Southern California Edison Company
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M. O. MEDFORD
MANAGER, NUCLEAR LICENSING

TELEPHONE
(818) 302-1749

May 1, 1986

Director, Office of Nuclear Regulation
Attention: Mr. George E. Lear, Director
PWR Project Directorate No. 1
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Gentlemen:

Subject: Docket No.1 50-206
Requests for Additional Information
San Onofre Nuclear Generating Station
Unit 1

References:

1. Letter, George E. Lear, NRC, to Kenneth Baskin, SCE, Request for Additional Information, March 25, 1986
2. Letter, Richard F. Dudley, NRC, to Kenneth P. Baskin, SCE, San Onofre Unit 1, April 21, 1986.
3. Letter, Richard F. Dudley, NRC, to Kenneth P. Baskin, SCE, San Onofre Unit 1, April 29, 1986.
4. Letter, M. O. Medford, SCE, to A. E. Chaffee, NRC, Investigation Report of November 21, 1985 Water Hammer Event, April 8, 1986

References 1, 2 and 3 requested additional information needed to review information provided to the NRC in meetings and in the SCE Investigation Report provided by Reference 4. The SCE Investigation Report identified three areas where further information would be provided to the NRC by April 30, 1986. Additionally, numerous telephone calls have occurred between SCE and the NRC Staff to clarify, respond to, or discuss new issues resulting from the review of the November 21, 1985 event. Accordingly, find enclosed the information necessary to resolve the issues raised to date.

The following listing describes the contents of the enclosures.

Enclosure 1 - Provides responses to the questions transmitted by Reference 1.

Enclosure 2 - Provides responses to the questions transmitted by Reference 2.

Enclosure 3 - Provides responses to the questions transmitted by Reference 3.

A00: NSIC

H001
1/5

Enclosure 4 - Provides the information deferred in Reference 4 to April 30, 1986.

If you have any questions, please let me know.

Very truly yours,

M. O. Medford

cc: Mr. J. B. Martin, Regional Administrator, NRC, Region V
Mr. A. E. Chaffee, Regulatory Projects Branch, Region V
Mr. Gary Zech, Office of Inspection and Enforcement
Mr. F. R. Huey, NRC Senior Resident Inspector, SONGS 1, 2 & 3

ENCLOSURE 1

RESPONSES TO MARCH 25, 1986 LETTER

ATTACHMENT 1

1965 HEAT BALANCE

QUESTION NO. 1

System Design/Operating Data

a. At steady state 92% rated thermal power (RTP), what are the feed flows (in lb/hr and gpm), pressures, and temperatures encountered at the feed pump discharge check valves (12") and the steam generator feed line check valves (10")? How was this data obtained?

b. What were the above data at steady state 100% RTP? How was the data obtained?

c. What is the minimum steady state flow rate, along with pressures and temperatures, that these valves encounter?

d. Clearly indicate the source and reliability of the Atwood Morrill valve data used in the redesign calculations.

RESPONSE

a. Using plant operating data based on station logs at 92% RTP extrapolated to the check valve locations, the values are:

	12" Valves	10" Valves
Flow (lb/hr)	2.5×10^6	1.67×10^6
Flow (gpm)	5600	3952
Temperature ^oF	332 (Note 1)	405 (Note 3)
Pressure (psia)	1080 (Note 2)	710 (Note 4)

Notes:

1. Based upon an increase of 2^oF through feed pump (typical from 1965 heat balances).
2. Based upon a 10 psi pressure drop through 1st Point Feedwater Heater (obtained from station manual) and a 10 psi drop through the piping up to control valve.
3. Based upon 2^oF temperature drop from first point heater to check valve.
4. Based on calculated 350 psi pressure drop across control valve ($C_V \approx 200$).

b. The flows, temperatures and pressures at 100% RTP for the subject valves are:

	12" Valves	10" Valves
Flow (lb/hr)	2.85×10^6	1.90×10^6
Flow (gpm)	6425	4533
Temperature ^oF	339	416 (Note 1)
Pressure (psia)	995 (Note 2)	620 (Note 2)

The data was obtained from the original calculated heat balance diagram M20-5687889-3 (Attachment 1).

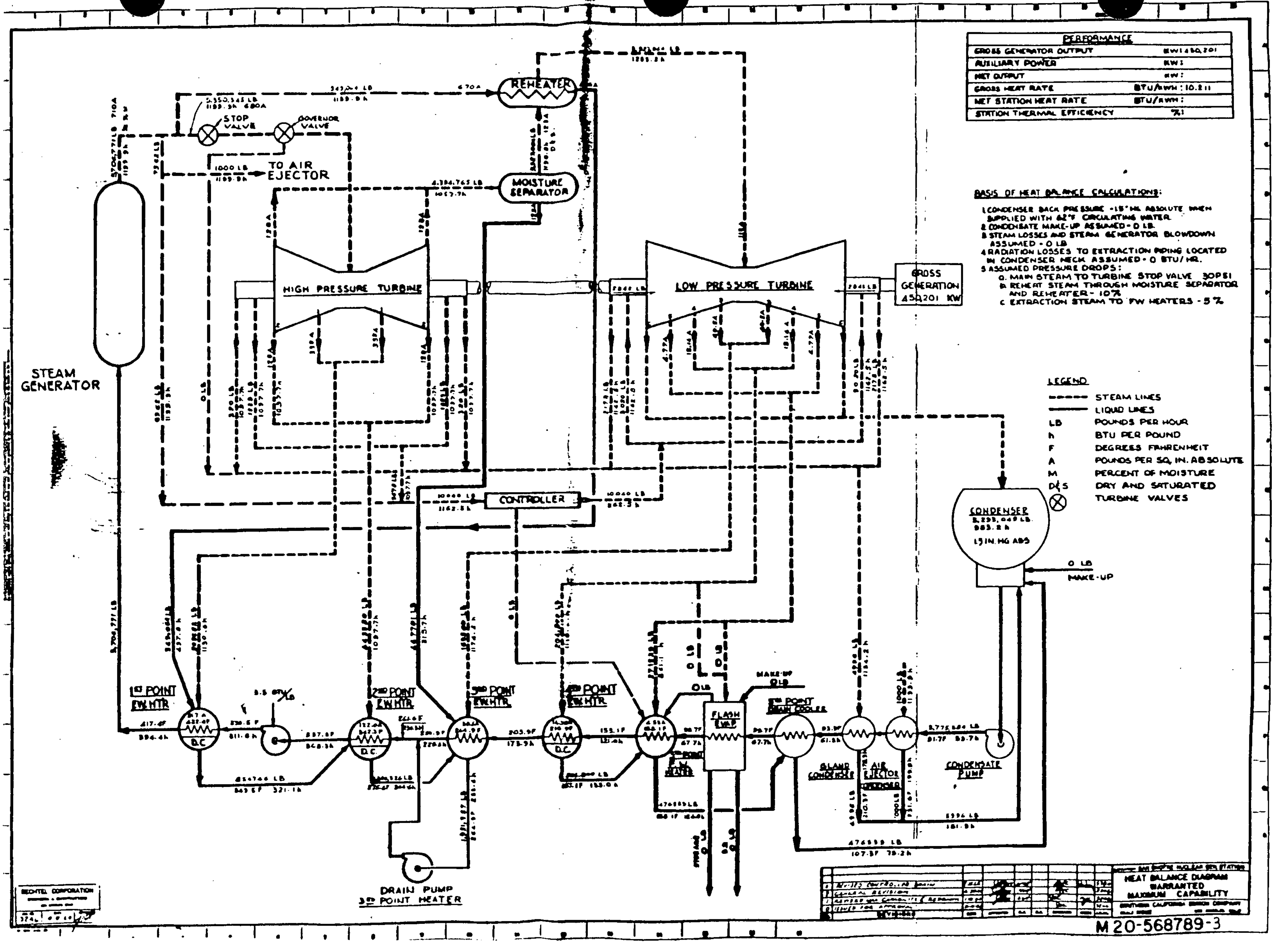
Notes: 1. Assumes approximately 2°F temperature drop from first point heater to check valve.

2. Pressures are approximate based on pump curves.

c. The expected minimum flows, pressures and temperatures are provided below. The flow for 10" check valves uses the minimum main feedwater flow control valve position of 5% as the basis. The flow for the 12" check valves uses the feedwater pump minimum flow as the basis.

	12" Check Valves	10" Check Valves
Flow (gpm)	700	200
Pressure (psia)	1,150	760
Temperature (°F)	220	260

d. Atwood-Morrill calculated pressure drop values were provided in their letter of February 20, 1986 (Attachment 2). Valve testing recently performed on one 10" check valve provided actual pressure drop under the modeled conditions. Both the calculated value and test results indicate pressure drops under 1 psi for low flow operation and in the 2-4 psi range under full flow conditions.


PERFORMANCE
GROSS GENERATOR OUTPUT
AUXILIARY POWER
NET OUTPUT
GROSS HEAT RATE
NET STATION HEAT RATE
STATION THERMAL EFFICIENCY
REHEATER
STOP VALVE
GOVERNOR VALVE
TO AIR EJECTOR
MOISTURE SEPARATOR
STEAM GENERATOR
HIGH PRESSURE TURBINE
LOW PRESSURE TURBINE
GROSS GENERATION 450,201 KW
BASIS OF HEAT BALANCE CALCULATIONS:
2 CONDENSATE MAKE-UP ASSUMED = 0 LB.
5 ASSUMED PRESSURE DROPS:
C EXTRACTION STEAM TO FW HEATERS - 5%
LEGEND
STEAM LINES
LIQUID LINES
LB POUNDS PER HOUR
h BTU PER POUND
F DEGREES FAHRENHEIT
A POUNDS PER SQ. IN. ABSOLUTE
M PERCENT OF MOISTURE
D/S DRY AND SATURATED
TURBINE VALVES
CONTROLLER
CONDENSER
0 LB MAKE-UP
1ST POINT FW HTR
2ND POINT FW HTR
3RD POINT FW HTR
4TH POINT FW HTR
FLASH EVAP
5TH POINT DRAIN COOLER
GLAND CONDENSER
AIR EJECTOR
CONDENSATE PUMP
DRAIN PUMP 3RD POINT HEATER
BECHTEL CORPORATION
HEAT BALANCE DIAGRAM WARRANTED MAXIMUM CAPABILITY
SOUTHERN CALIFORNIA EDISON COMPANY
M 20-568789-3

ATTACHMENT 2

ATWOOD-MORRILL LETTER DATED 02/20/86

ATWOOD & MORRILL CO. INC.
DESIGNERS AND MANUFACTURERS SINCE 1900
285 CANAL STREET · SALEM, MASSACHUSETTS 01970 · PHONE 617 744-5690 · TELEX 94-0299

February 20, 1986

Bechtel Power Corporation
12440 East Imperial Highway
Norwalk, CA 90650

Attention: Mr. Fred Lizmi

Subject: San Onofre
Check Valve Position Indicators
Bechtel P.O. Nos. V8200603
V8200611
A&M S.O. No. 15487

Dear Fred:

The following information is provided to confirm or clarify my previous discussions with Craig Walsh.

1. The reference dimensions on from the certified drawing (6.69", 8.50" and 10.94" for the 4", 10" and 12" valves, respectively) show the as cast ID of these valve bodies at the valve inlet and outlet. This small ID allows us to use the same castings for a variety of pipe sizes and pipe schedules. For your valves, this small ID is completely machined out so that the inlet and outlet are as shown on the weld end details and the minimum port size through these valves is as shown on previous correspondence.

   The certified drawings will be changed, removing these reference dimensions as requested.

2. For local position indication, we propose to extend a small diameter shaft through one of the bearing covers as shown on the attached sketch. With this arrangement a pointer attached to the small diameter shaft will rotate with the disc/disc arm indicating valve position.

We propose to use a small diameter shaft in lieu of a full diameter shaft to minimize the packing friction in the stuffing box. It is our design philosophy that the packing friction on a full size shaft would be so high that there would be a danger of preventing valve movement.

3. The calculated water velocity through the seat and the pressure drop through each 10" valve is as shown below. These calculation are based on the water density of 49 lbs/cubic foot.

Flow Rate	Seat Velocity (ft/sec)	Delta P (psi)
1,830,000 lb/hr	28	2.6
4200 GPM	25	2.0
165 GPM	1	0.6
25 GPM	0.2	0.6

Please note that the velocities at 165 and 25 GPM are far below the minimum recommended velocities and that the pressure drops for these velocities are at best crude estimates. A better calculation for these pressure drops could be done only at a price increase.

Intermittent operation for short periods of time under these low flow conditions is, of course, permissible. However, this is severe service for a check valve and we would expect the valve disc to repeatedly open and bang closed.

We trust this information is satisfactory. If you have any questions, please contact us.

Very truly yours,

ATWOOD & MORRILL CO., INC.

John T. Mahoney
Senior Sales Engineer

JTM/ko
JTM23

c: M. Macdonald - A&M

Robert Burns & Associates, Inc.
Attn: Robert Burns

QUESTION NO. 2

Valve Technical and Performance Requirements

a. What was the design basis for the 10" and 12" valves in terms of flows, port size, obturator weights, pressure, and temperatures for both the MCC-Pacific and Atwood-Morrill valves? How does this differ from actual values?

b. What are the acceptable operating ranges for the new valves and what is the impact on plant/system operations?

c. What are the maintenance, installation, and operation requirements or guidelines provided by MCC-Pacific and Atwood-Morrill?

d. Will the new valves be modified to include operator assists or position indicators?

e. What are the "enhanced" surveillance and maintenance requirements and their basis for the Atwood-Morrill valves? Are they from or concurred by the manufacturer?

f. What are the Atwood-Morrill bonnet and packing torque values?

g. Where is the Atwood-Morrill actual hinge and disc combination center of gravity?

RESPONSE

a. The design process conditions for the flow, temperature and pressure for the lines in which the 10" and 12" valves are installed is presented in Attachment 1. The 100% load 1965 data would apply to the MCC-Pacific valves and the 92% data applies to the Atwood-Morrill valves.

The port size is selected by the supplier. The MCC-Pacific design basis was originally based on the 100% data and is now subject to the 92% conditions.

b. Performance tests by Dr. J. Paul Tullis and Dr. William J. Rahmeyer of Utah State University Foundation have provided operating ranges for the San Onofre Unit 1 feedwater check valves. The test results showed the Atwood-Morrill check valves are acceptable for all of the tested operating ranges at the locations downstream of the feed pumps and control valves and the proposed locations inside containment. These flow ranges are:

10" Valves	Up to 4267 gpm
12" Valves	Up to 6000 gpm

c. Atwood-Morrill has provided an instruction manual detailing the maintenance and installation requirements and procedures for their valve (Attachment 2). Operational guidelines are being developed as explained in the response to Question 2e. The original maintenance procedures provided by MCC-Pacific could not be located. The current operation and maintenance manuals is provided as Attachment 3.

d. No operator assists or position indicators will be included on the valves.

Due to the fact that the Atwood-Morrill valve has a 20° seat angle, the arc of travel required from full open to full close is much shorter than typical swing check valves. This allows the valve to seat quickly upon flow reversal, therefore, operator assists are not required. The addition of position indicators requires, by nature, a bore and accompanying shaft seal in the valve body. This seal can lead to two significant complications, the first of which is the possibility of seal leakage. The other is the friction force of the seal on the hinge shaft. This force can inhibit valve closure and thus increase the severity of a possible water hammer event. Also, performance tests of the valve have not shown any need for operator assists. A final consideration is given in the A-M instruction manual (Attachment 2, page 3) which states, "For valves with . . . no outside lever or air closing cylinder, preventative maintenance is minimal."

e. Test procedure guidelines have been issued for leak rate testing of critical feedwater and auxiliary feedwater check valves (Attachment 4). SCE is developing test procedures for surveillance testing and maintenance of check valves from these guidelines. These surveillance procedures have not been issued to date. The surveillance leak rate limits have been calculated based upon limiting the steam admission to the feedwater piping. No supplier review or concurrence is required for the surveillance leak rate limits.

f. The Atwood-Morrill value has no packing and the bonnet is a pressure seal type. However, there are bolts on the bonnet to hold in the pressure seal. Atwood-Morrill has provided a bolt-torque table (Attachment 2, page 7), a portion of which is shown below.

Valve	Bolt Size	Required Bolt Stress	Required Bolt Torque
4"	5/8 - 11	25,000 psi	50 ft-lb
10"	7/8 - 9	25,000 psi	142 ft-lb
12"	7/8 - 9	25,000 psi	142 ft-lb

g. The center of gravity for the hinge/disc combination for the 4", 10" Schedule 60 and Schedule 80, and 12" valves are located as shown in the sketch provided by Atwood-Morrill (Attachment 5).

ATTACHMENT 1

PROCESS CONDITIONS AT 100% AND 92% RTP

Data \ Plant Condition	100% Load (1965) 10" Valves	100% Load (1965) 12" Valves	92% Load 10" Valves	92% Load 12" Valves
Flow (lb/hr)	1.90×10^6	2.85×10^6	1.67×10^6	2.50×10^6
Flow (gpm)	4533	6425	3952	5600
Temperature (^oF)	416	339	405	332
Pressure (psia)	620	995	710	1080

NOTE: See responses to Questions 1a and 1b for explanation of the basis for this data.

ATTACHMENT 2

ATWOOD-MORRILL INSTRUCTION MANUAL

INSTRUCTION MANUAL

FOR

FREE FLOW REVERSE CURRENT VALVES
DOUBLE BEARING COVER DESIGN

Manufactured by
Atwood & Morrill Co., Inc.
Salem, Massachusetts

Bechtel P.O. No. V8200603
Atwood & Morrill S.O. No. 15487

IMPORTANT
If the price or schedule is affected by this document, Bechtel must be notified prior to fabrication or such claims are waived.
Permission to proceed does not constitute acceptance or approval of documents involving design details, calculation, analysis or test report and is only an acceptance of the method used by the supplier. Supplier retains full responsibility for design.
Issuance of this document does not relieve the supplier from full responsibility for contract or purchase order requirements including, but not limited to, adequacy and suitability of materials and/or equipment represented thereon for the intended function.

DATE RECEIVED 2-24-86

DOC STATUS BY P. Cruz

DATE 3/5/86

DOCUMENT STATUS
- ☐ Manufacturer may proceed
- ☐ Exceptions as noted. Make changes and resubmit. Manufacturer may proceed.
- 4 ☐ Correct and resubmit.
- 7 ☒ Information only. ☐ Distribution required.

PF-1216 (10079) 8/82

☒ This revised Vendor Document incorporates changes associated with a Design Change Package (DCP).

DCP Number 3400.-

☐ This Vendor Document revision does not reflect any physical plant modification and is not associated with a DCP or FCR.

Explain change

Reviewed by P. Cruz Date 3/5/86

PF-6183 (10079) 8/83

S01-408-1-2-8-0

TABLE OF CONTENTS

SECTION I

GENERAL INFORMATION

Application

The check valve purpose is to prevent a reversal of flow, and consists of a swinging disc so arranged that when the flow enters the valve from the inlet end, the disc pivots on its shaft, swinging upward to allow a free flow through the valve. As flow diminshes disc will pivot downward toward its seat. If flow stops or if a reversal of flow occurs, the disc will seat and seal, preventing a reversal of flow through the protected system.

Construction

The valve is a straight-through type having a swinging disc rotating on a heavy shaft in bushed bearings with a pressure sealed bonnet or bolted bonnet. The combination disc and disc arm are of cast steel to guard against breakage. The shaft rides in nitrided stainless steel bushings. Shaft is sealed at each end by a bearing cover, using a flexitallic gasket. This construction eliminates end thrust as both ends of the internal shaft are subject to the same pressures.

Valve Operation - Normal

The check valve will protect against reverse flow through the section of the system where it is installed.

The valve is a free swinging, gravity closing typo check valve. The valve disc will open when the inlet pressure becomes slightly higher than the outlet pressure and will close when the inlet pressure becomes slightly less than the outlet pressure or a reversal of flow occurs.

SECTION II

INSTALLATION

The valve is connected to the line by butt welding or bolting through the valve flange and the pipe flange.

The valves are delivered by the manufacturer in a clean, dry condition free of grease, slag or other foreign matter. All openings are sealed to prevent the entry of any foreign matter into the valve during shipment. These seals should not be removed until just before the valve is installed.

Inspect the valve carefully for evidence of damage in transit.

After the valve has been installed, cycle it several times to be sure it functions properly.

MAINTENANCE

PREVENTIVE MAINTENANCE

For valves with double bearing covers with no outside lever of air closing cylinder, preventive maintenance is minimal. The gasket for the bearing covers should be checked for leaks periodically. Also during any period of shutdown, the disc and body seat should be checked for foreign particles, nicks or wear. This may be done by removing the bonnet.

PRESSURE SEAL RING PRECAUTIONS

Due to the customary elapsed time between final shop testing and initial site pressurizing, it is possible for the pressure seal to relax somewhat. We recommend, therefore, that prior to any line filling or pressurizing, the cover nuts be again tightly secured. This assures that the seal ring is firmly in position, ready for pressurizing. The more pressure, the tighter the seal. In other words, some showing of water through the seal with little or no pressure on the valve is not cause for concern as a good application of pressure will generally seal the cover tightly.

GENERAL MAINTENANCE

At valve disassembly, clean and inspect all parts, reworking the parts or replacing them from spare stock as inspection indicates. At reassembly, always use new gaskets.

Before disassembly, always clean and blow down with air any outside surface possible. Any paint or foreign matter such as dirt, rust or scale can greatly hamper the smooth operation of the valve.

Inspection or repair of valve internals can be accomplished without removal of the main valve body from the line.

After surface cleaning and inspection of the valve in the line, disassemble the valve, wire brush all parts and wash them with an approved cleaning solvent, wipe the surfaces with lint-free cloth, or allow the parts to air dry.

Inspect each part carefully for defective threads, excessive wear on seating surface, and bent or worn shaft. Replace any parts found excessively worn or damaged.

Disassembly - FTRCV With Bolted Bonnet

1. Clean cover area thoroughly.

2. Remove valve cover.

3. Block disc in seating position in valve body.

4. Remove both valve bearing covers from valve sliding them off the dowel pins and shaft.

5. Slide valve shaft out of valve from either side of body.

6. Remove valve disc from valve.

7. Inspect the valve shaft for wear or score marks. If shaft is worn or scored and cannot be repaired it should be replaced.

8. Inspect the seating surfaces of the body and the disc to determine if they require lapping. Any scratches or pitting from foreign matter would be cause for relapping.

9. Use an aluminum lapping plate. Fasten seat width pieces of #180 "grit cloth" to the lapping plate face by means of double backed tape. Leave a small space between the tapes.

10. Block the disc in a flat position, seat up, and lap with a disc lapping plate, either with an air tool or by hand, depending on the amount of lapping required. Lap until scratches and any indentations are removed. Clean grit cloth occasionally by blowing out with air and replace if worn down by prolonged lapping. To check the disc seat, cover with spray-on 603, brush-on-blue or equal. Allow to dry. Lap lightly with seat tool. The seat will be true and polished when all the blue wipes off.

11. Using a body seat lapping plate, lap the body seat using the same procedure as for lapping the disc.

12. After completing the lapping operation, thoroughly clean all parts with acetone or other approved solvent.

Reassembly - FFRCV With Bolted Bonnet

1. Install bushings in bearing covers and into disc arm.

2. Place valve disc in valve body and block it in seating position.

   NOTE: Caution should be used to prevent scratching the disc or body seats.

3. Slide shaft through the valve body and disc arm.

4. Install bearing covers to valve body being careful not to damage the dowel pins. Use new gaskets.

5. The seating of the valve can be checked by lifting the disc just enough to insert a ½" wide strip of toilet tissue between the disc body seats allowing the disc to seat. This should be checked at four points 90° apart. If at any point the tissue pulls out, the disc is being prevented from seating either from insufficient or improper lapping or a change of seat height from excessive lapping. The chances of the latter happening are extremely remote, but if this is the case, dowel pins should be removed and the bearing cover adjusted until the disc seats firmly all around. Wedge disc firmly in place on its seat and redowel.

6. Make sure after reassembly that bearing covers are in proper alignment and that there is no binding of shaft. Before access cover is replaced, check the end clearances between the disc arm and the bushings to make sure they do not bind on the ends of the disc arm.

7. Clean cover gasket area and install cover gasket and cover.

Disassembly - FFRCV With Pressure Seal Bonnet

1. Clean cover area thoroughly. Remove the four cover nuts.

2. Remove locking plate.

3. If cover does not drop to body shoulder, tap down using a piece of 4" x 4" wood or other suitable means. Again make sure that cover is clean.

4. Remove master segment of load keys. The master segment has parallel ends.

5. Remove balance of load keys.

6. Remove backing ring and again clean area thoroughly as any foreign matter will damage the seal ring and body sealing area during removal of the seal ring.

7. Install eight 3/8" long - all thread steel rods (not supplied) into seal ring tapped holes.

8. It can be useful to use, sparingly, some light approved lubricant around the seal ring to assure smooth removal. Once again it is of the utmost importance to keep the seal ring area clean.

9. Place the locking plate on the body so that the eight 3/8" rods pass through the ½" holes in the locking plate.

10. The locking plate is now resting evenly on top of the body face with the 3/8" rods evenly in the ½" holes.

11. Lubricate the 3/8" threads.

12. Install eight 3/8" steel hex nuts with 3/8" washers on the 3/8" rods lubricating under the nut and washer faces.

13. Tighten the 3/8" nuts using the diametrically opposed method.

14. The removal of the seal ring will now commence.

15. Once the seal ring is moving easily it may be possible to use four fiametrically opposed 3/8" nuts rather than the eight used to start the seal ring moving.

16. The seal ring can now be easily removed using caution when the top of the seal ring enters the area above the load key slot.

17. The body bore area is larger above the load key slot. Care should be taken not to cock the seal ring so that it binds going through this area.

18. The seal ring can now be carefully lifted from the body taking care not to cock the seal ring so that it binds.

19. The cover can now be carefully lifted from the body using a chain hoist.

20. Fasten one end of a sling to the upper section of the disc arm and fasten the other end of the sling to a suitable chain hoist. Take up on the chain hoist so there is just enough tension to support the weight of the disc and arm.

21. Remove the bearing cover nuts and remove the bearing cover. Be careful not to damage the dowel pins when removing the cover. One bushing will remain with the bearing cover. The other bushing will be removed with the shaft.

22. The shaft may be removed from either side of the body. One bushing will be removed with the shaft in the same direction that the shaft is removed. The other bushing can easily by removed after the shaft has been removed.

23. Remove shaft from either side of the body.

24. By means of the sling and chain hoist, lift the disc from the valve through the top cover opening.

25. Inspect the seating surfaces of the body and the disc to determine if they require lapping. Any scratches or pitting from foreign matter would be cause for relapping. If the valve seating surfaces require relapping, hand lap as follows:

26. Use an aluminum lapping plate, these are not furnished with the valve but are available as tools.

    Fasten 3" long seat width pieces of #180 "grit cloth" to the lapping plate face by means of double backed tape. Leave spaces of approximately 1" between tapes.

27. Block the disc in a flat position, seat up, and lap with an air tool or by hand, depending on the amount of lapping required. Using a disc lapping plate, lap until scratches and indentations are removed. Clean grit cloth occasionally by blowing out with air and replace if worn down by prolonged lapping. To check the disc seat, cover with spray-on 603 brush-on-blue or equal. Allow to dry. Lap lightly with seat tool. The seat will be true and polished when all the blue wipes off.

28. Using a body lapping plate, lap the body seat using the same procedure as for lapping the disc in Step #27.

29. After completing the lapping operation, thoroughly clean all parts with acetone or other approved solvent.

Reassembly - FFRCV With Pressure Seal Bonnet

1. Insert bushing into disc arm and using sling and chain hoist lower disc into body.

2. Slide shaft through body and disc arm.

3. Insert bushings into bearing cover making sure that they seat on their shoulders.

4. Install bearing cover and dowel to body.

5. The seating of the valve can be checked by lifting the disc just enough to insert a ½" wide strip to toilet tissue between the disc body seats allowing the disc to seat. This should be checked at four points 90° apart. If at any point the tissue pulls out, the disc is being prevented from seating either from insufficient or improper lapping or a change of seat height from excessive lapping. The chances of the latter happening are extremely remote but if this is the case, dowel pins should be removed and the bearing cover adjusted until the disc seats firmly all around. Wedge disc firmly in place on its seat and redowel.

6. Make sure after reassembly that bearing covers are in proper alignment and that there is no binding of shaft. Before access cover is replaced, check the end clearances between the disc arm and the bushings to make sure they do not bind on the ends of the disc arm.

7. Before reinstalling the cover and seal ring all parts should be cleaned and washed with an approved solvent such as acetone.

8. Assure that the seal ring and the stainless steel body sealing area have no nicks or marks that will prevent proper sealing. Dress up with light emery or crocus cloth if necessary.

9. Place cover in body resting on body shoulder.

10. Install seal ring over cover. Again be sure that the cover is absolutely clean. There is a possibility that the seal ring has moved slightly out of round. Therefore, we would suggest locating the best fitting position as the seal ring is starting to enter the body bore. The seal ring should now move down quite easily requiring at most a light tapping to move it into position just below the backing ring area.

11. Place backing ring into position on top of the seal ring.

12. Install segmented load keys.

13. Place locking plate over cover studs and install four hex nuts.

14. Tighten hex nuts using diametrically opposed method evenly and draw cover up evenly being sure it does not strike the load keys and stop there.

15. The cover will now have pulled the seal ring into a sealing position and the hex nuts should be tightened up snugly.

16. When the valve is pressurized, the seal ring will be further forced into position and will seal tightly. The more pressure the tighter the seal. After the cover is sealed tightly with line pressure still in the valve, the hex cover nuts should again be tightened so that the seal will not relax after the valve is depressurized.

STANDARD MANUFACTURING PROCEDURE	PAGE	PROCEDURE NO
	~~3 of 4~~	90-71-030
		Rev. 0

TABLE 1

BOLT TORQUE (FT. LBS.)

Bolt Size	Bolt Stress (psi) 5,000	10,000	15,000	20,000	25,000
1/4-20	1	1	2	2	3
5/16-18	1	2	3	5	6
3/8-16	2	4	6	8	10
7/16-14	3	6	10	13	16
1/2-13	5	10	15	20	25
9/16-12	7	14	21	28	35
5/8-11	10	20	30	40	50
3/4-10	18	35	53	71	89
7/8-9	28	57	85	114	142
1"-8	42	85	127	170	212

ATTENTION: PAT SONTI EXT 857752

714-368-7654

385

FOR AZM NO 15487

7752

85

TABLE 2

ALLOWABLE BOLT STRESS

Bolt Material	Allowable Stress (psi)
A/SA 193-B7	25,000
A/SA 193-B6	20,000 (Note 1)
A/SA 193-B6	21,200 (Note 2)
A/SA 193-B8	15,000 (Note 1)
A/SA 193-B8	18,700 (Note 2)
A/SA 193-B8M	15,000 (Note 1)
A/SA 193-B8M	18,700 (Note 2)
B/SB 150-CDA 630	12,500 (Note 3)
B/SB 150-CDA 630	25,000 (Note 4)

Note 1. Valves built up to 1977 Edition of Code, No Addenda.

Note 2. Valves built to 1977 Edition W/Summer 1977 Addenda or later.

Note 3. Valves built to 1977 Edition up to Summer 1977 Addenda.

Note 4. Valves built to 1977 Edition W/Winter 1978 Addenda or later.

ATTACHMENT 3

MCC-PACIFIC OPERATION AND MAINTENANCE MANUAL

FAMILIAN INDUSTRIAL SUPPLY CO.

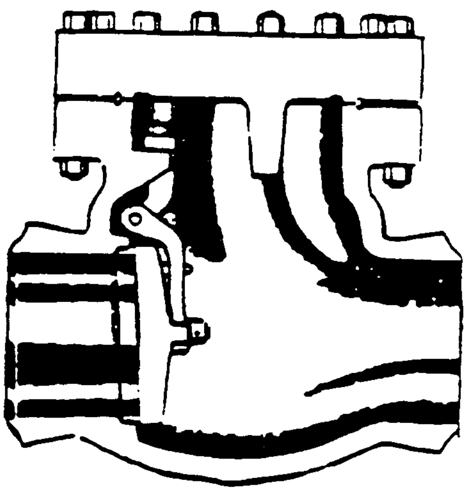
918 Mahar Avenue
Wilmington, CA 90744

P.O. No. IN 81536

OPERATION AND MAINTENANCE MANUAL

Pacific Valves Shop Job 4L0065

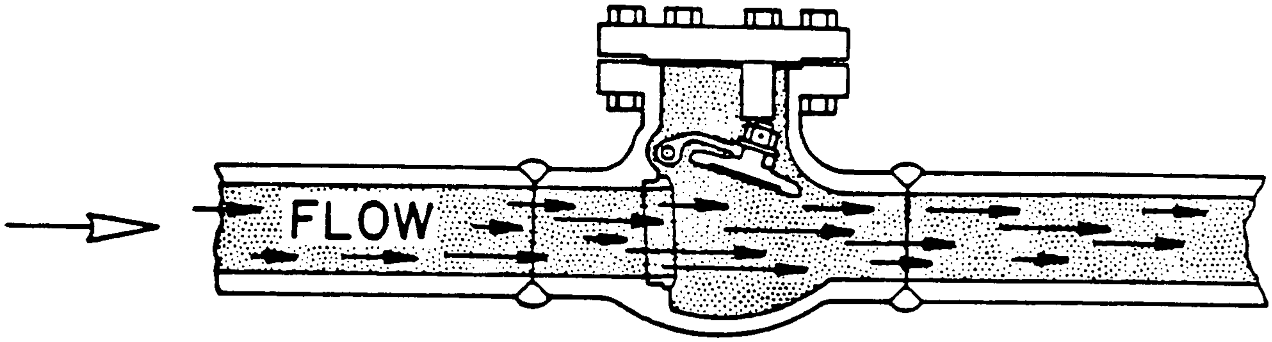
PACIFIC SWING CHECK VALVES



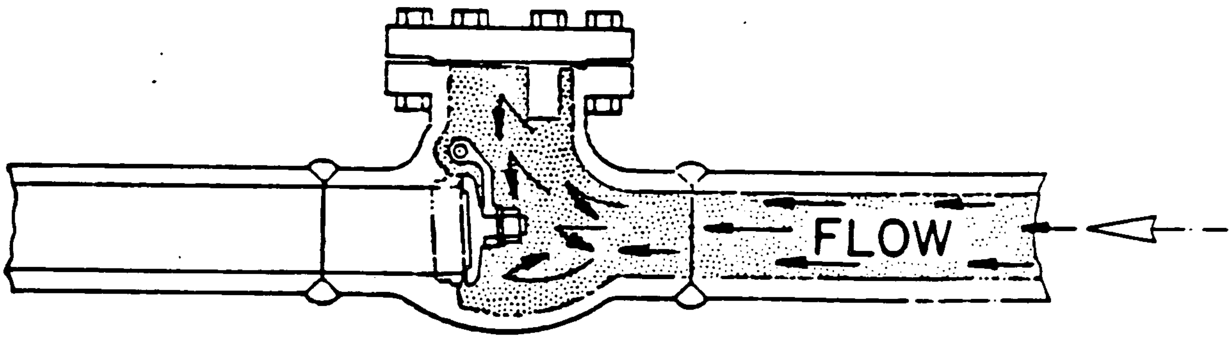
CONTENTS

1.0 THEORY OF OPERATION

Swing check valves are designed to open by the pressure of the line. The desired direction of flow in the line will open the valve and any attempt by the flow to reverse will, in its self, close the valve completely. (See illustration below).



DESIRED DIRECTION OF FLOW



REVERSE IN FLOW

THESE DRAWINGS SHOW-GENERAL ARRANGEMENT ONLY.

2.0 DESCRIPTION

This manual covers all Pacific swing check valves. These valves are designed within the limits of ANSI B16.34. Being self-operating, no electrical power, signals or other remote controls or indicators are required. See Section 4.0 for operation of valve.

3.0 INSTALLATION

When unpacking, care should be exercised in lifting and handling to avoid damage to valves or injury to personnel. These valves may be installed in lines varying in angle from horizontal to vertical, provided that the flow is upward. Valves with outside lever and weight are recommended to be mounted only in a horizontal position.

When installing, be certain that all foreign material is removed from the interior of the valve, including desiccants.

A protective paint has been applied to the weld ends on some valves and it should be removed before welding.

For soft seated valves, the temperature of the valve body should not exceed 200°F during welding to avoid damaging the elastomers. Check temperature with Tempil-Stik. Avoid heating valve body excessively, especially small sizes, where a heat sink may be necessary.

Use the smallest electrode and minimum amperage practicable, consistent with efficient welding to minimize warpage.

Tack welds should be ground out before completing the root pass in that area.

Valves of carbon steel should be allowed to cool slowly. The valve may be covered with an asbestos blanket to promote slow cooling and limit the heat-affected zone.

4.0 OPERATING INSTRUCTIONS

Swing check valves are designed to be operated by the line pressure.

When the line is pressurized, the flow will open the disc.

While the pressure is off or there is back pressure, the disc will be closed.

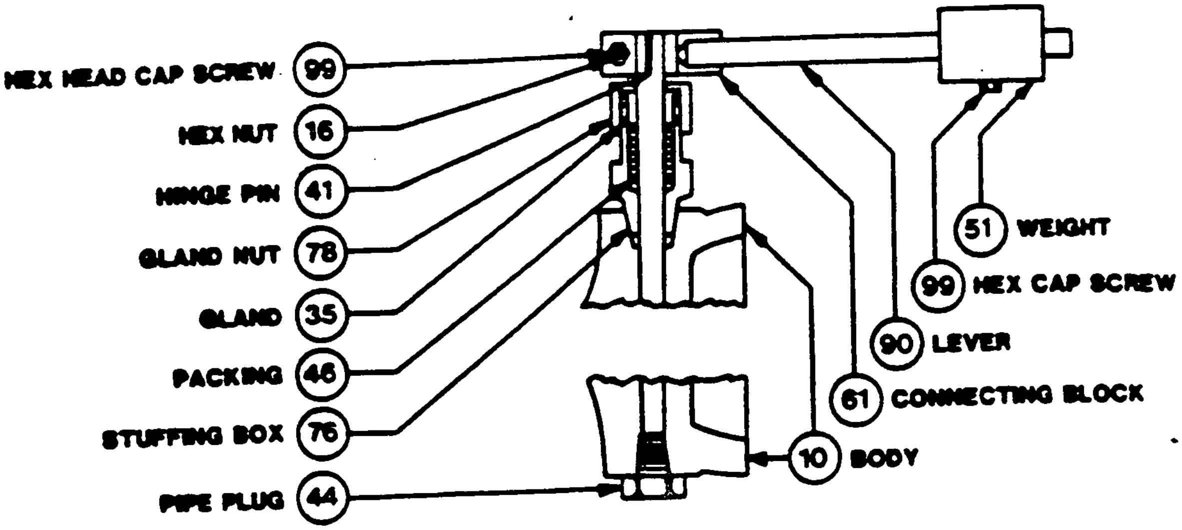
(See illustration in Section 1.0).

CAUTION!

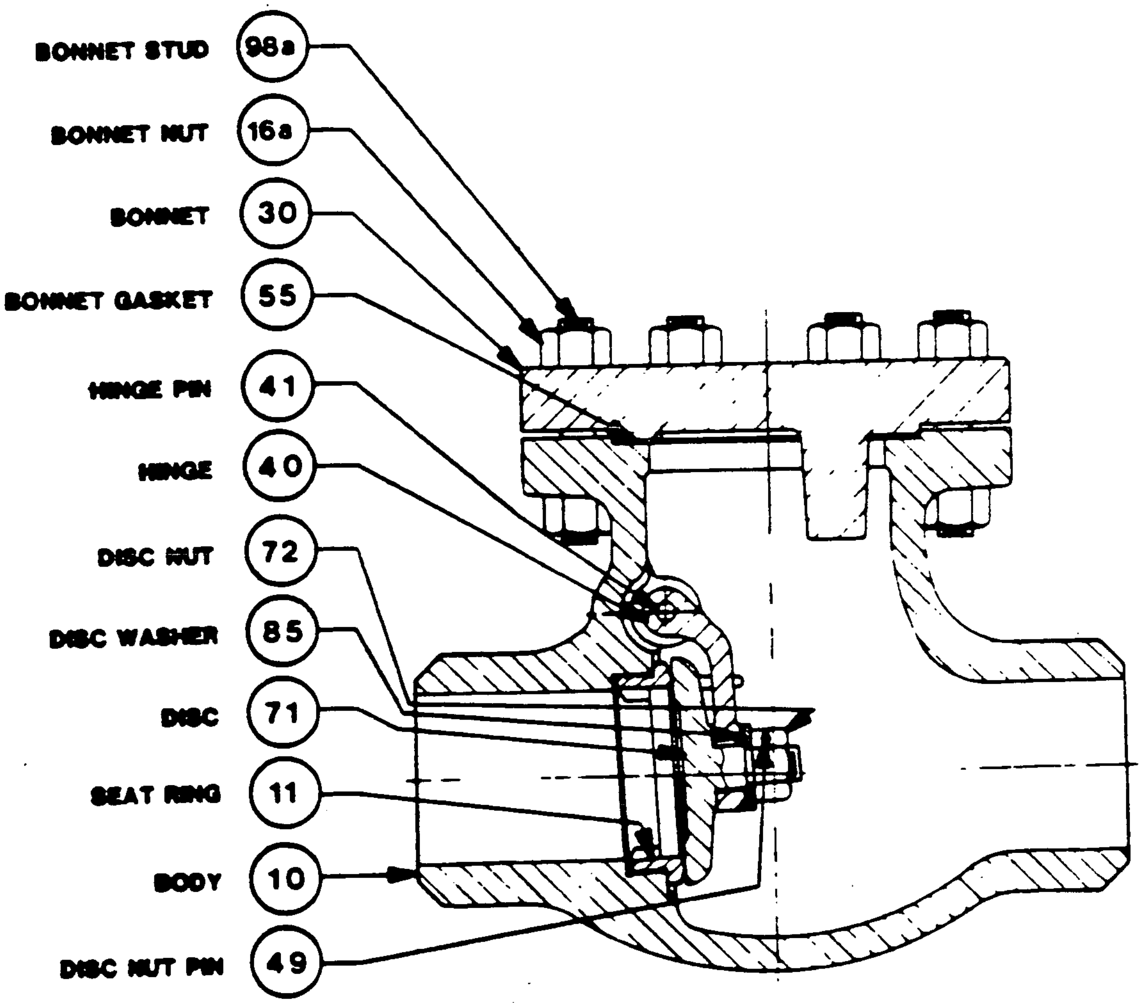
These valves are designed to operate within the pressure and temperature limits of ANSI B16.34. Do not exceed these limits.

5.0 MAINTENANCE

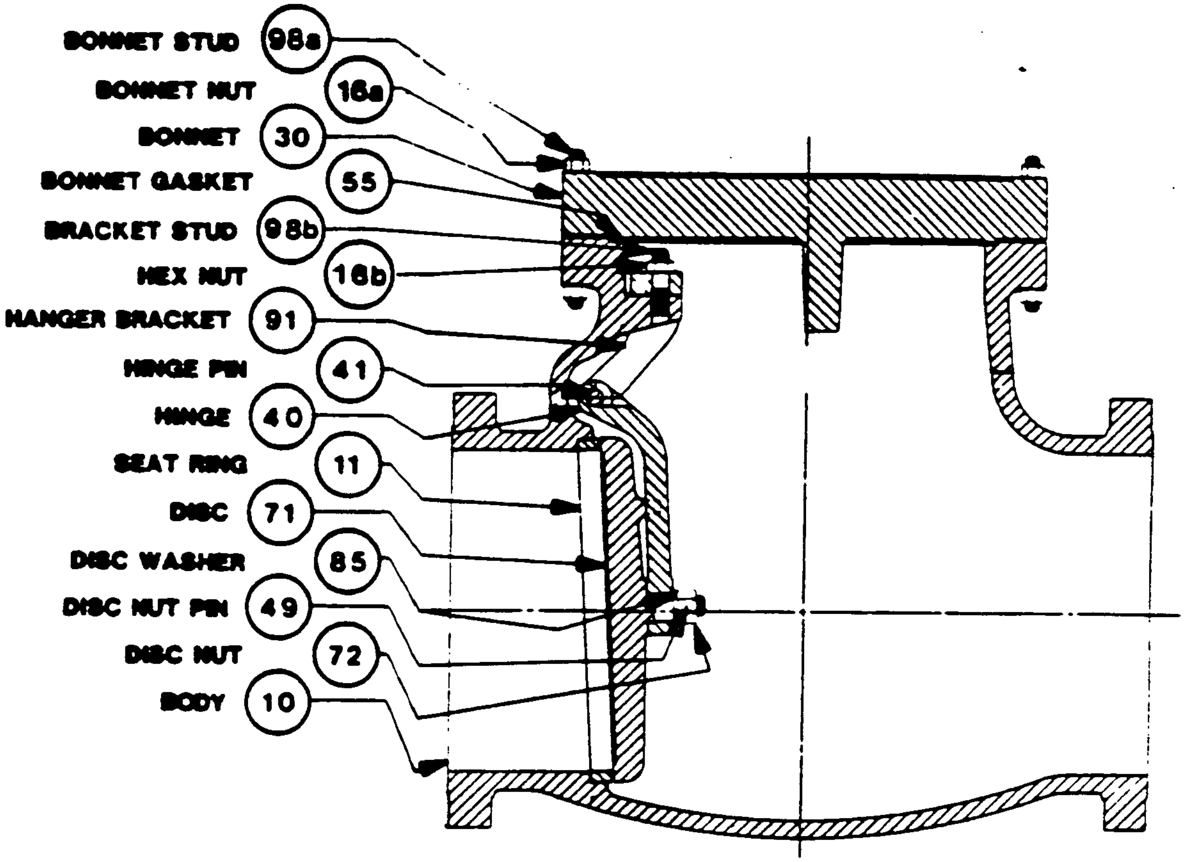
5.1 Complete Disassembly



SPECIAL OUTSIDE LEVER & WEIGHT ASSEMBLY



WELD END SWING CHECK VALVE



FLANGE END SWING CHECK VALVE
WITH INTERNAL HANGER

CAUTION! Before complete disassembly, make sure no residual pressure is left in the line.

5.1.1 Remove bonnet stud nuts or cap screws (16a) (98a).

NOTE! Studs need not be removed unless replacement is necessary.

5.1.2 Lift off bonnet cap (30).

5.1.3 Remove bonnet gasket (55).

For check valves with internal hanger:

5.1.4 Remove bracket stud nut (16b). Note: Stud (98b) need not be removed unless replacement is necessary.

For check valves with hinge pin through body:

Remove pipe plugs (44) from both side of body and slip out hinge pin (41). If pipe plugs are seal welded, they need to be ground free first.

For check valves with outside lever and weight:

Remove connecting block (61) and lever-weight assembly (90) - (99) - (51). Remove gland nut (48) and gland (35). Remove packing (46) from stuffing box (76) then remove stuffing box. Remove pipe plug (44) and slip out hinge pin (41).

5.1.5 Lift out disc assembly (40), (71), (85), (49) and (72).

5.1.6 Slip out hinge pin (41). Remove bracket (91) from disc assembly.

5.1.7 Drive out disc nut pin (49) and remove nut (72) in a counterclockwise direction. Slip off washer (85) and hinge (40) from disc (71).

5.1.8 At this time the seat ring (11) may be removed if necessary. It is usually seal welded to the body (10) and must be cut free. It is advisable to leave it in place unless wear prevents further use.

5.2 Complete Assembly

Reverse the steps in Section 5.1. NOTE: If disc has anti-rotation lugs, be sure to replace hinge so that it is aligned between them.

6.0 PREVENTIVE MAINTENANCE

6.1 Normal Duty Inspection

The only in-service check that can be made is to inspect the body/bonnet gasket joint (55) or hinge pin stuffing box (76) for leaks.

6.2 Maintenance of Valve Under Pressure

If the inspection of Section 6.1 reveals any trouble, the following is recommended, if necessary.

6.2.1 If leakage develops at the body (10) bonnet (30) joint, the bonnet stud nuts or cap screws (16a) should be tightened uniformly around the circle.

CAUTION!

Do not over stress the bolting
(See torque charts in Appendix)
If leakage continues, the gasket (55) should be replaced.
(See disassembly procedure in Section 5.0).

6.2.2 If leakage develops at the stuffing box (76), the gland nut (78) can be tightened. If the packing continues to leak, the packing (46) should be replaced during line shutdown (see 6.3).

6.3 Maintenance of Valve Relieved of Pressure

CAUTION!

Make certain line pressure is zero.

6.3.1 Following disassembly procedures in Section 5.1, examine body cavity (10) for deposits of foreign material.

6.3.2 Examine seating surfaces of seat ring (11) and disc (71) for wear.

6.3.3 If excessive wear is evident, worn parts or, if necessary, entire valve should be reconditioned or replaced.

6.3.4 Whenever reconditioning a valve, it is always good practice to replace gaskets.

6.3.5 Pacific offers complete replacement seal kits and spare parts for reconditioning. When ordering, always state the figure number of the valve and the body material, as well as the quantity desired.

6.3.6 Pacific Valves also offers complete reconditioning services to rework your valve. If you find this necessary, our nationwide network of reconditioning centers will rebuild your valve "like new".

6.4 <u>Lubrication</u>

6.4.1 Parts requiring lubrication are nuts before torquing and both sides of gasket before assembly.

7.0 SPECIAL TOOLS AND INSTRUCTIONS

7.1 Recommended bolting torques are shown in the Appendix.

7.2 No special tools are required.

ATTACHMENT 4

TEST PROCEDURE GUIDELINES

TEST PROCEDURE GUIDELINE FOR CHECK VALVES LEAKAGE RATE TEST

I. Functional Test for Check Valves FWS-006, FWS-007 and FWS-012 Inside the Containment:

A. Objective: To verify that the check valve back leakage rates are within the allowable limits. Correct deficiencies if required.

B. References:

1. P&ID 5178225, Revision 4, Main Steam System

2. P&ID 5178206, Revision 3, Feedwater System

C. Prerequisites:

1. Completion of check valve installation.

2. Verify calibration of pressure gauges.

3. Test to be done during Mode V or VI.

4. Isolation valves (FWS-343, FWS-377, FWS-339, AFW-325, FWS-342, FWS-376, FWS-352, AFW-326, FWS-396, FWS-415, FWS-382 and AFW-328) upstream of the check valves are closed.

5. Establish that the feedwater level of the steam generator at the feed ring elevation $\pm 2'-0"$.

6. Nitrogen system blanket is established per procedure.

D. Acceptance criteria: Check valves back leakage rate is within 0.48 gallons per minute at 150 psig. This test procedure was written for testing at 150 psig. Alternate test pressures can be used. The acceptance cirteria for using the alternate shall follow the equation.

Allowable leak rate at pres. P, $Q = 0.48 \sqrt{\frac{P}{150}}$ (gpm), see Fig. 2.

The allowable fluctuation in the test pressure is ± 5 psi or $\pm 10\%$ whichever is greater. If test pressures less than 150 psig are used, functional testing of the feedwater main and bypass values must be done at a test pressure of 150 psig(Test II).

E. Method

1. Test the check valve one at a time only. Close isolation valves upstream of the check valve.

2. Connect measuring hose at the designated drain connection (see Table 1) upstream of the check valve. Make sure that the highest point of the connected measuring hose has a minimum loop as it is shown in Fig. 1.

3. Open drain valve (FWS-337, FWS-338, FWS-340, ~~FWS-426~~ and FWS-424) to depressurize the isolated line upstream of the check valve to atmospheric conditions. To confirm that the upstream isolation valves do not leak, monitor and maintain atmospheric reading on the gauges on the main feedwater and auxiliary feedwater pumps.

4. Using nitrogen, pressurize the steam generator downstream of the check valve (if pressure is not already established). Monitor and maintain steam generator pressure at 150 psig minimum to 165 psig.

5. At steady state, and using a container of known volume, measure and record the check valve back leakage rate by measuring the time required to accumulate one gallon. Take two measurement test readings for comparison.

6. After measuring the check valve back leakage rate, close the nitrogen pressurizing line (if not required for other than testing).

7. Making sure the system is vented, close the drain valves and disconnect the measuring hose.

8. Open back all the isolation valves that were closed during the test.

F. Alternate method for functional test of FWS-006, FWS-007 and FWS-012:

Performance of this test is subject to the availability of the auxiliary feedwater pumps as a pressurization source.

1. With a nitrogen blanket established, initiate auxiliary feedwater flow to pressurize the steam generator. When a test pressure has been established, perform the back leak rate test in accordance with E1 through E5 above. As the pressure will decay during the test, the following requirements apply to the test pressure:

   a. The decay in steam generator pressure shall be no more than 10% of the final pressure.

   b. For the purpose of determining the allowable leak rate, the final measured steam generator pressure shall be used.

      NOTE: The allowable leakage rate shall be determined using the minimum pressure value obtained during the test.

II. Functional Test for Check Valves FWS-345, FWS-346, FWS-398, FWS-379, FWS-378, FWS-417 in the feedwater system.

A. Objective: To verify that the feedwater system check valves back leakage rates are within the allowable limit. Correct deficiencies if required.

B. Reference:

1. P&ID 5178206, Revision 4, Feedwater System.

C. Prerequisites:

1. Completion of check valve installation.

2. Verify calibration of pressure gauges.

3. Isolation valves (FWS-343, MOV-21, FWS-377, FWS-381, FWS-342, MOV-20, FWS-376, FWS-372, FWS-396, MOV-22, FWS-415 and FWS-419) upstream and downstream of the check valves are closed.

4. Test to be done in Mode V or VI.

D. Acceptance criteria: This criteria applies to the combined check valves back leakage rates of the following paired check valves: FWS-345 and FWS-379; FWS-346 and FWS-378 and FWS-398 and FWS-417 leakage shall be less than is 0.48 gallons per minute. This procedure is written using test pressures of 150 psig. Other test pressures can be used. The allowable leak rate at other test pressures shall follow the equation

Allowable leak rate at pres. P, $Q = 0.48 \sqrt{\frac{P}{150}}$ (gpm), see Fig. 2.

If the test pressure used on the downstream check valves (Test I) is less than 150psig, this test shall be performed at 150 psig minimum.

The allowance fluctuation in the test pressure is ± 5 psi or $\pm 10\%$ whichever is greater.

E. Method:

1. Test the check valves one at a time only. Close isolation valves upstream and downstream of the check valve.

2. Connect measuring hose at the designated drain or vent connections (see Table 1). Make sure that the highest point of the connected measuring hose has a minimum loop as it is shown in Fig. 1.

3. Open the drain or vent valve where the measuring hose is connected to depressurize the line to atmospheric conditions. To confirm the upstream isolation valves do not leak, monitor and maintain atmopsheric reading on the gauges on the main feedwater pumps.

4. Connect the high pressure water supply to the drain or vent connection designated downstream of the check valve (see Table 1). The water supply must meet the requirement of the chemistry flush specification for the feedwater system. Open the drain or vent valve and high pressure water supply valve and pressurize the line. Using the pressure gauge provided in the water supply hose, maintain and monitor the pressure downstream of the check valve at 150 psig minimum to 165 psig.

5. At steady state, and using a container of known volume, measure and record the check valve back leakage rate by measuring the time required to accumulate one gallon. Take two measurement test readings for comparison.

6. After measuring the check valve back leakage rate, close the drain or vent valve where the measuring hose is connected and disconnect the hose.

7. Making sure the system water is vented, close the high pressure water supply valve and close the drain or vent line valve and disconnect the high pressure water supply.

8. Open back all the isolation valves upstream and downstream of the check valve that were closed during the test.

F. Alternate Procedure:

The back leakage rate test for the feedwater system check valves can also be done during Mode III subject to the availability of the auxiliary feedwater pump as a pressurization source. The following procedure would be used.

1. Test and isolate the check valves one at a time only. Close isolation valve upstream of the check valve.

2. Connect measuring hose at the designated drain or vent connections (see Table 1). Make sure that the highest point of the connected measuring hose has minimum loop as it is shown in Fig. 1.

3. Open the drain or vent valve where the measuring hose is connected to depressurize the line to atmospheric conditions. To confirm the upstream isolation valves do not leak, monitor and maintain atmospheric reading on the gauges on the feedwater pumps.

4. Install a temporary test pressure gauge and open the valve of the vent connection upstream of the check valve as indicated in Table 1.

5. Initiate the auxiliary feedwater pump flow to pressurize the line downstream of the check valve to within ± 10% of the normal operating pressure. Maintain and monitor the pressure at the test pressure gauge installed at the vent connection.

6. At steady state, and using a container of known volume, measure and record the check valve back leakage rate by measuring the time required to accumulate one gallon. Take two measurement test readings for comparison.

7. After measuring the check valve back leakage rate, close the drain or vent valve where the measuring hose is connected and disconnect the hose.

8. Close the vent connection valve where the test pressure gauge is installed and remove the gauge.

9. Open back all the isolation valves upstream of the check valve that was closed during the test.

III. Functional Test for Check Valves FWS-438 and FWS-439 in the feedwater system.

A. Objective: To verify that the feedwater system check valves are still intact and functional.

Correct deficiencies if required. These valves have been provided with a 9/32" orifice hole drilled in the check valve disc. Standard leak rate tests cannot be performed. This testing will determine the functionality of the check valve.

B. Reference:

1. P&ID 5178205, Revision 2, Feedwater System.

C. Prerequisites:

1. Completion of check valve installation.

2. Verify calibration of pressure gauges.

3. Isolation valves (FWS-441, FWS-469, CV-875B, HV-854B, FWS-556, FWS-440, FWS-472 and HV-854A) upstream and downstream of the check valves are closed.

4. Test to be done during Mode V or VI.

D. Acceptance criteria: When the downstream piping is pressurized to 150 psig the upstream leakage rate is less than 20 gpm. Other test pressures can be used. The allowable leakage rate at an alternate pressure P would follow the equation

$$Q = 20 \sqrt{\frac{P}{150}} \quad \text{(GPM)}$$

The allowable fluctuation in test pressure is ±5psi or ±10% whichever is greater.

E. Method:

1. Test the check valve one at a time only. Close isolation valves upstream and downstream of the check valve.

2. Connect measuring hose at the designated drain or vent connections (see Table 1). Make sure that the highest point of the connected measuring hose has a minimum loop as it is shown in Fig. 1.

3. Open the drain or vent valve where the measuring hose is connected to depressurize the line to atmospheric conditions. To confirm the upstream isolation valves do not leak, monitor an maintain atmospheric reading on the gauges on the main feedwater pumps.

4. Connect the high pressure water supply to the drain or vent connection designated downstream of the check valve (see Table 1). The water supply must meet the requirement of the hemistry flush specification for feedwater system and can provide 20 gpm at 150 psig minimum pressure to 165 psig. Open the drain or vent valve and high pressure water supply valve and pressurize the line. Using the pressure gauge provided in the water supply hose, maintain and monitor the pressure downstream of the check valve at 150 psig minimum to 165 psig.

5. At steady state and using a container of known volume, measure and record the check valve back leakage rate by measuring the time required to accumulate ten gallons. Take two measurement test readings for comparison.

6. After testing, close the vent valve where the measuring hose is connected and disconnect the hose.

7. Making sure the system is vented, close the high pressure water supply valve and close the vent line valve and disconnect the high pressure water supply.

8. Open back all the isolation valves upstream and downstream of the check valves that were closed during the test.

F. <u>Alternate Method for Functional Test of FSW-438, FWS-439.</u>

This method is subject to the availability of the feedwater pumps as a pressurization source during mode 5 or 6. Test only one check valve at a time feedwater system will be aligned such that, one feedwater pump will be run and the water will be recirculated to the condenser via the 3" miniflow line. The check valve on the discharge of the out-of-service feedwater pump will be tested as follows;

1. Establish feedwater flow and flow path form one feedwater pump close the upstream isolation valve on the check value on the discharge of tag out-of-service pump.

2. With the flow path in the crosstie between the feedwater heaters open, install a temporary pressure gauge on the pressurized side of the check value.

3. Connect measuring hose at the designated drain or vent connections (see Table 1). Make sure that the highest point of the connected measuring hose has a minimum loop as it is shown in Figure 1

4. Open the drain or vent valve where the measuring hose is connected to depressurize the line to atmospheric conditions.

5. At steady state, and using a container of known volume, measure and record the check valve leakage rate by measuring the time required to accumulate 20-40 gallons.

6. After measuring the check valve back leakage-rate, close the drain or vent valve where the measuring hose is connected and disconnect the hose.

7. Making sure the system is vented, terminate Feedwater miniflow.

CAUTION: Care should be taken when performing this alternate testing, as the potential exists for overpressurization of the feed water suction piping. The suggested test pressure is 150 psig.

IV. Functional Test for Check Valves AFW-321, AFW-322, AFW-324, in the Auxiliary Feedwater Systems. (Continued)

B. Reference: P&ID 5178220, Revision 5 Auxiliary Feedwater System.

C. Prerequisites:

1. Completion of check valve installation.

2. Verify calibration of pressure gauges.

3. Isolation valves(AFW-325, FCV-2300, AFW-326, FCV-3301, FCV-2301, AFW-338, FCV-3300,) upstream and downstream of the check valve are closed.

4. Test to be during Mode V or VI.

D. Acceptance criteria: Check valve back leakage rate is within 0.48 gallons per minute. This procedure is written using test pressures of 150 psig. Other test pressures can be used. The allowable leak rate at other test pressures shall follow the equation.

Allowable leak rate at pres. P, $Q = 0.48 \sqrt{\frac{P}{150}}$ (gpm), see Fig. 2.

The allowable fluctuations in test pressure is ±5psi or ± 10% whichever is greater.

E. Method:

1. Test check valve one at a time only. Close isolation valves upstream and downstream of the check valve.

2. Connect measuring hose at the designated connections upstream of the check valve (see Table 1). Make sure that the highest point of the connected measuring hose has a minimum loop as it is shown in Fig. 1 is higher than the highest point of the isolated line where it is connected (see Fig. 1).

3. Open the drain or vent valve where the measuring hose is connected to depressurize the line to atmospheric condition. To confirm the upstream isolation valves do not leak, monitor and maintain atmospheric reading on the gauges on the auxiliary feedwater pumps.

4. Connect the high pressure water supply to drain or vent connection designated downstream of the check valve (see Table 1). Tehe water supply must meet the requirement of the chemistry flush specification for the feedwater system. Open the drain or vent valve and the high pressure water supply valve and pressurize the line. Using the pressure gauge provided in the water supply hose, maintain and monitor pressure downstream of the check valve at 150 psig to 165 psig.

5. At steady state, using a container of known volume, measure and record the check valve back leakage rate by measuring the time required to accumulate one gallon and the check valve minimum downstream pressure value. Take two measurement test readings for comparison.

6. After measuring the check valve back leakage rate, close the valve where the measuring hose is connected and disconnect the hose.

7. Making sure the system is vented, close the high pressure water supply valve and close the vent or drain valve where high pressure water supply is connected and disconnect the high pressure water supply line.

8. Open back all the isolation valves upstream and downstream of the check valve that were closed during the test.

Enclosure

TABLE 1

CHECK VALVE	HIGH PRESSURE SUPPLY CONN.	MEASURING CONNECTION	ISOLATION VALVES
FWS-006		FWS-338	FWS-376, AFW-326, FWS-352 and FWS-342
FWS-007		FWS-337	FWS-339, FWS-377, FWS-343 and AFW-325
FWS-012		FWS-424	FWS-382, FWS-396, FWS-415 and AFW-328
FWS-417	FWS-432	FWS-423	FWS-415 and FWS-419
FWS-398	FWS-368	FWS-365	FWS-396 and MOV-22
FWS-378	FWS-428	FWS-422	FWS-376 and FWS-372
FWS-346	FWS-446	FWS-366	FWS-342 and MOV-20
FWS-379	FWS-423	FWS-421	FWS-377 and FWS-381
FWS-345	FWS-425	FWS-367	FWS-343 and MOV-21
FWS-439	FWS-445	FWS-565	HV-854B, HV-852B, CV-875B and FWS-473
FWS-438	FWS-540	FWS-510	FWS-440, FWS-556, FWS-472 and HV-854A
AFW-321	DRAIN	VENT	AFW-325 and FCV-2300
AFW-322	DRAIN	VENT	AFW-326, FCV-3301 and FCV-2301

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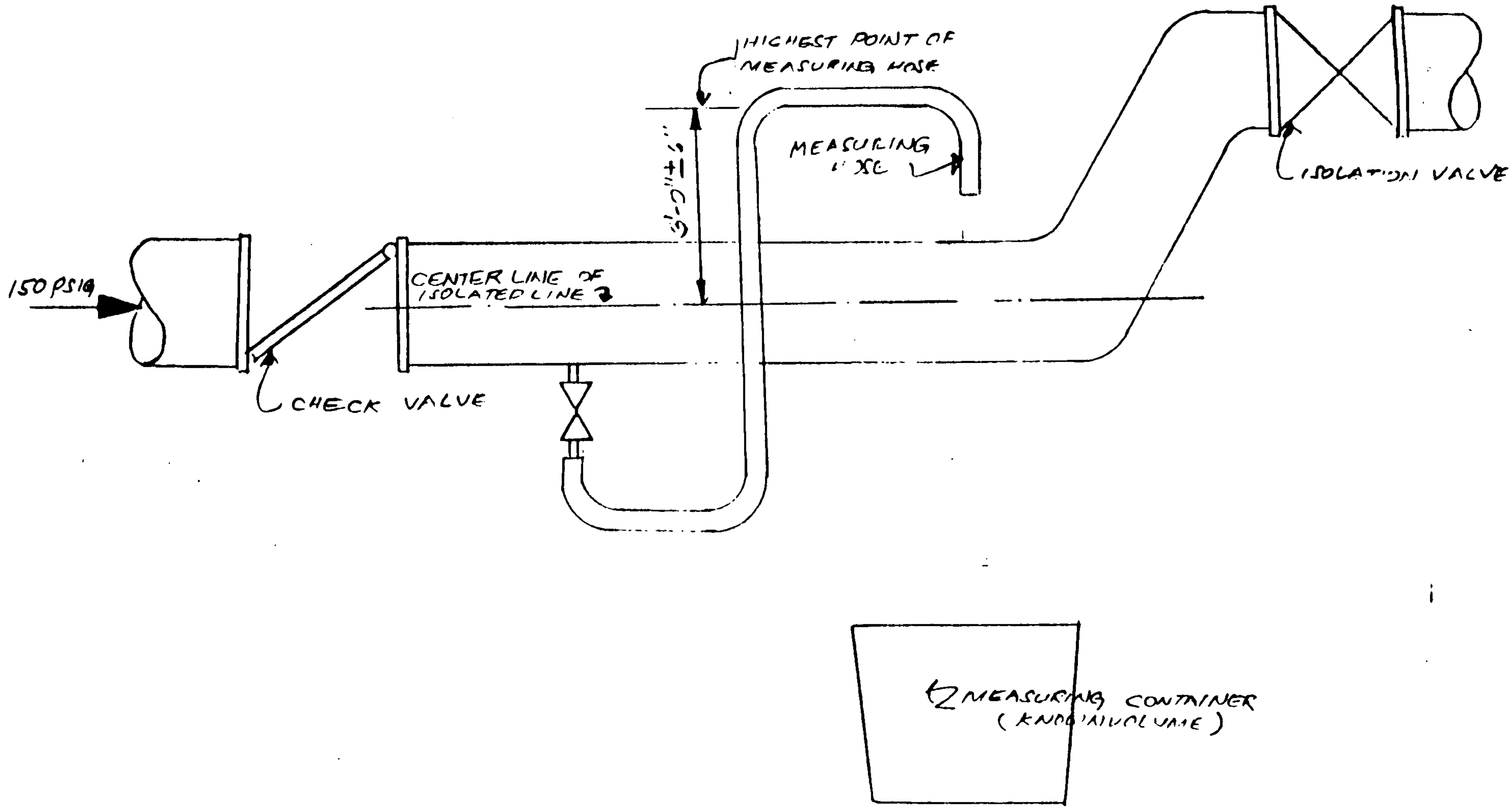
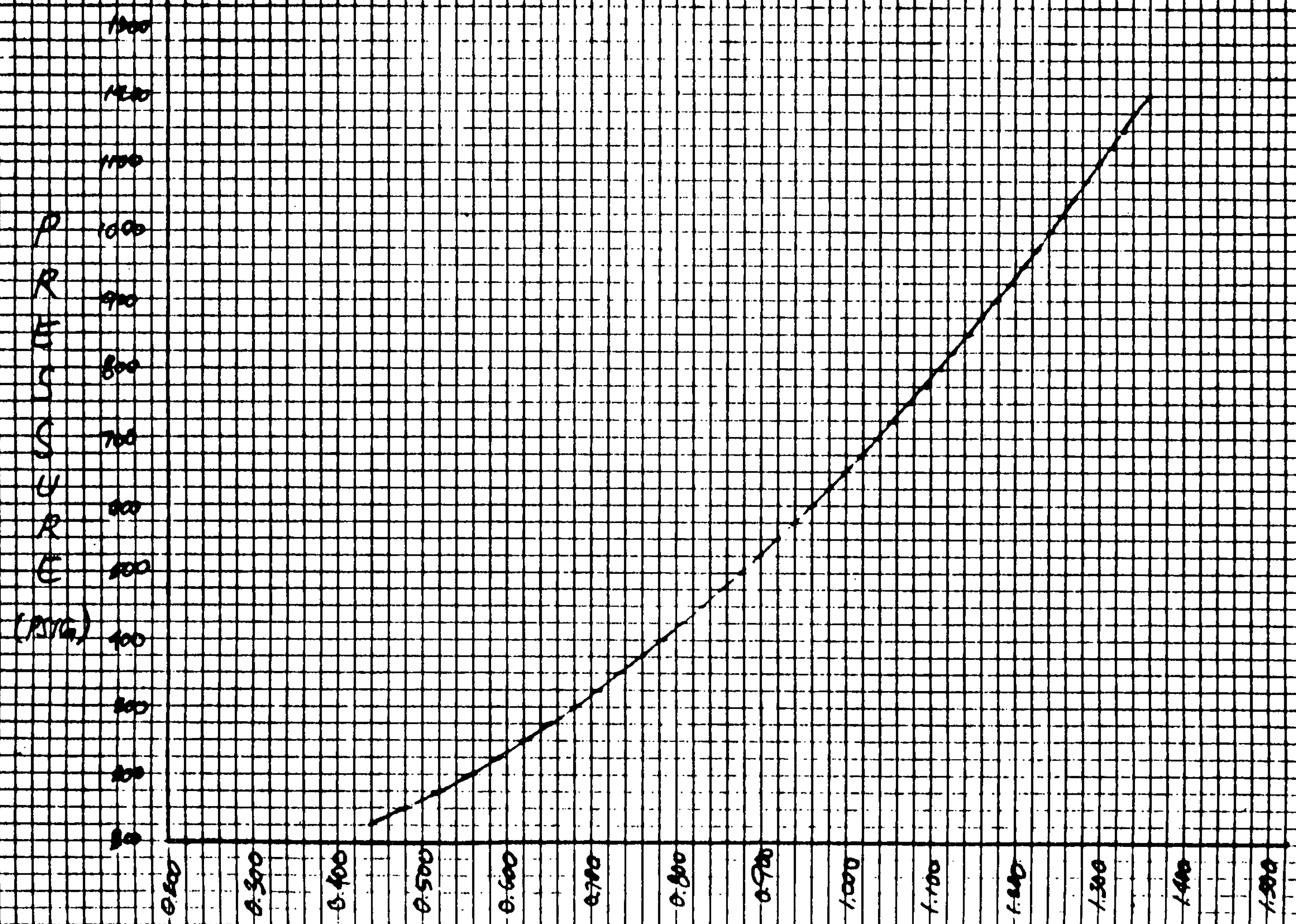


FIG. 1 - TYPICAL HOOKUP OF
MEASURING HOSE FOR
CHECK VALVE BACKFLOW
LEAKAGE TEST.

FIG. 2 - ALLOWABLE CHECK VALVE BACK FLOW LEAKAGE RATE



NOTE: TESTS SHOULD BE PERFORMED AT 150psig OR GREATER WHENEVER POSSIBLE.

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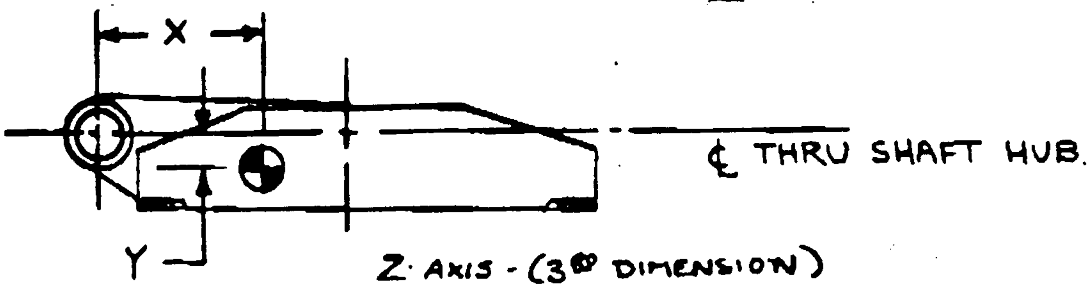
ATTACHMENT 5

CENTER OF GRAVITY SKETCH

DISC WEIGHT / CG -- 900 # DBC BFPCV'S

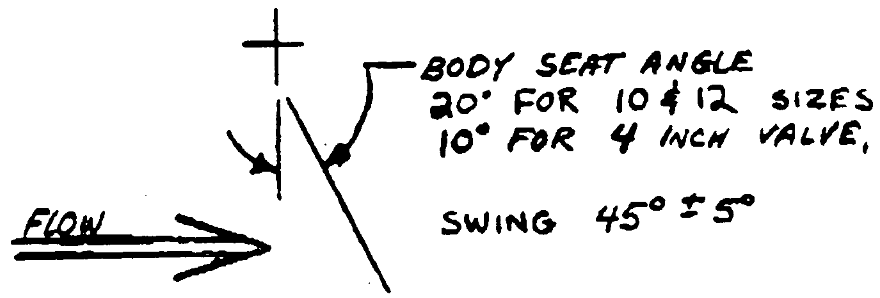


Z AXIS - (3RD DIMENSION)
CG IS ON PIPE / VALVE ℄.

TO: RICHARD JENSEN BECHTEL POWER NORWALK CA	FR. E. BOLTON ATWOOD & MORRILL SALEM MA.

EJB
4-11-86

SIZE	REF.	WGT	X	Y
10	15487-01 15487-05 15487-06 15487-07	51 LBS.	4.65 IN.	.54 IN.
12	15487-02	86 LBS.	6.03 IN	.64 IN.
4	15487-03	6.2 LBS.	2.17 IN.	.14 IN.



QUESTION NO. 3

Vibratory Loads

a. Clarify the method of development of the factor that turbulence loads from upstream components will not exceed 10% of disc weight?

b. The ISA Handbook of Control Valves provides recommendations on installation. Why or why can't these locational restrictions be correlated to check valves?

c. Atwood-Morrill recommends not locating check valves within specific distances of turbulence producing components. What is the basis for deviating from these recommendations?

RESPONSE

a. For the response to this question, reference Appendix D of the SCE Investigation Report submitted to the NRC by letter dated April 8, 1986.

b. The ISA Handbook, Chapter 12, page 339 (Attachment 1), recommends 10-20 pipe diameters of straight run piping upstream of control valves and 3-5 pipe diameters downstream. The handbook acknowledges that the 10-20 diameters upstream may be next to impossible to obtain in line sizes larger than nominal 5". These values actually correlate quite well with those of 10 pipe diameters upstream and 5 diameters downstream given as optimum by Atwood-Morrill for their check valves. However, as explained in our response to Question 3c, Atwood-Morrill check valves can be located at less than these optimum conditions without experiencing any significant vibration or disc flutter.

c. Per a February 24, 1986 letter from L. Hutton of Atwood-Morrill (Attachment 2), they do not expect any problems resulting from the chosen check valve locations. Independent tests conducted at Utah State University Foundation by Dr. P. Tullis, demonstrate the acceptability of the Atwood-Morrill valves at all of the San Onofre Unit 1 feedwater check valve design locations. The most severe location is downstream of the flow control valves. This testing confirms the acceptability of locating the check valve five diameters downstream of the control valve.

ATTACHMENT 1

ISA HANDBOOK, PAGE 339

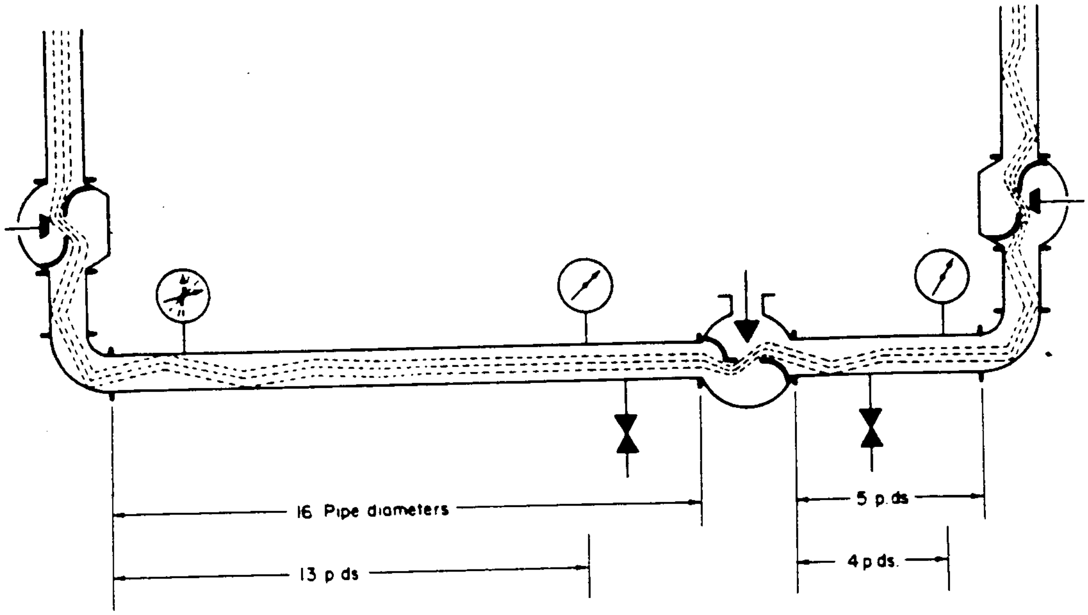


Figure 3. TYPICAL SATISFACTORY ARRANGEMENT OF UPSTREAM AND DOWNSTREAM PIPING.

trol engineer's calculations, or vice versa. Figure 2 shows a method of plotting system pressures to arrive at available pressure drop vs. valve lift. A similar plot will be used by the valve manufacturer to accurately design the valve plug. The piping design engineer should review such plots in designing the piping system. The design friction loss, through the lengths of pipes and fittings selected, can be made consistent with such plots. This calculation should include the friction drop through the fully opened control valve as part of the piping system. The characteristic pump curve is generally available from the pump manufacturer. The terminal pressure drop vs. flow through the process vessel may be more difficult to obtain.

It can be seen from Figure 2 that valve performance—capacity and flow vs. valve lift, will be altered if the actual piping system consumes more pressure drop (curve 4) than that considered in the valve sizing calculation.

In designing the inlet and exit piping at a control valve, a conservative approach is to consider the control valve as a variable orifice; thus, the piping recommendations used to pipe orifice plate assemblies can be applied. The following considerations are recommended:

1. Allow the maximum number of feet of straight run inlet piping that is consistent with other piping demands. A good rule of thumb is 10 to 20 pipe diameters. This is easy to obtain in small size lines, but may be impossible to obtain in line sizes larger than nominal 5 inches. Nonetheless the practice of allowing for a maximum straight inlet run will allow better valve performance.
2. Where possible, allow a straight run of 3 to 5 pipe diameters for the outlet piping.
3. The straight run on the inlet to the valve will permit the fluid stream to enter the valve at a steady inlet pressure. Thus, for every position taken by the valve, or in other words, for every new orifice opening, a steady inlet pressure condi-

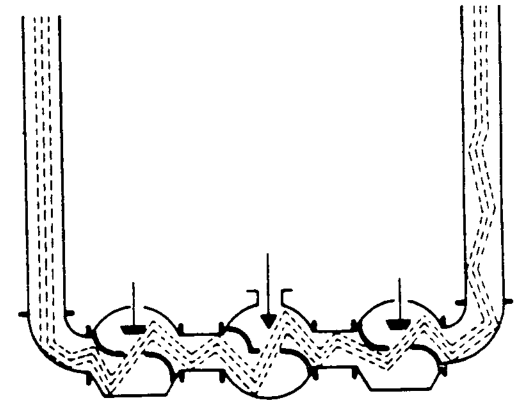


Figure 4. A LESS SATISFACTORY ARRANGEMENT OF UPSTREAM AND DOWNSTREAM PIPING.

ATTACHMENT 2

ATWOOD-MORRILL LETTER DATED 02/24/86

ATWOOD & MORRILL CO. INC.
DESIGNERS AND MANUFACTURERS SINCE 1900
285 CANAL STREET · SALEM MASSACHUSETTS 01970 · 617 744-5690 · TELEX 94-0285 · TWX 710-347-0220

PRVB-86-6208

February 24, 1986

RECEIVED
MAR 03 1986
SONGS 2 & 3-10079
PURCHASING
BECHTEL POWER CORP.

Bechtel Power Corporation
Post Office Box 60860
Terminal Annex
Los Angeles, CA 90060

Attention: Mr. Fred Lizmi

Subject: Your P.O. No. V8200603
Southern California Edison
Feedwater Check Valves
A&M S.O. No. 15487

Reference: Your February 14, 1986 letter transmitting pipe configuration and valves location dwgs.

Gentlemen:

While it is true that during the meeting with representatives of Bechtel and Southern California Edison, I recommended that no piping changes be made prior to installing our valves, we cannot guarantee that you will never encounter problems. However, based on our past experience with this design which includes approximately 30 years installed operating experience in similar applications with no major failure, we are confident that the valves will perform as specified for a full design life of 40 years. It is because of this successful operating experience that we felt that Southern California Edison should avoid the expense of reconfiguration of their piping systems. During the meeting, I noted that if problems did occur, the piping could then be modified.

The optimum installation location for check valves would include 10 pipe diameters upstream and 5 pipe diameters downstream of straight piping without other valving or reducers. Although this is optimum, in the real world of power plant design this configuration cannot always be adhered to. We note many similar Atwood & Morrill valves installed immediately after an elbow, in between two elbows, and even close coupled to a pump discharge with an elbow immediately downstream of the valve, again with no major failure.

Some of the reasons for the successful operation history of this design are as follows:

1) The 20° seat angle minimizes impact velocity due to a lower disc swing angle between full open and full closed.

2) The integral disc/disc arm assembly cannot separate as is typical with the conventional two piece disc assemblies in swing check valves.

3) The substantial disc stop restricts disc opening angle assuring that the disc cannot become jammed open and that the disc is in the flow stream and be forced to close upon flow reversal.

Should you have any further questions concerning this or require further clarification, please do not hesitate to contact us.

Very truly yours,

ATWOOD & MORRILL CO., INC.

Lauren Hutton

Lauren C. Hutton
Vice President Sales

LCH/ko
LCH 22

Enclosure

c: Robert Burns & Associates, Inc.

Mike Macdonald - A&M

QUESTION NO. 4

What was the procurement history for the original valves and spare parts?

RESPONSE

The original valves were procurred under Bechtel Specification BAL-560, a portion of which appears in the Attachment. Due to the age of the microfilm for which the copy was made, the quality of the print is poor but is the best available.

As discussed in Section 6.5.3.4 of the Water Hammer Investigation Report, there was some difficulty in retrieving maintenance records for the failed check valves. The efforts to date have been unsuccessful in locating spare parts procurement records and additional efforts are not planned.

BECHTEL SPECIFICATION BAL-560

ALAMITOS STEAM STATION, UNITS NO. 5 AND 6

CAST STEEL, CAST IRON AND BRONZE VALVES

SPECIFICATION NO. AL-560

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BECHTEL CORPORATION

[illegible], California

INSTRUCTIONS AND INFORMATION TO BIDDERS

(Vendor)

JOB [illegible]

[illegible] LOCATION AND SCOPE OF WORK

A. The jobsite is at the Alamitos Steam Station, located in Los Angeles County, California east of the City of Long Beach. [illegible] [illegible], where applicable, shall be made at the East Long Beach [illegible]. [illegible] routing [illegible] [illegible] [illegible] [illegible] the Purchaser prior to shipment. [illegible] [illegible] [illegible] instructions [illegible] the Purchaser's Construction Superintendent. [illegible] entrance to the jobsite by truck will be from the vicinity of Pacific Coast Highway and Second Street by [illegible] of the [illegible] entrance to the property.

B. The Bidder shall make his proposal with the understanding that the specification and applicable drawings are intended to cover all of the work to be done, and, unless expressly excluded, any and all labor and materials not indicated therein but which may be necessary to complete any part of the work in a proper, substantial and [illegible] manner are to be furnished by the Vendor without extra charge or cost to the Purchaser.

C. Any intended omissions or exceptions to the requirements of this specification must be stated in writing in the proposal. Otherwise it will be understood that all work is included.

[illegible] CORRESPONDENCE

A. Any and all correspondence relating to price or schedule shall be forwarded in triplicate to Bechtel Corporation, P. O. Box 58587, Vernon Branch, Los Angeles 58, California, Attention: D. [illegible] B[illegible], Purchasing Supervisor.

B. Any and all correspondence relating to engineering, after award of Purchase Order, shall be forwarded in triplicate to Bechtel Corporation, P. O. Box 58587, Vernon Branch, Los Angeles 58, California, Attention: E. C. Lyons, Project Engineer, Alamitos Steam Station, Unit No. 5.

[illegible] DEFINITIONS: Wherever [illegible] words occur in this specification, they shall have the following meanings:

1.03 DEFINITIONS (Continued)

A. "Specification" - The Instructions and Information to Bidders, Special Conditions, Drawing and Data Requirements, the Specific Conditions, the Proposal Bidding Sheet, and any supplemental drawings, sketches and data sheets attached thereto, or referred to herein, together with the Conditions of the Purchase Order, comprise the complete specification.

B. "Purchaser" - The Bechtel Corporation [illegible]

C. "Owner" - The party or parties [illegible] whose behalf the Bechtel Corporation acts as Engineer, Contractor and/or Constructor [illegible]

D. "Vendor" - The party or parties [illegible] with the Purchaser for the work specified herein.

E. "Bidder" - The party or parties [illegible] a proposal for the work.

F. "Work" - All work specified [illegible], including the furnishing of all labor, plant, materials, equipment, services and [illegible] incidentals necessary, and the performance of all [illegible] to complete and test the work specified.

Where "as shown", "as detailed", "as indicated", or words of like import are used, it shall be understood that reference to the project drawings is made unless stated otherwise. Where "as directed", "as required", "as approved", "Acceptance", or words of like import are used, it shall be understood that the direction, requirement, approval or acceptance of the Purchaser is intended.

1.04 DRAWINGS: The Drawings [illegible] shall not be used for any other [illegible] the instant [illegible]

1.05 PROPOSALS

A. Proposals shall be submitted in quadruplicate [illegible] enclosed in a sealed envelope distinctly marked "Proposal" with the [illegible] given, and delivered to Bechtel Corporation, Attention: [illegible] A. [illegible], Purchasing Supervisor, 4550 Seville Avenue, Vernon, California, on or before the appointed hour.

B. The proposal shall be signed with the full name and local address of the Bidder; if a co-partnership by a member of the firm with the name and address of each member; if a corporation, by an officer, in the corporate name, and with the corporate seal.

C. Unless otherwise stipulated herein, the Purchaser reserves the right to reject any and all proposals, to accept other than the

1.05 PROPOSALS (Continued)

lowest proposal, to accept one part of a proposal and reject the [illegible] [illegible] combination of proposals [illegible] technical information in any proposal.

D. [illegible] may withdraw [illegible] proposals [illegible] before the time set for the opening [illegible] is made to Bidder [illegible] submission of a revised proposal within the [illegible] period prior to opening of the proposals will not be permitted.

E. The specifications [illegible] submitted therewith and [illegible] shall become a part of the contract [illegible] reference.

1.06 STANDARD PRODUCTS - Except [illegible] normally manufactured [illegible] is the intention of the Purchaser that all equipment and material to be furnished hereunder shall be [illegible] the standard [illegible] manufacturers regularly engaged in their [illegible] sizes and capacities, and [illegible] the Vendor's standard [illegible] specification the Vendor shall so state in [illegible] substitute alternative.

1.07 ACCEPTANCE OF PURCHASE ORDER [illegible] shall promptly execute an acceptance [illegible] purchase order issued by the Purchaser confirming [illegible] purchase order shall [illegible] incorporate by reference [illegible] specifications and the general conditions in the forms attached [illegible] made [illegible] corporation may be required to furnish [illegible] existence of its right to do business in [illegible] of the authority of the officers signing the contract.

BAL-10.63

BECHTEL CORPORATION

Vernon, California

SPECIAL CONDITIONS

(Vendor)

JOB 4666

2.01 STANDARD OF DESIGN AND WORKMANSHIP

A. The finished work shall be complete in all respects and shall fully conform to the description thereof set forth in the purchase order.

B. The intent of the specification is to secure for the Purchaser work of first class workmanship in all respects. All components shall be manufactured, fabricated, assembled and finished with workmanship of the highest quality throughout, and in accordance with the best of recognized correct practice. All materials shall be new and suitable for the conditions specified.

2.02 INSPECTION, TEST AND EXPEDITING: The Owner and the Purchaser and either alone, shall be allowed access to the Vendor's shops and those of the Vendor's suppliers to inspect and/or expedite the work and workmanship and to obtain other desired information. The Vendor shall furnish to the Owner and the Purchaser, if so requested, at no additional cost, shop and mill test reports when specified. The Vendor shall inform the Purchaser of progress of the work and shall give the Purchaser ample advance notice of appropriate times for inspection and test. Specified tests will be approved and supervised by the Purchaser. When specific inspections or tests are required, the work involved shall not proceed beyond that point until the Purchaser has made or waived such inspections or tests.

2.03 ACCEPTANCE: The acceptance of the work will be given after the Purchaser has made sufficient tests and inspections to determine the compliance of the work with the specifications and any written agreements between the Vendor and the Purchaser. Tests and inspections will be made within six (6) months from the date work is complete and ready for use. If tests and/or inspections show the work not to be as represented or contracted for, the Purchaser may refuse to accept it and the Vendor shall be so advised, and given a reasonable time to make the necessary corrections. All corrections shall be made at the Vendor's expense.

2.04 WARRANTY

A. Vendor shall warrant that all materials, labor, work and all parts thereof to be furnished and performed hereunder shall be of the kind

2.04 WARRANTY (Continued)

and quality as described in the Specific Conditions, shall be [illegible] the use contemplated and shall perform in the manner specified therein; no other warranty by the Vendor or such suppliers, except of title, shall be implied. Vendor obligations under this warranty extend to both [illegible] and Owner for enforcement by either Purchaser or Owner or both.

B. Should any non-compliance, defect or failure to fulfill such warranty appear within one year from date of "Turbine Roll", Vendor shall correct the defective work, or defective designs, as the case may be, by repairing the defective part or parts, by correcting the design, or by supplying a non-defective replacement thereof without delay and at no expense to the Purchaser or Owner. Such repair, correction or replacement shall constitute complete fulfillment of the obligation of Vendor under this warranty, and upon expiration of the applicable warranty period specified herein, all such obligations shall terminate, except as provided in Paragraph (C) hereof.

C. In the event that Vendor or their suppliers, as the case may be, shall correct any defective parts of work pursuant to Subparagraph (A) or (B) hereof, then with respect to the parts or work corrected, the aforesaid warranty period shall run for one (1) year from the completion of such correction.

2.05 CHANGES: The Purchaser shall have the right to make reasonable changes at any time in drawings and specifications by a Change Order in writing. In the event any such change is ordered and such change causes and increase or decrease in the amount due and/or in the time required for performance, an equitable adjustment of the price and/or time of performance shall be made in account thereof.

2.06 FORCE MAJEURE

A. Vendor shall not be held responsible or liable for any loss, damage, detention or delay caused by fire or strike, civil or military authority or insurrection or riot, or by any other cause which is beyond his reasonable control.

B. Vendor and its suppliers shall not be liable to the Owner or Purchaser for any consequential damages resulting from the performance or nonperformance of the work included herein.

2.07 RIGHT TO USE WORK REQUIRING CORRECTION: After installation, the Purchaser and/or Owner shall have the right to use work which may require correction by the Vendor until such time as it is convenient to the Purchaser that this work be removed from service for correction.

2.08 SHIPMENT, DELIVERY AND PIECE MARKING: The work shall be shipped in assembled units, insofar as is consistent with good shipping practice. When items must be dis-assembled for shipment they shall be match-marked. All

BAL 10/81

2.08 [illegible] OF DELIVERY AND [illegible] [illegible]

[illegible] their containers shall be [illegible] [illegible] the purchase [illegible] number. [illegible] and other unprotected [illegible] shall be [illegible] protected from impact and weather damage with all [illegible] [illegible] [illegible].

2.09 TITLE: The title to the work [illegible] [illegible] [illegible] [illegible] expressly provided elsewhere in this [illegible] order, [illegible] the Vendor delivers the work to the [illegible] for [illegible] [illegible] Purchaser. This provision shall not be construed to impair the Purchaser's right [illegible] spect the work so delivered, and to reject any portion [illegible] [illegible] where provided.

2.10 INSURANCE: In order to permit the Purchaser, [illegible] delivered to the carrier [illegible] [illegible] [illegible] thereof sufficient [illegible] [illegible] the Vendor agrees immediately to inform the Purchaser [illegible] of each shipment, giving detailed information [illegible] [illegible] numbers, [illegible] and of the value of each such carload and [illegible] to enable the Purchaser to maintain such insurance.

2.11 TAXES: The Purchaser agrees to pay [illegible] [illegible] applicable [illegible] use taxes imposed by Federal, State, [illegible] [illegible] by any foreign government upon the [illegible] [illegible] [illegible] reimburse the Vendor for all such taxes required to be paid [illegible] paid by the Vendor, except that the Purchaser shall not be obligated to pay and shall promptly be reimbursed [illegible] [illegible] any additional amounts of sales or use taxes levied or assessed against the Vendor or the Purchaser by reason of any failure [illegible] [illegible] [illegible] with the [illegible] of Section 2.02 of [illegible] [illegible] [illegible] and other [illegible] thereof or of other provisions of the Purchase Order [illegible] alleged by applicable taxing authorities [illegible] result [illegible] the passage of title to the work at a point other than is specified in the Purchase Order of which these Special Conditions are a part. If the delivery point specified in the Purchase Order is outside the State of California and the Vendor is authorized to collect California Use Tax, the Vendor shall show his California State Use Tax Permit Number on all invoices.

2.12 SEGREGATION OF FREIGHT CHARGES: Freight charges, if the Vendor elects to prepay the same, shall be stated separately in invoices applicable thereto.

BAL-10/63

SPECIFICATION [illegible]

3.01 PURPOSE. This Specification states the [illegible] requirements for the furnishing and delivering globe or [illegible] Station. The station will be of the [illegible] Universal Pressure Boilers supplying [illegible].

3.02 CONDITIONS OF AWARD. The Bidder shall [illegible] applicable to his general catalog and shall indicate [illegible] extent of firm price. It is contemplated that a [illegible] valves of the type specified will be selected on the basis of proposals received and a blanket award issued to the Bidder submitting the most attractive offer. Requests for shipment will be issued as engineering and construction progress. These "Requests" will list specific [illegible] and will constitute authorization to make shipment as indicated.

3.03 BID REQUIREMENTS: Bids are [illegible] following categories:

A. Cast carbon or chrome - moly steel [illegible] valves, 2-1/2 inch and larger, 150 psi through [illegible].

B. Cast iron gate, globe and check [illegible] and larger, 125 psi and 250 psi.

C. Bronze gate, globe and check valves, [illegible] and larger, 125 psi through 200 psi.

3.04 GENERAL REQUIREMENTS

A. Code. Castings, forgings, [illegible] dimensions, facing and drilling [illegible] applicable ASTM or ASA Standards. [illegible] also conform [illegible] designated codes.

B. Finish. All seating and sliding surfaces shall be properly finished to prevent seizing, galling, spalling, chipping or other undesirable conditions that may hinder normal operation of the valves or prevent shut-off during normal usage.

C. Drawing and Data Requirements (To be Furnished by the Supplier).

Type of Drawing or other Information Required	No. Copies Required Each Drawing: With Proposal	No. Copies Required Each Drawing: After Award (Within 15 Days)
1. Outline Dimensions (If not in Vendor's regular catalog)	None	11

3.04 GENERAL REQUIREMENTS (Continued)

Type of Drawing or other Information Required	[illegible] Drawing [illegible] Proposal	[illegible] (within 15 Days)
* 2. Motor Operated Valve		
A. Wiring Diagrams	None	[illegible]
B. Catalog Information	[illegible]	None
C. Orientation of Motor on Valve	None	[illegible]
3. Installation Instructions and Parts List	[illegible]	[illegible] Shipment

*Wiring Diagrams and motor operator orientation drawing shall be submitted to the Purchaser for approval before the Manufacturer proceeds with valve fabrication. Drawings submitted for approval will be returned [illegible] within 15 days with our comments or approval.

D. The equipment provided under this Specification shall comply with the latest requirements of the Southern California Edison Company for this class of material.

3.05 TESTS

A. Hydrostatic Tests. Valves shall be thoroughly cleaned and free from sand, slag, chips or other foreign matter before hydrostatic tests are made.

B. The Vendor shall conduct all tests required by ASTM Specification and shall keep a complete record. Castings from any melt not meeting the specification requirements shall be rejected. All valves shall successfully pass hydrostatic shop tests as to body and seat tightness in accordance with Vendor's standard practice.

The Purchaser's Inspector may be present at any of the tests, and, if he so requests, shall be furnished with two certified copies of the results, whether or not he is present at the actual test.

3.06 DEFECTS. Defects which do not impair the strength of the casting may be repaired by an approved process. The defects shall be cleaned out to solid metal before repairing. All steel for forgings and castings shall be heat treated after welding in accordance with requirements of the ASTM Code. Valve bodies and welding shall be properly heat treated and stress relieved. (Cast Steel Valves only).

3.07 MARK NUMBERS: The designated mark number shall be app[illegible]ed to a weather-proof metal tag securely fastened to each valve by either s[illegible] welding or [illegible]ing.

3.08 SURFACE PREPARATION AND PAINTING (C[illegible] Steel and [illegible] Valves Only)

A. Exterior ferrous surfaces to be protected by painting shall be cleaned in accordance with the "Steel Structures Painting [illegible] Surface Preparation Specifications No. 6 Commercial Blast Cleaning." The surface profile of the blast pattern shall not exceed 2 mils.

B. After completion of all tests and inspection, all unfinished exterior surfaces of each valve will be [illegible] with one [illegible] coat of paint conforming to Federal Specification No. [illegible], Type II.

3.09 SHIPPING PREPARATION. Finished [illegible] ends shall be suitably protected by covering other than oils, grease or paint as protection against damage during transit or storage. Other finished surfaces shall be adequately protected against damage. Unpainted ferrous metal other than machine beveled ends may be covered with grease before shipment. The valves shall be closed by plugs or covers securely fastened before shipment.

3.10 LOCAL FACILITIES. Each bidder shall [illegible] a complete description of his local service facilities, including [illegible] ability to install new seat rings in valves in service at the jobsite, availability of personnel for field service, policy and procedure for rectifying faulty operation and material.

3.11 EXPOSURE

A. Indoors. - relative humidity up to [illegible] percent.

B. Outdoors. - Subject to the corrosive conditions of fog, salt spray and dust, relative humidity of 100 percent and air temperatures varying from approximately 40F to 100F.

3.12 DELIVERY: Prices shall be furnished to cover the period between April 1, 1964 and April 1, 1966.

NOTE TO BIDDER: It is considered that book list prices include special paint and packing on all cast steel valves and special paint on cast iron valves. Preferential discounts applicable to book list prices may be adjusted accordingly, if necessary.

SPECIFIC REQUIREMENTS - CAST STEEL VALVES

4.01 DESIGN: Gate and globe valves shall be [illegible] type. Gate valves shall have single wedge discs. Globe valves shall [illegible] type plug discs. Check valves shall have swing type [illegible]. [illegible] valves shall have stellited seat rings and 12 percent chromium plugs or discs with stellite overlay of disc or plug surfaces for [illegible] and above.

Bonnet joints on all valves shall be flanged and bolted to provide ready accessibility to the valve internals. Seat rings for all gate valves, globe valves and check valves shall be renewable and shall be either screwed or pressed in place and fully seal welded.

Castings on all carbon steel valves shall conform to ASTM Specification A-216 Gr. WCB. Chrome - Moly Valves shall be [illegible] in accordance with ASTM A-217 Gr. WC-6.

4.02 PACKING: Gate and globe valves shall be provided with stem packing, molded to fit the gland and suitable both for the service conditions and hydrostatic tests. Gate and globe valves shall have bolted gland followers and shall be back-seated so the valve stem can be packed while the valves are open and in service. All valves shall be packed with [illegible] Crane No. [illegible] packing.

4.03 CONNECTIONS: No by-pass valves are to be furnished on any valve. Valves requiring by-passes or drains shall have [illegible] long schedule [illegible] capped nipples welded in locations indicated on the purchase order.

4.04 END PREPARATIONS:

A. Flanged valves shall have standard ASA raised and serrated flanges on each end with standard drilling and face to face dimensions corresponding to pressure-temperature rating of the valve.

B. Butt-weld end valves shall have standard ASA bevel on each end and shall be bored to match standard or extra strong pipe size as indicated on "Request to Ship" form.

4.05 ELECTRIC VALVE OPERATORS: Electric motor operated valves shall be furnished in accordance with attached Motor Operated Valve Specification. (Attachment A).

4.06 LIMIT SWITCHES: Limit Switches, when required on manually operated valves, shall be furnished and mounted in accordance with the attached Specification for Limit Switches. (Attachment B).

4.07 GEAR OPERATORS: When required, gear operators shall be bevel type with either open or enclosed gearing. The pinion shaft shall be extended and shall terminate in a machined 7/8" hexagon end to suit the socket of an air operated wrench.

4.05 AIR WRENCHES FOR VALVE OPERATION. Approximately se[illegible] [illegible] Power Tool Co. Reversable Nut Setters, Fig. No. 57A-223(RPM), [illegible] 7/8 inch [illegible] sockets and 25 foot piece of 1/2 in. [illegible] [illegible] No. 2071 coupling and No. 71680 nipple will be required.

SPECIFIC REQUIREMENTS - CAST IRON VALVES

5.01 DESIGN: Gate and globe valves [illegible] be [illegible] outside screw, rising stem, bolted flanged [illegible]-bonnet, [illegible] disc with end flanges faced and drilled according to ASA B[illegible]. Check Valves shall be bolted cap with renewable bronze seat [illegible] disc. All bodies, bonnets and caps are to be [illegible] according to ASTM A-126, Class [illegible].

SPECIFIC REQUIREMENTS - BRONZE VALVE

6.01 DESIGN: Gate, Globe, [illegible] and [illegible] Valves will [illegible] rated [illegible] 125 psi steam at 353F through 200 psi steam at 550F pressure class [illegible] screwed or flanged. Gate and Globe Valves shall be inside screw, union bonnet [illegible] stem, nickel [illegible] bronze alloy renewable or pressed in seat ring, or integral [illegible] of same material with solid hardened alloy renewable disc.

Both Horizontal Lift Type and Swing Check Valves, screwed or flanged, will be required in 150 and 200 pound steam ratings. All body bonnet and cover castings shall conform to ASTM B61 Specification.

QUESTION NO. 5

Were other types of valve designs considered for this application (e.g., tilting or damped disk)? What is the basis for choosing a swing check design?

RESPONSE

In considering other types of valve designs, the primary focus was on the tilting disc type due to its short arc of travel. The geometry of the Atwood-Morrill swinging disc is such that the arc of travel from full open to full close is very similar to that of a tilting disc but without the detriment of having the disk and hinge suspended in the flow path. Atwood-Morrill, in fact, does not make a tilting disc check valve but instead offers the subject swing check valve as its equivalent.

The original Westinghouse valve equipment Spec. 675268, paragraph 4.2.3, dated 12/16/64 (Attached), also recommended swing type check valve for valves 2" and larger.

The damped disc was not considered for this application as this type of valve would not mitigate any of the check valve problems experienced on San Onofre Unit 1.

WESTINGHOUSE VALVE E-SPEC 675268, page 6

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E Spec.
675268

EQUIPMENT SPECIFICATION COVER SHEET

WESTINGHOUSE FORM 54C64 A

EQUIPMENT SPECIFICATION	DATED	REVISION NO.	DATED	ORIGINAL ISSUE	SUPERSEDES PREVIOUS REVISIONS
675268	12/?/64	0	—	[X]	[ ]

ATTACHMENTS

Ⓦ Drawing 498 B 932
Ⓦ APD E.D. SK. 322694
Ⓦ PS 292722-1
Specification Sheets

PROJECT: SAN ONOFRE NUCLEAR GENERATING STATION, UNIT NO. 1

SHOP ORDER: SCE-220

SYSTEM: ALL SYSTEMS

EQUIPMENT: MANUAL GLOBE, MANUAL GATE, AND SELF-ACTUATED CHECK VALVES

FOR SUPPLIER'S CONVENIENCE

REV. NO.	REVISION ENTERED BY & DATE

WESTINGHOUSE ELECTRIC CORPORATION
Atomic Power Division
P.O. Box 355
Pittsburgh, Pennsylvania, 15230

APPROVAL

	ORIGINAL ISSUE	REV. 1	REV. 2	REV. 3	REV. 4
AUTHOR	J.R. Blanchfield				
SHOP ORDER HOLDER	[signature] 12/16/64				
PROJECT MANAGER	[signature] 12/17/64				

4.0 **REQUIREMENTS**

4.1 Service Requirements

4.1.1 The design of each valve shall accommodate the design conditions set forth on the valve "Specification Sheet" for the particular valve.

4.1.2 All stainless steel valves shall be suitable for service in demineralized water containing up to 12% boric acid (H_3BO_3).

4.1.3 All carbon steel valves shall be suitable for service in demineralized water inhibited with KOH and K_2CrO_4.

4.1.4 Some of the valves of this specification will be exposed to the step changes of working fluid temperature described below. If these thermal transients are thought to be too severe for the supplier's standard valves, the supplier shall so advise. Ⓦ APD will then indicate which valves must be suitable for the thermal transients and review the necessary modifications to the supplier's valves.

The thermal transients are:

a. 150 cycles of a step change of plus or minus 300°F (or a temperature differential equal to the valve design temperature less 40°F--whichever is smaller) and

b. 10 cycles of a step change from 500°F (or the valve design temperature--whichever is lower) to 40°F.

4.2 Mechanical Design Requirements

Any exceptions to the following will be as stated on the "Specification Sheet" for the individual valve.

4.2.1 Gate valves may be either straight through or venturi type providing the valve pressure drop is acceptable to WAPD. The wedge may be either split or solid. All gate valves shall have backseat and outside screw and yoke.

4.2.2 Globe valves shall be full-ported with backseat and outside screw and yoke.

4.2.3 ~~Check valves shall be spring-loaded lift or in-line type for sizes 1-1/2 inch and smaller and swing type for sizes 2 inches and larger.~~

4.2.4 The pressure containing parts of the valve assemblies shall be designed in accordance with ASA B16.5 or in accordance with MSS SP-66.

QUESTION NO. 6

What flow band can result in a valve disk flutter problem for each of the new valves?

RESPONSE

Atwood-Morrill has an integral hinge/disc design and as such the disc cannot "flutter" about the hinge arm.

Per testing results reported by P. Tullis, the flowbands which cause disc "tapping" (intermittent contact of the disc assembly with the valve body) are as follows:

Location	Plant Flow (gpm)
12" Valves Downstream of Feedwater Pumps	3650 - 5700
10" Valves Downstream of Flow Control Valves	2600 - 3900
Proposed 10" Valves Inside Containment	2700 - 3050

In all cases the tapping was not judged to be severe enough to cause damage to the valve body or disc over long term service. Phase 1B testing is planned to develop wear rate information on the valves.

QUESTION NO. 7

Include a discussion on how the auxiliary feedwater operating flow band avoids disk flutter or vibration from other check valves in the main feedwater and auxiliary feedwater piping system.

RESPONSE

The check valves currently installed in the 3" auxiliary feedwater lines were originally sized based on the auxiliary feedwater flow rates. The operating history of the plant indicates that these valves have performed satisfactorily. Therefore, there is no reason to discontinue the use of these valves.

The new 10" Atwood-Morrill valves in the main feed system have been tested at low flowrates representative of the auxiliary feedwater flows and found to be totally stable. Additionally, there was virtually no downstream pressure fluctuations generated by the valve at any flowrate.

QUESTION NO. 8

Clarify the statement made in handouts used at the January 31, 1986 meeting with the NRC that an error existed in Crane Technical Paper 410 that may have contributed to this problem.

RESPONSE

The following statement was provided during the referenced meeting in the course of discussing the cause of the multiple check valve failures:

> "Valves were oversized for the range of line flow due to 1965 design guide error (Crane Technical Paper No. 410); the 1986 Crane design guide as well as the check valve vendor's 1986 design practice identify the failed check valves as oversized (valve will not be fully opened)."

The following information is provided from Appendix D to SCE's report of April 8, 1986.

The equation used by MCC Pacific Valves for the minimum velocity to maintain the check valve disc fully open has changed over the years. These changes are depicted in Table 4 of Appendix D. The 1978 minimum velocity recommended by Pacific was based upon the minimum velocity published by Crane for its swing check valves. In 1982, Crane revised its equation for minimum velocity. These and other changes were much less than what was recommended in a 1985 revision to Pacific's recommended minimum flow velocity.

SCE believes that to have characterized the Crane document as being in error was inappropriate. It appears that the revisions in the equation given by Crane were based upon results of more recent tests. It should merely be noted that application of the revised Pacific recommendation (based upon the 1985 Bulletin on Technical Information) is more appropriate and demonstrates that the Pacific valves are improperly sized for this application.

QUESTION NO. 9

Submit the results of the re-analysis of the auxiliary feedwater (AFW) initiation timing requirements that determine how quickly the emergency diesel generators must be manually loaded in the case of a loss-of-offsite power and a single failure of the turbine-driven AFW pump.

RESPONSE

See the attached reanalysis.

ENCLOSURE 1

Loss of Normal Feedwater and Main Feedline Rupture Reanalysis

San Onofre Unit 1

BACKGROUND

The Loss of Normal Feedwater (LONF) event and the Main Feedline Rupture (FLB) event were analyzed in 1981[1] for Southern California Edison's (SCE) SONGS-1. The analysis concluded that an auxiliary feedwater (AFW) flowrate of 165 gpm, initiating 3 minutes after reactor trip, to 3 steam generators was required to show acceptable results for the LONF (with reactor coolant pumps (RCP) operational) event. An AFW flowrate of 250 gpm, initiating 15 minutes after reactor trip, to 2 steam generators was shown to be needed to provide acceptable results for the FLB (with RCP's operational) event. The LONF and FLB events were reanalyzed to determine if specified maximum delays of operator initiation of the AFW for the LONF and FLB events are acceptable.

The LONF event was reanalyzed assuming loss of RCP's, modelling SONGS 1 specific RCP coastdown, 1979 ANSI Decay Heat, and an AFW flow of 165 gpm to 3 steam generators initiated 30 minutes after reactor trip. The FLB event was reanalyzed with the same loss of RCP's and decay heat assumptions but with a delay of 20 minutes after reactor trip for initiation of an AFW flow of 250 gpm to 2 steam generators.

ANALYSIS

As in the 1981 LONF and FLB analysis, the LOFTRAN code [2] is used to simulate the transients. The reanalysis consists of 2 cases. The assumptions modelled in the 2 cases are the same assumptions used in the 1981 analysis except as noted below.

CASE 1: Loss of Normal Feedwater with AFW flow of 165 gpm at 30 minutes.

Assumptions:

A. Loss of reactor coolant pumps with SONGS-1 specific RCP coastdown is modelled. An operating pump heat addition to the RCS of of 3 Mwt/pump is assumed.

B. 1979 ANS 5.1 Decay Heat is modelled.

C. Pressurizer power-operated relief valves and pressurizer sprays are available.

D. 20% steam generator tube plugging parameters with plant initially operating at 103 percent of rated power is assumed.

E. Reactor trip is assumed to occur 10 seconds into the transient. (Same as 1981 analysis)

CASE 2: Feedline Break with AFW flow of 250 gpm at 20 minutes.

Assumptions:

A. Loss of reactor coolant pumps with SONGS-1 specific RCP coastdown is modelled. An operating pump heat addition to the RCS of 3 Mwt/pump is assumed.

B. 1979 ANS 5.1 Decay Heat is modelled.

C. Pressurizer power-operated relief valves are available, but no credit is taken for pressurizer sprays.

D. 20% steam generator tube plugging parameters with plant initially operating at 103 percent of rated power is assumed.

E. Reactor trip is assumed to occur 5 seconds into the transient. (Same as 1981 analysis)

RESULTS

CASE 1: Loss of Normal Feedwater

The results of the transient of pertinent plant parameters are shown in Figures 1-1 through 1-7. The figures show that the AFW flow of 165 gpm to 3 steam generators initiated 30 minutes after reactor trip provides acceptable results. The assumed AFW flow provides sufficient heat removal capability. A maximum pressurizer water volume of 1139 ft^3 (88% of total pressurizer volume) was obtained at 2553 seconds.

CASE 2: Feedline Break

The results of the transient are presented in Figures 2-1 through 2-7. The results show that the AFW flow of 250 gpm to 2 steam generators initiated 20 minutes after reactor trip is sufficient to remove core decay heat. The reactor coolant system (RCS) remains subcooled and the pressurizer does not fill, with a peak pressurizer water volume occurring at 1483 seconds.

CONCLUSIONS

Results of the analysis show that for the LONF with loss of RCP's, an AFW flow of 165 gpm to 3 steam generators initiated 30 minutes after reactor trip provides acceptable results. An AFW flow of 250 gpm to 2 steam generators initiated 20 minutes after reactor trip is adequate to remove decay heat for the FLB with loss of RCP's event.

LIST OF REFERENCES

1. Letter from K. P. Baskin (SCE) to D. M. Crutchfield (NRC) dated November 18, 1981, Enclosure 1 titled, "Figures 1-10 AFWS Reanalysis San Onofre Unit 1"

2. Burnett, T. W. T., et al., "LOFTRAN Code Description," WCAP-7907-A, April, 1984.

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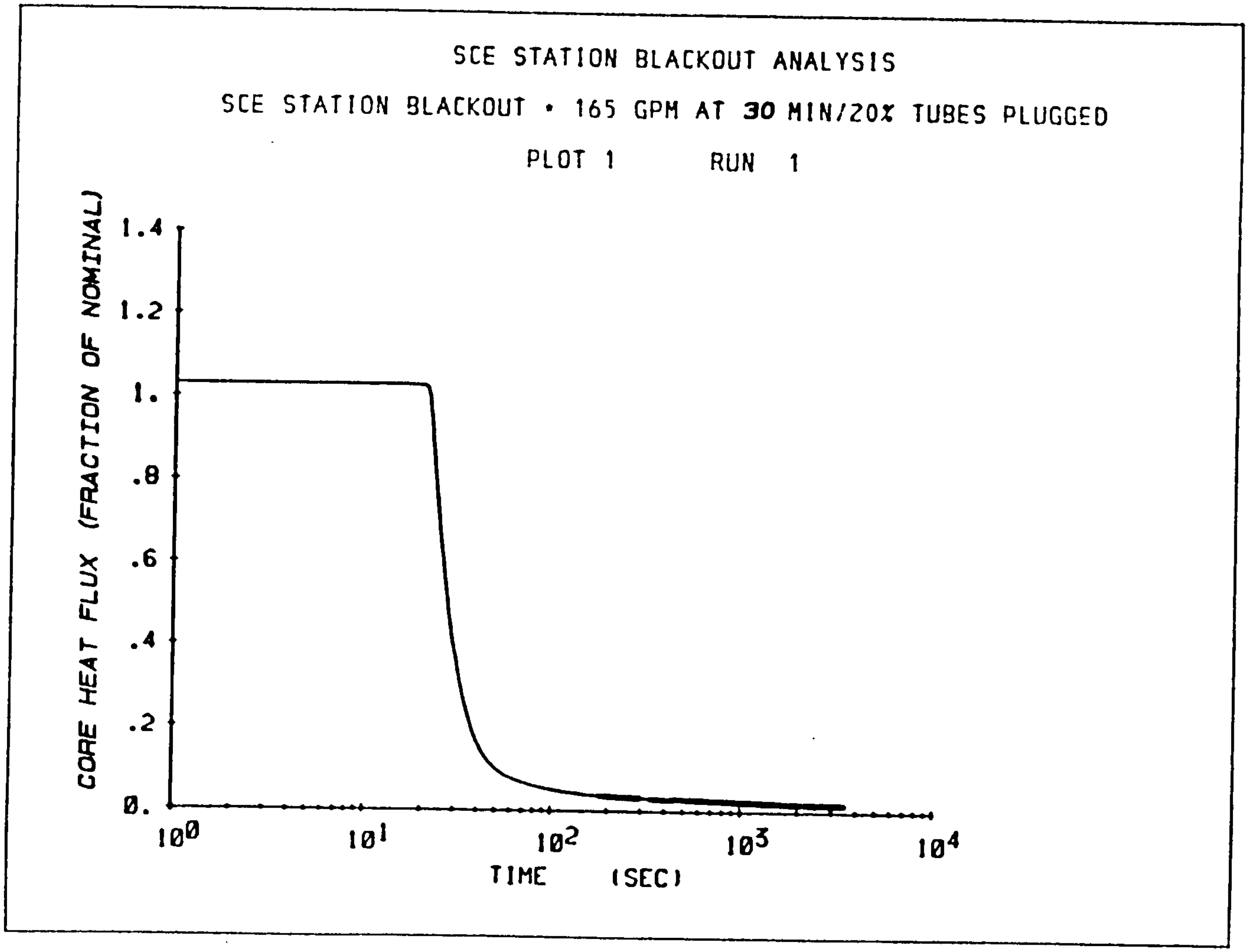

FIGURE 1-1 CORE HEAT FLUX

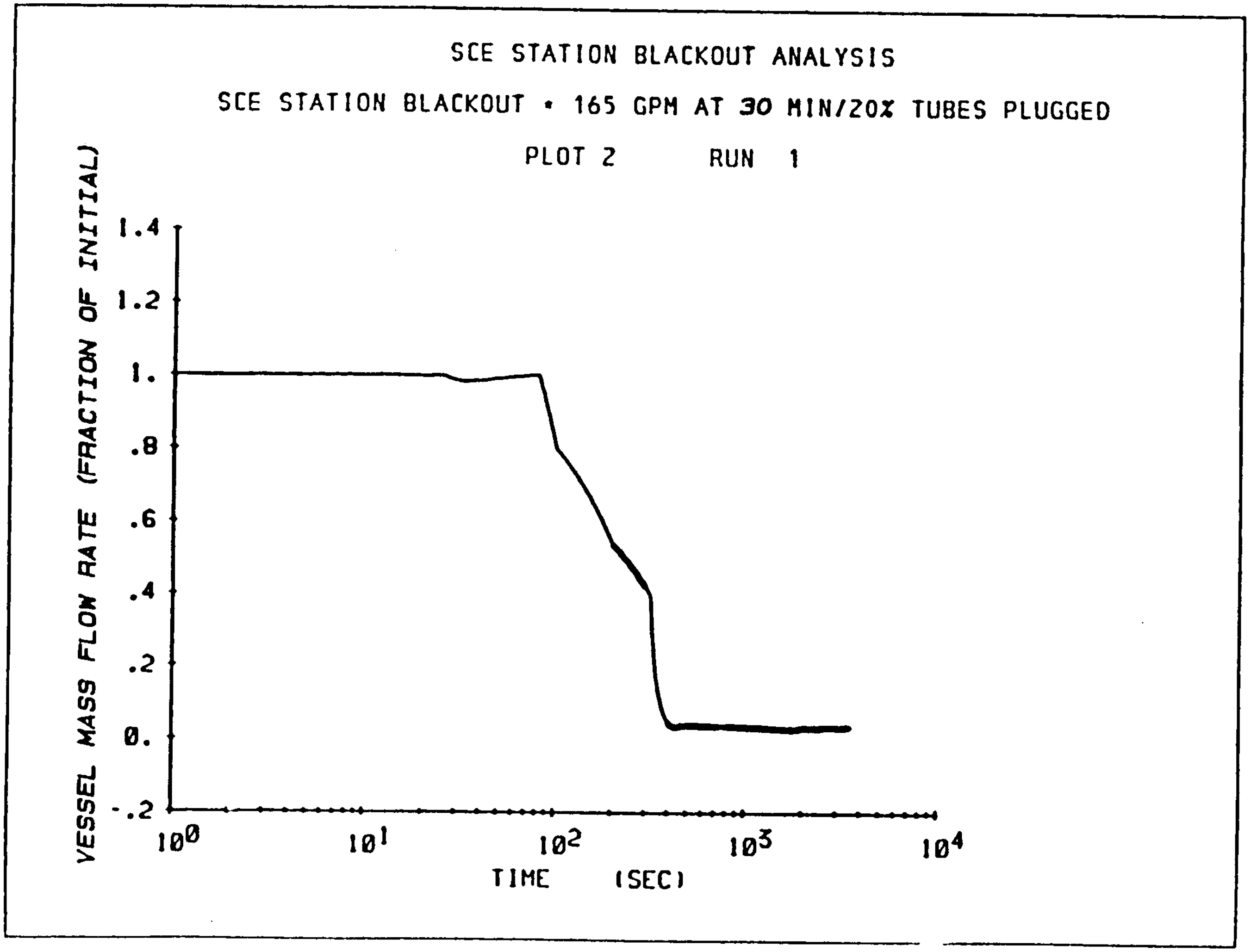

FIGURE 1-2 VESSEL MASS FLOW RATE

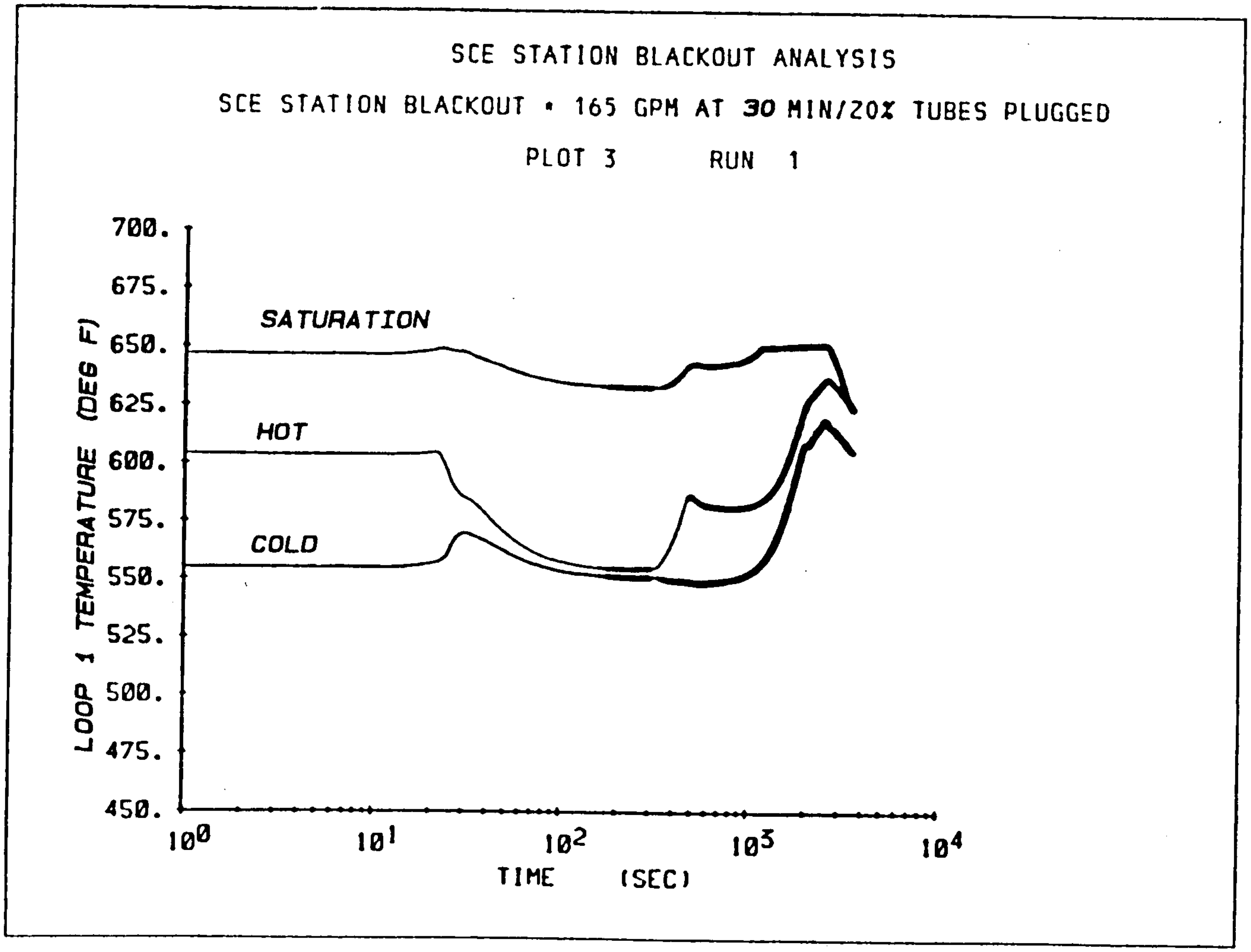

FIGURE 1-3 LOOP 1 TEMPERATURE

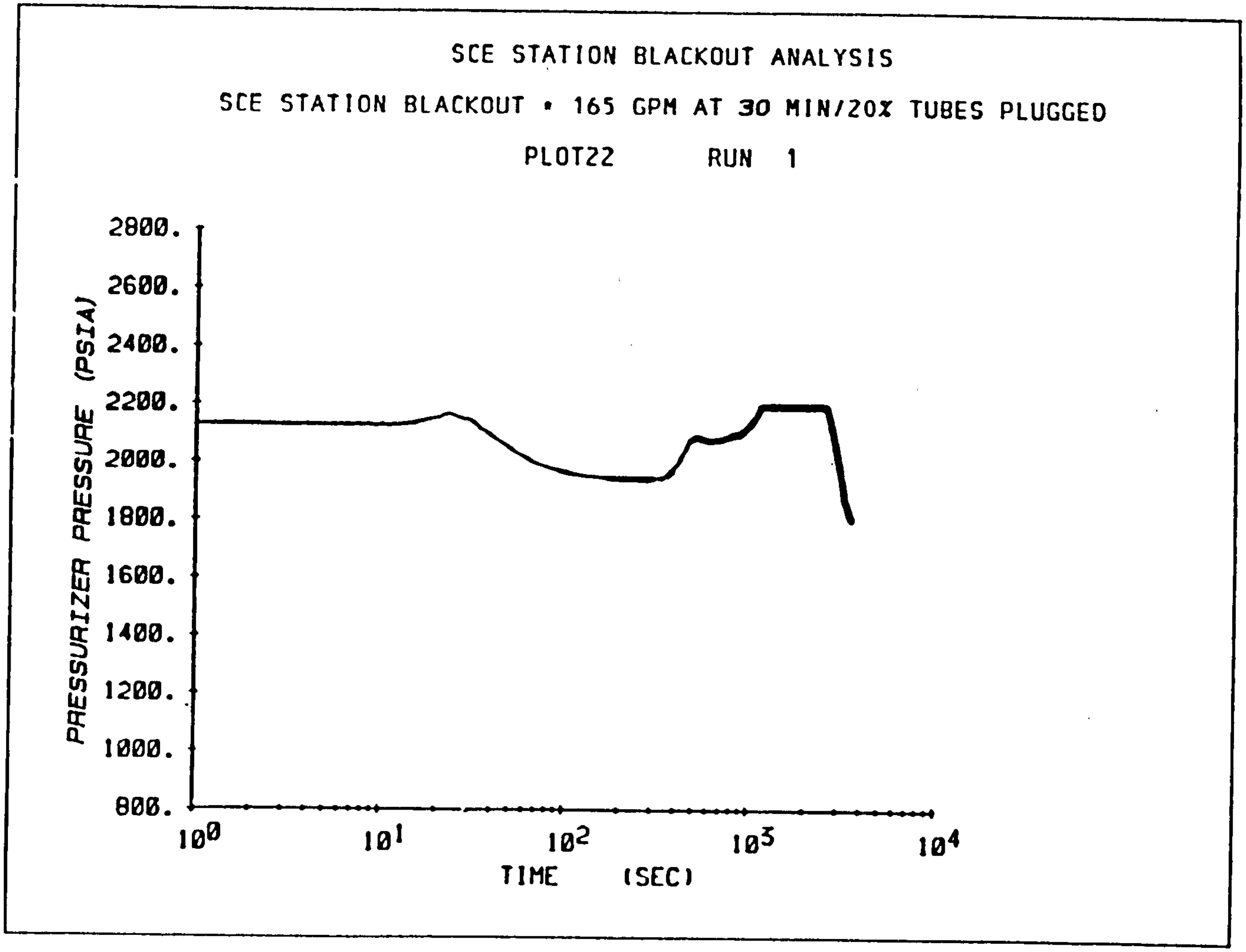

FIGURE 1-4 PRESSURIZER PRESSURE

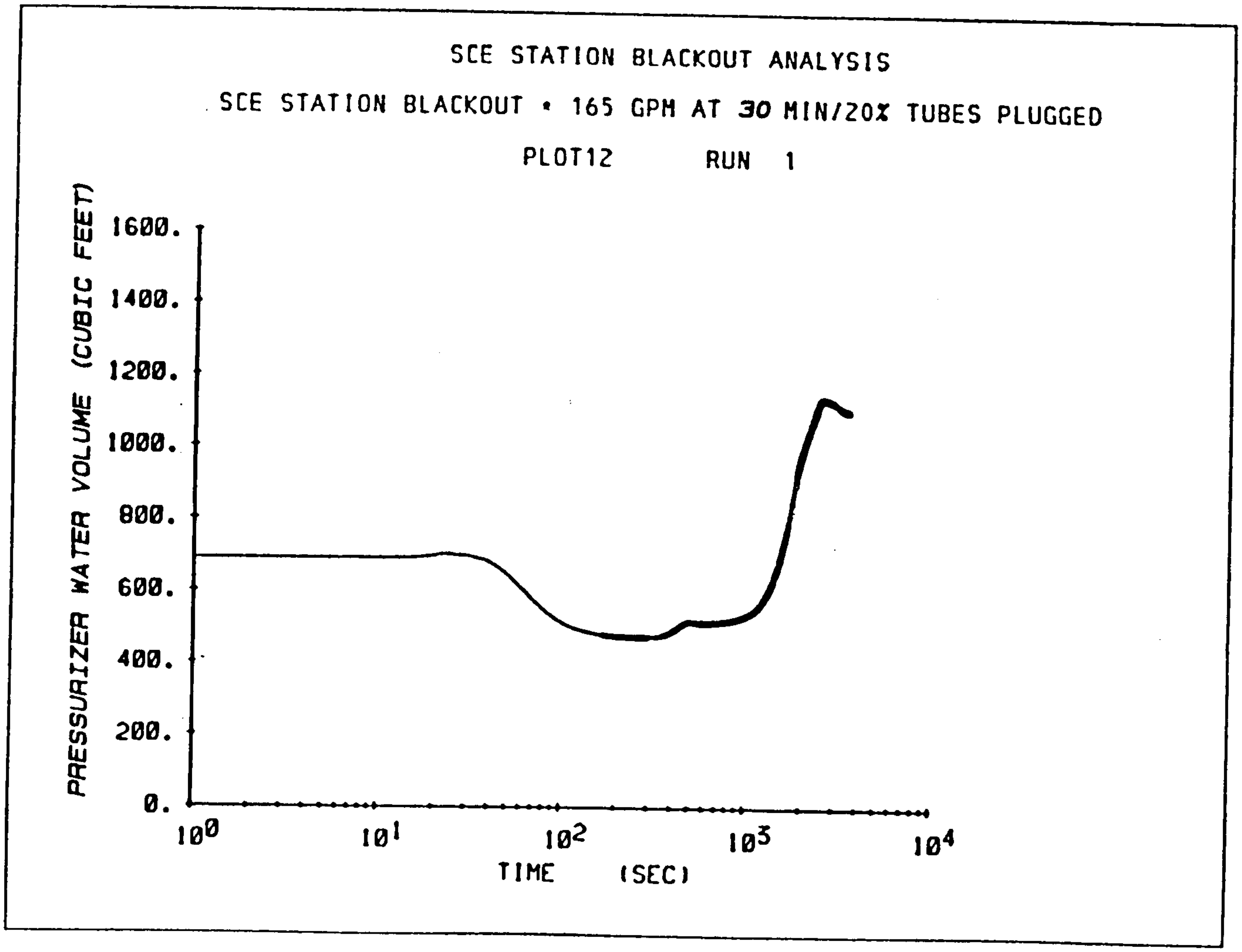

FIGURE 1-5 PRESSURIZER WATER VOLUME

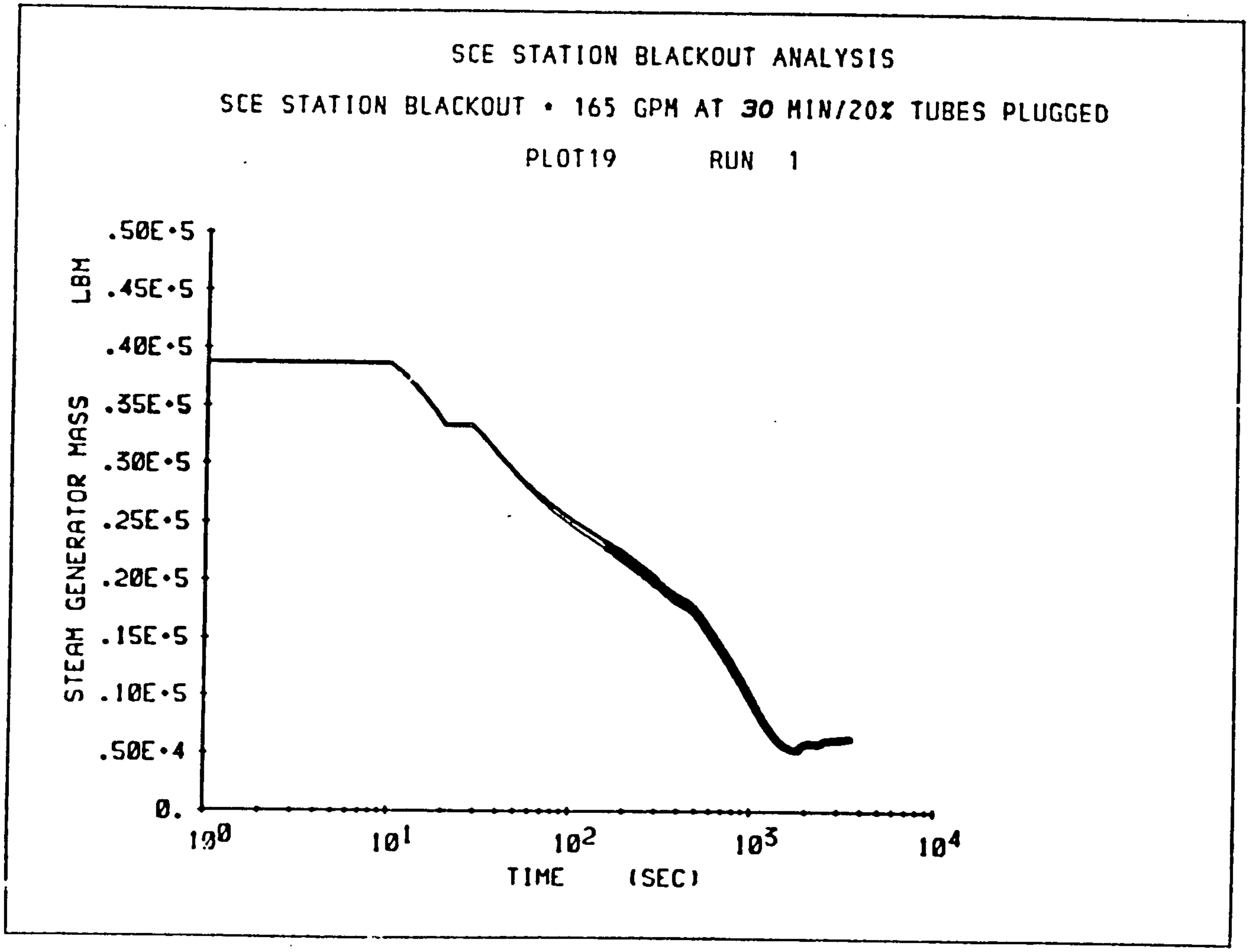

FIGURE 1-7 STEAM GENERATOR MASS

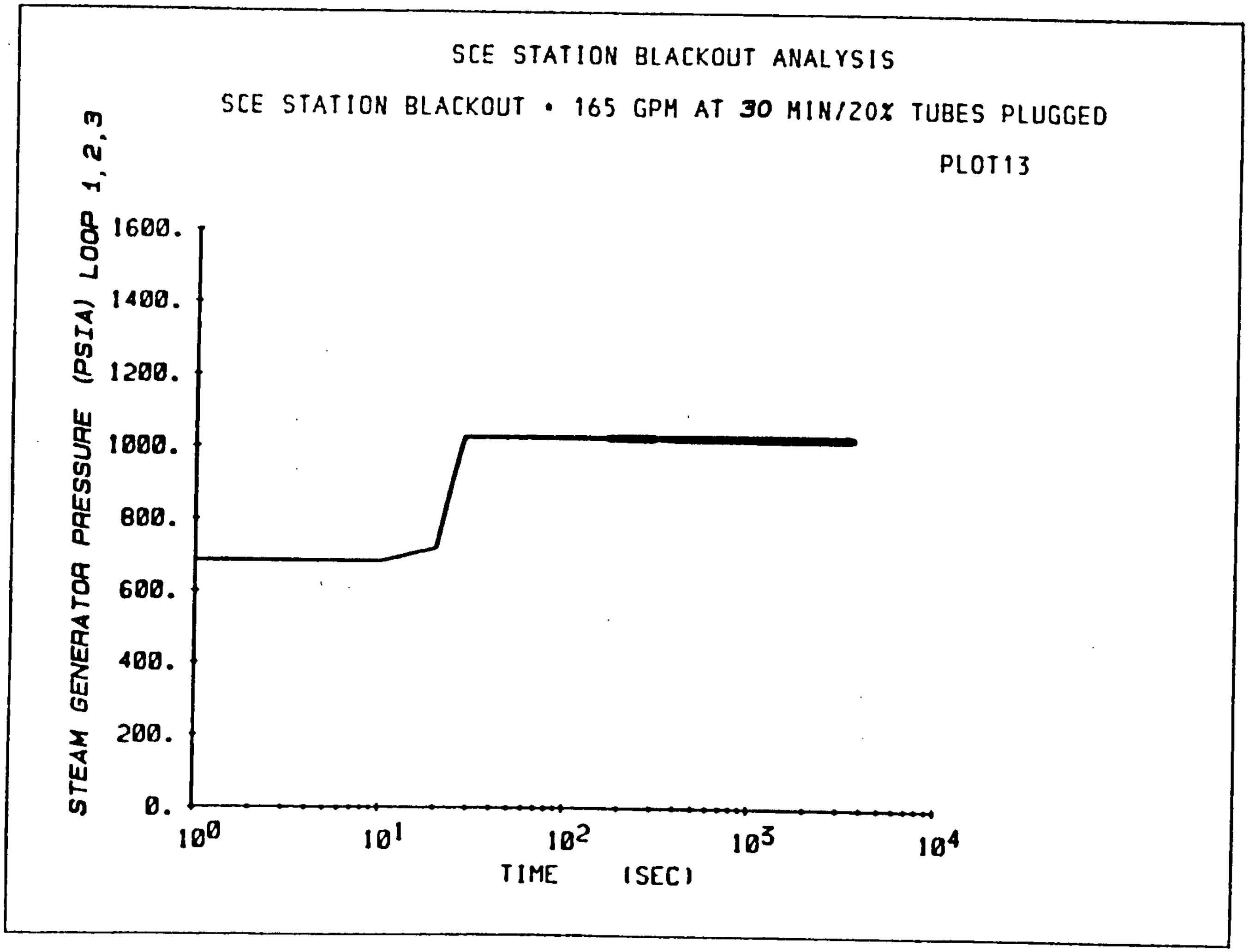

FIGURE 1-6 STEAM GENERATOR PRESSURE

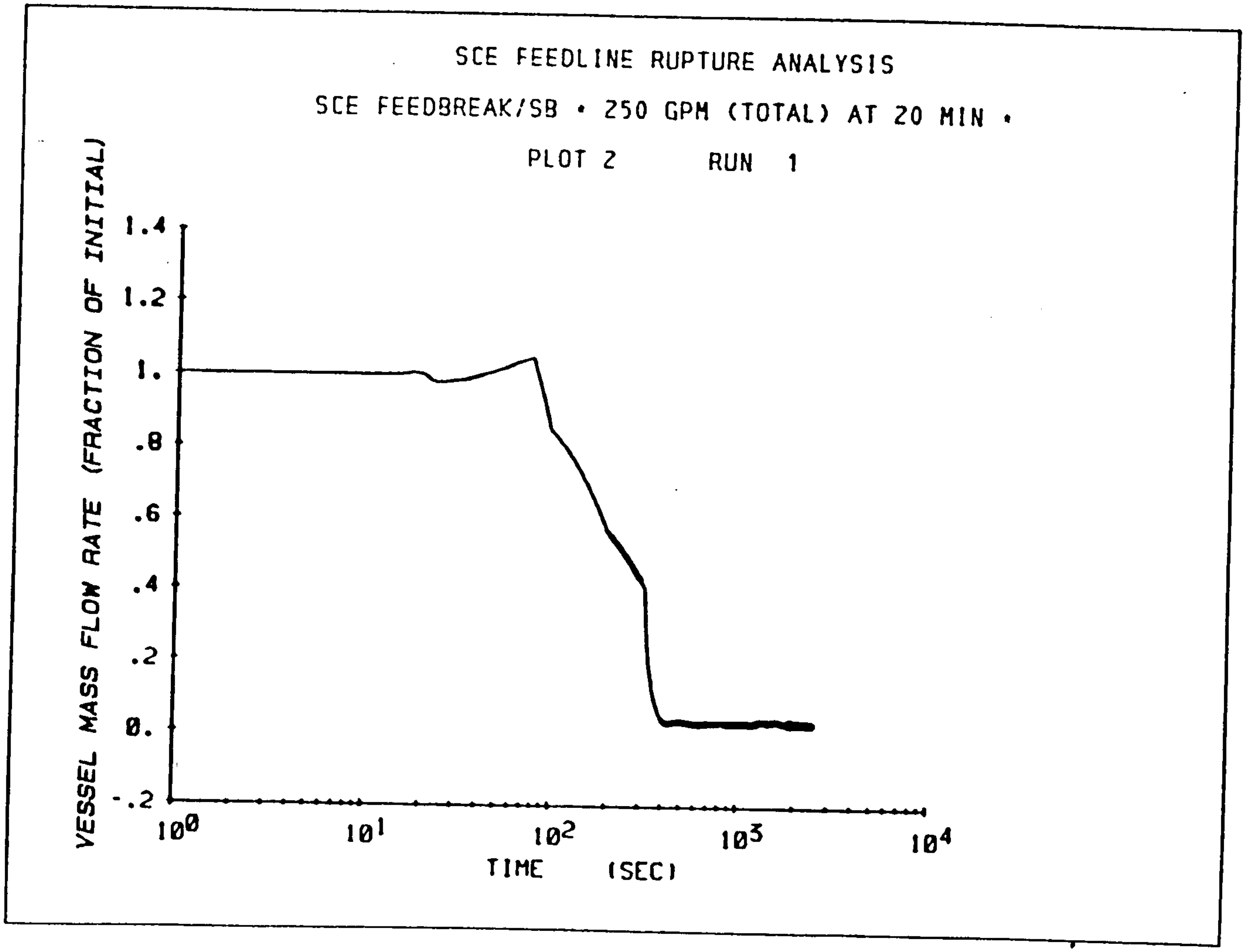

FIGURE 2-2 VESSEL MASS FLOW RATE

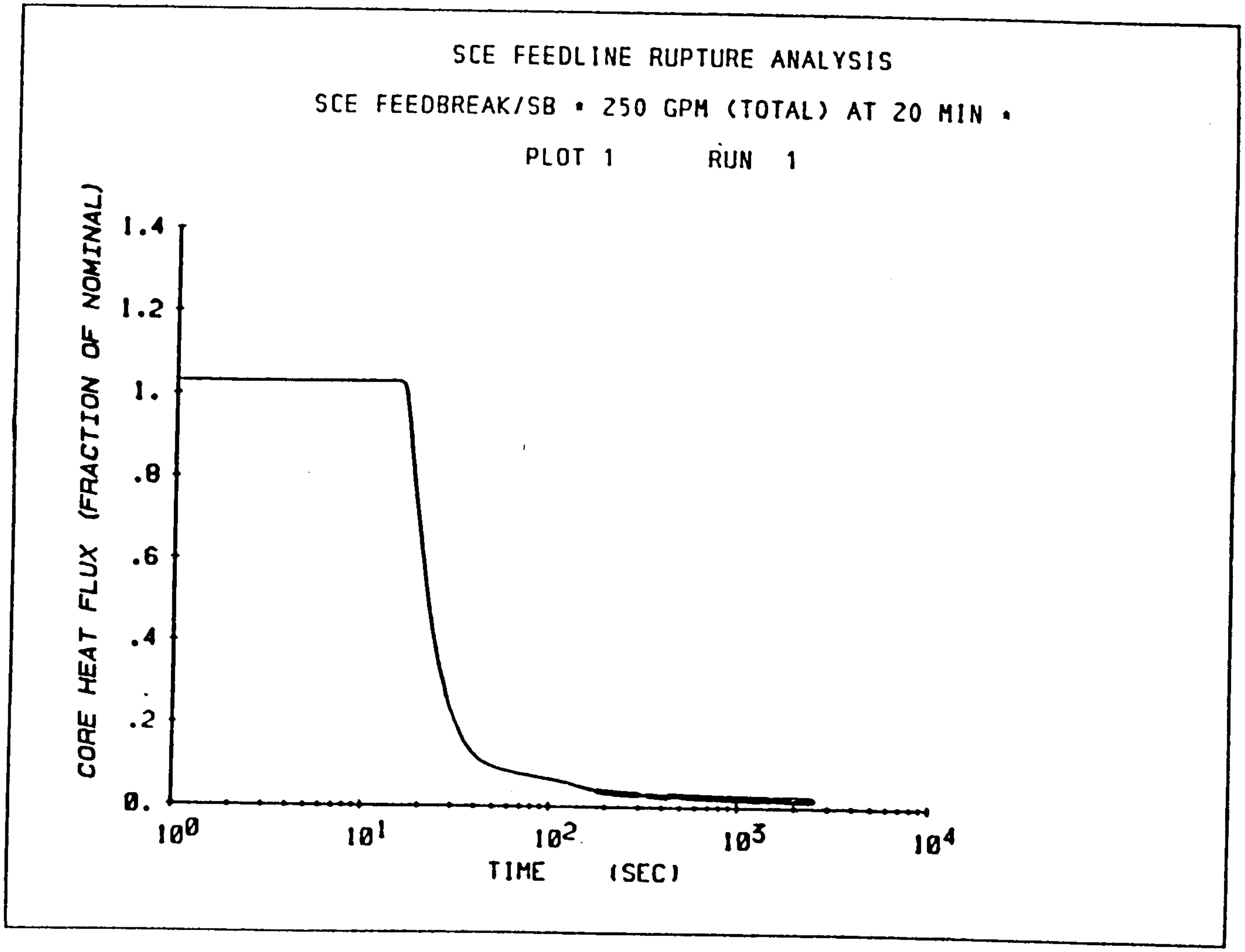

FIGURE 2-1 CORE HEAT FLUX

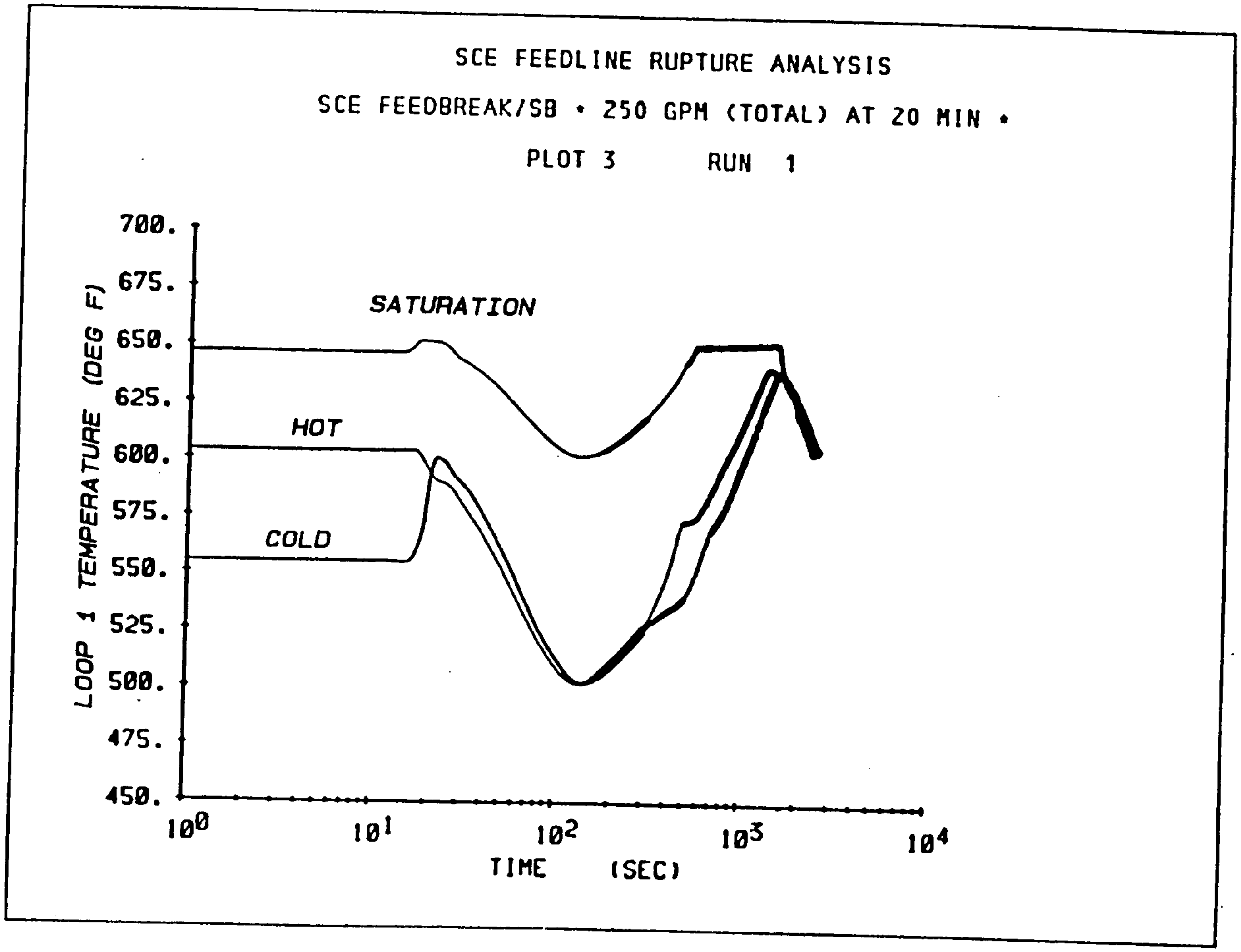

FIGURE 2-3 LOOP 1 TEMPERATURE

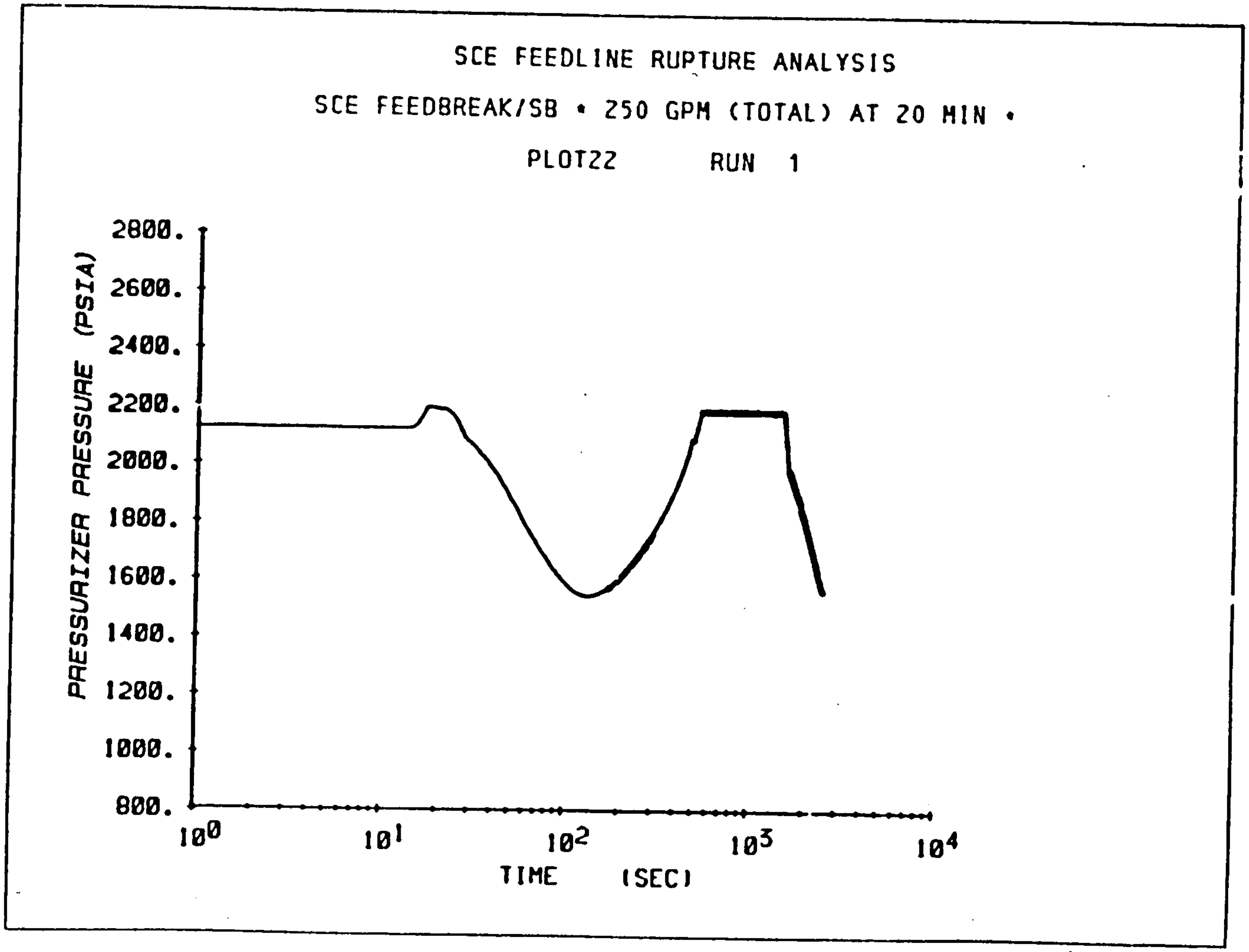

FIGURE 2-4 PRESSURIZER PRESSURE

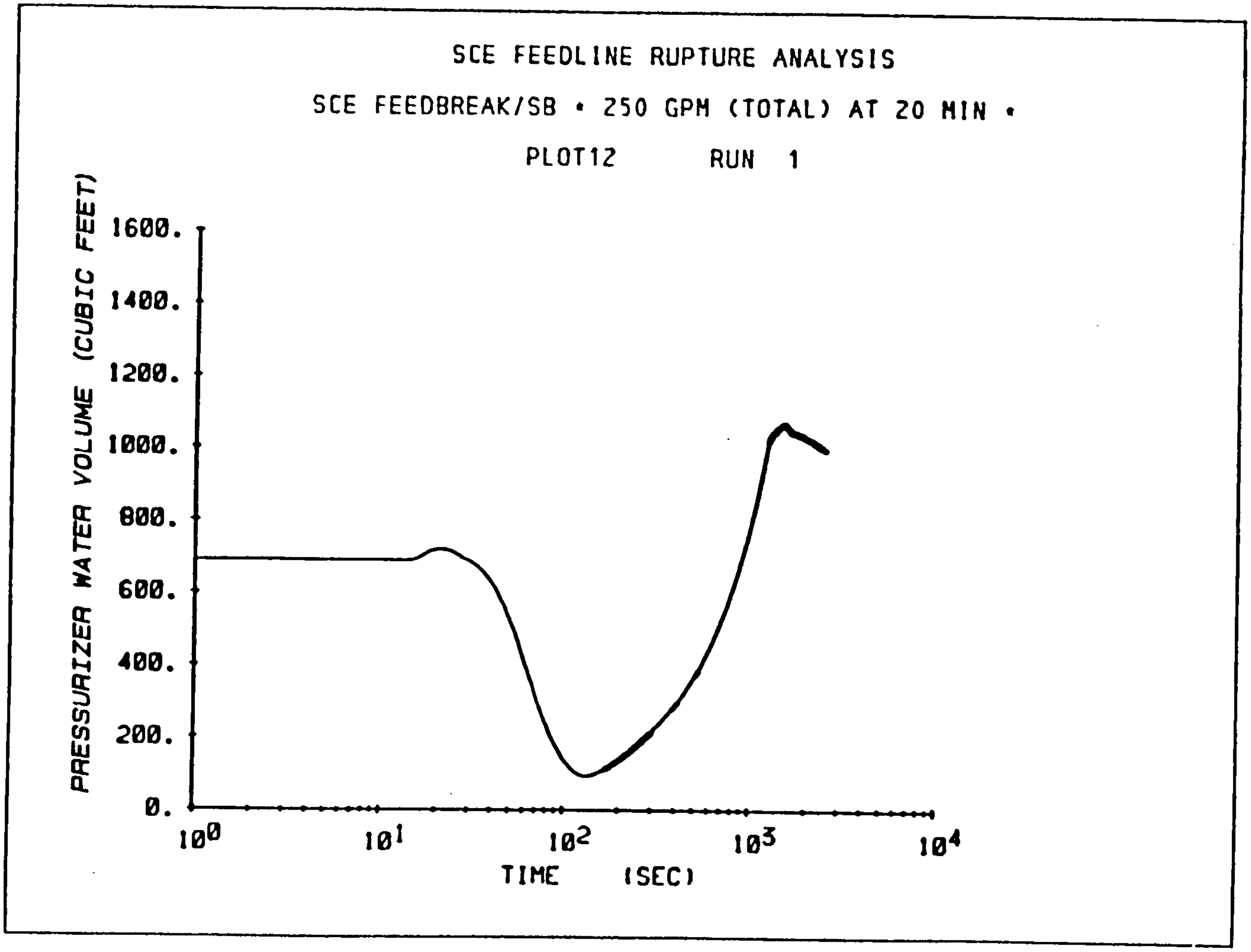

FIGURE 2-5 PRESSURIZER WATER VOLUME

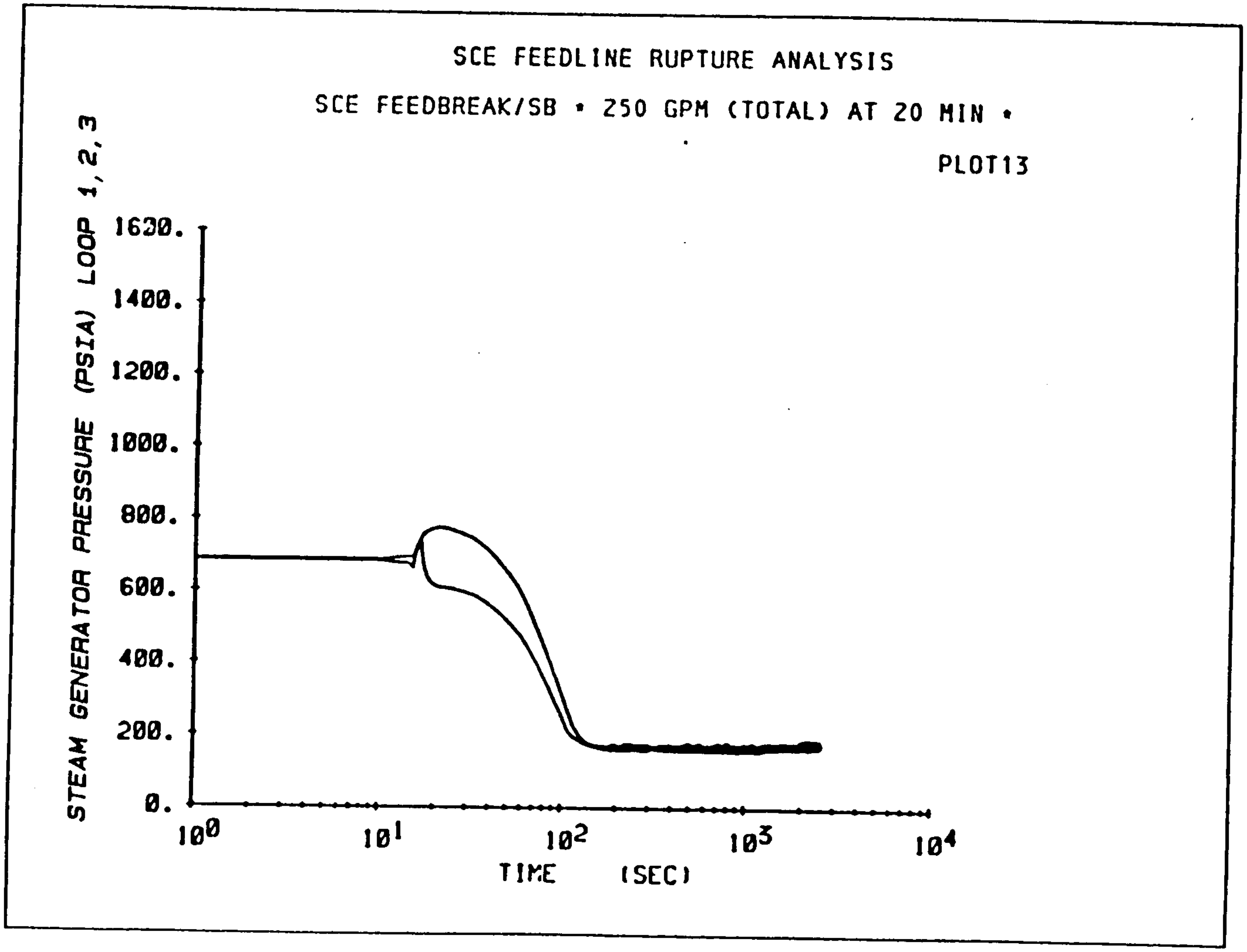

FIGURE 2-6 STEAM GENERATOR PRESSURE

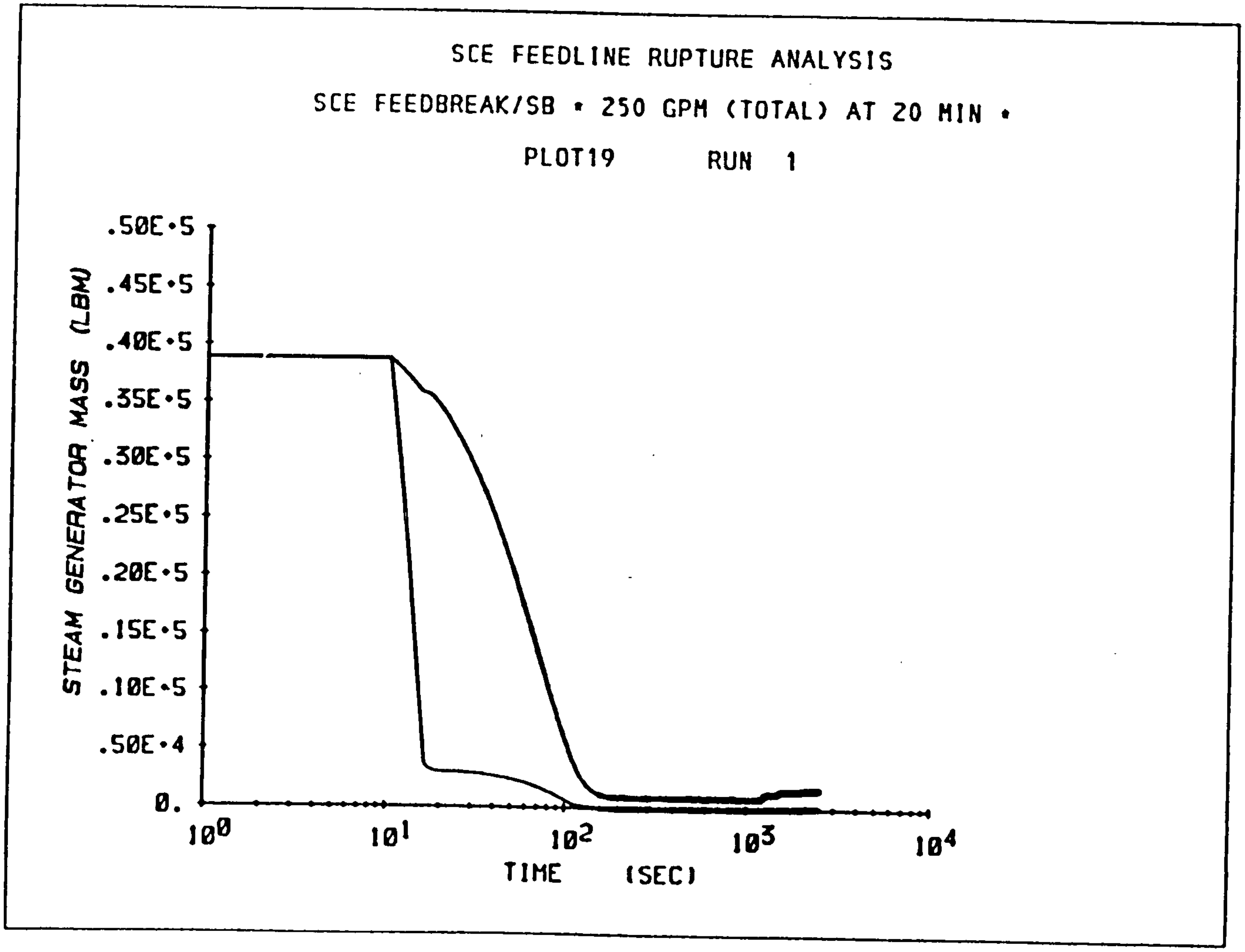

FIGURE 2-7 STEAM GENERATOR MASS

QUESTION NO. 10

Document the basis for your conclusions stated in the March 5, 1986 meeting regarding the possible effects on the November 21, 1985 event if the diesel generators had been designed to automatically load upon loss of offsite power.

RESPONSE

The conclusion stated by SCE in the March 5, 1986 meeting was that the effect which would have resulted had the diesel generators automatically loaded upon loss of offsite power would not have differed from the actual event. The basis for this conclusion is the fact that the steam generator feedwater lines voided in approximately one minute subsequent to the rupture in the east condensate train. Thus, automatic loading of the diesel generators would not have prevented the voiding but would merely have reduced the length of time feedwater and AC power was lost. The consequences would have remained unchanged.

The time required to void the steam generator feedwater lines was determined by calculation. A total leakage area of 3 square inches is estimated based upon leakage from tubes in the first point feedwater heater and the evaporator condenser.

The damage to the evaporator condenser was discussed in our Investigation Report submitted by letter dated April 8, 1986. However, the report itself incorrectly states that helium leak checks were performed on all the other heaters and that no leakage/damage which was found could be attributed to the event (page 6-136). In fact, a helium leak check performed on the first point feedwater heater indicated the presence of a large tube leak.

Based upon the estimated leakage area and the steam generator pressure, a critical flow was developed from which a blowdown rate was calculated. It was thus determined that the feedwater lines voided in a time period on the order of one minute.

QUESTION NO. 11

Document the operator actions needed to:

a. Transfer loads from the onsite power sources (diesels) back to an offsite power source when offsite power is recovered, and

b. load the diesel generators to provide motive power to the electric-driven auxiliary feedwater pump in case of loss-of-offsite power.

RESPONSE

Design changes made as part of the corrective action from the SCE analysis result in differences between those operator actions which would have been required during the event and those actions which would be required after return to service. The following information addresses both cases.

The San Onofre Unit 1 diesel generators (DG) have two alternative modes of operation: isochronous and droop. In picking up a dead bus (either manually or automatically), isochronous control is required for speed regulation. In paralleling the DG with the offsite power system, droop is required in order to have load control. After design changes are made during this outage, the diesel will automatically transfer to the droop mode when ever it is paralleled to the offsite power system through either the A, B or C transformer. The existing design (and the operating procedures) does not provide for changing from isochronous to droop control when the DG is loaded.

With the present design, the loads from the onsite power sources cannot be transferred back to an offsite power source by paralleling buses. Restoration of offsite power by drop (deenergization) and pickup is described as follows:

Verify offsite power is available
Verify plant conditions permit momentary deenergization of the effected 4 kV bus
If reconnecting to "C" transformer, ensure reactor bypass breaker closed
Open DG output breaker
Synchronize and close offsite power source 4 kV breaker
Verify 4 kV bus is energized
Complete shutdown of diesel generator
Repeat sequence for a second train if required

After completion of the design changes, the loads from the onsite power sources will be transferred back to the offsite power system by paralleling. No interruption in the operation of in-plant equipment will occur. The operator actions required will be similar to the following:

Verify offsite power is available
Synchronize the diesel to the offsite power system using the bus main or tie breaker
Verify offsite power connected
Open DG output breaker
Close reactor bypass breaker (if open)
Complete shut down of diesel generator
Repeat sequence for second train if required

With respect to operator action required to power the motor-driven AFW pump from the DG's upon loss of offsite power, reference is made to Emergency Operating Instruction (EOI) S01-1.0-60, "Loss of All AC Power." Step 1 of the EOI directs the operators to verify offsite power available (i.e., in the switchyard). If offsite power is unavailable, the operator is directed to align the DG to the 4 kV system using the following steps:

Present	After DCP
Verify DG is running	Verify DG is running
Ensure 4 kV bus source breakers are open	Ensure 4 kV bus is isolated (tie and main breaker is open)
Open 4 kV bus tie breakers	Reset LOP
Open C transformer reactor bypass breakers	Close DG output breaker
Reset LOP at the sequencer panel	Verify 4 kV bus energized
Close DG output breaker	
Verify 4 V bus is energized	

Upon re-energizing the 4 kV bus, the motor-driven AFW pump would automatically start if a low steam generator level signal is present.

Subsection 8.1.3, Hardware Changes, of SCE's April 8, 1986 report provides a summary of hardware changes which will be completed prior to return to service. Item 12 of this list states:

"The diesel governor control will be modified so that it switches automatically from the isochronous mode to the droop mode whenever the associated bus is paralleled with the offsite power system through the A, B or C auxiliary transformers. (The speed control will automatically switch back to isochronous whenever the parallel with the offsite power system is broken). This eliminates the need to deenergize the bus in order to transfer it from the diesel to an offsite source."

The motor-driven AFW logic will remain unchanged, starting automatically in the presence of a low steam generator level signal.

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ENCLOSURE 2

RESPONSES TO APRIL 21, 1986 LETTER

QUESTION NO. 1

What are the new locations of the 10-inch feedwater system check valves relative to the flow control valve upstream and the block valve downstream? The Isometric Drawings previously provided only show the original locations.

RESPONSE

Figures 1, 2 and 3 are IDCN's from DCP 3400.30 BM which relocate the check valves 4' - 6-3/4" downstream of the reducer of each flow control valve and 0' - 7" from the downstream block valve. The offsite test program modeled this configuration.

BECHTEL

INTERIM DESIGN CHANGE NOTICE (IDCN)

AREA 2

SUPPLEMENTAL PAGE

AFTER

DOCUMENT NO.	SHEET NO.	REV NO.	DCN CONV DATE / DOC REV	SUB NO.	QUALITY CLASS
IDCN NUMBER S-4					
334539	-	2			SR

JOB NO. 15691-791 PAGE 4 OF 8 PAGE

DATE: 3/29/86 BY: F. GODEK

DESCRIPTION OF CHANGE

MODIFY FEEDWATER PIPING DOWNSTREAM OF FLOW CONTROL VALVE. ASSIGN SECTION XI WELD IDENTIFIERS

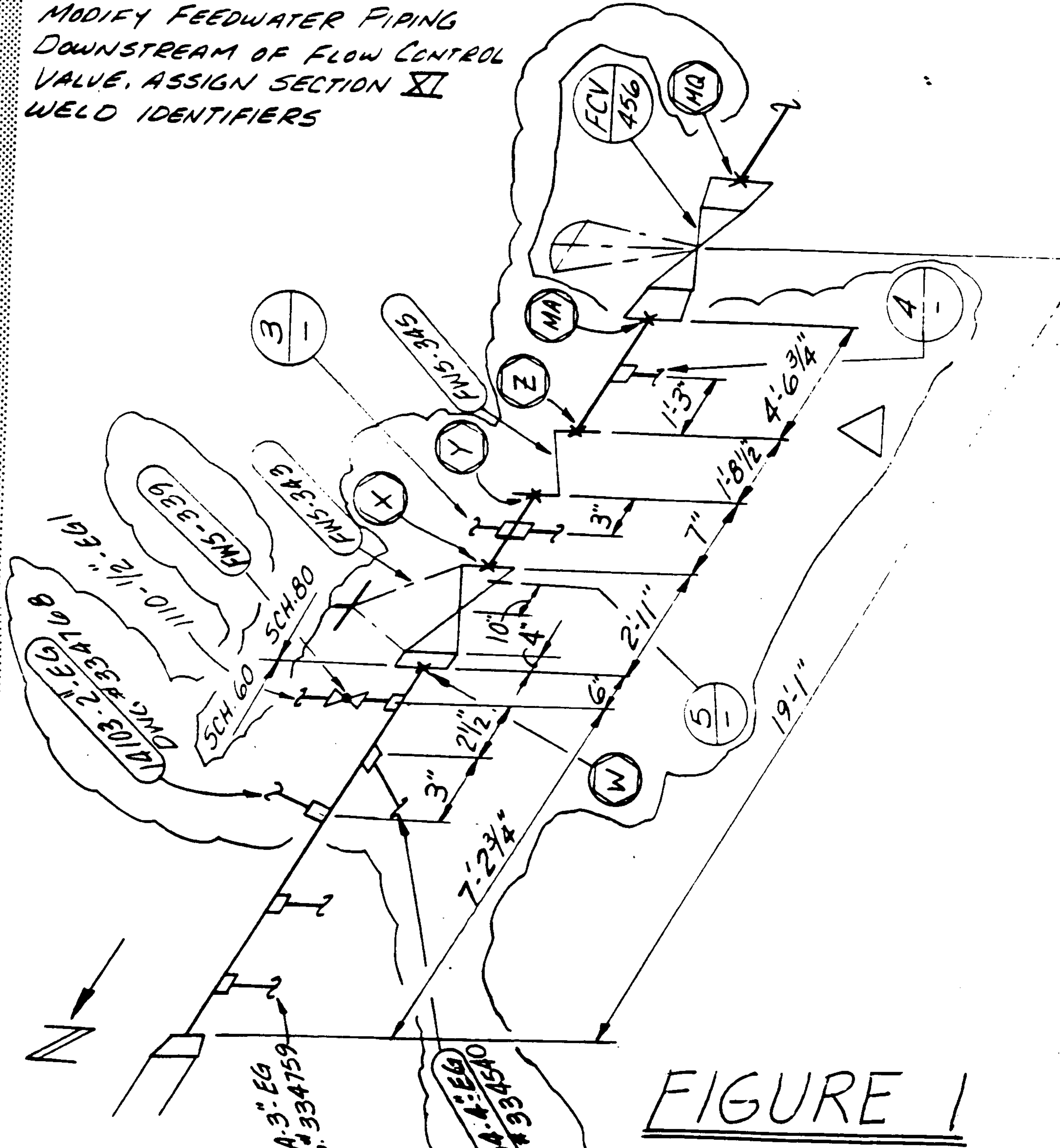

FIGURE 1

DCP 3400.308M REV A SH___ OF___

BECHTEL INTERIM DESIGN CHANGE NOTICE (IDCN)

SUPPLEMENTAL PAGE

IDCN NUMBER	S-4					
DOCUMENT NO.	SHEET NO.	REV NO.	DCN CONV. DATE:	DOC REV	SUB NO	QUALITY CLASS
334538	–	3				SREAN

AREA 2

JOB NO. 15691-791 PAGE 4 OF 7 PAGE

DATE: 3/27/86 BY: E. HOLGUIN

DESCRIPTION OF CHANGE

MODIFY FEEDWATER PIPING DOWNSTREAM OF FLOW CONTROL VALVE. ASSIGN SECT. XI IDENTIFIERS.

AFTER

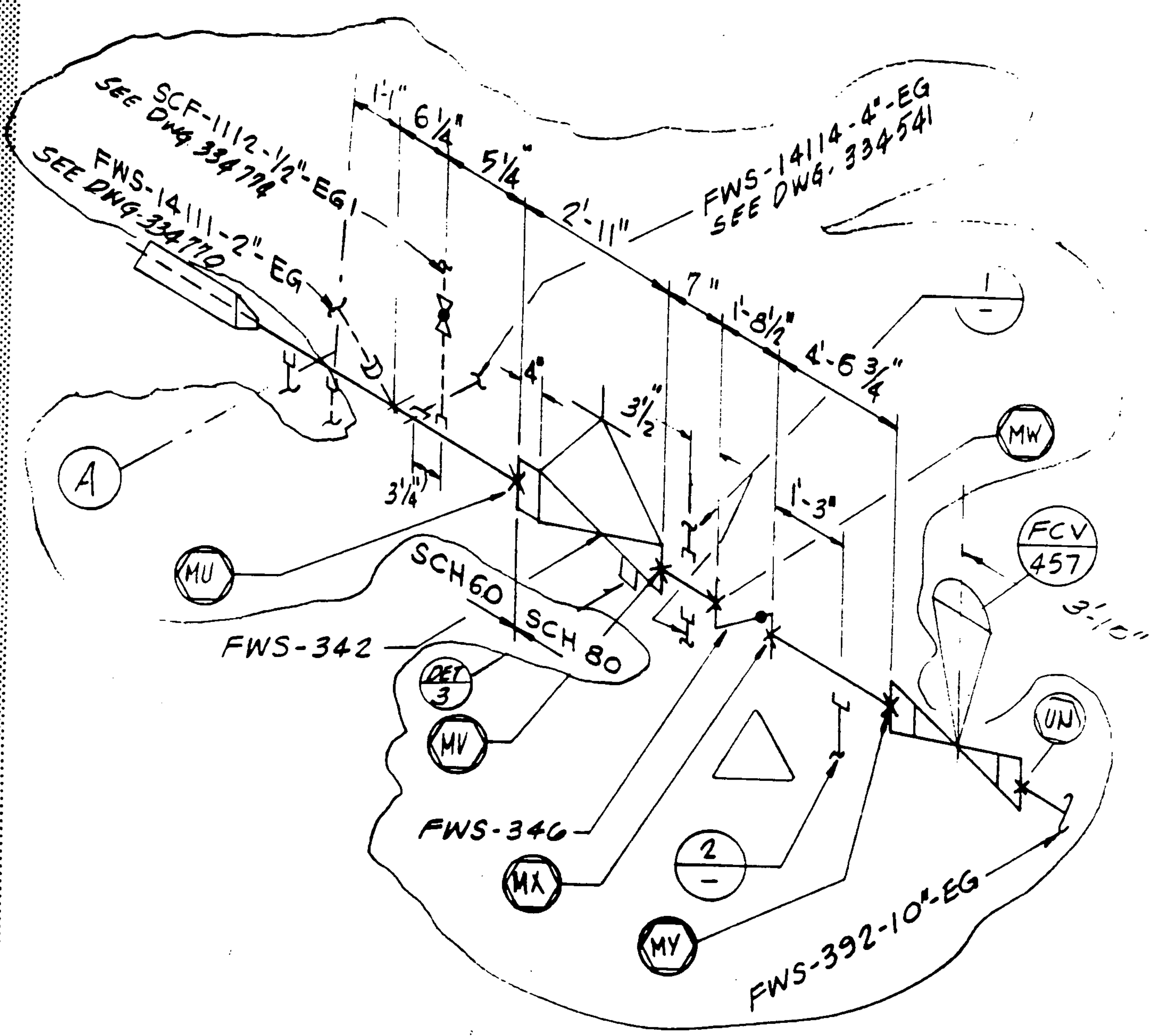

FIGURE 2

DCP 3400.308M REV A SHEET ___ OF ___

PF-2534.1 4/85

89

PF-6396 (10079) 4/84

BECHTEL

INTERIM DESIGN CHANGE NOTICE (IDCN)

AREA 2

SUPPLEMENTAL PAGE

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IDCN NUMBER S-4					
DOCUMENT NO.	SHEET NO.	REV NO.	DCN CONV. DATE: DOC REV	SUB NO.	QUALITY CLASS
334537	-	3			SR EAN

JOB NO. 15691-791 PAGE 4 OF 7 PAGE

DATE: 3/28/86 BY: F. G...ER

DESCRIPTION OF CHANGE

MODIFY FEEDWATER PIPING DOWNSTREAM OF FLOW CONTROL VALVE

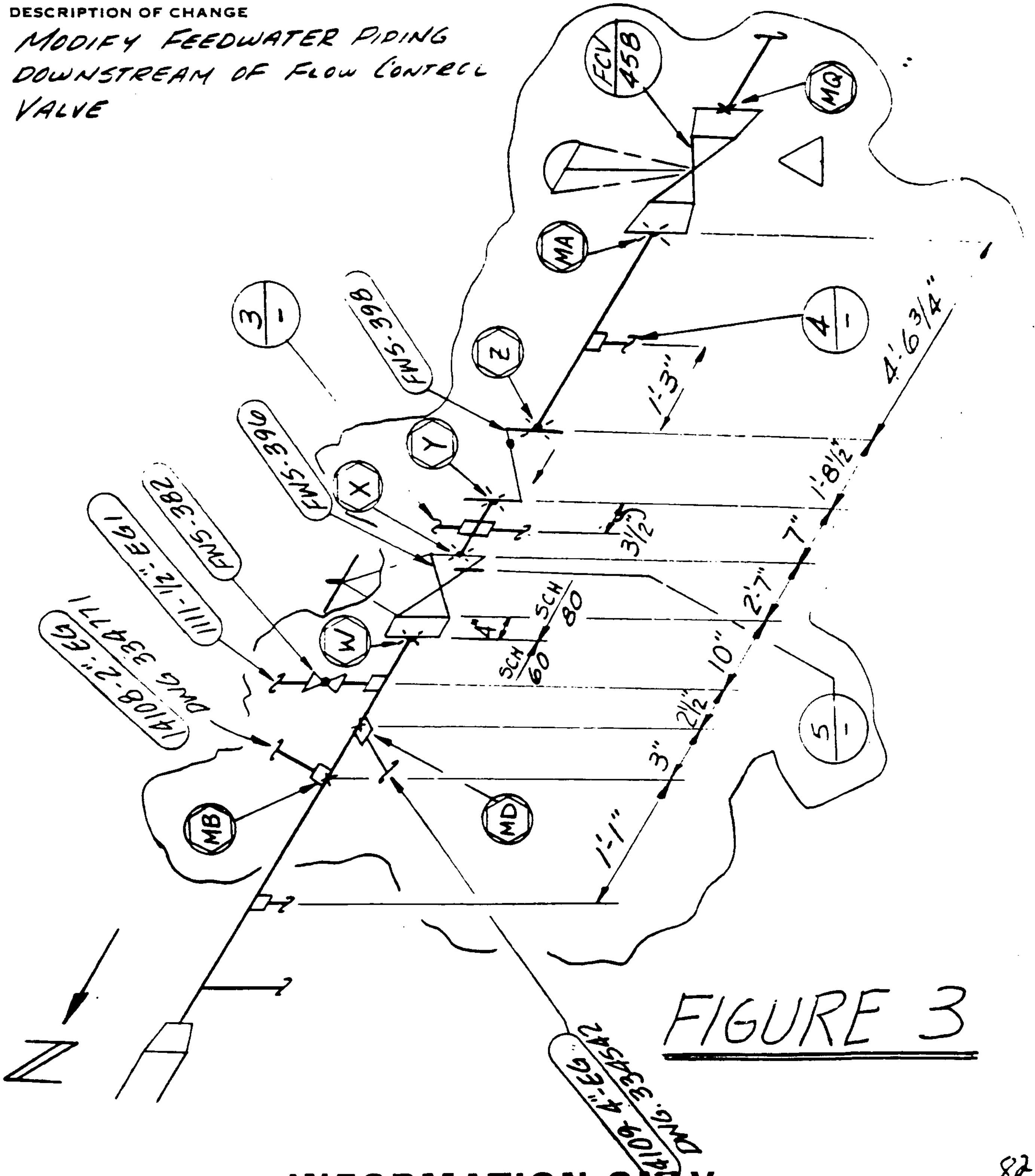


FIGURE 3

DCP 3400.30BM REV A SHEET ___ OF ___

QUESTION NO. 2

With regard to your current IST program, it appears that at least some of the five check valves which failed can be (and have been) tested while the plant is hot. However, relief from the Code has been requested for these valves to only test during cold shutdown. What is the basis for the reduced periodicity of testing these valves in light of the code requirements and the recent failures?

RESPONSE

The five check valves mentioned above are presently tested (closed direction) in Mode 3 to provide the necessary differential pressure to assure closure. Relief from the ASME Code testing frequency was requested because the valves cannot be tested quarterly in Mode 1. The term "cold shutdown" as it is used in the IST program actually means Modes 3-5 since not all "cold shutdown" valves can actually be tested in Mode 5. It is our intended practice to initiate "cold shutdown" testing within 48 hours of entry into Mode 3 for valves required to be tested in Mode 3, within 48 hours of entry into Mode 4 for valves required to be tested in Mode 4, and within 48 hours of entry into Mode 5 for values required to be tested in Mode 5. All initiated testing would continue until complete, i.e., all valves tested within the last 92 days, or the unit is ready to return to Mode 1. The IST procedures will be revised to more clearly identify this intent. Typically, valves are tested based on previous test date, that is, the most recently tested valve is tested last and the valve with the longest interval since its previous test is tested first. The previously submitted ASME Code relief request will be clarified to more clearly identify the intended testing conditions as specified above.

QUESTION NO. 3

What enhanced testing is planned for each of the new Atwood-Morrill check valves, including any quantitative leak rate criteria, procedures, and how new testing taps will be utilized?

RESPONSE

Demonstration testing has been and will be performed on the Atwood-Morrill check valves by Drs. Paul Tullis and William Rahmeyer (Utah State University Foundation). The first phase of testing was completed during the week of March 31, 1986 and included flow stability tests. The second phase of testing will be performed later this year and will involve accelerated wear tests. It is expected that the testing will be completed in August, 1986, with the final report completed approximately 45 days following test completion.

Quantitative leak rate criteria have been developed and are included in the guidelines (Attached). The guidelines also describe how the new test taps will be utilized. Station personnel are presently using the test guidelines to develop comprehensive procedures for testing the valves.

TEST PROCEDURE GUIDELINE FOR CHECK VALVES LEAKAGE RATE TEST

I. Functional Test for Check Valves FWS-006, FWS-007 and FWS-012 Inside the Containment:

A. Objective: To verify that the check valve back leakage rates are within the allowable limits. Correct deficiencies if required.

B. References:

1. P&ID 5178225, Revision 4, Main Steam System
2. P&ID 5178206, Revision 3, Feedwater System

C. Prerequisites:

1. Completion of check valve installation.
2. Verify calibration of pressure gauges.
3. Test to be done during Mode V or VI.
4. Isolation valves (FWS-343, FWS-377, FWS-339, AFW-325, FWS-342, FWS-376, FWS-352, AFW-326, FWS-396, FWS-415, FWS-382 and AFW-328) upstream of the check valves are closed.
5. Establish that the feedwater level of the steam generator at the ~~feed ring elevation ±2"-0".~~
6. Nitrogen system blanket is established per procedure.

D. Acceptance criteria: Check valves back leakage rate is within 0.48 gallons per minute at 150 psig. This test procedure was written for testing at 150 psig. Alternate test pressures can be used. The acceptance cirteria for using the alternate shall follow the equation.

Allowable leak rate at pres. P, $Q = 0.48 \sqrt{\frac{P}{150}}$ (gpm), see Fig. 2.

The allowable fluctuation in the test pressure is ±5 psi or ±10% whichever is greater. If test pressures less than 150 psig are used, functional testing of the feedwater main and bypass values must be done at a test pressure of 150 psig(Test II).

E. Method

1. Test the check valve one at a time only. Close isolation valves upstream of the check valve.
2. Connect measuring hose at the designated drain connection (see Table 1) upstream of the check valve. Make sure that the highest point of the connected measuring hose has a minimum loop as it is shown in Fig. 1.

3. Open drain valve (FWS-337, FWS-338, FWS-340, FWS-426 and FWS-424) to depressurize the isolated line upstream of the check valve to atmospheric conditions. To confirm that the upstream isolation valves do not leak, monitor and maintain atmospheric reading on the gauges on the main feedwater and auxiliary feedwater pumps.

4. Using nitrogen, pressurize the steam generator downstream of the check valve (if pressure is not already established). Monitor and maintain steam generator pressure at 150 psig minimum to 165 psig.

5. At steady state, and using a container of known volume, measure and record the check valve back leakage rate by measuring the time required to accumulate one gallon. Take two measurement test readings for comparison.

6. After measuring the check valve back leakage rate, close the nitrogen pressurizing line (if not required for other than testing).

7. Making sure the system is vented, close the drain valves and disconnect the measuring hose.

8. Open back all the isolation valves that were closed during the test.

F. Alternate method for functional test of FWS-006, FWS-007 and FWS-012:

Performance of this test is subject to the availability of the auxiliary feedwater pumps as a pressurization source.

1. With a nitrogen blanket established, initiate auxiliary feedwater flow to pressurize the steam generator. When a test pressure has been established, perform the back leak rate test in accordance with E1 through E5 above. As the pressure will decay during the test, the following requirements apply to the test pressure:

   a. The decay in steam generator pressure shall be no more than 10% of the final pressure.

   b. For the purpose of determining the allowable leak rate, the final measured steam generator pressure shall be used.

      NOTE: The allowable leakage rate shall be determined using the minimum pressure value obtained during the test.

II. Functional Test for Check Valves FWS-345, FWS-346, FWS-398, FWS-379, FWS-378, FWS-417 in the feedwater system.

A. Objective: To verify that the feedwater system check valves back leakage rates are within the allowable limit. Correct deficiencies if required.

B. Reference:

1. P&ID 5178206, Revision 4, Feedwater System.

C. Prerequisites:

1. Completion of check valve installation.

2. Verify calibration of pressure gauges.

3. Isolation valves (FWS-343, MOV-21, FWS-377, FWS-381, FWS-342, MOV-20, FWS-376, FWS-372, FWS-396, MOV-22, FWS-415 and FWS-419) upstream and downstream of the check valves are closed.

4. Test to be done in Mode V or VI.

D. Acceptance criteria: This criteria applies to the combined check valves back leakage rates of the following paired check valves: FWS-345 and FWS-379; FWS-346 and FWS-378 and FWS-398 and FWS-417 leakage shall be less than is 0.48 gallons per minute. This procedure is written using test pressures of 150 psig. Other test pressures can be used. The allowable leak rate at other test pressures shall follow the equation

Allowable leak rate at pres. P, $Q = 0.48 \sqrt{\frac{P}{150}}$ (gpm), see Fig. 2.

If the test pressure used on the downstream check valves (Test I) is less than 150psig, this test shall be performed at 150 psig minimum.

The allowance fluctuation in the test pressure is ± 5 psi or $\pm 10\%$ whichever is greater.

E. Method:

1. Test the check valves one at a time only. Close isolation valves upstream and downstream of the check valve.

2. Connect measuring hose at the designated drain or vent connections (see Table 1). Make sure that the highest point of the connected measuring hose has a minimum loop as it is shown in Fig. 1.

3. Open the drain or vent valve where the measuring hose is connected to depressurize the line to atmospheric conditions. To confirm the upstream isolation valves do not leak, monitor and maintain atmopsheric reading on the gauges on the main feedwater pumps.

4. Connect the high pressure water supply to the drain or vent connection designated downstream of the check valve (see Table 1). The water supply must meet the requirement of the chemistry flush specification for the feedwater system. Open the drain or vent valve and high pressure water supply valve and pressurize the line. Using the pressure gauge provided in the water supply hose, maintain and monitor the pressure downstream of the check valve at 150 psig minimum to 165 psig.

5. At steady state, and using a container of known volume, measure and record the check valve back leakage rate by measuring the time required to accumulate one gallon. Take two measurement test readings for comparison.

6. After measuring the check valve back leakage rate, close the drain or vent valve where the measuring hose is connected and disconnect the hose.

7. Making sure the system water is vented, close the high pressure water supply valve and close the drain or vent line valve and disconnect the high pressure water supply.

8. Open back all the isolation valves upstream and downstream of the check valve that were closed during the test.

F. Alternate Procedure:

The back leakage rate test for the feedwater system check valves can also be done during Mode III subject to the availability of the auxiliary feedwater pump as a pressurization source. The following procedure would be used.

1. Test and isolate the check valves one at a time only. Close isolation valve upstream of the check valve.

2. Connect measuring hose at the designated drain or vent connections (see Table 1). Make sure that the highest point of the connected measuring hose has minimum loop as it is shown in Fig. 1.

3. Open the drain or vent valve where the measuring hose is connected to depressurize the line to atmospheric conditions. To confirm the upstream isolation valves do not leak, monitor and maintain atmospheric reading on the gauges on the feedwater pumps.

4. Install a temporary test pressure gauge and open the valve of the vent connection upstream of the check valve as indicated in Table 1.

5. Initiate the auxiliary feedwater pump flow to pressurize the line downstream of the check valve to within ± 10% of the normal operating pressure. Maintain and monitor the pressure at the test pressure gauge installed at the vent connection.

6. At steady state, and using a container of known volume, measure and record the check valve back leakage rate by measuring the time required to accumulate one gallon. Take two measurement test readings for comparison.

7. After measuring the check valve back leakage rate, close the drain or vent valve where the measuring hose is connected and disconnect the hose.

8. Close the vent connection valve where the test pressure gauge is installed and remove the gauge.

9. Open back all the isolation valves upstream of the check valve that was closed during the test.

III. Functional Test for Check Valves FWS-438 and FWS-439 in the feedwater system.

A. Objective: To verify that the feedwater system check valves are still intact and functional.

Correct deficiencies if required. These valves have been provided with a 9/32" orifice hole drilled in the check valve disc. Standard leak rate tests cannot be performed. This testing will determine the functionality of the check valve.

B. Reference:

1. P&ID 5178205, Revision 2, Feedwater System.

C. Prerequisites:

1. Completion of check valve installation.

2. Verify calibration of pressure gauges.

3. Isolation valves (FWS-441, FWS-469, CV-875B, HV-854B, FWS-556, FWS-440, FWS-472 and HV-854A) upstream and downstream of the check valves are closed.

4. Test to be done during Mode V or VI.

D. Acceptance criteria: When the downstream piping is pressurized to 150 psig the upstream leakage rate is less than 20 gpm. Other test pressures can be used. The allowable leakage rate at an alternate pressure P would follow the equation

$$Q = 20 \sqrt{\frac{P}{150}} \quad \text{(GPM)}$$

The allowable fluctuation in test pressure is $\pm$5psi or $\pm$10% whichever is greater.

E. Method:

1. Test the check valve one at a time only. Close isolation valves upstream and downstream of the check valve.

2. Connect measuring hose at the designated drain or vent connections (see Table 1). Make sure that the highest point of the connected measuring hose has a minimum loop as it is shown in Fig. 1.

3. Open the drain or vent valve where the measuring hose is connected to depressurize the line to atmospheric conditions. To confirm the upstream isolation valves do not leak, monitor an maintain atmospheric reading on the gauges on the main feedwater pumps.

4. Connect the high pressure water supply to the drain or vent connection designated downstream of the check valve (see Table 1). The water supply must meet the requirement of the hemistry flush specification for feedwater system and can provide 20 gpm at 150 psig minimum pressure to 165 psig. Open the drain or vent valve and high pressure water supply valve and pressurize the line. Using the pressure gauge provided in the water supply hose, maintain and monitor the pressure downstream of the check valve at 150 psig minimum to 165 psig.

5. At steady state and using a container of known volume, measure and record the check valve back leakage rate by measuring the time required to accumulate ten gallons. Take two measurement test readings for comparison.

6. After testing, close the vent valve where the measuring hose is connected and disconnect the hose.

7. Making sure the system is vented, close the high pressure water supply valve and close the vent line valve and disconnect the high pressure water supply.

8. Open back all the isolation valves upstream and downstream of the check valves that were closed during the test.

F. Alternate Method for Functional Test of FSW-438, FWS-439.

This method is subject to the availability of the feedwater pumps as a pressurization source during mode 5 or 6. Test only one check valve at a time feedwater system will be aligned such that, one feedwater pump will be run and the water will be recirculated to the condenser via the 3" miniflow line. The check valve on the discharge of the out-of-service feedwater pump will be tested as follows;

1. Establish feedwater flow and flow path form one feedwater pump close the upstream isolation valve on the check value on the discharge of tag out-of-service pump.

2. With the flow path in the crosstie between the feedwater heaters open, install a temporary pressure gauge on the pressurized side of the check value.

3. Connect measuring hose at the designated drain or vent connections (see Table 1). Make sure that the highest point of the connected measuring hose has a minimum loop as it is shown in Figure 1

4. Open the drain or vent valve where the measuring hose is connected to depressurize the line to atmospheric conditions.

5. At steady state, and using a container of known volume, measure and record the check valve leakage rate by measuring the time required to accumulate 20-40 gallons.

6. After measuring the check valve back leakage rate, close the drain or vent valve where the measuring hose is connected and disconnect the hose.

7. Making sure the system is vented, terminate Feedwater miniflow.

   CAUTION: Care should be taken when performing this alternate testing, as the potential exists for overpressurization of the feed water suction piping. The suggested test pressure is 150 psig.

IV. Functional Test for Check Valves AFW-321, AFW-322, AFW-324, in the Auxiliary Feedwater Systems. (Continued)

B. Reference: P&ID 5178220, Revision 5 Auxiliary Feedwater System.

C. Prerequisites:

1. Completion of check valve installation.

2. Verify calibration of pressure gauges.

3. Isolation valves(AFW-325, FCV-2300, AFW-326, FCV-3301, FCV-2301, AFW-338, FCV-3300,) upstream and downstream of the check valve are closed.

4. Test to be during Mode V or VI.

D. Acceptance criteria: Check valve back leakage rate is within 0.48 gallons per minute. This procedure is written using test pressures of 150 psig. Other test pressures can be used. The allowable leak rate at other test pressures shall follow the equation.

Allowable leak rate at pres. P, $Q = 0.48 \sqrt{\frac{P}{150}}$ (gpm), see Fig. 2.

The allowable fluctuations in test pressure is $\pm$5psi or $\pm$ 10% whichever is greater.

E. Method:

1. Test check valve one at a time only. Close isolation valves upstream and downstream of the check valve.

2. Connect measuring hose at the designated connections upstream of the check valve (see Table 1). Make sure that the highest point of the connected measuring hose has a minimum loop as it is shown in Fig. 1 is higher than the highest point of the isolated line where it is connected (see Fig. 1).

3. Open the drain or vent valve where the measuring hose is connected to depressurize the line to atmospheric condition. To confirm the upstream isolation valves do not leak, monitor and maintain atmospheric reading on the gauges on the auxiliary feedwater pumps.

4. Connect the high pressure water supply to drain or vent connection designated downstream of the check valve (see Table 1). Tehe water supply must meet the requirement of the chemistry flush specification for the feedwater system. Open the drain or vent valve and the high pressure water supply valve and pressurize the line. Using the pressure gauge provided in the water supply hose, maintain and monitor pressure downstream of the check valve at 150 psig to 165 psig.

5. At steady state, using a container of known volume, measure and record the check valve back leakage rate by measuring the time required to accumulate one gallon and the check valve minimum downstream pressure value. Take two measurement test readings for comparison.

6. After measuring the check valve back leakage rate, close the valve where the measuring hose is connected and disconnect the hose.

7. Making sure the system is vented, close the high pressure water supply valve and close the vent or drain valve where high pressure water supply is connected and disconnect the high pressure water supply line.

8. Open back all the isolation valves upstream and downstream of the check valve that were closed during the test.

Enclosure

TABLE 1

CHECK VALVE	HIGH PRESSURE SUPPLY CONN.	MEASURING CONNECTION	ISOLATION VALVES
FWS-006		FWS-338	FWS-376, AFW-326, FWS-352 and FWS-342
FWS-007		FWS-337	FWS-339, FWS-377, FWS-343 and AFW-325
FWS-012		FWS-424	FWS-382, FWS-396, FWS-415 and AFW-328
FWS-417	FWS-432	FWS-423	FWS-415 and FWS-419
FWS-398	FWS-368	FWS-365	FWS-396 and MOV-22
FWS-378	FWS-428	FWS-422	FWS-376 and FWS-372
FWS-346	FWS-446	FWS-366	FWS-342 and MOV-20
FWS-379	FWS-423	FWS-421	FWS-377 and FWS-381
FWS-345	FWS-425	FWS-367	FWS-343 and MOV-21
FWS-439	FWS-445	FWS-565	HV-854B, HV-852B, CV-875B and FWS-473
FWS-438	FWS-540	FWS-510	FWS-440, FWS-556, FWS-472 and HV-854A
AFW-321	DRAIN	VENT	AFW-325 and FCV-2300
AFW-322	DRAIN	VENT	AFW-326, FCV-3301 and FCV-2301

(2002k)

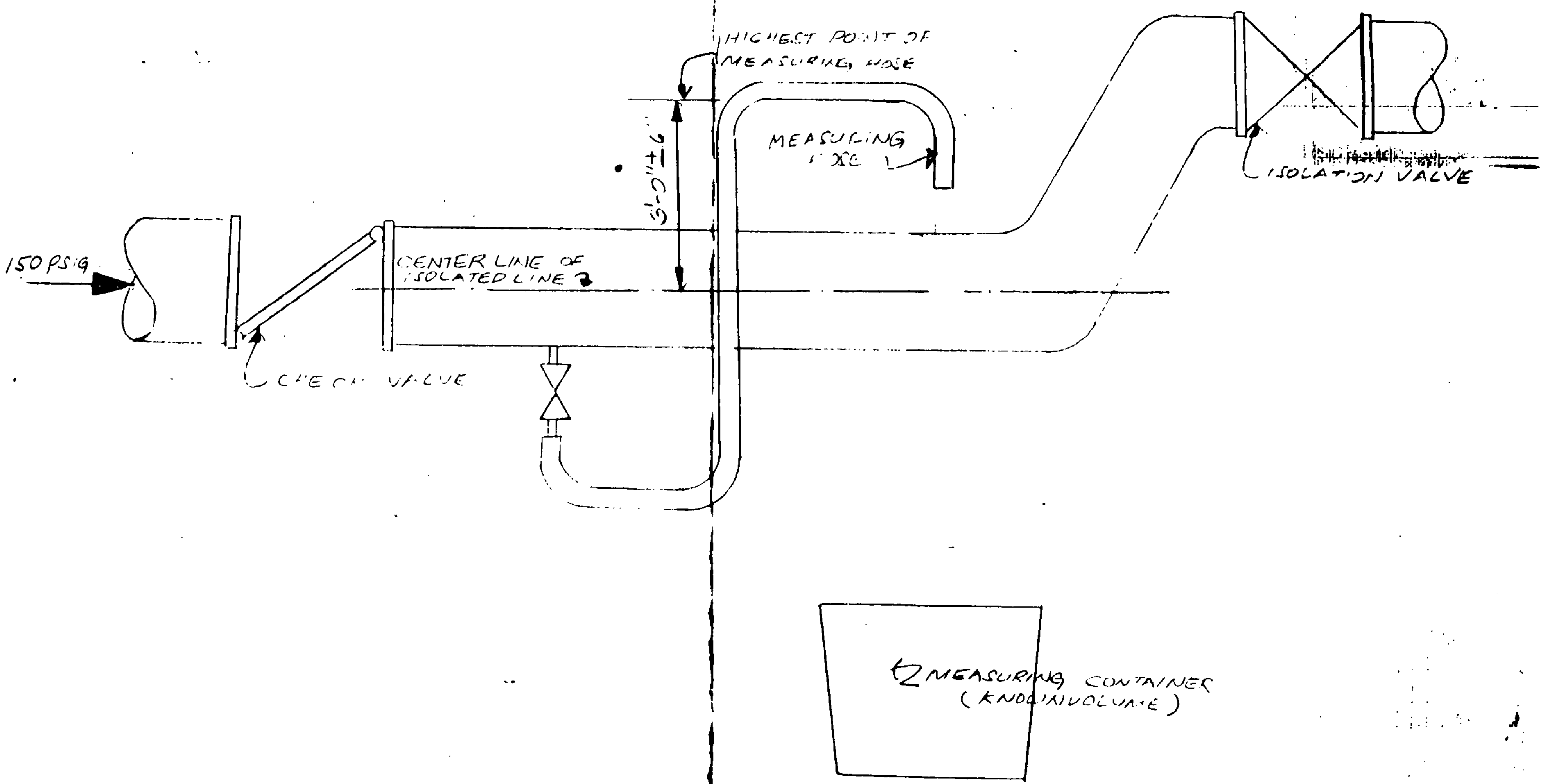
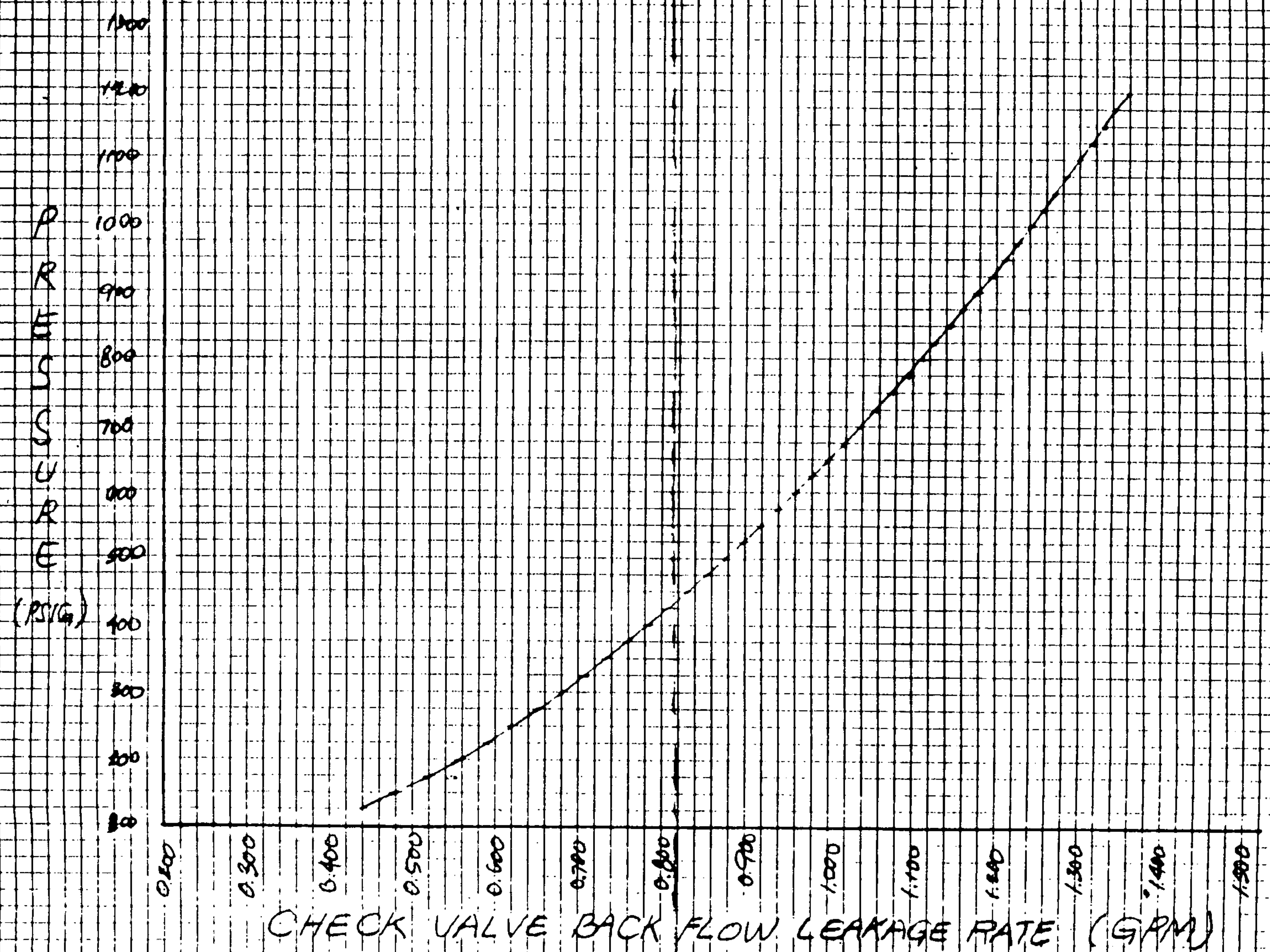


FIG. 1 - TYPICAL HOOKUP OF MEASURING HOSE FOR CHECK VALVE BACKFLOW LEAKAGE TEST.

FIG. 2 - ALLOWABLE CHECK VALVE BACK FLOW LEAKAGE RATE



NOTE: TESTS SHOULD BE PERFORMED AT 150 psig OR GREATER WHENEVER POSSIBLE.

QUESTION NO. 4

Please clarify your commitment with regard to opening and visually inspecting the new check valves. Specifically:

a. Which valves will be inspected?

b. How often will they be inspected?

c. If valves are noisy in operation, will inspection periodicity be increased?

RESPONSE

a. During the Cycle X refueling outage, one 10" valve inside containment, one 10" valve outside containment (downstream of an FCV), one 12" check valve and one 4" check valve will be opened and inspected.

b. How often the 10" and 12" valves will be inspected will be determined after evaluating the results of the accelerated wear tests to be performed later this year (see response to Question No. 3 of this Enclosure) and evaluating the results of the inspection performed at the next, Cycle X, refueling outage.

c. Based on the flow stability tests conducted by Drs. Tullis and Rahmeyer, the valves are expected to perform satisfactorily in the short term (i.e., one to two refueling cycles).

The wear testing program is expected to confirm the suitability of these valves for continued use and will establish appropriate inspection intervals for the remaining plant lifetime. Any noise from the valves during operation is expected to be minimal and similar to what was found during the flow stability tests. See response to Question No. 7 of this Enclosure for further discussion of the points.

QUESTION NO. 5

Since less than 165 gpm through the 10-inch check valves is considered to be severe service by the vendor, what additional actions do you intend to take to assure that operations within this regime (AFW flow) will not unacceptably degrade the valve.

RESPONSE

The flow stability tests performed by Dr. Tullis and Dr. Rahmeyer demonstrated that the valve was totally stable throughout the flow range from 40 gpm through 170 gpm. There was no noise from the valve nor were there any detectable pressure fluctuations downstream of the valve that would be indicative of an unstable disc. The accelerated wear tests to be performed later this year will also encompass these low flows.

QUESTION NO. 6

Please provide the results of the full scale valve testing performed by Dr. Tullis at Utah State University.

RESPONSE

The report on the tests performed by Dr. Tullis has not yet been completed. As soon as it has been finalized, a copy of it will be provided to the NRC. It is expected that this report can be provided on May 5, 1986.

QUESTION NO. 7

How do you intend to monitor the performance of these valves during startup and operation to determine if they are tapping?

RESPONSE

The loudness and rate of any tapping during startup and operation will be observed and evaluated against the results of the testing program.

Data will be obtained by methods similar to those used in the offsite tests: unaided ear, stethoscope and portable accelerometers. It is not intended to have any valves permanently instrumented for continuous monitoring.

It is expected that the valves' performance in service will be bounded by the results of the offsite testing program. If valve tapping as observed in the plant significantly exceeds the test performance results, the testing program will be reevaluated and further offsite testing may be performed.

QUESTION NO. 8

In Table 8 of Appendix D, provide the reason for replacement of the internals to valve DWN309.

RESPONSE

One hundred and forty-one maintenance orders were examined to identify troublesome check valves exhibiting past failures similar to failures seen following the water hammer event.

By reviewing old maintenance records, five check valves were identified and inspected which had problems during the last San Onofre Unit 1 outage, ranging from a history of seat leakage to a cracked diaphram. The 1986 current inspection results indicated no abnormal wear, no internal or external damage and all are operable.

To be specific, check valve S1-DWN-309 was chosen for inspection because its internal parts were replaced during the last outage. During this current refueling the internals were found to have no wear, no damage and were fully operable. Therefore, the internals were not replaced during this outage and no further action is required.

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ENCLOSURE 3

RESPONSE TO APRIL 29, 1986 LETTER

QUESTION NO. 1

Provide schedules for the implementation of all corrective actions listed in Section 6.5.7.3 of the April 8, 1986 report.

RESPONSE

a. Prior to return to service from the current outage, the TSC Fox III computer software will be modified to provide for automatic resumption of data collection when power is restored following any loss of power to the computer.

b. It is our intent to provide an uninterruptible power source (UPS) for the Fox III computer prior to return to service from the current outage. However, since on outage is not required for installation of this modification, if installation is not completed prior to return to service, the installation efforts will continue such that this modification will be implemented no later than July 15, 1986.

c. Vital bus no. 4 is scheduled to be provided with a UPS during the next refueling outage following return to service from the current outage.

QUESTION NO. 2

Provide the status and schedule of your efforts to respond to IE Information Notice 84-90, dated December 7, 1984. Will these efforts evaluate the containment pressure response considering the effect of superheat due to tube bundle uncovery in steamline break transients?

RESPONSE

Outside Containment

The impact of superheated steam blowdown on EQ outside containment is currently being evaluated. Westinghouse is generating plant-specific mass and energy release data similar to data provided to the WOG HELB/SBOC subgroup (WCAP-10961-P). The scheduled delivery of mass and energy data is June 1, 1986. Using the blowdown data developed, Impell Corp. will determine post-accident environmental conditions in the affected areas, assess the environmental qualification of equipment for the superheat profiles, perform equipment thermal response analysis where necessary, and recommend qualification solutions for equipment which is judged to be unqualified. The Impell evaluation and issuance of final report is scheduled to be completed 15 weeks after receipt of the blowdown data.

Inside Containment

The impact of superheated steam blowdown on EQ inside containment has been evaluated generically by Westinghouse. On January 25, 1985 Westinghouse met with the NRC to provide additional information on an NRC question on WCAP-8822 which is the mass/energy release topical. Westinghouse presented results of analyses performed using the superheat mass/energy release model developed in 1984. The results of these analyses supported the conclusions reached in the August 1983 SER on WCAP-8822 which stated that no reanalysis was required for dry containments. Westinghouse committed to provide a supplement to WCAP-8822 to include the details of the presentation. Supplement 2 to WCAP-8822 (Reference 1) was submitted to the NRC on October 7, 1985. Supplement 2 included the results of a sensitivity study on containment response using the superheat and non-superheat models and concluded that the effects of superheat were negligible. The NRC concurred with Westinghouse that superheat mass/energy does not require reanalysis inside dry containments. NRC concurrence was documented in Reference 2 which concluded that current mass/energy release calculations (without the superheat model) are adequate and revised temperature profiles for environmental qualification of equipment are not required. Based on discussions with Westinghouse, the results of Supplement 2 to WCAP-8822 are applicable to SONGS-1. Containment response analysis for SONGS-1 was submitted to the NRC in References 3 and 4. These analyses used the mass/energy release methodology of WCAP-8822 (without the superheat model).

References

1. Supplement 2 to WCAP-8822, "Impact of Steam Superheat in Mass/Energy Releases Following a Steamline Rupture For Dry and Subatmospheric Containment Designs" dated September, 1985.

2. Letter from Hugh Thompson to Edward L. Jordan, subject: I&E Information Notice 84-90, dated July 15, 1985

3. Letter from K. P. Baskin (SCE) to D. M. Crutchfield (NRC), Docket 50-206 Automatic Initiation of Auxiliary Feedwater System SONGS-1, dated June 10, 1980.

4. Letter from K. P. Baskin (SCE) to D. M. Crutchfield (NRC), Docket 50-206, Automatic Initiation of Auxiliary Feedwater System SONGS-1, dated March 6, 1986.

QUESTION NO. 3

Submit for staff review the re-analysis of Loss of Normal Feedwater and Main Feedline Rupture transients which are mentioned in Sections 6.1.2.2 and 6.1.2.3 of the April 8, 1986 report.

RESPONSE

See the response to Question No. 9 in Enclosure 1.

QUESTION NO. 4

Spurious indication of safety injection on loss of power.

a. Is the new power source for the SI annunciator auxiliary relay contact chain "backup up by an" or is it an uninterruptible power supply (UPS)?

b. Is the new power source the same power source that powers the annunciator? If not, indicate how spurious indication is prevented.

c. Is the new power source Class 1E and diesel backed?

d. Describe the power sources for the UPS and their priorities. Is divisional independence maintained?

RESPONSE

a. The SI annunciator relay auxiliary contact chain will be powered from a UPS through the security UPS distribution system. However, the security UPS will be disconnected and the distribution panel will be powered by the Units 2&3 non-Class 1E UPS.

b. No - The new power source is used to power the relay coil of the SI alarm relay. A contact from this relay will be used to pick up the annunciator window. The annunciator system power source is the 125 V DC system. This system is powered by the station batteries which are backed up by the diesel generators through the battery chargers. Since both the SI alarm relay and the annunciator system are both battery and diesel generator backed, no spurious SI alarm is postulated.

c. The UPS and all the associated circuits are non-Class 1E. However, the Units 2 and 3 non-1E UPS is backed up by batteries and diesel generators.

d. The primary source of power is the Unit 2&3 non-1E UPS inverter which supplies regulated 120 VAC to the system. This inverter is supplied with 125 V DC from non-1E battery system as well as from diesel backed 1E AC source via battery charger. In the event of loss of inverter, a static switch automatically transfers the UPS loads to a non-1E MCC via a regulating transformer.

Note: The SI annunciator relay circuit will be eventually powered from vital bus no. 4 UPS. As stated in our response to Question No. 1 in this Enclosure, this work is planned to be implemented during Cycle X Outage.

QUESTION NO. 5

Spurious remote indication for safeguard load sequencers.

a. Section 6.2.4.11 indicates that sequencer 1 and a spare logic board were tested. Was sequencer 2 and the plant wiring tested? If not, address the acceptability of not testing this equipment.

RESPONSE

Sequencer 2 was tested using MO 86021238. Testing was completed March 27, 1986. The second sequencer and existing wiring up to the remote panel was tested. Field transmission loops were not tested under this MO since they are included in the normal surveillance program. No defects or abnormalities were found.

QUESTION NO. 6

Reactance bypass circuit breaker.

a. Will the alarms be both local and in the control room?

b. Are the alarms actuated on the conditions diesel generator breaker closed and reactance breaker closed, or some other conditions?

c. When will the operating procedures be modified to incorporate the action to be taken in the event that this alarm sounds?

RESPONSE

a. No. The "sources parallel" annunciation will be provided only in the Control Room.

b. Annunciators are actuated under the following conditions:

   i. Transformer A (B) is paralleled with transformer 'C',

   ii. Transformer A (B) is paralleled with diesel #1 (#2), or

   iii. Transformer 'C' is paralleled with diesel #1 (#2) and the reactor bypass breaker RX1 (RY1) is not open.

c. The procedures will be modified prior to return to service from the current outage (defined as entry into MODE 2).

QUESTION NO. 7

Vital bus 4.

a. Describe in greater detail the UPS that will be provided as one of the power sources for vital bus 4. Will it be the normal power source? What are its power sources? Is divisional independence maintained?

b. Is the UPS sized to account for present and future loads?

RESPONSE

a. The UPS will be a 7.5 kVA inverter that will be connected to a transfer switch. The transfer switch will be connected to vital bus no. 4 and will allow transfer of the bus from the inverter (normal source) to the existing 130 V AC source (alternate source). The inverter will be connected to the generating unit DC Bus 1.

The normal power source to vital bus no. 4 will be the inverter which is connected to DC Bus 1.

The normal power source will be the inverter which will be connected to DC Bus 1. DC Bus 1 is supplied from battery chargers that are connected to buses that can be supplied from the diesel generator sets. The DC Bus 1 can also be supplied power from 125 V DC Battery 1.

The existing divisional independence of vital bus no. 4, the existing 120 V AC source (which will become the alternate source), DC Bus 1, DC Bus 1 battery chargers, and Battery #1, will be maintained.

b. The 7.5 kVA inverter and transfer switch exceeds present demand on vital bus no. 4, and expected demand of planned future modifications.

QUESTION NO. 8

What was the DC overvoltage high potential test values applied for testing 4160 volt cables? Was this test performed as a step voltage test? What was the time limit the final voltage was held on the cable? If the maximum test voltage was used on old cable, how has SCE assured that no further damage has been incurred in the cable?

RESPONSE

The DC overvoltage test value used at San Onofre for testing 4160 volt cables of this type is 28 kV for cables expected to remain in-service. Readings are required at 1/2, 1, 2, 5 and 10 minute intervals during the controlled rise DC voltage test (this is a step voltage test). Voltages are held for approximately one minute and allowed to stabilize. The last full test voltage interval is limited to five (5) minutes. Administrative controls prevent testing in excess of approved limits on equipment or cables which will be left in service.

The DC overvoltage test is performed in accordance with Station Procedure S0123-II-11.153 which is derived from the following established industry and SCE standards:

- o The National Electrical Manufacturers Association Standard for Rubber Insulating Power and Control Cables, Publication 49-141, February 1949, (recommends A.C. and D.C. overpotential test levels for cables).

- o The Insulated Power Cable Engineers Association General Specification for Wire and Cable with Rubber, Rubber-like and Thermoplastic Insulation, Second Edition, February 1951, (also recommends A.C. and D.C. overpotential test levels for cable).

- o The Southern California Edison Company Apparatus Division prepared "Instructions and Test Procedure, Over-voltage Testing of Power and Control Cable", dated May 21, 1956, which established A.C. and D.C. test levels based on existing National Standards, including those listed above.

- o The Association of Edison Illuminating Companies, Specification for Ethylene Propolene Rubber Insulated Cables, AEIC 6-73, has been also used as the basis for subsequent revisions to the SCE Test Procedure. It's latest edition is AEIC CS6-82.

- o The present SCE Test Procedure 6A2, last revised June 27, 1983, is included in SCE Substation Test Manual, Section 6A2. This procedure specifies D.C. test voltage levels similar to and consistent with those recommended in the above standards as refined by years of company experience. (S0123-II-11.153 refers to this SCE procedure.)

SCE has utilized DC overvoltage testing at generating stations and substations for over thirty (30) years. When correctly implemented the test will detect imminent cable failures and will not deteriorate the cable. Further, representative samples of 4kV cables that have been in serve at San Onofre Unit 1 since initial operation and were also recently DC overvoltage tested, have subsequently been laboratory tested to breakdown at voltages significantly higher than 28kV DC. Therefore, SCE is assured that no damage was incurred in 4160 volt cables which were DC overvoltage tested.

QUESTION NO. 9

The core ground insulation test indicated one hundredth of a meg-ohm resistance. This resistance is lower than the resistance measured during 1979 test. How do these values compare with previous test and/or factory test values? The core ground insulation value is extremely low. Provide the basis and rationale for accepting this value for safe operation of this transformer.

RESPONSE

The core ground insulation resistance values are as follows:

Factory Test	March 1979	2025 M
Initial Installation	08/01/79	14 K
Latest Test	12/17/85	10 K

During operation, the core is grounded by a ground strap so that the core to ground resistance is essentially zero. To perform this test, this ground strap is removed.

Generally the core voltages are in the region of milli-volts to a few volts. The presence of an additional high resistance ground path may cause extremely small circulating currents which will have negligible effect on the transformer. Dissolved Gas Analysis (DGA) of the transformer oil will show increased percentage of combustibles should a problem occur. To monitor the condition of the auxiliary transformer C Dissolved Gas analysis will be performed every 6 months. In the past this analysis was performed on an as required basis.

At SCE's fossil-fueled El Segundo plant one transformer has been in operation for 30 years. Its core to ground insulation was recently measured at 7 ohms and has been declared acceptable for use.

QUESTION NO. 10

Provide test data for the tests conducted "as found tests" and "as left tests". How do these tests/data compare to the previous years' tests and/or factory tests for transformer C and other equipment tested?

RESPONSE

"As found" and "as left" test data is attached. These tests compare favorably with previous tests conducted by SCE. One exception being the core to ground insulation as explained in the response to Question No. 9 in this Enclosure.

DC overvoltage test data for Safety Related 4 kV cables is also attached.

* * * * * * * * * * PLANNING APPROVALS CONTINUED * * * * * * * * * * * * * *

WORK PLANNED	HOGAN, W	12/13/85 08:14:55
WORK PLANNED REVIEW	GLOVER, F	12/13/85 09:33:01
ENGINEERING REVIEW	KHAMAMKAR, S	12/13/85 10:07:41
Q.A. REVIEW	WIMBERLY J	12/13/85 10:42:50
E.C. REVIEW	KUHNS, R	12/13/85 12:05:07
WORK SCHEDULED	KIMMEL, D	12/13/85 12:54:49

* * * * * * * * * * * * * * * CRAFT INFORMATION * * * * * * * * * * * * * * * *

CRAFT CODE	CRAFT DESCRIPTION	QTY	ESTIMATE HOURS	ACTUAL HOURS
1 - TT	TEST TECHNICIAN	2	16.0	96

* * * * * * * * * * * * * * MATERIAL REQUIREMENTS * * * * * * * * * * * * * * *

ESTIMATED DATE OF NEED - / /

--REQ'N-- NO.	LN MATERIAL CODE	DESCRIPTION	KEY CODE	S R	UNIT ISS.	QTY RQD	QTY NEEDED	QTY USED	C P

* * * * * * * * * * * * * * * * * WORK DONE * * * * * * * * * * * * * * * * *

WORK STARTED: DATE - 12/13/85 TIME - 14:00.00

WORK DONE.

12-23-85 PERFORMED CLOSING INSPECTION NO FOREIGN MATERIALS NOTED. John P. Arnault

STEP 2 - 12/13/85 PERFORMED TRANSFORMER TURNS RATIO TEST ON ALL TAPS.

STEP 5 - 12/17/85 PERFORMED TRANSFORMER CORE INSULATION RESISTANCE TEST. 10,000 Ω's ALTHOUGH READING IS NOT AS HIGH AS IT COULD BE, SHOP SERVICES & INSTRUMENTATION DIVISION RECOMMENDED TO ACCEPT THE READING, AS THIS CONDITION WILL NOT BE DETRIMENTAL TO THE OPERATION OF THE TRANSFORMER. Gary L. Hoyatt

SCET

FAULT GAS ANALYSIS

SOUTHERN CALIFORNIA EDISON CO.
SHOP & TEST DIVISION
501 S. MARENGO AVE.
ALHAMBRA, CA 91803

12/17/85
1:50 PM.

ATTN:

LOCATION: SONGS #1
BANK & PHASE: "C" BANK AUX
SERIAL NUMBER: RCS22281
MANUFACTURER:

VIA PHONE: STEVE

SAMPLE COLLECTED:
SAMPLE ANALYSED:

PREVIOUS ANALYSIS:
PREVIOUS REPORT No.:

SAMPLE VOLUME:
GAS VOL. @ 25 C:
VOL. % GAS IN OIL:

SAMPLE CONTAINER:
GAS VOLUME @ STP:
OIL TEMPERATURE:

COMPONENT	VOL. % IN OIL
HYDROGEN	.0002
OXYGEN	1.2417
CO2	.0331
ETHYLENE	.0004
ETHANE	0
ACETYLENE	0
NITROGEN	9.0776
METHANE	0
CO	.0006
SUMS:	10.36

COMMENTS:

- [x] ALL GASES ARE WITHIN NORMAL LIMITS
- [ ] POSSIBLE THERMAL DECOMPOSITION OF CELLULOSE
- [ ] POSSIBLE LOW ENERGY SPARK INVOLVING CELLULOSE
- [ ] POSSIBLE LOW ENERGY SPARK NOT INVOLVING CELLULOSE
- [ ] POSSIBLE SEVERE LOCAL OVERHEATING NOT INVOLVING CELLULOSE

OTHER

WATER 6 ppm
IFT 21 dynes/cm
ACID .012 mg KOH/g
COLOR NO. .5

P.C.B. ________ PPM.

TRANSFORMER TEST

AS FOUND

DATE [illegible] TS9 No. [illegible]

P.O. No. ______

KVA 30,000 MAKE WEST CLASS OR TYPE SL-OA FORM NO. ______ SERIAL NO. RCS 2228-1

CYCLES 60 PHASE 3 POLARITY SUB Δ-Δ GALLONS OIL 10046 % IMPEDANCE 60 CYC. 11-11-20? (50 CYC.) ——

HIGH VOLTAGE 241500 - 235750 - 230000 - 224250 - 218500 LOW VOLTAGE 4360 "X" 4360 "Y"

AMPERES 75.3 77.2 AMPERES 1968.3 1968.3

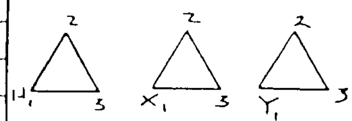
S.C.E. CO. SPEC. NO. ______ WIRING DIAG. ON N.P. ______ BLUE PRINT. TEST NO. ______

FOR OUTDOOR INSTALLATION. METHOD OF COOLING OA MFGR. SPEC. NO. ______ M. S. T. NO. 2596

RATIO AND POLARITY

ADJ. POS.	STRAP CONNECTIONS	TTR No. IE-7164 Test Ratio: H_1 H_2 / X_1 X_2	H_1 H_3 / X_1 X_3	H_2 H_3 / X_2 X_3	Nominal Ratio: HV	LV	Ratio
4	"X" WNDG	51.405	51.390	51.383	224250	4360	51.433
4	"Y" WNDG	51.406	51.384	51.381	224250	4360	51.433

POLARITY DIAGRAM



INIT. R. CRABB

RESISTANCE K = 1.245

WINDING VOLTAGE 22450 MAT'L. COPPER — INSTR. NO. 52-0503 — 14 °C

WINDING VOLTAGE 4360 × 4360 MAT'L. COPPER — INSTR. NO. ______ — 14 °C

CONNECTIONS	READING	K	OHMS	CONNECTIONS	"X" READING	"Y" READING	K	OHMS "X"	OHMS "Y"
H_1 H_2	.1783	20	3.566	X_1 X_2	.0461	.0490	.05	.002305	.002450
H_1 H_3	.1785	20	3.570	X_1 X_3	.0462	.0485	.05	.002310	.002425
H_2 H_3	.1782	20	3.564	X_2 X_3	.0465	.0487	.05	.002325	.002435
			10.700					.00694	.00731
			×1.5					×1.5	×1.5
			16.050					.01041	.010965

RESISTANCE CORRECTED TO 75 °C

INIT. ______

HIGH VOLTAGE WINDING 19.982 (4) OHMS. PHASE AMPS ______ I²R ______

LOW VOLTAGE WINDING X = .01296 Y = .01365 OHMS. PHASE AMPS ______ I²R ______

IMPEDANCE

INSTR. NO.	52-0506		POLYMETER			TEMP. ___ °C		WINDINGS H.V. ___ L.V. ___
% IMP.	VOLTS	K	AMPS. K	E/I	WATTS	K	W/I²	TEST WATTS @ °C
			SEE ATTACHED					I²R WATTS @ °C
			SHEET					STRAY WATTS @ °C
								STRAY WATTS @ °C
								I²R WATTS @ °C
NORMAL								IMP. WATTS @ °C

INSULATION TESTS

MEGOHMMETER 52-0504

INIT. ______

X-Y - 2800	OIL °C	HIGH TO LOW	HIGH TO GROUND	LOW TO GROUND	CORE TO GROUND (OHMS)	OIL TEST
FINAL MEGOHMS	14	1800 - X / 2000 - Y	1800	2400 - X / 2400 - Y	N/A	DOBLE

1 MINUTE READINGS

HIGH POTENTIAL TESTS:
- HIGH TO LOW AND GROUND N/A KV. FOR 1 MINUTE. RESULTS ______
- LOW TO HIGH AND GROUND N/A KV. FOR 1 MINUTE. RESULTS ______

CORE LOSS

INIT. R. CRABB

[illegible] NO. ______ AM NO. ______ WM NO. ______

VOLTS	K	AMPERES			AVG.	K	WATTS	K	% EXC. CUR.
			N/A						

PT NO ______ CT NO ______ INIT. ______

MAKE WEST KVA. 30,000 SERIAL No. RCS 2228-1

	S.C.E. Co. Tests	Mfgr. Certified Test	Mfgr. Guarantee	Remarks
CORE LOSS 100% VOLTAGE				
CORE LOSS 110% "				
% EXCITING CURRENT 100% VOLTAGE				
% EXCITING CURRENT 110% "				
H.V. RESISTANCE @ 75 °C TAP 4	19.982			
L.V. RESISTANCE @ 75 °C X	.01296	.01321		
Y	.01365	.01372		
I²R LOSS HIGH VOLTAGE				
I²R LOSS LOW VOLTAGE				
WATTS EDDY LOSS				
IMPEDANCE WATTS @ °C				
% IMPEDANCE VOLTS				
% REGULATION 100% P. F. FULL LOAD				
% " 80% " " "				
TOTAL LOSSES				
°C RISE-COPPER-HIGH VOLTAGE WINDING				
°C RISE- " -LOW " "				
[N]OISE LEVEL (DECIBELS)				

EFFICIENCIES AT 100% P. F.

% LOAD	25	100
% CORE LOSS		
% IMPEDANCE LOSS		
% TOTAL LOSS		
% EFF. — S.C.E. TESTS		
% EFF. — MFR.'S CERT. TEST		
% EFF. — MFR.'S GUARANTEE		

INSULATION POWER FACTOR

	H TO L-G			LO TO HI-G			H & LO TO G		
	CAPACITANCE (MF)		P.F. (%)	CAPACITANCE (MF)		P.F. (%)	CAPACITANCE (MF)		P.F. (%)
	READ	K=		READ	K=		READ	K=	
DIRECT									
REVERSED									
AVERAGE									

INIT. ______

NO. OF FANS O. VAC.-PRESS. RELIEF DEVICE YES. EMERG. PRESS. RELIEF DEVICE YES

TYPE OF SEAL: SEALED ____ GAS ✓ GAS-OIL ____ BREATHER ____ CONSERV. ____

TEMPERATURE IND. ____ TESTED ____. DRYOUT ____

TAP SETTING LEFT 227250. BUSHING TYPE: H.V. WEST "O" L.V. WEST

TAP CHANGER. HIGH VOLTAGE YES LOW VOLTAGE NO TAP CHGR. CENTERED YES

LOAD RATIO CONTROL. HIGH VOLTAGE NO LOW VOLTAGE NO

SERIES & PARALLEL STRAPS. HIGH VOLTAGE NO LOW VOLTAGE NO

CHECKED FOR OIL LEAKS SHOP GAL. OIL REMOVED NONE

MECHANICAL INSPECTION—VALVES & FITTINGS SHOP

[COR]E REMOVED BY SHOP FOR INSPECTION NO VACUUM FILLED NO

[REM]ARKS AS FOUND TEST

WEIGHTS

CORE & COILS 30500 LBS.

TANK & FITTINGS 52750 LBS.

TANK: OIL 10046 GAL. 75350 LBS.

COMP'T: OIL ____ GAL. ____ LBS.

TOTAL WEIGHT 208600 LBS.

FROM SONGS #1

TO ON SITE

TEST J. O. 6061-9358

DATE 12-11-85

TESTED BY R CRABB

CHECKED 2 Perk

APPROVED ____

DOBLE INSULATION TESTS

MISCELLANEOUS EQUIPMENT

(SPARE BUSHINGS, INSTRUMENT TRANSFORMERS, ETC)

DOBLE ENGINEERING COMPANY
WATERTOWN, MASS
FORM MIE-ME1?K

COMPANY SO CAL EDISON DATE 12-12-85

LOCATION OF TESTS SONGS #1 AIR TEMP. 14°C OIL TEMP. —

EQUIPMENT TESTED LIGHTNING ARRESTORS WEATHER CLEAR % HUM. —

"C" BANK AUX DATE LAST TEST

WEST CPL 3891A18A01 LAST TEST SHEET NO.

COPIES TO

LINE NO	SERIAL NO	TEST KV	EQUIVALENT 10 KV READINGS — AMPERES — METER READING	MULTI-PLIER	AMPERES	WATTS — METER READING	MULTI-PLIER	WATTS	% POWER FACTOR — MEASURED	COR 20°C			INSULATION RATING
1	78M9016	10	29	.01	.29	16	.002	.032					
2	78M9020	10	28.5	.01	.285	16	.002	.032					
3	78M9025	10	29	.01	.29	16	.002	.032					
4													
5													
6													
7													
8													
9													
10													
11													
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28													
29													

REMARKS

KEY TO INSULATION RATING

BUSHINGS, INSULATORS, ETC	WOOD MEMBERS, OIL, ETC	WINDINGS
G-GOOD	KG-GOOD	WG-GOOD
D-DETERIORATED	KD-DETERIORATED	WD-DETERIORATED
I-INVESTIGATE	KI-INVESTIGATE	WI-INVESTIGATE
B-BAD (REMOVE OR RECONDITION)	KB-BAD (REMOVE OR RECONDITION)	WB-BAD (REMOVE OR RECONDITION)

TEST SET NO 52/0522 TEST BY R CLARB CHECKED BY RP SHEET NO

OIL ✓
ASKAREL
AIR
GAS

DOBLE INSULATION TESTS

THREE - WINDING TRANSFORMER

DOBLE ENGINEERING COMPANY
WATERTOWN, MASSACHUSETTS
MH-3W7701

MO 85120824

COMPANY So Cal Edison DIVISION SSD DATE 12-12-85
LOCATION OF TESTS SONGS #1 AIR TEMP. 14°C TOP OIL TEMP 13°C
TRANSFORMER "C" AUX WEATHER CLEAR % HUMIDITY N/A
MFR. WEST SERIAL NO. RCS 2228-1 AGE 1979 TYPE/CLASS OA KVA 30,000
FREE BREATHING ☐ SEALED ☐ GAS BLANKETED ☒ CONSERVATOR ☐ GALLONS OF OIL 10,046

		BUSHINGS	MFR.	TYPE	CLASS	DWG. NO.	CAT. NO.	KV	YEAR
HIGH SIDE KV	230 Y☐ △☒		WEST	"O"	900 BIL	273C717ER3		196	1979
LOW SIDE KV	4.36 Y☐ △☒		WEST					15	1979
TERTIARY KV	4.36 Y☐ △☒		WEST					15	1979
NEUTRAL									

DATE LAST TEST
COPIES TO
LAST SHEET NO.

OVER-ALL TESTS

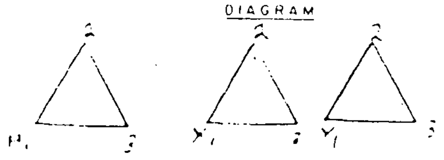
TEST	WINDING ENERGIZED	WINDING GROUNDED	WINDING GUARDED	TEST KV	MILLIAMPERES: METER READING	MILLIAMPERES: MULTIPLIER	MILLIAMPERES	WATTS: METER READING	WATTS: MULTIPLIER	WATTS	% POWER FACTOR K = 1.00: MEASURED	COR. 20°C	KEY TO INSULATION RATING (G = GOOD, D = DETERIORATED, I = INVESTIGATE, B = BAD (REMOVE OR RECONDITION))	INSULATION RATING
1	HIGH	LOW	TERT	10	90	.2	18.0	5.0	.1	.50	.278	.278	4748	
2	HIGH		LOW AND TERT.	10	58	.2	11.6	4.0	.1	.40	.345	.345	C_H 3048	
3	LOW	TERT.	HIGH	10	78	.2	15.6	7.5	.1	.75	.481	.481	4136	
4	LOW		HIGH AND TERT.	10	75	.2	15.0	7.0	.1	.70	.467	.467	C_L 3966	
5	TERT.	HIGH	LOW	10	24	1	24.0	4.5	.2	.90	.375	.375	6270	
6	TERT.		HIGH AND LOW	10	85.5	.2	17.1	7.2	.1	.72	.421	.421	C_T 4530	
7	ALL			10	44	1	44.0	9	.2	1.80	.409	.409	CHECK TEST (SHOULD EQUAL $C_H + C_L + C_T$)	
CALCULATED RESULTS					—	—	6.4	—	—	.10	.156	.156	C_{HL} (TEST 1 MINUS TEST 2) 1670	
					—	—	.6	—	—	.05	.833	.833	C_{LT} (TEST 3 MINUS TEST 4) 170	
					—	—	6.9	—	—	.18	.261	.261	C_{HT} (TEST 5 MINUS TEST 6) 1740	

BUSHING TESTS

	LINE NO.	BUSH NO.	PHASE	BUSHING SERIAL NO.	TEST KV	MILLIAMPERES: METER READING	MILLIAMPERES: MULTIPLIER	MILLIAMPERES	WATTS: METER READING	WATTS: MULTIPLIER	WATTS	% POWER FACTOR K = 1.035: MEASURED	COR. 20°C	COLLAR TESTS (WATTS/CURRENT): Meas. CAP	N/P DATA: % PF	N/P DATA: CAP	INSULATION RATING
HIGH SIDE	1			3	10	71.5	.02	1.43	7.5	.01	.075	.524	.543	376.8	.44	382	
C_1	2			4	10	72	.02	1.44	7.6	.01	.076	.528	.546	379.8	.43	384	
	3			6	10	72	.02	1.44	8.0	.01	.080	.556	.575	379.8	.44	387	
	4	N		3	10	20.2	1	20.2	5.0	.2	1.00	.495	.512	5390		5360	
LOW SIDE	5			4	10	20.5	1	20.5	5.0	.2	1.00	.488	.505	5450		5440	
C_2	6			6	10	21	1	21.0	5.5	.2	1.10	.524	.542	5470		5450	
	7																
	8	N															
TERTIARY	9			C_{HL}	10	63	.1	6.3	6	.02	.12	.190	.190	1667			
	10			C_{HT}	10	66	.1	6.6	6.2	.02	.124	.188	.188	1737			
	11			C_{LT}	10	32.5	.02	.65	6.	.01	.06	.923	.923	171.4			
	12	N															
	13																
	14	OIL SAMPLE			10	87	.01	.87	4	.002	.008	.092	.117	OIL TEMP. 13 °C			

N = NEUTRAL

DIAGRAM



REMARKS

EXCITATION-CURRENT TESTS

SINGLE PHASE

ENERGIZE	UST
H_1	H_2 (or H_0)
H_2 (or H_0)	H_1

THREE-PHASE WYE[1]

ENERGIZE	UST	PHASE
H_1	H_0	A
H_2	H_0	B
H_3	H_0	C

THREE-PHASE DELTA[1] ✓

ENERGIZE	UST	GROUND	PHASE
H_1	H_2	H_3	A
H_2	H_3	H_1	B
H_3	H_1	H_2	C

THREE-PHASE AUTO

ENERGIZE	UST	PHASE
H_1	H_0X_0	A
H_2	H_0X_0	B
H_3	H_0X_0	C

MFR. WEST SERIAL NO. RCS - 2228·1

NLTC POSITION (CHECK): 1(A) LINE 2 2(B) ____ 3(C) ____ 4(D) LINE 1 5(E) ____

TAP CHANGER FOUND/LEFT ON POSITION: A - A

TEST VOLTAGE: 10 kV(2)

LINE NO.	(3) ULTC POSITION	PHASE A METER READING	PHASE A MULTI-PLIER	PHASE A MILLI-AMPERES	PHASE B METER READING	PHASE B MULTI-PLIER	PHASE B MILLI-AMPERES	PHASE C METER READING	PHASE C MULTI-PLIER	PHASE C MILLI-AMPERES	REMARKS
1		29	.1	2.9	86	.1	8.6	83	.1	8.1	
2		26	.1	2.6	65	.1	6.5	68	.1	6.8	
3											
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NOTES:

1. IF THE LOW-VOLTAGE WINDING IS WYE CONNECTED, THEN X_0 IS CONNECTED AS IN SERVICE (USUALLY, THIS WOULD MEAN GROUNDING X_0)

2. ALL TESTS SHOULD BE PERFORMED ROUTINELY AT THE SAME VOLTAGE

ENGINEERING DEPARTMENT

CALCULATION SHEET

SUBJECT: C AUX XFMR IMPEDANCE
RCS 2228-1 RATED TAP "C"

DESIGN CALCULATION NO. DC ______ - ______

J.O. NO. 6061-9358 MADE BY R CRAGG DATE 12-13-85 CHK. BY ______ DATE ______

H1 H2 - X1 X2	E = 486.5	I = .626	%Z = 11.01
H1 H3 - X1 X3	E = 485.2	I = .632	%Z = 10.87
H2 H3 - X2 X3	E = 485.8	I = .631	%Z = 10.91
H2 H3 - Y2 Y3	E = 487.0	I = .630	%Z = 10.95
H1 H3 - Y1 Y3	E = 486.4	I = .630	%Z = 10.94
H1 H2 - Y1 Y2	E = 486.0	I = .620	%Z = 11.11

$$\Delta\ \Delta\ 1\emptyset\ \%Z = \frac{.866\left(\frac{E_T}{I_T} \times \frac{KVA}{KV \times \sqrt{3}}\right)100}{KV}$$

TAP 3 KV = 230000
KVA = 15000 PER WINDING

POLYMETER 520509 DUE 1-5-86
RANGE 1.5 AMPS AND 600 VOLTS

Roger A. Cragg

12-11-85
R. CRABB

ENGINEERING DEPARTMENT

CALCULATION SHEET

SUBJECT: SONGS "C" AUX XFMR TAP #4 IMPEDANCE

DESIGN CALCULATION NO. DC ______ - ______

J.O. NO. 6061-5858 MADE BY ______ DATE ______ CHK. BY ______ DATE ______

$H_1 H_2 - X_1 X_2$	E = 492.8	I = .665	%Z = 11.07
$H_1 H_3 - X_1 X_3$	E = 493.6	I = .672	%Z = 10.95
$H_2 H_3 - X_2 X_3$	E = 492.7	I = .669	%Z = 10.98
$H_2 - H_3 - Y_2 - Y_3$	E = 490.7	I = .664	%Z = 11.02
$H_1 H_3 - Y_1 Y_3$	E = 490.1	I = .664	%Z = 11.01
$H_1 H_2 - Y_1 Y_2$	E = 489.6	I = .653	%Z = 11.18

$$\Delta\ \Delta\ 1\phi\ \%Z = \frac{.866\left(\frac{E_T}{I_T} \times \frac{KVA}{KV\sqrt{3}}\right)100}{KV}$$

TAP 4 KV = 224250
KVA = 15000 PER WINDING (X - Y)

POLYMETER 52-0504 DUE 1-5-86
RANGE 1.5 AMPS AND 600 VOLTS

TRANSFORMER TEST

DATE 12-13-85 T59 No. 6061-9358

P.O. No. ______

KVA 30,000 MAKE WEST CLASS OR TYPE SL FORM No. ______ SERIAL No. RCS 2228-1

CYCLES 60 PHASE 3 POLARITY SUB Δ-Δ-Δ GALLONS OIL 10046 % IMPEDANCE 60 CYC. 11-11-20.9 (50 CYC.) ——

HIGH VOLTAGE 241500 - 235750 - 230000 - 224250 - 218500 LOW VOLTAGE 4360 'X' 4360 'Y'

AMPERES 75.3 AMPERES 1986.3 1986.3

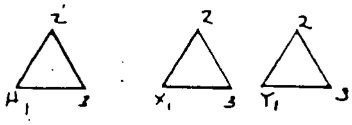
S.C.E. Co. SPEC. No. ______ WIRING DIAG. ON N.P. ______ BLUE PRINT. TEST No. ______

FOR OUTDOOR INSTALLATION. METHOD OF COOLING ______ MFGR. SPEC. No. ______ M. S. T. No. 2596

RATIO AND POLARITY

ADJ. POS.	STRAP CONNECTIONS	TTR No. I2 7164 TEST RATIO H1 X1 H2 X2	H1 X1 H2 X2	H1 X1 H2 X2	NOMINAL RATIO HV	LV	RATIO
1	H-X	55.335	55.297	55.272	241500	4360	55.390
2		54.027	53.990	53.969	235750	4360	54.071
3		52.683	52.646	52.621	2300000	4360	52.752
4		51.379	51.343	51.324	224250	4360	51.334
5		50.075	50.037	50.020	218500	4360	50.115
1	H-Y	55.328	55.291	55.256	241500	4360	55.390

POLARITY DIAGRAM



INIT. RC RABB

K = 1.266 **RESISTANCE**

WINDING VOLTAGE TAP 1 & 3 MAT'L. COPPER — WINDING VOLTAGE ______ MAT'L. ______

INSTR. NO. S2-0503 10 °C — INSTR. NO. ______ °C

CONNECTIONS	READING		K	OHMS		CONNECTIONS	READING	K	OHMS
H1 H2	.1905	.1812	20	3.810	3.624				
H1 H3	.1904	.1811	20	3.808	3.622		SEE TEST		
H2 H3	.1903	.1810	20	3.806	3.620		OF 12-11-85		
				11.424	10.866				
				x1.5	x1.5				
				17.136	16.299				

RESISTANCE CORRECTED TO ______ °C

INIT. ______

HIGH VOLTAGE WINDING 21.694 20.635 OHMS. PHASE AMPS ______ I²R ______

LOW VOLTAGE WINDING ______ OHMS. PHASE AMPS ______ I²R ______

IMPEDANCE

INSTR. No. / % IMP.	VOLTS	K	AMPS. K	E/I	WATTS	TEMP. °C K	W/I²	WINDINGS H.V. ____ L.V. ____
								TEST WATTS @ °C
								I²R WATTS @ °C
								STRAY WATTS @ °C
			SEE	TEST	OF	12-12-85		STRAY WATTS @ °C
								I²R WATTS @ °C
NORMAL								IMP. WATTS @ °C

SEE TEST OF 12-11-85 **INSULATION TESTS**

INIT. ______

	OIL °C	HIGH TO LOW	HIGH TO GROUND	LOW TO GROUND	CORE TO GROUND (OHMS)	OIL TEST
FINAL MEGOHMS						

HIGH POTENTIAL TESTS
- HIGH TO LOW AND GROUND ______ KV. FOR 1 MINUTE. RESULTS ______
- LOW TO HIGH AND GROUND ______ KV. FOR 1 MINUTE. RESULTS ______

CORE LOSS

INIT. ______

VM No. ______ AM No. ______ WM No. ______

VOLTS	K	AMPERES			AVG.	K	WATTS	K	% EXC. CUR.
			N/A						

PT. NO. ______ CT NO. ______ INIT. ______

MAKE WESTINGHOUSE KVA 30,000 SERIAL No. RCS 2228-1

	S.C.E. Co. Tests	Mfgr. Certified Test	Mfgr. Guarantee	Remarks
CORE LOSS 100% VOLTAGE				
CORE LOSS 110% "				
% EXCITING CURRENT 100% VOLTAGE				
% EXCITING CURRENT 110% "				
H.V. RESISTANCE @ 75 °C 1 & 3	21.694 20.635	20.707		
L.V. RESISTANCE @ °C				
I²R LOSS HIGH VOLTAGE				
I²R LOSS LOW VOLTAGE				
WATTS EDDY LOSS				
IMPEDANCE WATTS @ °C				
% IMPEDANCE VOLTS				
% REGULATION 100% P.F. FULL LOAD				
% " 80% " " "				
TOTAL LOSSES				
°C RISE-COPPER-HIGH VOLTAGE WINDING				
°C RISE- " -LOW " "				
OISE LEVEL (DECIBELS)				

EFFICIENCIES AT 100% P.F.

% LOAD	25	100
% CORE LOSS		
% IMPEDANCE LOSS		
% TOTAL LOSS		
% EFF. — S.C.E. TESTS		
% EFF. — MFR.'S CERT. TEST		
% EFF. — MFR.'S GUARANTEE		

INSULATION POWER FACTOR

	H TO L-G			LO TO HI-G			H & LO TO G		
	Capacitance (MF) Read	K=	P.F. (%)	Capacitance (MF) Read	K=	P.F. (%)	Capacitance (MF) Read	K=	P.F. (%)
DIRECT									
REVERSED									
AVERAGE									

INIT.

NO. OF FANS 0 VAC.-PRESS. RELIEF DEVICE YES EMERG. PRESS. RELIEF DEVICE YES

TYPE OF SEAL: SEALED ___ GAS ✓ GAS-OIL ___ BREATHER ___ CONSERV. ___

TEMPERATURE IND. ___ TESTED ___ DRYOUT ___

TAP SETTING LEFT 4 BUSHING TYPE: H.V. WEST "O" L.V. WEST

TAP CHANGER. HIGH VOLTAGE YES LOW VOLTAGE NO TAP CHGR. CENTERED YES

LOAD RATIO CONTROL. HIGH VOLTAGE NO LOW VOLTAGE NO

SERIES & PARALLEL STRAPS. HIGH VOLTAGE NO LOW VOLTAGE NO

CHECKED FOR OIL LEAKS SHOP GAL. OIL REMOVED NONE

MECHANICAL INSPECTION—VALVES & FITTINGS SHOP

ORE REMOVED BY SHOP FOR INSPECTION NO VACUUM FILLED NO.

MARKS PRELIMINARY TEST PRIOR TO WORK / INSPECTION

WEIGHTS

CORE & COILS 80500 LBS.

TANK & FITTINGS 52750 LBS.

TANK: OIL 10046 GAL. 75350 LBS.

COMP'T: OIL ___ GAL. ___ LBS.

TOTAL WEIGHT 20866 LBS.

FROM SONGS #1

TO ON SITE

TEST J. O. 6061-9358

DATE 12-13-85

TESTED BY R CRABB

CHECKED R PECK

APPROVED ___

FORM T 21 ___ CHECKED PRINT ___ OD 236 ___

Aux 'C'

SCET 32201

FAULT GAS ANALYSIS

SOUTHERN CALIFORNIA EDISON CO.
SHOP & TEST DIVISION
501 S. MARENGO AVE.
ALHAMBRA, CA 91803

ATTN: ROBERT PECK

LOCATION: [redacted]
BANK & PHASE: 1 WEST TX C AUX.
SERIAL NUMBER: RCS-2228-1 PH.3
MANUFACTURER:

SAMPLE COLLECTED: 29 DEC 85
SAMPLE ANALYSED: [redacted]

PREVIOUS ANALYSIS: 17 DEC 85
PREVIOUS REPORT No.: 31875

SAMPLE VOLUME: 55.7 ml
GAS VOL. @ 21.5 C: 1.8 ml
VOL. % GAS IN OIL: 4.34 ml

SAMPLE CONTAINER: 179
GAS VOLUME @ STP: 2.42 ml
OIL TEMPERATURE: 17

COMPONENT	PEAK AREA	VOL. % IN OIL	VOL. % IN GAS
YDROGEN		0.0001	0.0014
OXYGEN	948.0	0.9418	21.6972
CO2	6.5	0.0052	0.1205
ETHYLENE	0.0	0.0000	0.0000
ETHANE	0.0	0.0000	0.0000
ACETYLENE	0.0	0.0000	0.0000
NITROGEN	3590.0	3.3933	78.1739
METHANE	0.2	0.0002	0.0049
CO	0.1	0.0001	0.0021
SUMS:		4.34	100.00

COMMENTS:

ALL GASES ARE WITHIN NORMAL LIMITS

[illegible]TER	12	ppm
[illegible]	41	dynes/cm
[illegible]ID	.012	mg KOH/g
COLOR NO.	L0.5	

AUX "C"

TRANSFORMER TEST

DATE 12-29-85 TSO No. 6061-9358

P.O. No.

30000 @ 55° Rise
33600 @ 65° Rise
KVA. MAKE West. CLASS OR TYPE SL OA FORM No. SERIAL No. RCS-2228-1

CYCLES 60 PHASE 3 POLARITY △ △ △ GALLONS OIL 10046 % IMPEDANCE 60 CYC. 11.0 (50 CYC.)

HIGH VOLTAGE 241500/235750/230000/224250/218500 LOW VOLTAGE X wdg. 4360 // Y wdg. 4360

AMPERES 71.72 / 73.47 / 75.31 / 77.24 / 79.27 AMPERES 1986.3 @ 15MVA // 1986.3 @ 15MVA

S.C.E. Co. SPEC. No. WIRING DIAG. ON N.P. yes BLUE PRINT. TEST No. N.P.

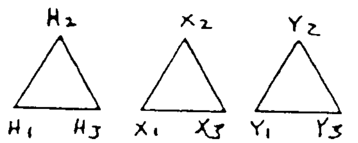
FOR INSTALLATION. METHOD OF COOLING OA MFGR. SPEC. No. M. S. T. No. 2596

RATIO AND POLARITY

TTR No. S2-0505 TEST RATIO

ADJ. POS.	STRAP CONNECTIONS	H1-H2 / X1-X2	H2-H3 / X2-X3	H3-H1 / X3-X1	NOMINAL RATIO HV	LV	RATIO
1	H-X	55.351	55.287	55.319	241500	4360	55.390
2		54.046	53.986	54.010	235750	4360	54.071
3		52.696	52.639	52.666	230000	4360	52.752
* 4		51.394	51.333	51.364	224250	4360	51.433
5		50.091	50.034	50.060	218500	4360	50.115
1	H-Y	55.352	55.282	55.314	241500	4360	55.390

POLARITY DIAGRAM



* Found & left on Tap 4

INIT. GF/WL

RESISTANCE

WINDING VOLTAGE All HV Taps MAT'L. Cu.
INSTR. NO. S2-0503 K 1.226 18 °C

CONNECTIONS Tap.	READING H1-H2	H2-H3	H3-H1	K	OHMS H1-H2	H2-H3	H3-H1
1	.1961	.1960	.1961	20	3.922	3.920	3.922
2	.1916	.1912	.1916	20	3.832	3.824	3.832
3	.1868	.1866	.1868	20	3.736	3.732	3.736
4	.1821	.1820	.1821	20	3.642	3.640	3.642
5	.1778	.1775	.1778	20	3.556	3.550	3.556

WINDING VOLTAGE 4360//4360 MAT'L. Cu.
INSTR. NO. S2-0503 K 1.231 17 °C

CONNECTIONS	READING	K	OHMS
X1-X2	.0471	.05	.002355
X2-X3	.0478	.05	.002390
X3-X1	.0470	.05	.002350
Y1-Y2	.0501	.05	.002505
Y2-Y3	.0500	.05	.002500
Y3-Y1	.0502	.05	.002510

INIT. GF/WL

RESISTANCE CORRECTED TO 75 °C

HIGH VOLTAGE WINDING (1) 21.6340 (3) 20.6042 OHMS. PHASE AMPS 43.48 I²R 38952

LOW VOLTAGE WINDING X .0131009 Y .0138764 OHMS. PHASE AMPS X 1146.8 Y 1146.8 I²R 17230 + 18250

IMPEDANCE

WINDINGS

INSTR. No.						TEMP. °C		H.V. L.V.
% IMP.	VOLTS	K	AMPS. K	E/I	WATTS	K	W/I²	TEST WATTS @ °C
								I²R WATTS @ °C
			No Test					STRAY WATTS @ °C
								STRAY WATTS @ °C
								I²R WATTS @ 75 °C 74432
NORMAL		-	See Test of	12-13-85				IMP. WATTS @ °C

INSULATION TESTS

INIT.

S2-0504

	OIL °C	~~HIGH TO LOW~~ H To X Y & GRD.	~~HIGH TO GROUND~~ X To H X & GRD.	~~LOW TO GROUND~~ Y To H X & GRD.	CORE TO GROUND (OHMS)	OIL TEST
FINAL MEGOHMS	17	3200	1680	1440	No Test	Doble & DGA

HIGH POTENTIAL TESTS { HIGH TO LOW AND GROUND No Test KV. FOR 1 MINUTE. RESULTS NA
LOW TO HIGH AND GROUND KV. FOR 1 MINUTE. RESULTS NA

INIT. GF/WL

CORE LOSS

VM No. AM No. WM No.

VOLTS	K	AMPERES			AVG.	K	WATTS	K	% EXC. CUR.
	No Test								

MAKE Westinghouse

KVA 33600 @ 65° Rise

SERIAL NO. RCS-2228-1

	S.C.E. CO. TESTS	MFGR. CERTIFIED TEST	MFGR. GUARANTEE	REMARKS
ORE LOSS 100% VOLTAGE		34116		
CORE LOSS 110% "	NA	47879		
% EXCITING CURRENT 100% VOLTAGE		.2792		
% EXCITING CURRENT 110% "		.3220		
H.V. RESISTANCE @ 75 °C	1 21.6340 3 20.6042	(3) 20.70703	NA	NA
L.V. RESISTANCE @ 75 °C	X .0131009 Y .0138764	X .01308 Y .01372		
I²R LOSS HIGH VOLTAGE	38952	39147		
I²R LOSS LOW VOLTAGE	X 17230 Y 18250	17202 18044		
WATTS EDDY LOSS	NA	26706		
IMPEDANCE WATTS @ 75 °C		101099		
% IMPEDANCE VOLTS	See Test of 12-12-85	H-X 10.96 H-Y 11.04 H-X+Y 11.65		
% REGULATION 100% P.F. FULL LOAD		.7760		
% " 80% " " "	NA	7.0907		
TOTAL LOSSES		135215		
°C RISE-COPPER-HIGH VOLTAGE WINDING		51.1		
RISE- " -LOW " "		X 61.2 Y 55.7		
SE LEVEL (DECIBELS)		62.1		

EFFICIENCIES AT 100% P.F.		
% LOAD	25	100
% CORE LOSS	NA	
% IMPEDANCE LOSS		
% TOTAL LOSS		
% EFF. — S.C.E. TESTS		
% EFF. — MFR.'S CERT. TEST	99.5065	99.7123
% EFF. — MFR.'S GUARANTEE		

INSULATION POWER FACTOR

	H TO L-G Capacitance (MF) Read	K—	P.F. (%)	LO TO HI-G Capacitance (MF) Read	K—	P.F. (%)	H & LO TO G Capacitance (MF) Read	K—	P.F. (%)
DIRECT				See	Doble				
REVERSED				Test					
AVERAGE									

NO. OF FANS None VAC.-PRESS. RELIEF DEVICE yes EMERG. PRESS. RELIEF DEVICE yes

TYPE OF SEAL: SEALED ✓ GAS ✓ GAS-OIL ___ BREATHER ___ CONSERV. ___

TEMPERATURE IND. 4ea Qualitrol TESTED yes DRYOUT NO

TAP SETTING LEFT 224250 BUSHING TYPE: H.V. West. Type O. L.V. West Type RJ

TAP CHANGER. HIGH VOLTAGE yes LOW VOLTAGE None TAP CHGR. CENTERED OK

LOAD RATIO CONTROL. HIGH VOLTAGE None LOW VOLTAGE None

SERIES & PARALLEL STRAPS. HIGH VOLTAGE None LOW VOLTAGE None

CHECKED FOR OIL LEAKS SSID GAL. OIL REMOVED all

MECHANICAL INSPECTION—VALVES & FITTINGS SSID

EMOVED BY SHOP FOR INSPECTION internal VACUUM FILLED yes

REMARKS Final Test made after internal inspection and filling.

Instruments: S2-0503 Bridge Cal. due 1-24-86
S2-0504 Megger Cal. due 1-5-86
~~S2-0505 TTR Cal. due 6-24-86~~

WEIGHTS

INIT. ___

CORE & COILS 80500 LBS.

TANK & FITTINGS 52750 LBS.

TANK: OIL 10046 GAL 75350 LBS.

COMPT: OIL ___ GAL ___ LBS.

TOTAL WEIGHT 20866 LBS.

FROM SONGS 1 "C" Aux.

TO Same

TEST J.O. 6061-9358

DATE 12-29-85

TESTED BY G.F./WL

CHECKED ___

APPROVED ___

GF/WL

EXCITATION - CURRENT TESTS

SINGLE PHASE

ENERGIZE	UST
H_1	H_2 (or H_0)
H_2 (or H_0)	H_1

THREE-PHASE WYE(1)

ENERGIZE	UST	PHASE
H_1	H_0	A
H_2	H_0	B
H_3	H_0	C

THREE-PHASE DELTA(1) ✓

ENERGIZE	UST	GROUND	PHASE
H_1	H_2	H_3	A
H_2	H_3	H_1	B
H_3	H_1	H_2	C

THREE-PHASE AUTO

ENERGIZE	UST	PHASE
H_1	H_0X_0	A
H_2	H_0X_0	B
H_3	H_0X_0	C

MFR. Westinghouse SERIAL NO. RCS-2228-1

SONGS Unit 1

"C" Aux. Bank

NLTC POSITION (CHECK): 1(A) ✓ 24/500 2(B) ____ 3(C) ____ 4(D) ____ 5(E) ____

TAP CHANGER FOUND/LEFT ON POSITION: 224250/224250

TEST VOLTAGE: 10 kV(2)

LINE NO.	(3) ULTC POSITION	PHASE A METER READING	PHASE A MULTI-PLIER	PHASE A MILLI-AMPERES	PHASE B METER READING	PHASE B MULTI-PLIER	PHASE B MILLI-AMPERES	PHASE C METER READING	PHASE C MULTI-PLIER	PHASE C MILLI-AMPERES	REMARKS
1	None	24.2	.1	2.42	43.6	.1	4.36	45.8	.1	4.58	
2											
3											
4											
5											
6											
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NOTES:

1. IF THE LOW-VOLTAGE WINDING IS WYE CONNECTED, THEN X_0 IS CONNECTED AS IN SERVICE (USUALLY, THIS WOULD MEAN GROUNDING X_0).
2. ALL TESTS SHOULD BE PERFORMED ROUTINELY AT THE SAME VOLTAGE

OIL ☑ ASKAREL ☐ AIR ☐ GAS ☐

DOBLE INSULATION TESTS

THREE - WINDING TRANSFORMER

DOBLE ENGINEERING COMPANY
WATERTOWN, MASSACHUSETTS
MH-3W7701

COMPANY Southern California Edison DIVISION SSID Alhambra DATE 12-29-85

LOCATION OF TESTS SONGS Unit 1 AIR TEMP. 21.5°c TOP OIL TEMP 18°c

TRANSFORMER "C" Aux. Bank (Reserve) WEATHER * See Remarks HUMIDITY High

MFR. West. SERIAL NO. RCS-2228-1 AGE 1979 TYPE/CLASS SL OA KVA 30000 @ 55° Rise / 33600 @ 65° Rise

FREE BREATHING ☐ SEALED ☑ GAS BLANKETED ☑ CONSERVATOR ☐ GALLONS OF OIL 10046

		BUSHINGS MFR.	TYPE	S.O.# ~~CLASS~~	DWG. NO.	CAT. NO.	KV	YEAR
HIGH SIDE KV 230	Y☐ △☑	West.	O	RCS2228	273C717G03		196	1979
LOW SIDE KV 4.36	Y☐ △☑	West.	XFMR				15	1979
TERTIARY KV 4.36	Y☐ △☑	West.	XFMR				15	1979
NEUTRAL								

DATE LAST TEST

COPIES TO

LAST SHEET NO.

OVER-ALL TESTS

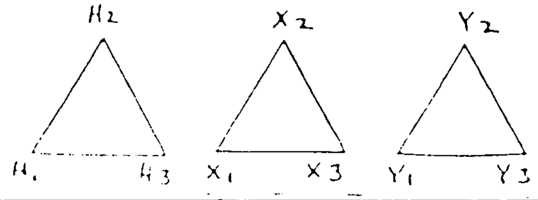
TEST	WINDING ENERGIZED	WINDING GROUNDED	WINDING GUARDED	TEST KV	MILLIAMPERES METER READING	MILLIAMPERES MULTIPLIER	MILLI-AMPERES	WATTS METER READING	WATTS MULTIPLIER	WATTS	% POWER FACTOR K 1.00 MEASURED	COR. 20°C	KEY TO INSULATION RATING (G = GOOD, D = DETERIORATED, I = INVESTIGATE, B = BAD (REMOVE OR RECONDITION))	INSULATION RATING
1	HIGH	LOW	TERT.	10	89.5	.2	17.90	4.8	.1	.48	~~.268~~	~~.268~~	4758 Pfd.	
2	HIGH		LOW AND TERT.	10	58.2	.2	11.64	3.5	.1	.35	.301	.301	C_H 3098 Pfd.	
3	LOW	TERT.	HIGH	5	78.25	.2	15.65	12.7	.1	1.27	~~.812~~	~~.812~~	4160 Pfd.	
4	LOW		HIGH AND TERT.	5	75.2	.2	15.04	12.1	.1	1.21	.805	.805	C_L 3988 Pfd.	
5	TERT.	HIGH	LOW	5	23.7	1	23.7	5.7	.2	1.14	~~.481~~	~~.481~~	6275 Pfd.	
6	TERT.		HIGH AND LOW	5	85.7	.2	17.14	9.4	.1	.94	.548	.548	C_T 4544 Pfd.	
7	ALL			5	4385	1	43.85	14.3	.2	2.86	~~.652~~	~~.652~~	CHECK TEST (SHOULD EQUAL $C_H + C_L + C_T$) 11675	
CALCULATED RESULTS					— —	— —	6.26	— —	— —	.13	.208	.208	C_{HL} (TEST 1 MINUS TEST 2) 1660	
					— —	— —	.61	— —	— —	.06	.984	.984	C_{LT} (TEST 3 MINUS TEST 4) 172	
* Measurod results below					— —	— —	6.56	— —	— —	.20	.305	.305	C_{HT} (TEST 5 MINUS TEST 6) 1731	

BUSHING TESTS

LINE NO.		BUSH NO.	PHASE	BUSHING SERIAL NO.	TEST KV	Milli ~~MICRO~~AMPERES Milli METER READING	MULTIPLIER	~~MICRO~~-AMPERES	WATTS METER READING	MULTIPLIER	WATTS	% POWER FACTOR K 1.00 MEASURED	COR. 20°C	COLLAR TESTS (WATTS/CURRENT) C Read TOP	Name Plate C1	%PF	INSULATION RATING
HIGH SIDE	1	H1		3	10	71.65	.02	1.433	7.0	.01	.070	.488	.488	379	382	.44	
	2	H2		4	10	71.6	.02	1.432	6.85	.01	.0685	.478	.478	381	384	.43	
	3	H3		6	10	72.1	.02	1.442	7.2	.01	.072	.499	.499	382	387	.44	
	4	N															
LOW SIDE	5																
	6																
	7																
	8	N															
* Measurod TEST	9			CHL	10	62.7	.1	6.27	6.95	.02	.139	.222	.222	1666 Pfd.			
	10			CLT	5	65.2	.01	.652	32.4	.002	.0648	.994	.994	172.7 Pfd.			
	11			CHT	10	65.4	.1	6.54	7.1	.02	.142	.217	.217	1735 Pfd.			
	12	N															
	13																
	14	OIL SAMPLE			10	86.2	.01	.862	2.25	.002	.0045	.0522	.0585	OIL TEMP 17 °C K 1.12			

N - NEUTRAL

DIAGRAM



REMARKS: * Occassional light rain during Test.

No Test were made on low voltage or Tertiary voltage bushings.

Thermometer I2-9807

DATA RECORD

6.7.3.4 and 6.7.4.3

Date 2-10-86

Rate of Rise: 2 kV/Min Routine Test ✓, Special Test ______

TIME	A Phase			B Phase			C Phase		
(Minutes)	kV	uA	REMARKS	kV	uA	REMARKS	kV	uA	REMARKS
1/2	9	.1		9	.1		9	.1	
1	9	.1		9	.1		9	.1	
2	11	.1		11	.1		11	.1	
3	13	.1		13	.1		13	.1	
4	15	.1	PI=	15	.1	PI=	15	.1	PI=
5	17	.1		17	.1		17	.1	
6	19	.1		19	.1		19	.1	
7	21	.1		21	.1		21	.1	
8	23	.1		23	.1		23	.1	
9	25	.1		25	.1		25	.1	
10	27	.1		27	.1		27	.1	
11	28	.2		28	.2		28	.1	
12	}	.1		}	.1		}	.1	
13	}	.1		}	.1		}	.1	
14	}	.1		}	.1		}	.1	
15	}	.1		}	.1		}	.1	
22									
23									
24									
25									
26									
27									
28									
29									
30									
31									
32									

MO# 86020871001

CHARGING PUMP 'A'

DATA RECORD

.4 and 6.7.4.3

Date 2-10-86

te of Rise: 2 kV/Min Routine Test ✓, Special Test ______

TIME	A Phase			B Phase			C Phase		
(Minutes)	kV	uA	REMARKS	kV	uA	REMARKS	kV	uA	REMARKS
1/2	9	.1		9	.1		9	.1	
1	9	.1		9	.1		9	.1	
2	11	.1		11	.1		11	.1	
3	13	.1		13	.1		13	.1	
4	15	.1	PI=	15	.1	PI=	15	.1	PI=
5	17	.1		17	.1		17	.1	
6	19	.1		19	.1		19	.1	
7	21	.1		21	.1		21	.1	
8	23	.1		23	.1		23	.1	
9	25	.1		25	.1		25	.1	
10	27	.1		27	.1		27	.1	
11	28	.2		28	.2		28	.1	
12		.1			.1			.1	
13		.1			.1			.1	
14		.1			.1			.1	
15		.1			.1			.1	
22									
23									
24									
25									
26									
27									
28									
29									
30									
31									
32									

MO# 8602087I001

CHARGING PUMP B

DATA RECORD

6.7.3.4 and 6.7.4.3 Date 2-26-86

Rate of Rise: 2 kV/Min Routine Test X, Special Test ______

TIME	A Phase			B Phase			C Phase		
(Minutes)	kV	uA	REMARKS	kV	uA	REMARKS	kV	uA	REMARKS
1/2	9	.2		9	.1		9	.2	
1	9	.2		9	.1		9	.2	
2	11	.2		11	.1		11	.2	
3 ~~5~~	13	.2		13	.1		13	.2	
4 ~~10~~	15	.2	PI=	15	.1	PI=	15	.2	PI=
5 ~~11~~	17	.2		17	.1		17	.2	
6 ~~12~~	19	.2		19	.1		19	.2	
7 ~~13~~	21	.2		21	.1		21	.2	
8 ~~14~~	23	.2		23	.2		23	.2	
9 ~~15~~	25	.2		25	.2		25	.2	
10 ~~16~~	27	.2		27	.2		27	.2	
11 ~~17~~	28	.2		28	.2		28	.4	
12 ~~18~~		.2			.2			.4	
13 ~~19~~		.2			.2			.4	
14 20		.2			.2			.4	
15 21		.2			.2			.4	
22									
23									
24									
25									
26									
27									
28									
29									
30									
31									
32									

86020868
FEEDWATER PP A

DATA RECORD

Date 2-17-86

6.7.3.4 and 6.7.4.3

Rate of Rise: 2 kV/Min Routine Test ✓, Special Test ______

TIME	A Phase			B Phase			C Phase		
(Minutes)	kV	uA	REMARKS	kV	uA	REMARKS	kV	uA	REMARKS
1/2	9	1.1		9	6		9	.5	
1	9	1.2		9	6		9	.5	
2	11	1.5		11	7		11	.7	
3 5	13	1.8		13	9.5		13	.7	
4 10	15	3.2	PI=	15	10	PI=	15	.8	PI=
5 11	17	3.7		17	12		17	1	
6 12	19	6		19	20		19	1.6	
7 13	21	8		21	19		21	1.7	
8 14	23	6		23	20		23	2.1	
9 15	25	7		25	32		25	2.4	
10 16	27	9		27	23		27	2.9	
11 17	28	13		28	33		28	3.1	
12 18	28	12			30			3.2	
13 19	28	13			29			3.2	
14 20	28	13			30			3.2	
15 21	28	15			30			3.2	
22									
23									
24									
25									
26									
27									
28									
29									
30									
31									
32									

MO # 86020851

FEEDWATER PP B

DATA RECORD

SST #1

Date 2-22-86

6.7.3.4 and 6.7.4.3

Rate of Rise: 2 kV/Min Routine Test ✓, Special Test ______

TIME (Minutes)	A BC A Phase kV	uA	REMARKS	B Phase kV	uA	REMARKS	C Phase kV	uA	REMARKS
1/2	9	.3							
1	9	.3							
2	11	.3							
5 3	13	.3				PI=			PI=
10 4	15	.4	PI=						
11 5	17	.4							
12 6	19	.4							
13 7	21	.5							
14 8	23	.5							
15 9	25	.5							
16 10	27	.6							
17 11	29	.6							
18 12		.6							
19 13		.6							
20 14		.6							
21 15		.6							
22									
23									
24									
25									
26									
27									
28									
29									
30									
31									
32									

NOTE: SINCE CABLES ARE SHIELDED TEST WAS MADE W/3 1/C CABLES TIED TOGETHER AT EACH END W/SHIELDING GROUNDED - [signature]

8602084I

DATA RECORD

SST #2

6.7.3.4 and 6.7.4.3

Date 2/05/86

Rate of Rise: 2 kV/Min Routine Test ✓, Special Test ________

TIME	A Phase			B Phase			C Phase		
(Minutes)	kV	uA	REMARKS	kV	uA	REMARKS	kV	uA	REMARKS
1/2	9	.2		9	.1		9	.2	
1	9	.2		9	.1		9	.2	
2	11	.2		11	.1		11	.2	
3 ~~5~~	15	.2		15	.1		13	.2	
4 ~~10~~	15	.2	PI=	15	.1	PI=	15	.2	PI=
5 ~~11~~	17	.2		17	.2		17	.2	
6 ~~12~~	19	.2		19	.2		19	.2	
7 ~~13~~	21	.2		21	.2		21	.2	
8 ~~14~~	23	.2		23	.2		23	.2	
9 ~~15~~	25	.2		25	.2		25	.2	
10 ~~16~~	27	.2		27	.2		27	.2	
11 ~~17~~	28	.2		28	.2		28	.2	
12 ~~18~~		.2			.2			.2	
13 ~~19~~		.2			.2			.2	
14 ~~20~~		.2			.2			.2	
15 ~~21~~		.2			.2			.2	
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MO # 86020877

SST#3 (NORMAL)

DATA RECORD

6.7.3.4 and 6.7.4.3 **Date** 5-1-86

Rate of Rise: 2 **kV/Min** **Routine Test** X**, Special Test** ______

TIME	A Phase			B Phase			C Phase		
(Minutes)	kV	uA	REMARKS	kV	uA	REMARKS	kV	uA	REMARKS
1/2	9	.2		9	.1		9	.1	
1	9	.2		9	.1		9	.2	
2	11	.2		11	.1		11	.2	
~~5~~ 3	13	.2		13	.1		13	.3	
~~10~~ 4	15	.2	PI=	15	.1	PI=	15	.3	PI=
~~11~~ 5	17	.2		17	.1		17	.3	
~~12~~ 6	19	.2		19	.1		19	.4	
~~13~~ 7	21	.2		21	.2		21	.4	
~~14~~ 8	23	.2		23	.2		23	.4	
~~15~~ 9	25	.2		25	.2		25	.4	
~~16~~ 10	27	.2		27	.2		27	.4	
~~17~~ 11	28	.2		28	.3		28	.4	
~~18~~ 12		.2			.3			.4	
~~19~~ 13		.2			.3			.4	
~~20~~ 14		.2			.3			.4	
~~21~~ 15		.2			.3			.4	
22									
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32									

MO # 86020840

DATA RECORD

6.7.3.4 and 6.7.4.3 SST #3 (Alternate)-X08 Date 3-1-86

Rate of Rise: 2 kV/Min Routine Test X, Special Test ______

TIME	A Phase			B Phase			C Phase		
(Minutes)	kV	uA	REMARKS	kV	uA	REMARKS	kV	uA	REMARKS
1/2	9	.3		9	.1		9	.2	
1	9	.3		9	.1		9	.2	
2	11	.2		11	.1		11	.2	
~~5~~ 3	13	.2		13	.1		13	.2	
~~10~~ 4	15	.2	PI=	15	.2	PI=	15	.2	PI=
~~11~~ 5	17	.2		17	.2		17	.2	
~~12~~ 6	19	.2		19	.2		19	.2	
~~13~~ 7	21	.2		21	.2		21	.2	
~~14~~ 8	23	.2		23	.2		23	.2	
~~15~~ 9	25	.2		25	.2		25	.2	
~~16~~ 10	27	.3		27	.2		27	.2	
~~17~~ 11	28	.3		28	.2		28	.2	
~~18~~ 12		.3			.2			.2	
~~19~~ 13		.3			.2			.2	
~~20~~ 14		.3			.2			.2	
~~21~~ 15		.3			.2			.2	
22									
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32									

MO # 86020878

MO # 86020836

DATA RECORD

DG # 1

6.7.3.4 and 6.7.4.3

Date 2-11-86

Rate of Rise: 2 kV/Min Routine Test ✓, Special Test ________

TIME	A-B-C Φ'S ~~A Phase~~ 2-11-86			B Phase			C Phase		
(Minutes)	kV	uA	REMARKS	kV	uA	REMARKS	kV	uA	REMARKS
1/2	9	.001							
1	9	.001							
2	11	.001							
~~5~~ 3	13	.04							
~~10~~ 4	15	.04	PI=			PI=			PI=
~~11~~ 5	17	.04							
~~12~~ 6	19	.04							
~~13~~ 7	21	.04							
~~14~~ 8	23	.04							
~~15~~ 9	25	.05							
~~16~~ 10	27	.05							
~~17~~ 11	29	.03							
~~18~~ 12	29	.03							
~~19~~ 13	29	.03							
~~20~~ 14	29	.03							
~~21~~ 15	29	.03							
22									
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NOTE: TEST MADE W/12 1/C CABLES TIED TOGETHER IN 4KV CABINET 11C14.

BRIDGE READINGS SHIELD TO GROUND.

CONDUIT #1. AΦ 1.168Ω BΦ 1.078Ω CΦ 1.072Ω

#2. AΦ 1.215Ω BΦ 1.263Ω CΦ 1.269Ω

#3. AΦ 1.056Ω BΦ 1.246Ω CΦ 1.098Ω

#4. AΦ 1.166Ω BΦ 1.027Ω CΦ 1.019Ω

} 4KV Rm TO J.E # 717F IN DG #1

DATA RECORD

DG#2 MO#8602 ~~8830~~ 0882

6.7.3.4 and 6.7.4.3

Date 3-5-86

Rate of Rise: 2 kV/Min Routine Test X, Special Test ____

4KV RM TO JUNCTION BOX PB931G. GENERATOR TO JUNCTION BOX

TIME (Minutes)	A&B&C Phase kV	uA	REMARKS	B Phase kV	uA	REMARKS	A&B&C Phase kV	uA	REMARKS
1/2	9	50.							
1	9	50.					9	1.5	
2	11	50.					9	1.5	
~~5~~ 3	13	50.					11	1.7	
~~10~~ 4	15	50.	PI=				13	2.5	
~~11~~ 5	17	50.				PI=	15	3.7	PI=
~~12~~ 6	19	50					17	4.2	
~~13~~ 7	21	50.					19	.70	
~~14~~ 8	25	50.					21	.70	
~~15~~ 9	25	50.					23	.90	
~~16~~ 10	27	50.					25	12.	
~~17~~ 11	29	50.					27	14.	
~~18~~ 12		50.					29	15.	
~~19~~ 13		30.						19.	
~~20~~ 14		30.						20.	
21 15		30.						20.	
22								20.	
23									
24									
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30									
31									
32									

BRIDGE READINGS

CABLE #1.	A. 1.408 Ω	B. 1.345 Ω	C. 1.311 Ω	4KV ROOM TO JUNCTION BOX
CABLE #2.	A. 1.380	B. 1.238	C. 1.405	
CABLE #3	A. 1.220	B 1.374	C 1.356	
CABLE #4	A. 1.394	B 1.385	C. 1.280	

CABLE # 1.	A. .053 Ω	B. .050 Ω	C. .051 Ω	JUNCTION BOX TO GENERATOR
CABLE #2	A. .052 Ω	B. .053 Ω	C. .055 Ω	
CABLE #2	A .052 Ω	B. .051 Ω	C. .048 Ω	

NUCLEAR GENERATING SITE
UNITS 1, 2 AND 3

DATA RECORD

SI PUMP 650 A

6.7.3.4 and 6.7.4.3

Date 2-26-86

Rate of Rise: 2 kV/Min Routine Test ✓, Special Test ______

TIME	A Phase			B Phase			C Phase		
(Minutes)	kV	uA	REMARKS	kV	uA	REMARKS	kV	uA	REMARKS
1/2	9	.2		9	.1		9	.2	
1	9	.2		9	.2		9	.2	
2	11	.2		11	.2		11	.2	
5 3	13	.2		13	.2		13	.2	
10 4	15	.2	PI=	15	.2	PI=	15	.2	PI=
11 5	17	.2		17	.2		17	.2	
12 6	19	.2		19	.2		19	.2	
13 7	21	.2		21	.2		21	.2	
14 8	23	.3		23	.2		23	.2	
15 9	25	.3		25	.2		25	.2	
16 10	27	.3		27	.2		27	.2	
17 11	28	.3		28	.2		28	.2	
18 12		.3			.2			.2	
19 13		.3			.2			.2	
20 14		.3			.2			.2	
21 15		.3			.2			.2	
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M.O. # 86020869

DATA RECORD

6.7.3.4 and 6.7.4.3 S.I. PUMP G50'B'

Date 2-26-86

Rate of Rise: 2 kV/Min Routine Test ✓, Special Test ______

TIME (Minutes)	A Phase kV	A Phase uA	A Phase REMARKS	B Phase kV	B Phase uA	B Phase REMARKS	C Phase kV	C Phase uA	C Phase REMARKS
1/2	9	.2		9	.2		9	.2	
1	9	.2		9	.2		9	.2	
2	11	.2		11	.2		11	.2	
5 3	13	.2		13	.2		13	.2	
10 4	15	.2	PI=	15	.2	PI=	15	.2	PI=
11 5	17	.2		17	.2		17	.2	
12 6	19	.2		19	.2		19	.2	
13 7	21	.2		21	.2		21	.2	
14 8	23	.2		23	.2		23	.2	
15 9	25	.2		25	.2		25	.2	
16 10	27	.2		27	.2		27	.2	
17 11	28	.2		28	.2		28	.2	
18 12		.2			.2			.2	
19 13		.2			.2			.2	
20 14		.2			.2			.2	
21 15		.2			.2			.2	
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MO # 86020848

QUESTION NO. 11

What type of 4160V cable was used for replacement of old cable? Provide information or cable type and materials. What type of testing was performed on the new cable before it is energized?

RESPONSE

The A, B and C transformer replacement feeder cable is 5kV shielded 3 conductor copper 750 or 500 kcmil, with Kerite HTR insulation, aluminum interlocked armor, and a flame-retardant jacket manufactured by Kerite Company (Nos. E1795 and E2058) meeting IEEE 383 (Vertical Tray Flame Test).

The charging pump replacement cable is Anaconda, 8kV shielded 3 conductor copper, 250 kcmil, with ethylene propolene insulation, and a shielded hypalon jacket meeting IEEE 383 (Vertical Tray Flame Test).

All replacement cable is DC overvoltage tested at 36kV in accordance with Station Procedure S0123-II-11.153 prior to being placed in service (in addition to the extensive in-process and product testing conducted by the manufacturers).

QUESTION NO. 12

Provide information on the systematic method for monitoring selected electrical circuits for establishment of a surveillance program as noted in your report, (i.e. EG&G ECCAD system). Does SCE company have in place any other testing program for monitoring cable (and other electrical equipment) integrity over time?

RESPONSE

The method for monitoring selected electrical circuits as described in the April 8, 1986 report utilizes the Electrical Circuit Characterization and Diagnostic (ECCAD) system. The ECCAD System was developed by EG&G Idaho for performing in-situ testing of circuits and is based on an extension of Time Domain Reflectometry (TDR) technology. By imputing a series of short low-voltage pulses into a circuit, ECCAD measures the characteristics of the reflected signal(s) due to impedances in the circuit. The reflected wave forms can be plotted and analyzed for an indication of a circuit's integrity. By comparing baseline plots to subsequent plots, an indication of circuit degradation over time can be interpreted.

SCE has undertaken an effort to acquire a set of baseline plots for selected electric circuits during the current outage. This sample set includes selected instrumentation, 480V, and 4kV circuits. This is being performed as a research and development effort at this time to assess whether or not the TDR technology can produce consistent data that would give an indication of long term circuit condition.

If, as future plots are obtained and analyzed, it is determined that the collected data is credible and meaningful, the usefulness of a long-term surveillance program will be assessed and implemented as appropriate. A systematic selection of a larger sample set will also be evaluated at that time.

SCE Company's testing program for monitoring integrity of electrical equipment is as follows:

1) Cables

Hi Pot tested every 15-20 years. For suspect cables Hi Pot testing is done every 5-10 years.

2) Motors

4 kV - Bridged, Meggared, Hi Potted and impedance tested every refueling (18 months).

480 V - Meggar tested every 12-18 months, overhaul - 5 years, 1st motors every 18 months.

3) <u>Buses</u>

Meggar tested every 36 months.

4) <u>Relays</u>

Functionally tested, calibrated and adjusted every 36-48 months.

5) <u>Transformers</u>

Overhauled every 5 years.

6) <u>Turbine Generator</u>

Inspect, Meggar, Hi Pot, repair every 36 months.

7) <u>Breakers</u>

Inspect test, adjust and replace worn parts every 36 months.

QUESTION NO. 13

It is referenced in section 6.2.1.4 item 6 (page 6-102) that additional design changes are being made to enhance the performance of the electrical system. Item E refers to plant improvement to increase reliability of the electrical system, a modification will be implemented to enhance the availability of the second source of offsite power. Describe what this modification will consist of and when will it be implemented.

RESPONSE

The different options being considered to enhance the availability of the offsite power supply are at present in the developmental stage. Since any improvements in this area cannot be implemented until the next refueling outage, the schedule for completion of the preliminary assessment of the different options, extends into the post-RTS time frame. In addition, due to the significant nature of these types of modifications, their impact on the Integrated Living Schedule at San Onofre Unit 1 is also being evaluated. It is expected that additional information on this subject can be provided to the NRC by June 30, 1986.

QUESTION NO. 14

Has any evaluation and analysis performed to trend the test results to assess the auxiliary transformer C condition and reliability? Provide information, if any, in this regard.

RESPONSE

The test data from 1979/1980 and 1985 were reviewed and found to be comparable.

This review of the test data shows that the auxiliary transformer C is in a condition to operate reliably until the next normal test is performed in 1990. No trending was necessary in the review process.

QUESTION NO. 15

Provide the test voltage value at which the insulation resistance tests were performed for transformer C and other electrical equipment.

RESPONSE

The insulation resistance tests on the auxiliary transformer C were performed at 1000 V DC. Equipment with operating voltage of 480 V and below is tested with 500 V meggar. All others are tested with 1000 V meggar.

QUESTION NO. 16

Would the "4160 volt bus sources parallel" annunciator with 10 second time delay include the diesel generator source when it is paralleled with the offsite source?

RESPONSE

Yes. See answer to Question 6b.

QUESTION NO. 17

Is there any operating mode when diesel generator may be paralleled with auxiliary transformer A and/or B? Is this mode of operations acceptable and would it be covered in the proposed new procedures.

RESPONSE

Yes, for short periods of time, when transferring 4 kV sources. This mode of operations will be covered in revisions to operating procedures to be implemented prior to return to service from the current outage (defined as entry into MODE 2).

QUESTION NO. 18

On page 8-2, item 6, "Guidance will be issued to address the reenergization of station auxiliary equipment using diesel generators....". When will this guidance be issued and/or submitted for NRC review?

RESPONSE

The guidance will be issued prior to return to service from this outage (defined as entry into MODE 2). However, there are no plans to submit this information to the NRC for review.

QUESTION NO. 19

On page 8-3, reference is made to the evaluation of the material condition of electrical power cable to identify causes of the cable failure. When will this evaluation be submitted to NRC? How will the result of this report be incorporated in the evaluation of the remaining cable and/or how the impact of this evaluation of existing cable, if any, be handled by SCE?

RESPONSE

As discussed in Section 6.2.1.3.1, a special Cable Evaluation Task Force was established to conduct an extensive effort to assess the material condition of cable remaining in place. The Task Force is comprised of senior SCE engineers, SCE cable experts, an independent cable consultant and senior Architectural/Engineer personnel. The objective of the Task Force is to determine the mechanisms of failure of both the in-service 4kV C transformer cable fault and the cable failing DC Overvoltage testing, and identify the implications of those failures to other cables.

The Task Force has also removed samples of 4kV cable representative of cable remaining in-service and forwarded those samples to independent laboratories for both physical analysis and electrical testing. The data from these laboratories will be used to establish the material condition of the 4kV cable not replaced. Additionally, by determining the root cause of the above mentioned cable failures, SCE can identify and implement the necessary modifications required to preclude cable failures due to similar causes.

Laboratory results received to date indicate that the cause of the failure of the 4kV cable that initiated the November 1985 transient is directly related to overheating of the cable due to long-term exposure to a localized heat source. SCE has initiated plant walkdowns to identify and eliminate any instances wherein a localized heat source (that could potentially degrade cables) is in direct proximity to cable raceways. Additionally, preliminary results from other laboratory physical analysis and electrical testing confirm that the cable remaining in use at San Onofre Unit 1 has retained its dialectric properties, is suitable for continued use, and has substantive remaining life.

All of the actions, analysis, testing, conclusions and recommendations of the Cable Evaluation Task Force will be documented in a final comprehensive report which will address mechanisms of failure and the material condition of the remaining cable. It is expected that a report will be provided to the NRC by May 30, 1986.

QUESTION NO. 20

The LOVATS and end of sequence light - Is this light a single light and if so, how will its reliability be affected?

RESPONSE

The LOVATS end of sequence light is a single light module with two lamps. Therefore, indication will be maintained even if one lamp burns out. In the event both lamps are out, the operator can verify the end of sequence by observing the status of indicating lights for breakers 11A04 and 11B04. We are not aware of any unexplained failure modes associated with LOVATS end of sequence light like that experienced with the spurious safety injection indication from the safeguards load sequencer neon lamps.

QUESTION NO. 21

For Piping Inside Containment on Feedwater Line B.

a. Did the licensee ultrasonically inspect each weld that was not replaced?

b. Will the licensee ultrasonically inspect each weld in the replacement line and the welds connecting the replacement line to the existing line?

c. Will the licensee radiographically inspect the welds connecting the replacement line to the existing line?

d. Identify ASME Code and Addenda standard, including class, used to inspect these welds.

e. Why are indications in piping attached to steam generator E-1B feedwater nozzle considered non-relevant?

f. Indicate size (length and depth) of flaw remaining in containment penetration C-3C.

RESPONSE

a. Yes. Each weld that was not replaced was examined by ultrasonic testing (UT).

b. Yes. Each weld in the replacement line and the welds connecting the replacement line to the existing line were examined by UT. In addition, the surface of the above welds was examined by MT.

c. No. Radiographic examination is not required by the construction code (see response 21.d for construction code). However, the closure welds connecting the pipe spool to the existing line near the second elbow upstream of the feedwater nozzle on the steam generator will be radiographed.

d. Replacements were performed in accordance with ASME Section XI, 1977 Edition, with Addenda up through Summer 1978. As permitted by Article IWA-7200 of ASME Section XI, a later edition of the original construction code was used for materials, design, fabrication and installation for replaced piping. The construction code used is ASME Section I, 1983 Edition, which in turn refers to ANSI B31.1, 1980 Edition, including Summer 1980 Addendum, for materials, design fabrication and installation. The construction code required visual examination for the 10 in., 0.500 in. wall pipe welds.

In accordance with the preservice examination requirements, the welds were examined by MT and UT to meet the requirements of ASME Section XI, 1974 Edition, with addenda up through Summer 1975. Since the applicable edition with addenda of ASME Section XI does not have acceptance standards for examination of piping, the provisions in IWB-3514 of ASME Section XI, 1977 Edition, with Addenda up through Summer 1978, was used.

The ISI classification for the feedwater piping inside containment is Class 2.

e. The UT indications detected in steam generator E-1B feedwater nozzle weld 392-13 (refer to page 6-124, second paragraph) were recorded at an amplitude of 80% DAC. These indications are considered recordable to the applicable ASME Section XI code, but do not require sizing (length and through wall dimensions) or evaluation (a/l aspect ratio) for acceptability (a/t %). The dimensions, a, l and t are defined in Article IWA-3000. Furthermore, since the UT indications exhibited characteristics typical of weld discontinuties and these discontinuities were observed on radiographs taken in 1980, they were determined to be preexisting relative to the event.

f. The description of three (3) indications remaining in containment penetration C-3C as a result of examination by MT is as follows:

   o Fillet weld between reinforcing pad and sphere inside containment - Refer to Figure 1 of Attachment 1 for location of indications. One (1) indication, 7/32 in. long, at location B; and one (1) indication, 5/32 in. long, at location C.

   o Weld between plate and sleeve outside containment - Refer to Figure 2 of Attachment 2 for location of indication. One (1) indication, 1/8 in. long, at location 2.

   o The indications meet the acceptance criteria of Article IWB-3510.1 (d) of ASME Section XI, 1977 Edition, with Addenda up through Summer 1978.

   o Due to the configuration of the welds, depth measurement using UT was not feasibile.

Also provided as Attachment 2 is a copy of the report that documents the metallurgical and failure analysis for the feedwater piping that was requested in a telephone call with the NRC staff on April 22, 1986.

ATTACHMENT 1
FIGURE 1

WESTINGHOUSE NUCLEAR SERVICE DIVISION
INSPECTION SERVICES

GENERAL – INDICATION DATA

PLANT SAN ONOFRE UNIT 1 SKETCH N/A

SYST/COMP CONTAINMENT VESSEL & PENETRATION C-3C PROCEDURE SO1-W-ISI-70/0

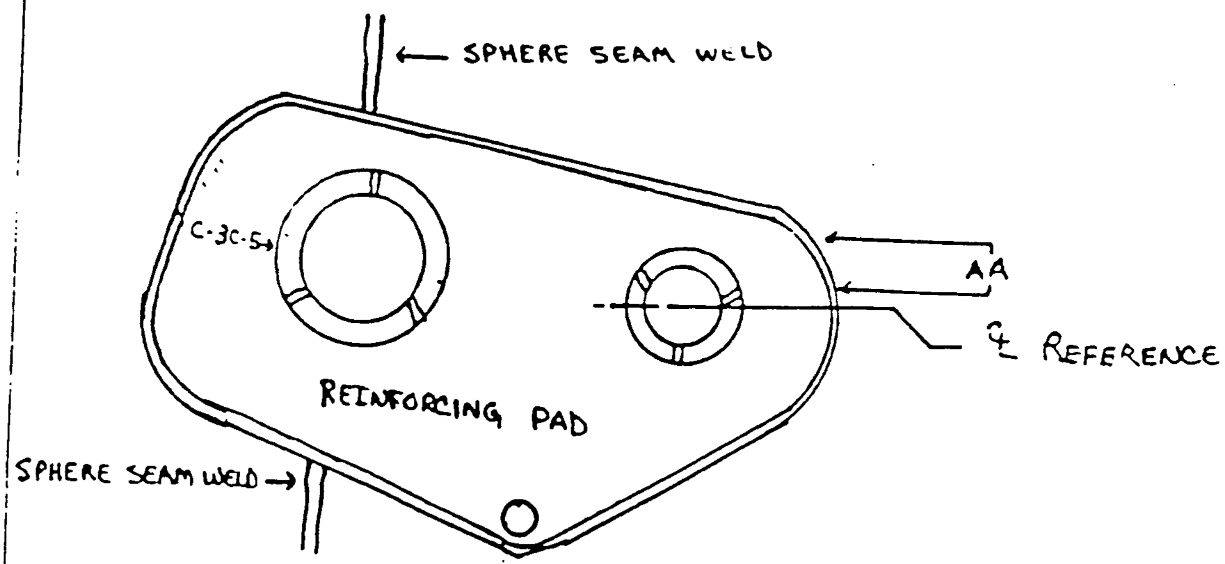
EXAMINER James R. Dellusso II LEVEL II DATE 1-17-86

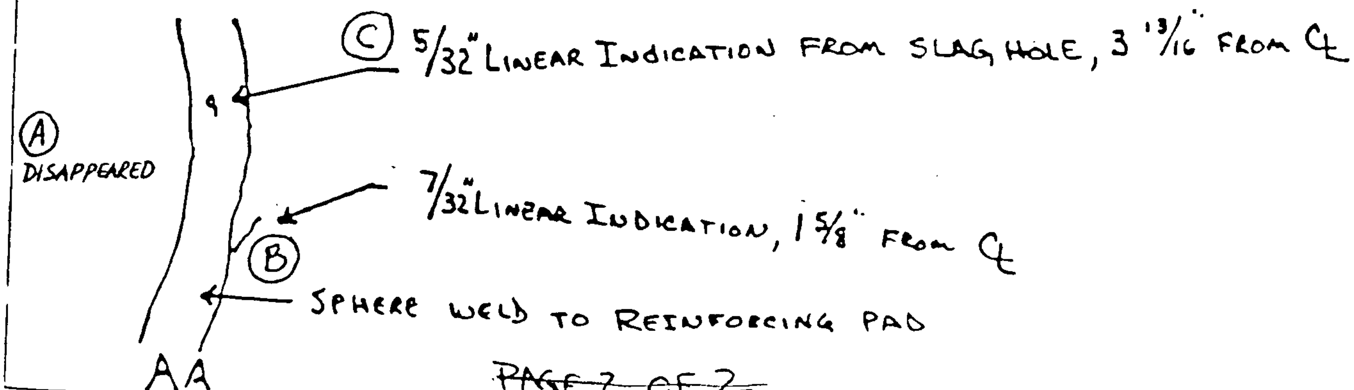
DETECTED BY U/T ____ P/T ____ M/T ✓ V/T ____ IDENT NO. SPHERE WELD TO REINFORCING PAD AT PENETRATION C-3C

PROVIDE SUFFICIENT INFORMATION TO DESCRIBE SIZE, LOCATION AND TYPE OF INDICATION. DESCRIBE EXTRA OR SPECIAL EQUIPMENT IF USED FOR SIZING OR REPORTING. IF NECESSARY INCLUDE SKETCH SHOWING GENERAL CONFIGURATION OF ITEM OR AREA.

INSIDE CONTAINMENT

AFTER BUFFING





~~PAGE 2 OF 2~~

FORM 45936A

WESTINGHOUSE FORM 2444D

WESTINGHOUSE ELECTRIC CORPORATION

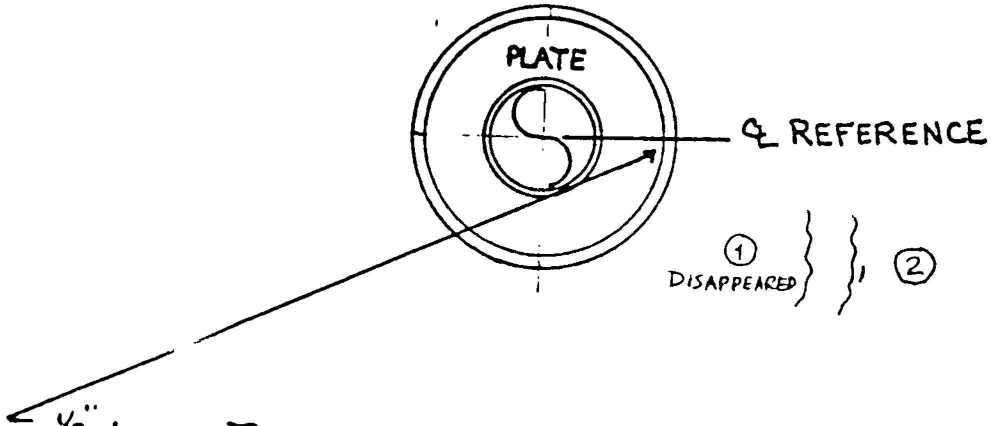
ATTACHMENT 1
FIGURE 2

AFTER BUFFING

1-18-86

PENETRATION C-3C OUTSIDE CONTAINMENT

WELD C-3C-1
PLATE TO SLEEVE WELD



② 1/8" LINEAR INDICATION, TOE OF WELD, SLEEVE SIDE, PARALLEL TO WELD, 2 1/8" DOWN FROM ℄ REFERENCE

James R. Dellbusso
LEVEL II