Consumers Power Company

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May 15, 1979

Director, Nuclear Reactor Regulation
Att: Mr Dennis L Ziemann, Chief
Operating Reactors Branch No 2
US Nuclear Regulatory Commission
Washington, DC 20555

DOCKET 50-255 - LICENSE DPR-20 -
PALISADES PLANT - RAPID RESPONSE
TO ADDITIONAL INFORMATION REQUEST
ON THREE MILE ISLAND

Consumers Power Company's response to questions handed to us by A Schwencer at a meeting in Bethesda on Saturday afternoon, May 12, 1979, is attached. These questions concern the TMI incident and were to have been telecopied to us on May 9, 1979. We never received them by telecopy, however.

Our response to Item 1 was telephoned to the NRC contact on May 14, 1979. We attempted to telephone our responses to Items 2 and 3 on both May 14, and May 15, but the reviewer assigned to these items failed to return our calls.

It should be noted that:

1. The plant staff worked overtime to answer these questions on Sunday, May 13, 1979, due to the NRC's failure to telecopy the questions to us on May 9, 1979.

2. After having formulated our responses, we were unable to contact the NRC personnel assigned to accept them. These responses were requested by 3:30 PM on May 14, 1979. They (Items 2 and 3) did not lend to telecopy.

In the future, if you desire rapid responses, it is requested that you ensure the questions are sent through the NRC Project Manager and that you make personnel available to accept our responses.

David P. Hoffman

David P Hoffman
Assistant Nuclear Licensing Administrator

CC: JGKeppler, USNRC

Note: 1 oversize drawing Rec'd Sent to Reg file

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ATTACHMENT

ITEM 1 - PRESSURIZER DATA

A. Pressurizer Heaters
Balance of Plant Instrument Power Source - (class IE or non class IE or both) -
Backup Heater Power Source -

B. Backup Heaters on set points =
off set points =

C. Variable Heater Transfer Function -

D. Spray Valve Transfer Function -

E. Power Operated Relief Valve #2 (if applicable)
open set point (in control output units)
close set point (in control output units)

Describe Controller Transfer Function $\left(\frac{\text{output}}{\text{psia}}\right) =$

including, Proportional Gain =
Integral Gain =
Derivative Gain =

Response

A. Y-10 and Y-20 (preferred AC buses No 1 and No 2) provide power to pressurizer heater control circuits.

Half of the backup heaters are powered from 480 volt Bus 16 (powered from 2400 volt Bus 1D). Half are powered from 480 volt Bus 15 (powered from 2400 volt Bus 1E).

B. Backup heaters are maintained energized in manual control.

C. Variable heater transfer function:

$$\% \text{ off} = \frac{P\text{-}1985 \text{ psia}}{50 \text{ psia}} \times 100$$

D. Spray valve transfer function:

$$\% \text{ open} = \frac{P\text{-}2085 \text{ psia}}{50 \text{ psia}} \times 100$$

E. This question is not applicable to Palisades.

ITEM II

Describe all events that resulted in a complete loss of main feedwater over the last three years of operation. Include as a minimum the following information: date, initiating event, power level, consequences (one paragraph description), and safety significance of event.

Each event which occurred during a startup need not be described separately.

Response

The following table presents the data requested above:

Date	Initiating Event	Power Level	Consequences and Safety Significance
5-10-76	Feed-water pump trip from low suction pressure.	25%	None
1-17-77	High-level dump valve on moisture separator and reheater drain tank failed open, resulting in tank low level and tripping of the heater drain pumps which led to tripping of the "B" feed-water pump from low suction pressure. The reactor was manually tripped.	100%	None
1-18-77	The "A" feed-water pump tripped. The cause of the FWP was not known. The reactor was manually tripped.	35%	None
3-25-77	Loss of the "A" main feed-water pump resulted in a reactor trip from low steam generator water level.	90%	None
3-27-77	The "B" main feed-water pump tripped resulting in a reactor trip from steam generator low water level.	82%	None
11-27-77	Loss of the "A" main feed-water pump while attempting to shift from manual to automatic control.	50%	None

Date	Initiating Event	Power Level	Consequences and Safety Significance
4-21-78	Loss of "B" MFW pump (due to a damaged vibration detector).	50%	None - lowest steam generator level was 20%.
5-11-78	FW pump low suction pressure (due to condenser and demin strainer plugging).	Beginning power escalation	None
6- 7-78	"B" steam generator low level (malfunction of FW regulator valves during changing FW control from bypass valves to main FW regulator valves).	23%	None
6- 8-78	"A" low steam generator level ("B" steam generator FW isolation valve closed. After it was opened erratic swings in FW with FW regulator valves in auto).	20%	None - changes made to start-up checksheets to prevent this from recurring. Lowest steam generator level ~ 24%.
6-13-78	"B" FW pump trip (lost auto control on FW regulator valves and changed to manual). Transient caused FW pump trip.	84%	None
8- 7-78	"B" FW pump trip.	86%	None
10-17-78	"B" FW pump trip occurred coincident to operators opening LP T&T valve.	84%	None
12-16-78	"A" FW pump trip (low steam generator level).	88%	
3- 3-79	FW pumps trip (low suction pressure. Heater drain pump had tripped.	100%	It appeared that a portion of steam generators' tubes became uncovered. Approximately eight hours were required to regain the lost water inventory.

Date	Initiating Event	Power Level	Consequences and Safety Significance
4- 7-79	"B" FW pump trip (cause unknown).	100%	It appeared that a portion of steam generators' tubes became uncovered. Took ~1 hour to restore the level in steam generator. Subsequent to this trip, Bus 10 failed to transfer to start-up power and had to be manually switched to the 1-1 EDG. This resulted in a delay of about 1-1/2 minutes in establishing auxiliary feedflow, but had no adverse effect on recovery.

Item 3

Provide a schematic diagram of the steam generator. Identify important characteristics. As a minimum provide the liquid level and volume for normal plant operation at power and the liquid level and volume at low level set point for reactor trip (for W plants low level with steam flow/feed flow mismatch) subsequent to a loss of feedwater. Describe the basis for this determination including a description and use of steam generator level span.

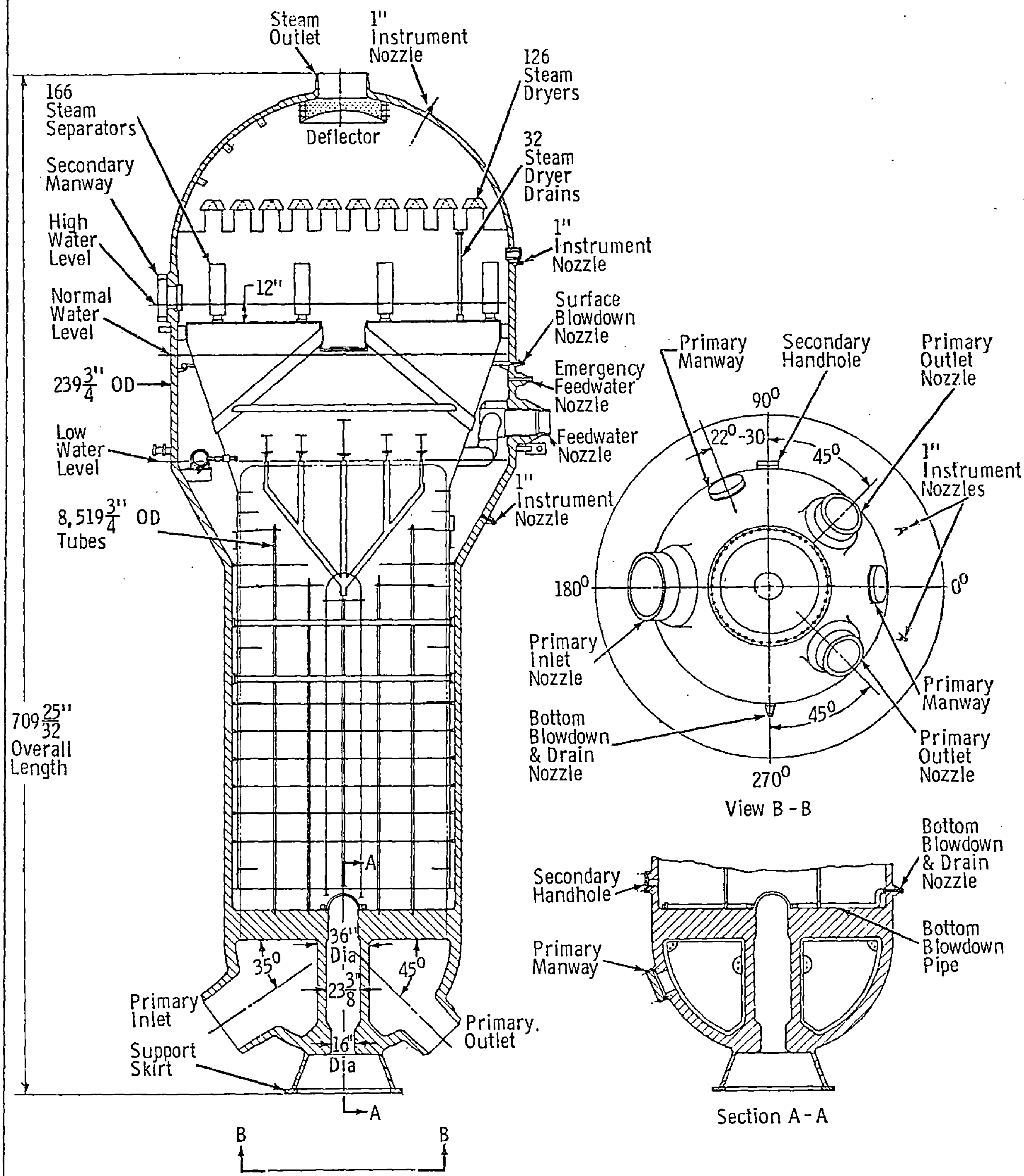
Response

The attached prints and schematics provide the information requested. Water volumes and levels are as follows:

Normal: 382 11/16" above tube sheet, 5022 cu ft

Low Level Trip: 310 11/16" above tube sheet, volume not known

STEAM GENERATOR



COMBUSTION ENGINEERING, INC.
WINDSOR, CONNECTICUT

Figure 4-3

4.3.4 STEAM GENERATOR

The nuclear steam supply system utilizes two steam generators, Figure 4-3, to transfer the heat generated in the reactor coolant system to the secondary system. The design parameters for the steam generators are given in Table 4-5.

The steam generator is a vertical U-tube heat exchanger and is designed in accordance with ASME Boiler and Pressure Vessel Code, Section III, Class A. The steam generator operates with the primary coolant in the tube side and the secondary fluid in the shell side.

Primary coolant enters the steam generator through the inlet nozzle, flows through 3/4" OD U-tubes, and leaves through two outlet nozzles. Vertical partition plates in the lower head separate the inlet and outlet plenums. The plenums are stainless steel clad, while the primary side of the tube sheet is Ni-Cr-Fe clad. The vertical U-tubes are Ni-Cr-Fe alloy. The explansion process is used for expanding the steam generator tubes in the tube sheet. The tube-to-tube sheet joint is welded on the primary side.

Feedwater enters the steam generator through the feed-water nozzle where it is distributed via a feed-water distribution ring having bottom apertures which direct the flow through the downcomer. The downcomer is an annular passage formed by the inner surface of the steam generator shell and the cylindrical shell which encloses the vertical U-tubes.

Upon exit at the bottom of the downcomer, the secondary water is directed upward over the vertical U-tubes. Heat transfer from the primary side converts a portion of the secondary water into steam.

Upon exiting from the vertical U-tube heat transfer surface, the steam-water mixture enters the centrifugal type separators. These impart a centrifugal motion to the mixture and separate the water particles from the steam. The water exits from the perforated separator housing and combines with the feedwater. Final drying of the steam is accomplished by passage of the steam through the corrugated plate dryers. The moisture content of the exiting steam is limited to a maximum of 0.2% at design flow.

The power operated steam dump valves and steam bypass valve prevent opening of the safety valves following turbine and reactor trip from full power. The steam dump and bypass system is described in Section 9.

The steam generator shell is constructed of carbon steel. Manways and handholes are provided for easy access to the steam generator internals.

Overpressure protection for the shell side of the steam generators and the main steam line piping up to the inlet of the turbine stop valve is provided by twenty-four (24) safety valves. These valves

are ASME Code spring loaded, open bonnet, safety valves and discharge to atmosphere. Twelve safety valves are mounted on each of the main steam lines upstream of the steam line isolation valves but outside the containment. The valves are divided into three groups of four valves, each valve within a group having the same nominal opening pressure, but with staggered group opening pressures consistent with ASME Code allowances. The valves can pass a steam flow equivalent to an NSSS power level of 2650 Mwt at the nominal 1000 psia set pressure. Parameters for the secondary safety valves are given in Table 4-4.

TABLE 4-4

SECONDARY SAFETY VALVE PARAMETERS

Design Pressure, Psia	1,000
Design Temperature, ^{o}F	550
Fluid - Saturated Steam	
Capacity, Minimum per Valve, Lb/Hr	486,600
Total Capacity, Lb/Hr	11,678,400
Set Pressure	
Eight Valves, Four per Unit, Psia	1,025
Eight Valves, Four per Unit, Psia	1,005
Eight Valves, Four per Unit, Psia	985
Body Material	ASTM 216, Gr WCB
Trim Material	Stainless Steel

The steam generators are mounted vertically on bearing plates to allow horizontal motion parallel to the hot leg due to thermal expansion of the reactor coolant piping. Stops are provided to limit this motion in case of a coolant pipe rupture. The top of the unit is restrained from sudden lateral movement by energy absorbers mounted rigidly to the concrete shield.

In addition to the transients listed in Section 4.2.2 each steam generator is also designed for the following accident conditions such that no component will fail either by rupture or by developing deformations (elastic or plastic) that will impair the function, performance, or integrity of the steam generator for further operation.

1. Eight cycles during which the primary side is at 2500 psia and 600^{o} F while the secondary side is depressurized to atmospheric pressure.

2. One cycle during which the steam on the shell side is at 900 psia and 532° F while tube (primary) side is depressurized to atmospheric pressure.

3. 2400 cycles of transient pressure differentials of 85 psi across the primary head divider plate due to starting and stopping the primary coolant pumps.

4. 10 cycles of hydrostatic testing of the secondary side at 1250 psia.

5. 320 cycles of leak testing of the secondary side at 1000 psia.

6. 5,000 cycles of adding 425 gpm of 70° F feedwater with the plant in hot standby condition.

7. 8 cycles of adding a maximum of 300 gpm of 70° F feedwater with the steam generator secondary side dry and at 600° F.

The unit is capable of withstanding these conditions for the prescribed numbers of cycles in addition to the prescribed operating conditions without exceeding the allowable cumulative usage factor as prescribed in ASME Code, Section III.

TABLE 4-5

STEAM GENERATOR PARAMETERS

Number		2	
Type		Vertical U-Tube	
Number of Tubes		8,519	
Tube Outside Diameter		0.750 Inch	
	Quantity	**Size**	
Nozzles and Manways			
Primary Inlet Nozzle	1	42 Inch ID	
Primary Outlet Nozzle	2	30 Inch ID	
Steam Nozzle	1	34 Inch ID	
Feedwater Nozzle	1	18 Inch Nominal	
Instrument Taps	9	1 Inch Nominal	
Primary Manways	2	16 Inch ID	
Secondary Manways	2	16 Inch ID	
Secondary Handhole	1	5-11/16 Inch ID	
Secondary Drain & Blowdown	1	2 Inch Nominal	
Surface Blowdown	1	1 Inch Nominal	
Spare	1	4 Inch Nominal	
		Initial	**Stretch**
Primary Side Design			
Design Pressure, Psia		2,500	2,500
Design Temperature, °F		650	650
Design Thermal Power (NSSS), Mwt		2,212	2,650
Cold Leg Temperature, °F		545	540.5
Hot Leg Temperature, °F		591	595
Coolant Flow Rate (Each), Lb/Hr		62.5×10^6	65.45×10^6
Normal Operating Pressure, Psia		2,100	2,250
Secondary Side Design			
Design Pressure, Psia		1,000	1,000
Design Temperature, °F		550	550
Normal Operating Steam Pressure, Full Load, Psia		770	764
Normal Operating Steam Temperature, Full Load, °F		514	514
Steam Moisture Content, Maximum, %		0.20	0.20
Blowdown Flow, Lb/Hr		2,000	2,000
Drying Capacity at 770 Psia, Maximum (Each), Lb/Hr		5.86×10^6	5.86×10^6
Design Thermal Power (NSSS), Mwt		2,212	2,650
Steam Flow (Each), Lb/Hr		4.701×10^6	5.81×10^6
Feed-Water Temperature, °F		418	438

TABLE 4-5 (Contd)

Dimensions	
Overall Height, Including Support Skirt	59 Feet - 2 Inches
Upper Shell Outside Diameter	20 Feet - 10 Inches
Lower Shell Outside Diameter	13 Feet - 8 Inches
Dry Weight	924,600 Lb
Flooded Weight	1,496,000 Lb
Operating Weight	1,109,000 Lb

3.7 LOSS OF FEEDWATER FLOW INCIDENT

A loss of feedwater flow incident may arise due to the rupture of the feedwater cross-over line downstream of the main feedwater pumps or a condensate pump fault which would cause low suction pressure on both feed-water pumps. When operating at full power, there would be no corresponding decrease in steam flow from the steam generators. If loss of main feedwater is unchecked, the normal primary coolant system heat sink would be reduced and eventually eliminated. The result would be an increase in core inlet temperature with only the presssurizer relief valves and auxiliary feedwater system available for the removal of decay heat, until a controlled system cooldown is initiated. The reactor protection system provides reactor protection through a reactor trip activated by low water level in each steam generator with additional protection for the reactor provided by the high pressurizer pressure and thermal margin trips.

The transient was initiated from 102% of rated power (2530 Mwt). Only complete loss of feedwater is assumed in this analysis since this condition requires the most rapid response from the reactor control and portection system. Beginning-of-cycle (BOC) kinetic coefficients were conservatively assumed, with an 0.8 multiplier applied to the Doppler coefficient. The initial reactor pressure is 2010 psia which is 50 psi below the nominal value of 2060 psia. The feedwater flow is reduced to zero in two seconds.

Figures 3.76 through 3.80 show the system responses during the loss-of-feedwater flow incident. The reactor trips at 26.7 seconds on low steam generator water level. This precipitates a turbine trip and activates

the atmospheric and condenser steam dump systems. An MDNBR of 1.65 occurs 0.3 seconds after trip. The atmospheric steam dump valves are controlled by the average primary coolant temperature following a turbine trip. The atmospheric dump valves are completely closed 38.3 seconds following the reactor trip, after which decay heat is removed via the steam bypass to the condenser. The water inventory in the steam generators is adequate to accommodate decay heat and pump heat for an additional 15 minutes, at which time the mass inventory of each steam generator is no less than 1700 lbs. Hence, the operator will have 16 minutes after the initiation of the incident to restore partial feedwater flow by activation of the auxiliary feedwater system.

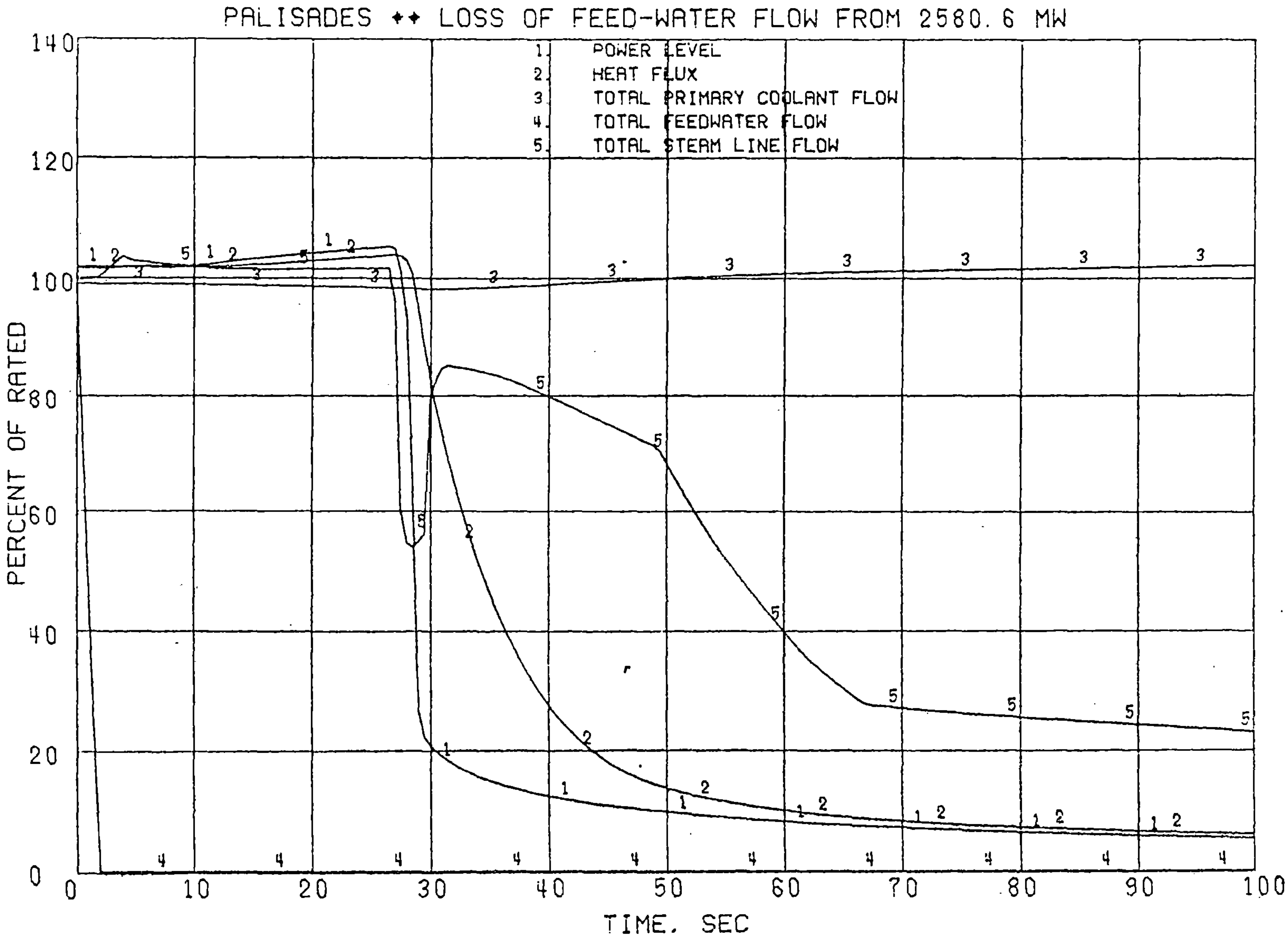


FIGURE 3.76 POWER, HEAT FLUX, AND SYSTEM FLOWS, LOSS OF FEEDWATER FLOW

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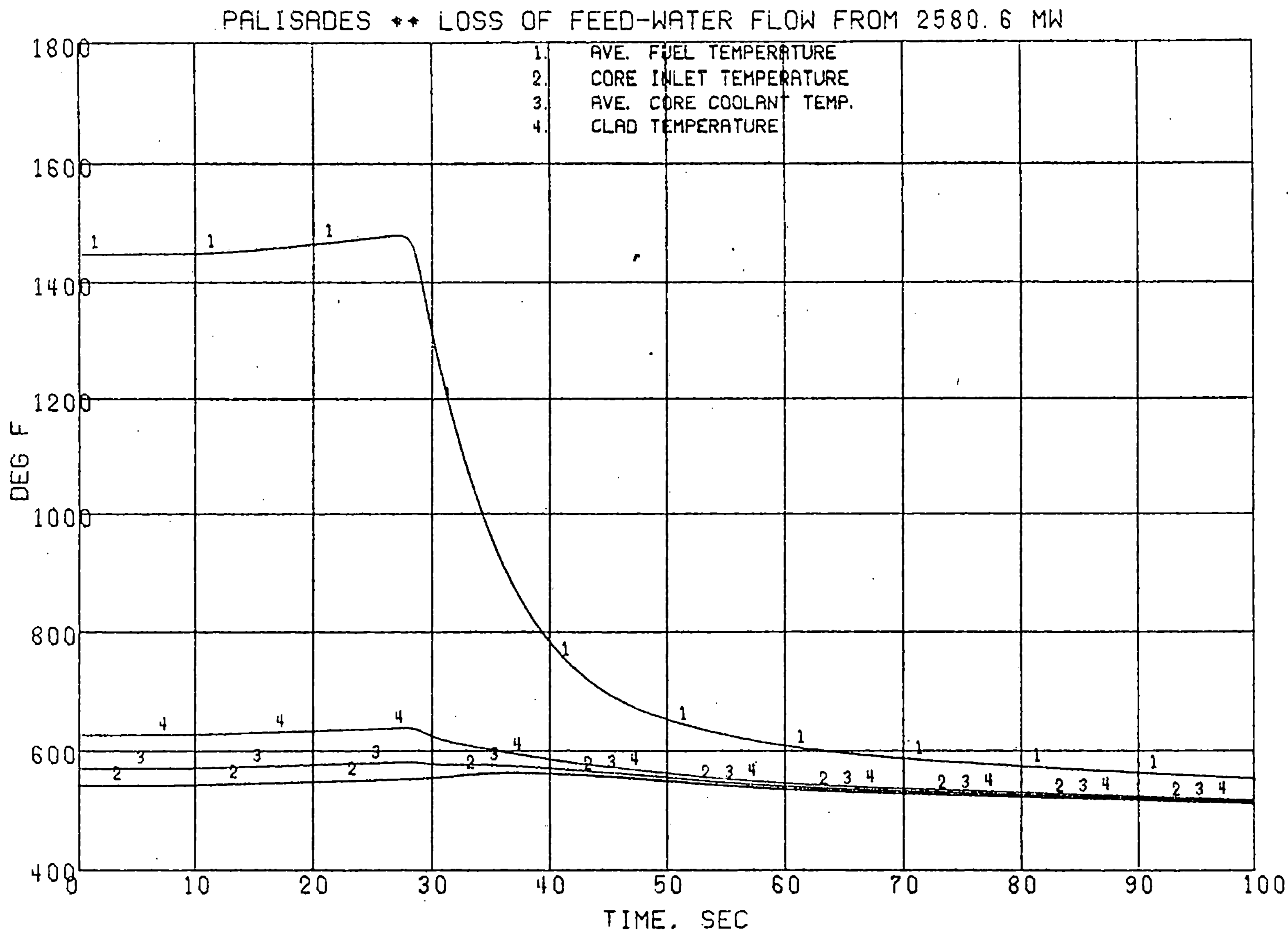

FIGURE 3.77 CORE TEMPERATURE RESPONSES, LOSS OF FEEDWATER FLOW

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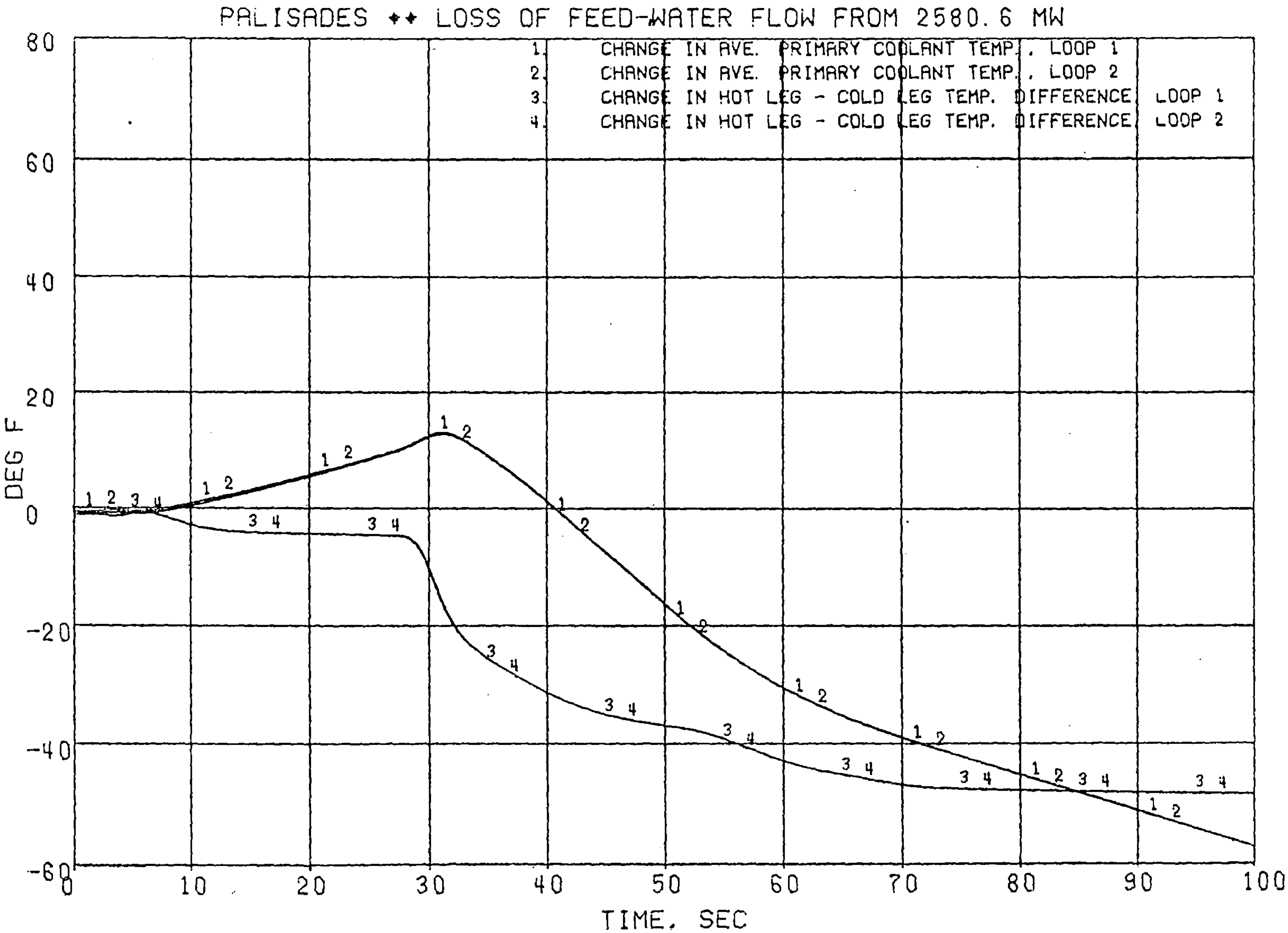

FIGURE 3.78 PRIMARY LOOP TEMPERATURE CHANGES, LOSS OF FEEDWATER FLOW

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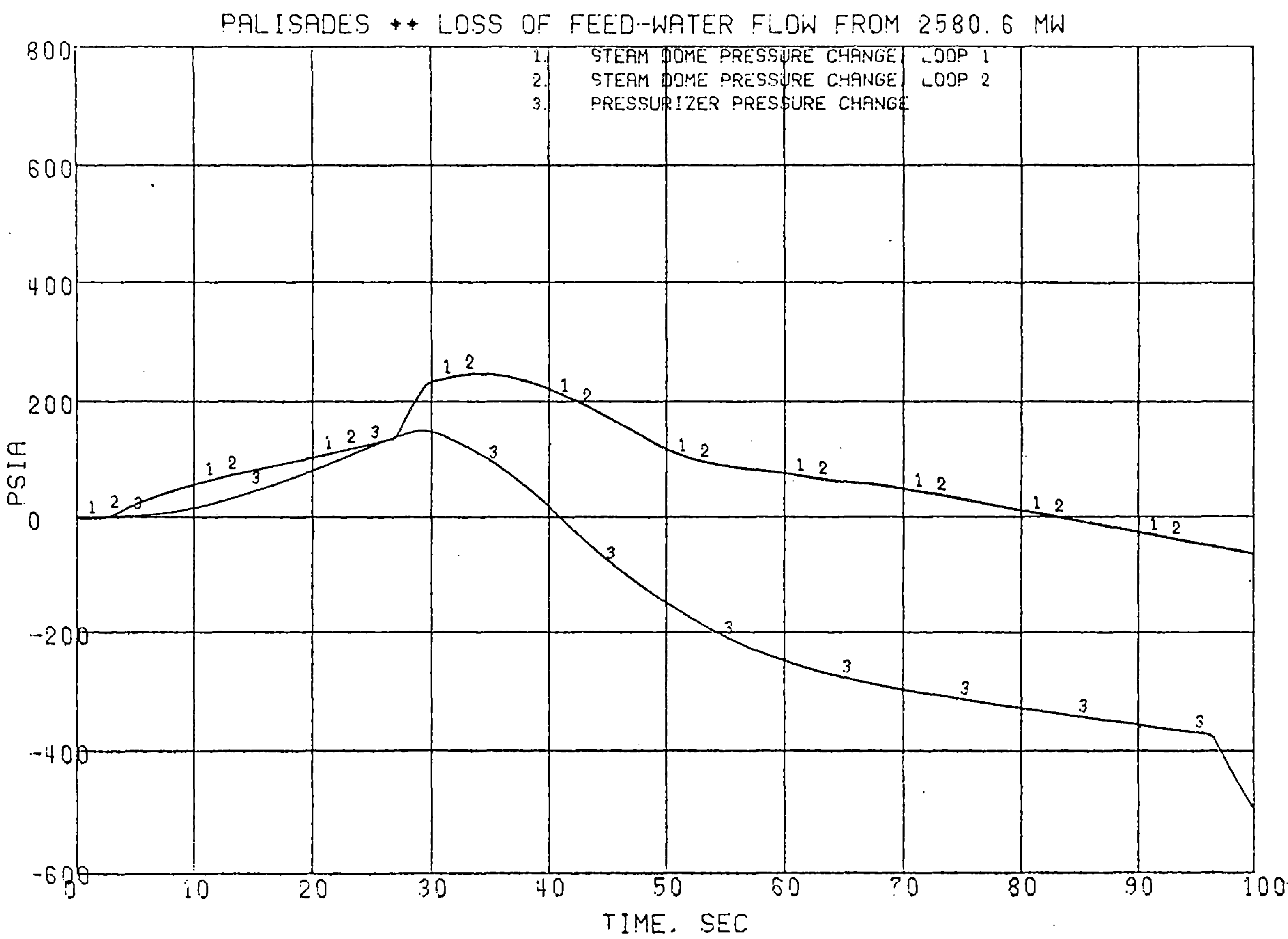

FIGURE 3.79 PRESSURE CHANGES IN PRESSURIZER AND STEAM GENERATORS, LOSS OF FEEDWATER FLOW

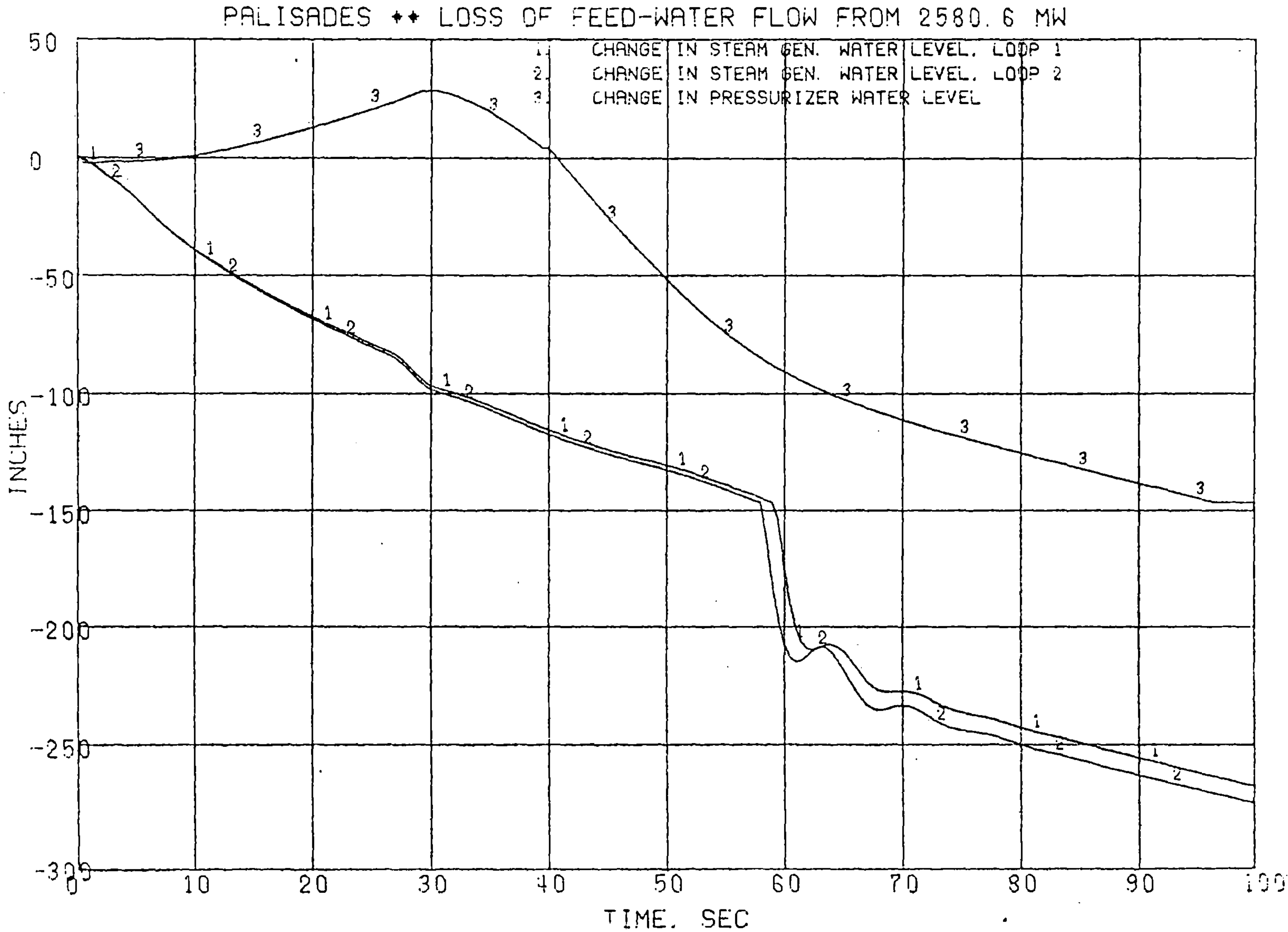

FIGURE 3.80 LEVEL CHANGES IN PRESSURIZER AND STEAM GENERATORS, LOSS OF FEEDWATER FLOW

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