required times. Valve de-actuation for water only is outside the specified times.

TRC Recommendation: Accept as is.

Technical Justification: After a review of the test facility it was decided to remove the diode which was used for protecting the switches within the test facility. This diode will tend to maintain the EMF within the solenoid, thereby maintaining the circuit. By removing the diode the EMF will dissipate at a much faster rate, thereby breaking the circuit and causing the valve to de-actuate. With the diode removed the valve was retested on both steam and water. Valve de-actuation times during the steam test fell within specified requirements however these were still outside the acceptable range during the water test.

Both steam and water tests were repeated with the diode back in place. The de-actuation times were significantly lengthened, proving that the diode had an effect.

During the water test with the diode, the valve de-actuated in greater than six seconds; without the diode, de-actuation was in approximately 4.5 seconds. Target Rock Corporation recommends acceptance of this test on the basis that a six second de-actuation should not adversely affect plant safety.

TARGET ROCK CORPORATION

Your disposition of this non-conformance is requested at your earliest possible convenience.

Very truly yours,

TARGET ROCK CORPORATION

Peggy Bruno

Peggy Bruno
Senior Contracts Administrator

PB:nps
Attachment

cc: J. Bocci
V. Liantonio
J. Soldano
R. Beauman

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TARGET ROCK CORPORATION
E. FARMINGDALE, N.Y. 11735

IN-PROCESS STATUS SHEET IPS # 3686 - 451

PART NAME Test Valve DWG. NO. 1071240-5 REV. D

PROJ. NO. 88RR (Body S/N 258) SOURCE

# PCS. INSP.	# PCS. ACC.	# PCS. REJ.
reference ~~S/N~~ TRP 4913 rev E		

DETAILS Valve was tested within TRC "Blow down" facility, with actuation/de-actuation and other appropriate parameters being recorded as a function of time. The valve was tested with both steam (sat @ 2500 psig) and water (455 psig & 388°F). For both the water & steam tests the valve actuated within the required times (ie: 0.2 sec ≤ time ≤ 2.0 sec)

But for the de-actuation times, the valve was beyond the required times (ie: 0.2 sec ≤ time ≤ 2.0 sec).

After a review of the test facility, it was decided to remove the diode (which was used for protecting the switches within the test facility). The diode will tend to maintain the EMF within the solenoid thereby maintaining the circuit. By removing the diode, the EMF will dissipate at a much ~~faster~~ ~~pace~~ rate; thereby breaking the circuit and causing the valve to de-actuate.

REMARKS	DISPOSITION OF ACCEPTED ITEMS	DISPOSITION OF REJECTED ITEMS
☒ Use As Is	☐	☐
☐ HOLD DETAIL ____ FOR	☐ DELIVER TO STOCKROOM	☐ REWORK
DISPOSITION BY Ron Bos[illegible]	☐ DELIVER TO ASS'Y	
20 July 89	INSPECTED BY: DATE:	
V. [illegible]	APPROVED BY: DATE:	RELEASED BY: DATE:

TARGET ROCK CORPORATION
E. FARMINGDALE, N.Y. 11735

IN-PROCESS STATUS SHEET IPS # 3686 - 451

PART NAME Test Valve DWG. NO. 1071240-5 REV. D

PROJ. NO. 88RR (Body S/N 258) SOURCE

# PCS. INSP.	# PCS. ACC.	# PCS. REJ.
reference ~~S/N~~ TRP 4913 rev E		

DETAILS Once the diode was removed, the valve was re-tested on both steam & water. For the steam case the de-actuation times fell within the requirements; while for the water case the times are still outside the acceptable range

For both steam & water the test was repeated with the diode back inplace and the times were significantly lengthened. Thereby, proving that the diode affected the valve de-actuation times

Therefore, only the water case is outside the time requirements on de-actuation only. In summary, with the diode the valve de-actuated in greater than ~~approx.~~ 6 seconds; RD 21July89 while without the diode the de-actuation was in approx 4.5secs

Therefore, Target Rock recommends that the valves be used as is; because a 6 second de-actuation should NOT adversely affect plant safety

REMARKS	DISPOSITION OF ACCEPTED ITEMS	DISPOSITION OF REJECTED ITEMS
☒ Use As Is	☐	☐
☐ HOLD DETAIL ______ FOR	☐ DELIVER TO STOCKROOM	☐ REWORK
DISPOSITION BY Ron Bezenik 20July89	☐ DELIVER TO ASS'Y	
Vito Licandro	INSPECTED BY: DATE:	
	APPROVED BY: DATE:	RELEASED BY: DATE:

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TRC test facility 100,000 lbs per hour of saturated steam ... 166.2 lb
Blowdown sec. of water at a flow at 467 psia and 338°F.

88RR

	Valve Pressure psig		Upstream Temperature °F	Coil V.dc	Amps	Valve Actuation Time in seconds		7/1...
	Inlet	Outlet				OPEN	CLOSED	
1)	430	85	253	125.0	3.07	2.085	5.92	
2)	470	120	319	125.0	3.08	1.915	3.692	
3)	470	125	332	125.0	2.94	1.84	3.48	

WATER

7/20/...

Run	Valve Pressure Psig		Upstream Temperature °F	Coil DATA V.dc	Amp	Valve Actuation Time in seconds	
	Inlet	Outlet				Open	Closed
1)	2550	110	665	125.0	2.65	1.310	0.436
2)	2550	95	665	125.0	2.63	1.635	0.419
3)	2560	95	665	125.0	2.60	1.860	0.387

STEAM

* A spacer was used to limit the opening ~~travel~~ of the valve. This was done to limit the depletion of the generated Steam.

Recording Device: ~~Magwell~~ ~~[illegible]~~ Recorder
Make Honeywell
Model TR 2162
Calibration date: before use

Pages 33 and 34 of SP-MP-8304-002(2). Specifies the ~~opening~~ and closing times of the Relief PORVs to be ~~[illegible]~~ 0.25 minimum and 2.0 seconds maximum for High Pressure Relief: 2450 psia Saturated Steam
Lo Pr Relief: 357 psia 435°F (LTOP-1) 465 psi 460°F LTOP 2

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MPR ASSOCIATES, INC.

September 12, 1989
98-108-07

Mr. James L. Topper
Consumers Power Company
1945 West Parnall Road
Jackson, MI 49201

Subject: Computed Stroke TImes for Palisades Replacement Power Operated Relief Valves

Reference: GWO 8304, File -011, -317.0

Dear Mr. Topper:

In accordance with our telephone conversation of September 12, 1989 and my subsequent discussion with Mr. Ashworth of CPCo, we have computed the expected opening stroke times for the Palisades replacement Target Rock Power Operated Relief Valves (PORV) for several LTOP set points assuming saturation conditions in the pressurizer. These computations included the effects of the RCS pressure ramp rates that have been calculated by CPCo personnel at these LTOP set points. The following summarizes the results of the computations and identifies the conditions analyzed.

Pressure Set Point (psia)	Pressurizer Temp (°F)	Ramp Rate (psi/sec)	Coil Energize Time (sec)	Depressurize Time (sec)	Slew Time (sec)	Total Time (sec)
330.0	426.1	93.0	0.23	1.45	0.20	1.88
500.0	467.1	93.0	0.26	1.41	0.16	1.83
1000.0	544.6	63.0	0.32	0.97	0.10	1.39

These analyses assume no subcooling in the fluid at the LTOP set point and, therefore, represent an upper limit on the temperature conditions of the pressurizer when the setpoint pressure is reached. We consider this assumption to be very conservative yet the analyses indicate that the valve will open within 2 seconds. As indicated in prior analyses any subcooling of the fluid will reduce the total valve response time.

This information will be included in the final report. If you have any questions or require further information please give me a call.

Sincerely,

L E Demick

L. E. Demick

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To	RTGilmore, P-13-107B	
From	JLTopper, P-13-425	CONSUMERS POWER COMPANY
Date	July 17, 1989	
Subject	PALISADES PLANT PRESSURIZER VALVES REPLACEMENT PROJECT TRIP REPORT - TARGET ROCK CORPORATION GWO 8304, FILE -011, -312.0	Internal Correspondence JLT 169-89
CC	TWBowes, P-13-413A PDFlenner, P-13-427 YFChan, P-13-236 JEHarding, P-24-204 RWSmedley, P-24-616 KPMeigh, P-13-422	DEEngle, Palisades GFPratt, Palisades [redacted] JGAshworth, Palisades TMBlasco, Palisades LDSeamans, Palisades

A trip was made to the offices of Target Rock Corporation, Farmingdale, New York, on July 3-7, 1989, to witness testing of the Replacement Power-Operated Relief Valves (PORV) that Target Rock is furnishing under Purchase Order Number 2003-4152(Q). Participating in the testing were J E Harding, Quality Assurance; T M Blasco, ESS-Testing; and Y F Chan, ESS-Engineering. The purpose of the tests was to demonstrate the operability of the replacement valves under the expected operating conditions, to complete the qualification of the equipment, and to obtain performance data which will be used to determine operational parameters for the new, variable LTOP set point system.

The operability tests consisted of the installation of one (1) of the two (2) new valves in Target Rock's test loop and the execution of a series of opening and closing cycles against pressures that the valves would be expected to experience during actual operation. This included saturated steam at approximately 2,500 psig and subcooled water at approximately 450 psig and 390°F. Due to the capacity limitations of Target Rock's test facility, the flow of steam was restricted, via an orifice, to 100,000 lbm/hr; the flow of water was similarly restricted to an equivalent thermal input. The test facility exhausts to a suppression pool, rather than to atmosphere, which is the limiting factor in terms of flow capacity. Due to the location of Target Rock's facilities, direct discharge to atmosphere was not possible. The test facility was instrumented to collect data concerning pressure and valve position versus valve opening time. This data was collected using a multi-pen strip chart recorder. A summary of the data is attached for the steam tests. The data for the water test was not summarized. Finally, a summary of the C_v test results is also attached.

The first test to be conducted, on July 5, 1989, was the high pressure steam test. A series of four (4) cycles of the valve was ultimately conducted. On the first test, the valve opening time appeared to be greater than what was analytically predicted. A second cycle revealed a still greater opening time. Closing times also appeared to be successive. A third cycle was then executed, with the trend continuing. On the fourth cycle, the rupture disk on the discharge pipe failed due to an over pressure situation. The thermal capacity of the suppression pool had apparently been exceeded which caused excessively high pressures in the valve discharge piping. This, in turn, caused the rupture disk to fail, thus protecting the rest of the system. The excessive opening and closing times were initially attributed to the orifice that was installed to limit the capacity of the system. The recordings indicated that the pressure downstream of the orifice (upstream of the valve) decreased very rapidly once the valve began to open, due to the very high capacity of the valve. This drop in pressure reduced the force available to open the valve and, in subsequent runs, actually caused the valve to cycle because the inlet pressure decreased faster than the pressure in the valve chamber.

Having rendered the test facility inoperative for at least a day while the ruptured disk was replaced, the valve was moved to the C_v flow loop. In this facility, the capacity of the valve would be determined using a pump-driven water flow loop. The original analysis performed by EI Services, Inc indicated that under a two (2) high pressure safety injection (HPSI) pump start situation, at temperatures above 325°F, a minimum flow capacity of 167 lbm/sec at a pressure of approximately 467 psia would be required. Target Rock's analytical flow capability determination revealed that the valve would have a C_v of approximately 192.7, which would produce a flow of approximately 220 lbm/sec. Actual test results, a copy of which is attached, yielded an average C_v of 219.4, which should be good for approximately 250 lbm/sec at the specified inlet capacity. Thus, the capacity of the valve appears to be more than sufficient for the required duty, for a water flow situation. Initial calculations had indicated that the effective flow area of the valve would be approximately 5.1 in^2; actual measurements, using actual valve lift, revealed that the valve effective area is approximately 5.8 in^2.

On the following day, July 7, 1989, the test valve was reinstalled in the test facility for the water tests. The valve was again cycled through several opening and closing sequences, and again displayed longer than expected opening times. This type of valve opens in two steps. Energization of the solenoid opens a pilot valve which allows the valve upper chamber to depressurize. Once a sufficient differential pressure exists, the valve main disk begins to open. With steam as the process fluid, the major time interval is the depressurization of the pilot chamber, while with water, the major time interval is the opening of the main disk. This is due to the compressibility of steam and the lack of compressibility of water. On the water test, the valve disk movement was much longer than expected; however, the depressurization time appeared to be correct.

The final test, conducted on July 7, 1989, was a repeat of the initial steam test. For this series of tests, however, a spacer was placed in the valve chamber to limit the valve disk to one-quarter of its normal travel. This was done in an attempt to limit the effects of the limited capacity of the test system. The test data attached are the results of this last test. The data shows that, although the valve was again slow to depressurize, its actual main disk movement times, projected from the recorder traces for the restricted lift versus time, weren't too different from what had been analytically predicted.

At the exit meeting, theories were postulated as to what went wrong. It was agreed that, before anything else happened, the test valve would be disassembled and inspected for damage. It was also agreed that Target Rock would review their design in an effort to determine if there was any internal flow restriction that could possibly prolong the depressurization cycle and thus cause longer opening cycles. Target Rock will make whatever restitution is required and will retest the valve during the week of July 17, 1989. They will also be providing a summary of their findings and their recovery plan prior to the initiation of any retesting.

The test program was obviously not the total success that was initially hoped it would be, and it was not possible to obtain the test data needed for the calculation of the LTOP set-points. However, on the positive side, the valve proved to have additional capacity, and the problems encountered do not appear to be insolvable. The shipment of the valves will not be seriously impacted as a result of the problems encountered. As a side note, the limitations of Target Rock's test facility, and of Rockwell's facility when it comes time to test the block valves, might make it possible, or even necessary, to rethink the option of employing an independent test facility if regulatory requirements and/or analytical needs require that the valves be tested at full capacity. This possibility will be explored with each supplier in the event that this becomes necessary.

PREPARED BY ____	**TARGET ROCK CORPORATION**	PAGE 4 OF 5
DATE ____	EAST FARMINGDALE — LONG ISLAND, N. Y.	REPORT 4946
APPROVED BY ____		PROJECT 88RR
DATE ____		

TABLE 1: C_v TEST DATA

PROJECT: 88RR VALVE S/N: 001

CUSTOMER P.O.: 2003-4152-(Q) VALVE TAG NO.: ____

EVENT NO.	VALVE INLET TEMP. ■ °F	VALVE INLET PRESS. ■ psig	VALVE Δp■ psid	FLOW METER READING	FLOW gpm	C_v
1	73	70	5.0	73	~~482~~ 482	~~215.6~~ 215.6 7-6-89
2	73	66	7.0	106	582	220
3	73	59	10.0	156	700	221.4
4	74	62	10.5	161	711	219.4
5	74	70	5.0	73	482	215.6
6	74	67	7.0	106	582	220
7	74	60	10.0	155	~~705~~ 700 7-6-89	221.4
8	75	63	10.5	161	711	219.4
9	75	70	5.0	74	490	219.1
10	75	66	7.0	106	582	220
11	76	60	10.0	155	700	221.4
12	76	63	10.5	161	711	219.4

E. Pears 7-6-89
TEST TECHNICIAN DATE

Ron Bergmann
TRC ENGINEERING

7/6/89
CUSTOMER WITNESS
(WHEN APPLICABLE)

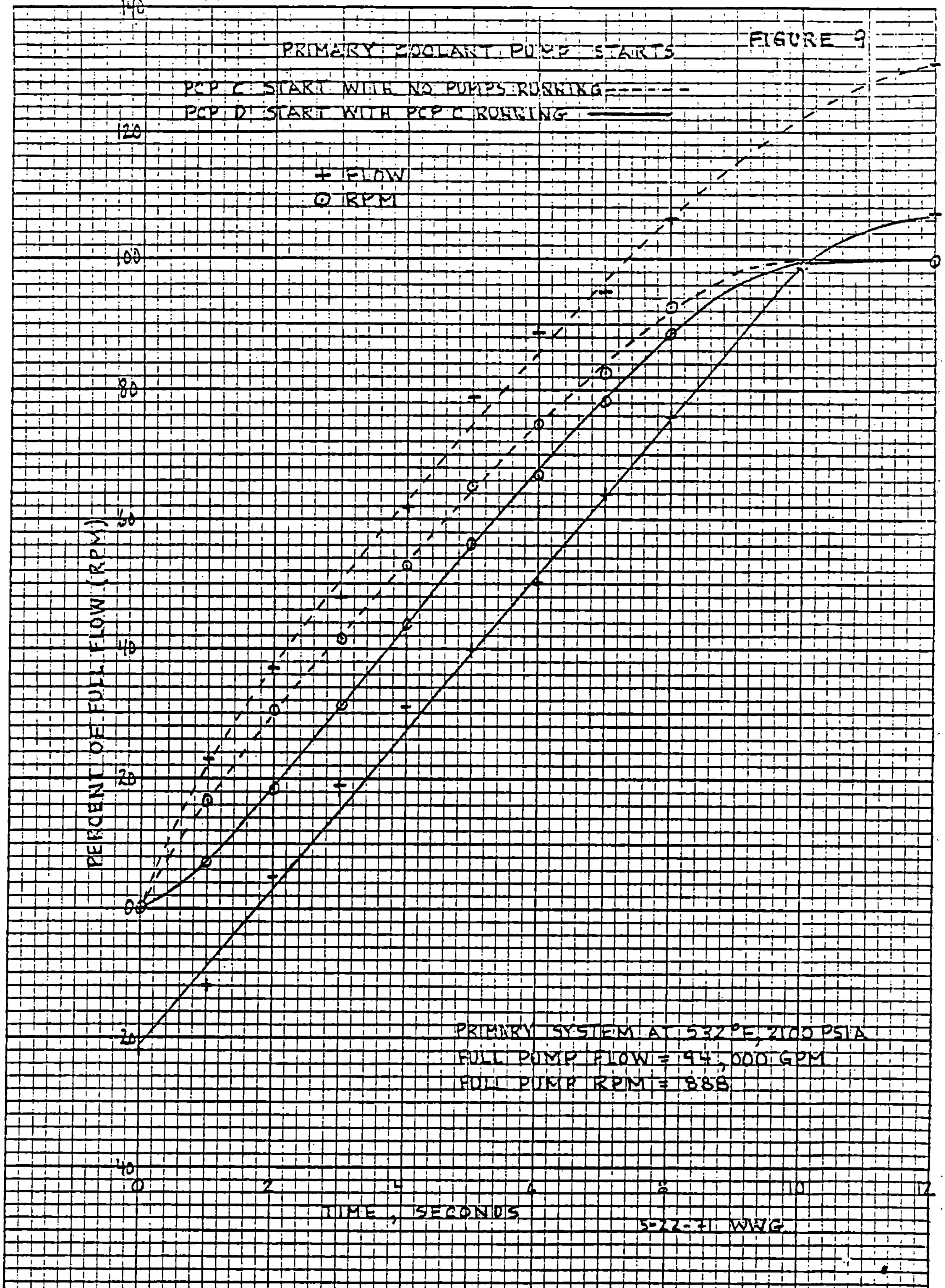
A

TRENG—104 (3/88)

Attachment 3

Palisades PCP Start Time Data

Ref. - Palisades PTR-04



Attachment 4

Appendix G Pressure Limits

Appendix G. Pressure Limits (PSIG)

The Appendix G limits were calculated in Ref 5, part IV at 1/4 t, with no measurement uncertainties for both heat-up and cool down rates ranging from 0 °F/HR to 100 °F/HR.

The limiting pressure (i.e. heat-up or cool down) was used based on the assumed PCS ~~tem~~ temperature for each case.

CASE #	HEAT-UP/COOL DOWN RATE °F/HR	PCS Temp °F	App G Limit psig/psia
1	20°/HR. C.D.	120	387/401.7
2	40°/HR. C.D.	170	375/389.7
2A	40°/HR. C.D.	170	375/389.7
3	40°/HR. C.D.	210	444/458.7
4	60°/HR. C.D.	250	522/536.7
5	100°/HR H.U.	350	1085/1099.7
6	100°/HR H.U.	418	2201.3/2216

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DELETED