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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

October 30, 1979

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Docket No. 50-206

Mr. James H. Drake
Vice President
Southern California Edison Company
2244 Walnut Grove Avenue
Post Office Box 800
Rosemead, California 91770

Dear Mr. Drake:

RE: REQUEST FOR ADDITIONAL INFORMATION
SYSTEMATIC EVALUATION PROGRAM TOPIC III-7.D

To continue our review of the Systematic Evaluation Program Topic III-7.D, we request that you provide a description of the procedures and results of the containment structural integrity test for San Onofre Unit No. 1.

Sincerely,

Richard L. Tedesco for

Dennis L. Ziemann, Chief
Operating Reactors Branch #2
Division of Operating Reactors

cc: see next page

dupe #7911130286

cc
Charles R. Kocher, Assistant
General Counsel
Southern California Edison Company
Post Office Box 800
Rosemead, California 91770

David R. Pigott
Samuel B. Casey
Chickering & Gregory
Three Embarcadero Center
Twenty-Third Floor
San Francisco, California 94111

Jack E. Thomas
Harry B. Stoehr
San Diego Gas & Electric Company
P. O. Box 1831
San Diego, California 92112

U. S. Nuclear Regulatory Commission
ATTN: Robert J. Pate
P. O. Box 4167
San Clemente, California 92672

Mission Viejo Branch Library
24851 Chrisanta Drive
Mission Viejo, California 92676

K M C, Inc.
ATTN: Richard E. Schaffstall
1747 Pennsylvania Avenue, N. W.
Suite 1050
Washington, D. C. 20006

50-206

REPORT OF
INITIAL OVERLOAD TEST AND
LEAKAGE RATE DETERMINATION OF
THE REACTOR CONTAINMENT SPHERE

AT

SAN ONOFRE NUCLEAR GENERATING STATION
SOUTHERN CALIFORNIA EDISON COMPANY

FOR

THE BECHTEL CORPORATION

BY

CHICAGO BRIDGE & IRON COMPANY

MAY 1965

CHICAGO BRIDGE & IRON COMPANY

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INTRODUCTION

The San Onofre Nuclear Generating Station of the Southern California Edison Company is located 4 miles south of San Clemente, California on the edge of the Pacific Ocean. The Containment Vessel at the Station is to provide a leak-tight pressure enclosure for the Nuclear Reactor.

The Containment Vessel for the Nuclear Reactor was designed, erected and tested by the Chicago Bridge & Iron Company under contract with, and in accordance with specifications prepared by Bechtel Corporation. The vessel was designed, and constructed in conformance with the rules in Section III, 1963 Edition, of the ASME Code and other Sections of the ASME Code (including Sections II, VIII, and IX), to the extent that they are applicable. In addition, the Containment Vessel design, fabrication, erection and testing conforms with the requirements of the Proposed Safety Standard for Design, Fabrication and Maintenance of Steel Containment Structures for Stationary Nuclear Power Reactors, prepared by Subcommittee No. 6, American Standards Association Sectional Committee N 6, Reactor Safety Standard, latest published edition at this date.

The Containment Vessel consists of a 140 foot diameter sphere constructed in one stage on temporary columns attached to the equator. All plate seams were accessible for inspection inside and outside before and after the test. All permanent connections were welded in place in the shell.

It is intended that one temporary construction opening in the steel shell of the Containment Vessel be made after successful completion of the leakage rate test. After the test, the bottom of the vessel is to be embedded in concrete and the temporary columns removed. Following completion of the interior construction and the installation of equipment, the shell cutout is to be rewelded and the closure welds are to be 100 per cent radiographed.

General

The procedure for the overload test fulfilled the requirements of the ASME Code. The leakage rate test was conducted in a manner similar to previously successful tests on containment vessels, including Vallecitos, California; Dresden, Illinois; Lagoona Beach, Michigan; Indian Point, New York; and Charlevoix, Michigan.

The method used for the leakage rate test consisted, basically, of comparing the pressure in the Containment Vessel with an airtight inner chamber which is an integral part of a Reference System. The location of the inner chamber inside of the Containment Vessel and approximately at the center of the air mass enabled the average temperature of the air in both inner and outer vessels to be reasonably close during the daylight hours and practically equal during the late night hours. Data obtained from previous tests have shown during the midnight-to-dawn periods of normal atmospheric conditions that the air temperature becomes relatively uniform throughout the Containment Vessel and that the temperature at the geometric center represents the average air temperature throughout the vessel.

With negligible difference in average air temperature between the inner chamber and the Containment Vessel, the possibility of a pressure differential being caused by temperature can be eliminated. With the complete Reference System proved to be tight by preliminary thorough inspection methods, and relative decrease in Containment Vessel pressure under this temperature condition must be considered to be external leakage. By measuring the difference in pressure between the two air volumes with a water manometer, a high degree of sensitivity to this pressure differential can be accomplished.

Page 5 describes the relationship of the differential pressure measurements to the percent leakage. Figure 1 on page 6, illustrates the schematic arrangement of the piping and the instruments.

The steps of the preliminary tests, the overload test, and the leakage rate test are given in the Test Procedure in Appendix E.

Preliminary Check

Before the overload and leakage rate tests at San Onofre, preliminary testing was performed in the shop and field. All air locks were shop tested for tightness and the operation of the door mechanism, including the equalizing valves were checked. All shop-welded manholes and nozzles were magnafluxed inside and outside after shop stress relief. The Reference Chamber was shop-tested with freon to 50 psig after assembly.

Following the final installation of the leakage rate equipment inside and outside of the vessel, the Reference System was pressurized to 50 psig with freon, all joints enclosed in polyethylene bags,held for 12 hours, and then checked again for leakage. A secondary holding check with temperature-pressure data was also conducted April 30 through May 3, 1965.

Overload Test

After the successful checking of the test equipment illustrated in Figure 1, the vessel was closed for the overload test. No water was introduced into the differential manometer in order that the Containment Vessel and the Reference System would be pumped up simultaneously to the same pressure.

The vessel was pressureized to 5 psig on May 3 1965 from 4.30 P.M. to 10:30 P.M. All connections and welds were checked by a soapsuds inspection on May 4. Starting at 9 A.M. May 5, the air pressure was increased to 10 psig and held. At 4 30 P.M. the pressure was again increased in increements to the test pressure of 53 3/8 psig which was reached about 3 25 P.M. on May 6. The locks were also pressurized in accordance with the test instructions. After the holding period of one hour pressure in the vessel was reduced to approximately 48 psig. The second and final soapsuds inspection was conducted at the design pressure on May 7.

Leakage Rate Test

Prior to the start of the leakage rate test the blow-off valve at the bottom of the Containment Vessel was opened for the purpose of draining off the condensate that had accumulated during the pressurization.

At 11 P.M. May 6, water was introduced into the differential manometer to approximately mid-height of the scale. Air was then withdrawn from the Containment Vessel until the water manometer indicated about 8 inches lower pressure in the Containment Vessel. At this time it was discovered that the Reference Chamber was connected to the Dial Gage side of the manometer. From a practical standpoint, this location of the Dial Gage is of minor importance since the pressure in Reference Chamber and Containment Vessel differed only by the inches of water indicated by Differential Water Manometer. To move the Gage at this time would have necessitated another check of the Reference System and disruption of the testing schedule.

The pressure and temperature readings were recorded hourly starting at midnight of May 6-7. The holding period was continued for 55 hours, until 7 A.M. of May 9, when the test was accepted as successful. The blowdown of pressure was started at 8 A.M. on May 9.

The Reference System was pressurized again to 50 psig with freon on May 10. A halide leak detector was used to confirm the tightness of the Reference System in the same manner as the preliminary check.

MEASUREMENT OF LEAKAGE BY THE INNER CHAMBER METHOD

V = Geometric Volume of Containment Vessel

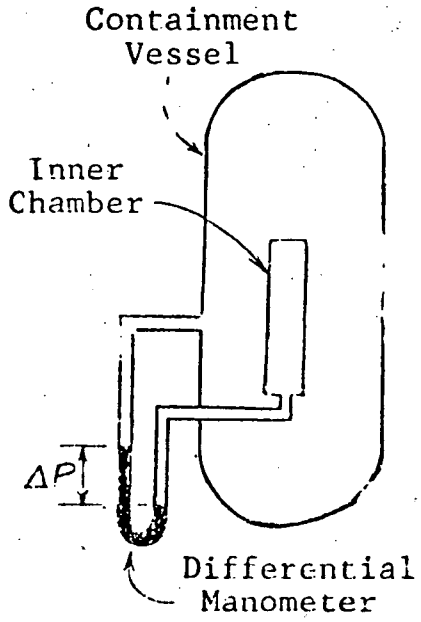
P = Absolute Pressure of Containment Vessel

E.A. = Total Expanded Air Content = $V \times \frac{P}{14.7}$

Loss = Initial Expanded Air - Final Expanded Air

$$\text{Per Cent Loss (as a positive Value)} = \frac{V \times \frac{\text{Int. P}}{14.7} - V \times \frac{\text{Fin. P}}{14.7}}{V \times \frac{\text{Int. P}}{14.7}} \times = \frac{\text{Initial P - Final P}}{\text{Initial P}} \times$$

A basic preliminary step is the installation and thorough check of an Inner Chamber with connecting tubing and instruments to assure that the assembly will be an absolutely tight reference system.



The Inner Chamber Method eliminates temperature measurements from the calculations. At periods of relatively uniform temperature throughout the Containment Vessel and the Inner Chamber, usually midnight to dawn, the temperature will cause negligible differential pressure reading on the Manometer. During the uniform temperature periods, however, a leakage of air from the Vessel will be measured on the Manometer by a decrease in Vessel pressure as compared with the leaktight Inner Chamber. This decrease in pressure between the Initial and Final periods of uniform temperature is Final P - Initial P.

Hence, Per Cent Loss * = $\frac{\text{Final } \Delta P - \text{Initial } \Delta P}{\text{Int. P}} \times 100$ = a positive value

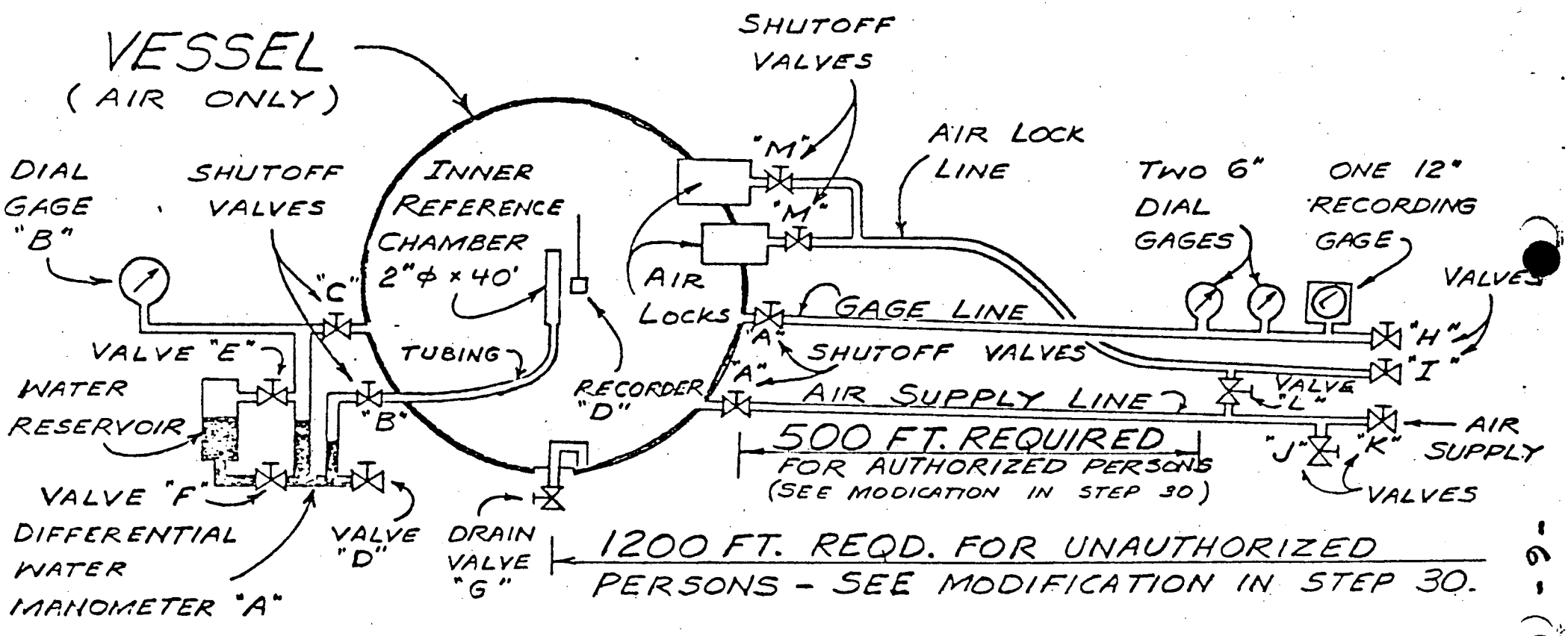
If ΔP and P are measured in inches of water and inches of mercury, respectively, and the leakage is to be calculated as a negative value,

Then, Per Cent Loss * = $\frac{\text{Initial } \Delta P - \text{Final } \Delta P}{\text{Int. P} \times 13.6} \times 100$

* These equations applicable only when the temperature in the Containment Vessel and Inner Chamber are approximately equal and the Initial & Final temperatures are approximately equal.

TEST LAYOUT - CONTR. 9-0381

THIS LAYOUT IS SCHEMATIC - NOT TO SCALE:



INSTRUMENTS:

"A" = 36" U-TUBE MANOMETER (MERRIAM #20 AA 25 WM)

"B" = 6" DIAL PRES. GAGE, RANGE 0 TO 100 PSIG, GRADATIONS 1/2 PSIG, ACCURACY 1/4 OF 1%. (ASHCROFT #1082 A)

"C" = 36" U-TUBE ABS. PRES. MANOMETER (MERRIAM #11 AA 10 WM)

"D" = TEMPERATURE - HUMIDITY RECORDER WITH 7-DAY CLOCK (TAYLOR # 2362 PP)

"E" = MERCURY THERMOMETERS, RANGE -30 F TO 120 F (TAYLOR # 21200)

FIGURE 1.

18 NOV 69 RVM

RESULTS OF INSPECTIONS AND TESTS

Preliminary Check

The shop testing of the locks indicated adequate strength and tightness. The shop and field magnafluxing of the manholes and nozzles did not find any indication of cracks or defects.

The first tightness test with freon of the Reference System, after installation inside the Containment Vessel, showed minor leakage with a halide leak detector. The leaks were eliminated. For a final check with a halide leak detector, the valves and connections were enclosed in polyethylene bags. No leaks were found.

An approximate check of the Reference System was then made by comparing pressure-temperature data during the holding period. The temperatures were measured at the suspended Reference Chamber by a recorder and by a mercury filled glass thermometer. The average of the two readings were used.

The data listed in Appendix A shows an exceptionally close check between the first two 6:30 a.m. readings but a small drop-off in pressure in the third 6.30 a.m. reading. Because of the recognized inaccuracies of the instrumentation the calculations were not accepted as providing an accurate comparison and thus the approximate check with pressure-temperature data was considered inconclusive. The tightness of the Reference System however, was accepted on the basis of the thorough halide check and later confirmed by a halide test after completion of test of the Containment Vessel.

When closing the Containment Vessel for pressurizing with air, a bearing on the door operating arm was found to be broken. The bearing was removed. A replacement will be installed later.

Overload and Soapsuds Inspection

The soapsuds inspection at 5 psig found several small leaks around the inner bulkheads of the locks The leaks in the piping, shafts, and valves were eliminated and the pressure increased to the test pressure without difficulty The test pressure was applied to both the inner and outer doors of the locks.

The final soapsuds inspection at the design pressure found the following minor leaks:

1. Two manhole leaks in temporary openings which will be seal-welded at a later date.
2. The electrical plug connections which were leaking will have to be disassembled later for the installation of the permanent wiring.

Overload and Soapsuds Inspection (continued)

3. Inner bulkhead of small personnel lock:

   a. At bottom shaft seal, a small soap bubble 1½ in. diameter formed and broke in about 30 seconds.

   b. At top shaft seal, several bubbles formed up to 3/4 in. diameter and broke.

   c. At equalizing valve port, soap film over 2 in. diameter opening formed bubble with 3/4 in. rise before breaking in 30 seconds.

4. Inner bulkhead of large personnel lock:

   a. At top shaft seal, several bubbles about 3/4 in. diameter formed around shaft every 5-10 seconds.

   b. At equalizing valve port, soap film over 4 in. diameter opening formed bubble with 1/2 in. rise before breaking in 20 seconds.

The time to equalize the pressure between the Containment Vessel (at the design pressure) and the locks was 45 and 46 seconds, respectively, for the small and large personnel locks. To equalize the lock pressure with the atmospheric pressure, permitting the outer door to be opened, was 97 and 98 seconds, respectively for the small and large locks.

Leakage Rate Test

The hourly data recorded during the holding period of the leakage rate test is tabulated in Appendix C

The differential manometer readings, in inches of water, and the absolute pressure of the Containment Vessel, for the 1 A.M.-6 A.M. hours used for the calculation of the leakage are summarized as follows:

Leakage Rate Test (continued)

Hours	May 7		May 8		May 9	
	Lbs. per Sq. Inch	Inches Water	Lbs. per Sq. Inch	Inches Water	Lbs.per Sq. Inch	Inches Water
1 A.M.	58.31	6.73	58.48	7.18	58.56	7.42
2 A.M.	58.32	6.68	58.28	6.95	58.27	7.19
3 A.M.	58.21	6.63	58.08	6.90	58.07	7.10
4 A.M.	58.10	6.52	57.77	6.72	57.75	7.03
5 A.M.	57.99	6.46	57.57	6.74	57.65	7.05
6 A.M.	58.00	6.47	57.37	6.79	57.55	7.11
Average =	58.16	6.58	57.92	6.88	57.97	7.15
Average (4 A.M.-6 A.M)=		6.48		6.75		7.06
Initial ΔP - Fin. ΔP (1-6 A.M.)=			0.30		0.27	
" " - " " (4-6 A.M.)=			0.27		0.31	

Using the 1 A.M.-6 A.M. manometer data for the three successive nights, the calculated per cent leakage per 24 hour period is as follows:

$$= 1/2 \left[\frac{(0.30 + 0.27)}{(58.16)\ (27.68)} \right] \times 100 = 0.0175\%$$

Using the 4 A.M.-6 A.M. manometer data for the three nights, the calculated per cent leakage for 24 hour period is as follows:

$$= 1/2 \left[\frac{(0.27 + 0.31)}{(58.16)\ (27.68)} \right] \times 100 = 0.0180\%$$

The above two calculations are exceedingly close. The uniformity between the differential pressures of the first and second 24 hour periods would also produce a leakage rate very close to 0.018 per cent for each period. The calculated leakage is substantially smaller than the allowable of 0.1 of 1 per cent.

Both the overload test and the leakage rate were considered acceptable by the Bechtel Corporation.

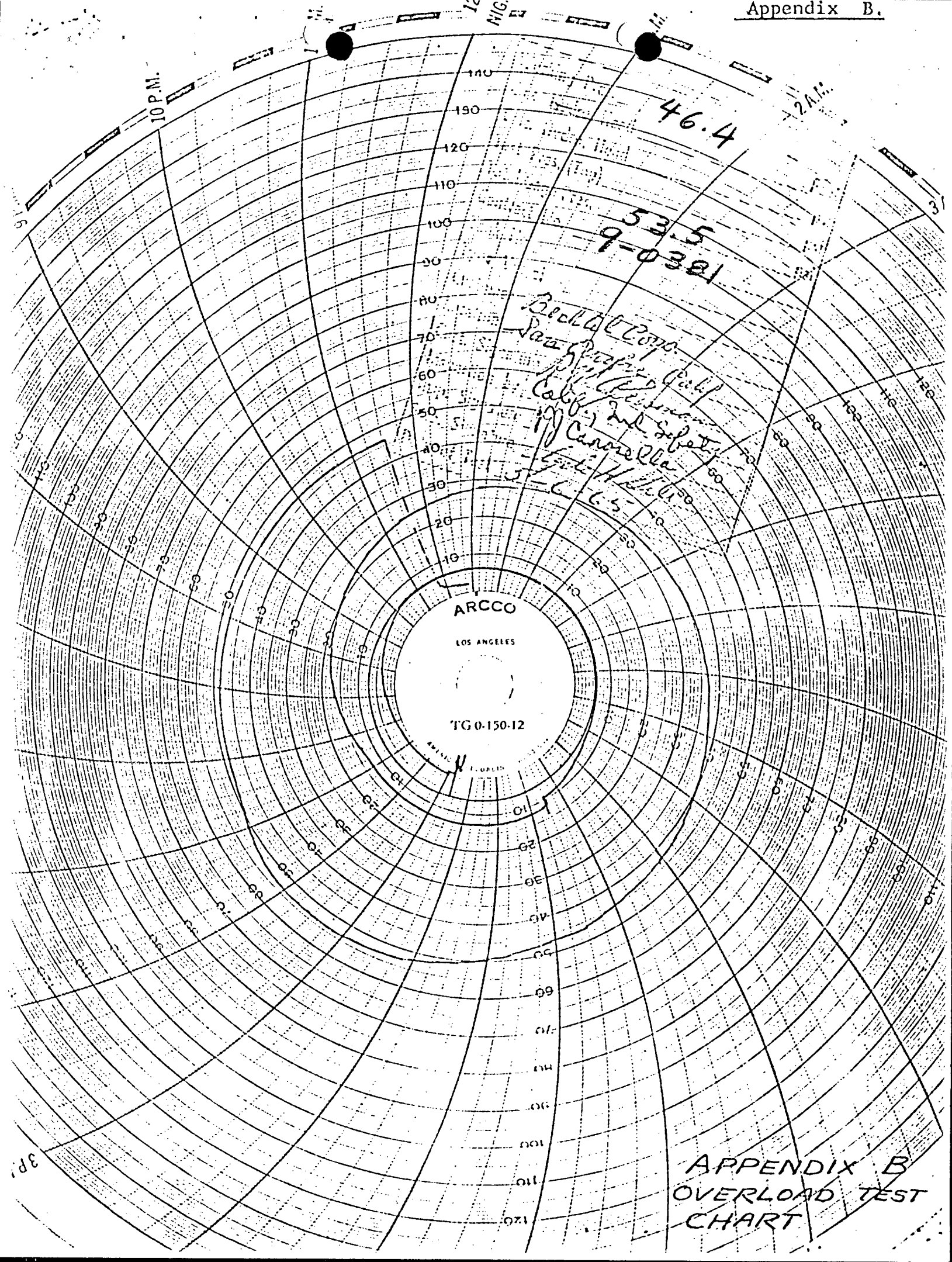
CHICAGO BRIDGE & IRON COMPANY

Appendix A

CHECK OF REFERENCE SYSTEM

TIME	TEMPERATURE OF REF. SYS.		BAROMETRIC PRESSURE	REFERENCE SYSTEM PRESSURE		
				MEASURED	ABSOLUTE	CORRECTED
1965	Deg. Fahr.	Deg. Abs.	Lbs. per Sq. In.	Lbs. per Sq. In.	Lbs. per Sq. In.	Lbs. per Sq. In.
Apr.30						See Note 1.
4:00 p.m.	76	536	14.82	52.0	66.82	
May 1						
6:30 a.m.	60.5	520.5	14.81	48.8	63.61	63.61
9:40 a.m.	60.75	520.75	14.79	48.9	63.69	63.66
12:45 p.m.	71.0	531.0	14.82	50.5	65.32	64.03
4:35 p.m.	79.6	539.6	14.79	52.3	67.9	64.72
May 2						
6:30 a.m.	61.5	521.5	14.74	49.0	63.74	63.62
10:00 a.m.	68.3	528.3	14.74	50.0	64.74	63.78
May 3						
6:30 a.m.	56.55	516.55	14.72	48.2	62.92	63.40

Note 1: Corrected absolute pressure is the measured absolute pressure corrected to the temperature at the start of the holding period = Measured Absolute Press. x $\frac{\text{Init. Abs. Temperature}}{\text{Measured Abs. Temperature}}$



APPENDIX B
OVERLOAD TEST
CHART

Appendix C-1

LEAKAGE RATE TEST - FIRST DAY

TIME 1965	ATMOSPHERIC CONDITIONS Temp. Deg. Fahr.	Baro. Pres. Lbs. per Sq. In.	CONTAINMENT VESSEL Gage Pres. Lbs. per Sq. In.	Abs. Pres. Lbs. per Sq. In.	DIFFERENTIAL-MANOMETER Refer. Cham. Inches Water(2)	Cont. Vessel Inches Water(2)	Pres. Diff. Inches Water(3)
12:00 M	-	14.71	43.8	58.51	B 3.55	A 3.82	+7.37
1:00 A.M.	58.3	14.71	43.6	58.31	3.33	3.40	6.73
2:	57.3	14.72	43.6	58.32	3.35	3.33	6.68
3:	56.3	14.71	43.5	58.21	3.35	3.28	6.63
4:	54.5	14.70	43.4	58.10	3.32	3.20	6.52
5: May 7, 1965	53.2	14.70	43.29	57.99	3.31	3.15	6.46
6:	52.1	14.71	43.29	58.00	3.35	3.12	6.47
7:	51.8	14.71	42.8	57.51	3.44	3.20	6.64
8:	54.0	14.72	42.9	57.62	3.31	3.05	6.36
9:	57.1	14.73	43.5	58.23	2.09	1.50	3.59
10:	58.2	14.74	43.8	58.54	1.33	0.80	2.13
11:	60.3	14.76	44.55	59.31	1.09	0.28	1.37
12:00 N	62.1	14.76	45.2	59.96	1.29	0.33	1.62
1:00 P.M.	64.6	14.78	45.6	60.38	1.29	0.33	1.62
2:	66.9	14.77	45.9	60.67	1.42	0.34	1.76
3:	67.2	14.76	46.2	60.96	1.76	0.58	2.34
4:	69.7	14.77	46.5	61.27	2.62	1.40	4.02
5: May 7, 1965	70.8	14.76	46.6	61.36	3.42	2.15	5.57
6:	71.6	14.76	46.9	61.66	4.78	3.46	8.24
7:	69.7	14.75	46.8	61.55	6.29	4.95	11.24
8:	67.3	14.77	46.5	61.27	6.80	5.47	12.27
9:	63.5	14.77	45.5	60.27	6.10	4.85	10.95
10:	61.4	14.77	44.9	59.67	5.33	4.05	9.38
11:	58.9	14.77	44.4	59.17	4.56	3.30	7.86

(1) Recorded temperatures are averages of four readings taken outside of the sphere at N-S-E-W quadrants.

(2) "A" or "B" refers to Water Level ABOVE or BELOW Zero Mark on Manometer.

(3) A "+" Difference means Cont. Vessel Pressure LOWER than Reference System.

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Appendix C-2

LEAKAGE RATE TEST - SECOND DAY

TIME	ATMOSPHERIC CONDITIONS		CONTAINMENT VESSEL		DIFFERENTIAL-MANOMETER		
1965	Temp. Deg. Fahr.	Baro. Pres. Lbs. per Sq. In.	Gage Pres. Lbs.per Sq. In.	Abs. Pres. Lbs.per Sq. In.	Refer. Cham. Inches Water 2	Cont. Vessel Inches Water 2	Pres. Diff. Inches Water 3)
12:00 M	59.3	14.78	44.0	58.78	B 4.43	A 3.20	+ 7.63
1:00 A.M.	58.5	14.78	43.7	58.48	4.19	2.99	7.18
2:	55.8	14.78	43.5	58.28	4.10	2.85	6.95
3:	53.5	14.78	43.3	58.08	4.10	2.80	6.90
4:	51.9	14.77	43.0	57.77	4.05	2.67	6.72
5:	51.2	14.77	42.8	57.57	4.06	2.68	6.74
6: May 8, 1965	50.2	14.77	42.6	57.37	4.11	2.68	6.79
7:	49.9	14.77	42.5	57.27	4.20	2.72	6.92
8:	53.4	14.77	42.6	57.37	3.98	2.55	6.53
9:	56.4	14.77	43.2	57.97	3.01	1.57	4.58
10:	58.5	14.79	43.9	58.69	1.99	0.32	2.31
11:	60.2	14.79	44.5	59.29	2.06	0.21	2.27
12: N	62.0	14.78	45.1	59.88	2.21	0.22	2.43
1:00 P.M.	63.8	14.78	45.6	60.38	2.21	A 0.11	2.32
2:	65.7	14.78	46.1	60.88	2.17	B 0.01	2.16
3:	66.9	14.78	46.3	61.08	2.55	A 0.24	2.79
4:	69.0	14.78	46.5	61.28	3.37	1.05	4.42
5: May 8, 1965	69.8	14.77	46.8	61.57	4.57	2.13	6.70
6:	71.6	14.75	46.8	61.55	5.71	3.27	8.98
7:	68.7	14.75	46.6	61.35	7.07	4.61	11.68
8:	67.2	14.75	46.0	60.75	7.44	5.02	12.46
9:	65.4	14.77	45.5	60.27	6.80	4.45	11.25
10:	64.3	14.77	45.2	59.97	5.97	3.65	9.62
11:	61.9	14.77	44.5	59.27	5.26	2.90	8.16

(1) Recorded temperatures are averages of four readings taken outside of the sphere at N-S-E-W quadrants.

(2) "A" or "B" refers to Water Level ABOVE or BELOW Zero Mark on Manometer.

(3) A "+" Difference means Cont Vessel Pressure LOWER than Reference System.

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Appendix C-3

LEAKAGE RATE TEST - THIRD DAY

TIME	ATMOSPHERIC CONDITIONS.		CONTAINMENT VESSEL		DIFFERENTIAL MANOMETER		
1965	(1) Temp. Deg. Fahr.	Baro. Pres. Lbs.per Sq. In.	Gage Pres. Lbs.per Sq. In.	Abs. Pres. Lbs.per Sq. In.	Refer. Cham. Inches Water (2)	Cont. Vessel Inches Water (2)	Pres. Diff. Inches Water (3)
12:00 M	58.8	14.77	44.1	58.87	4.98	2.56	7.54
1:00 A.M.	57.3	14.76	43.8	58.56	4.92	2.50	7.42
2:	55.5	14.77	43.5	58.27	4.81	2.38	7.19
3:	54.2	14.77	43.3	58.07	4.78	2.32	7.10
4:	53.0	14.75	43.0	57.75	4.73	2.30	7.03
5:	52.0	14.75	42.9	57.65	4.77	2.28	7.05
6:	52.4	14.75	42.8	57.55	4.80	2.31	7.11
7:	53.1	14.75	42.8	57.55	4.90	2.41	7.31

May 9, 1965

(1) Recorded temperatures are averages of four readings taken outside of the sphere at N-S-E-W quadrants:

(2) "A" or "B" refers to Water Level ABOVE or BELOW Zero Mark on Manometer.

(3) A "+" Difference means Cont. Vessel Pressure LOWER than Reference System.

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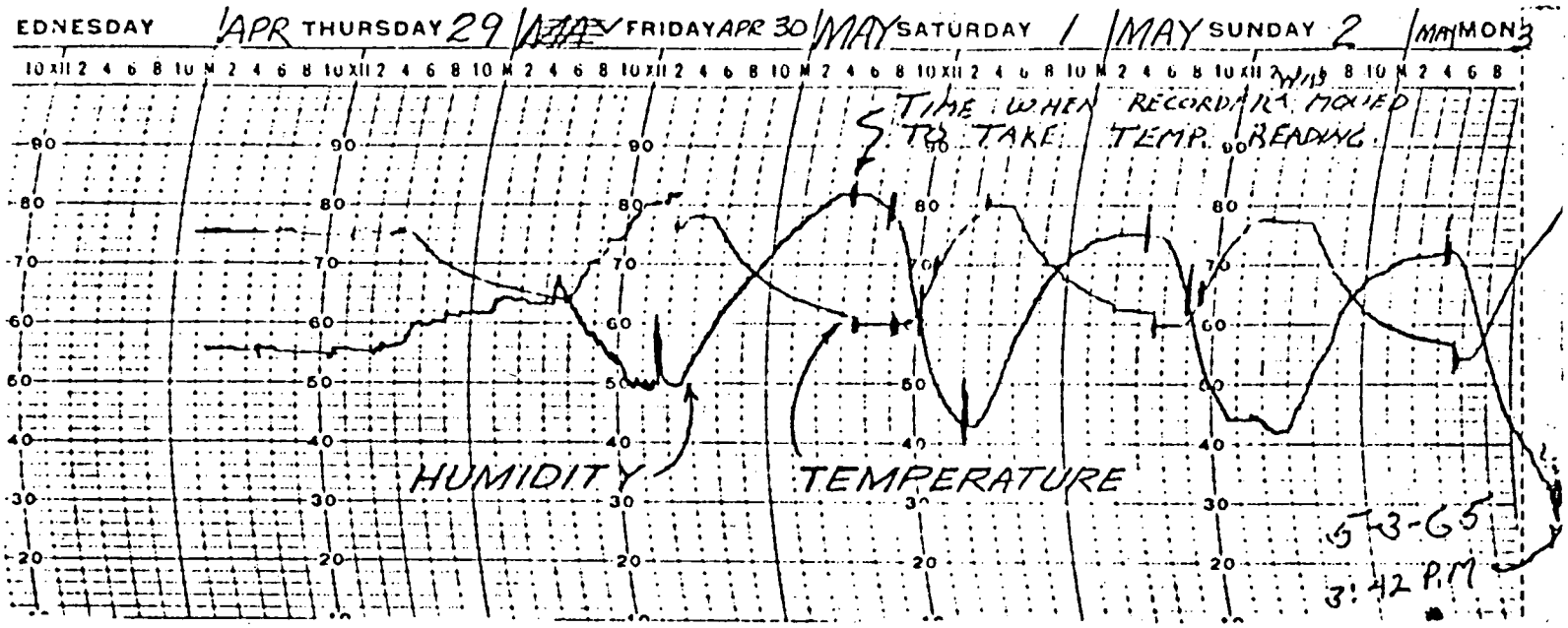
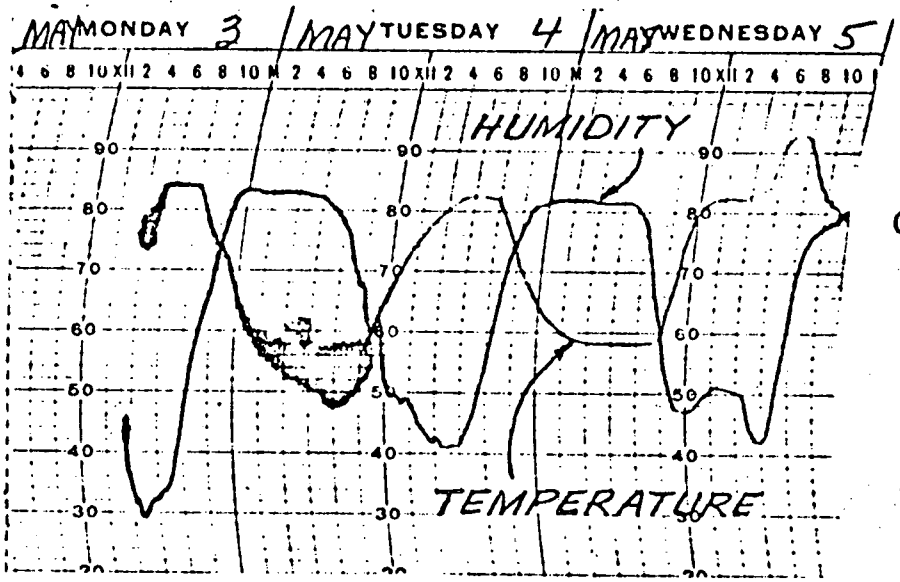
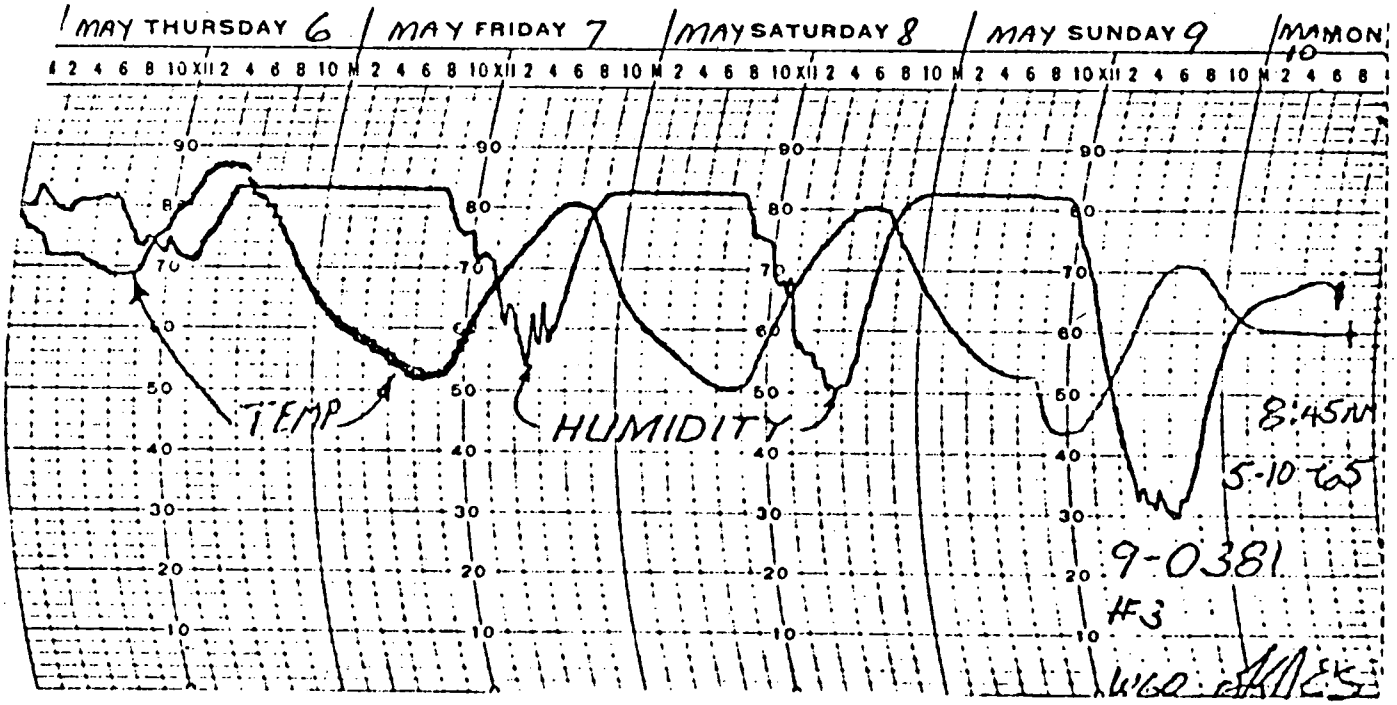




Temperature-Humidity from recorder "D" at center of Containment Sphere



CHICAGO BRIDGE & IRON COMPANY

INITIAL TEST PROCEDURE

SAN ONOFRE CONTAINMENT VESSEL

CONTRACT 9-0381

PART A -- PRELIMINARY

1. Shop magnaflux all shop-welded manholes and nozzles inside and outside after shop stress-relief.

2. Field magnaflux all manhole and nozzle welds above 40" diameter inside and outside.

3. If any cracks or leaks are found:

   (a) Use chipping tool or arc-air gouge to remove defect.

   (b) Magnaflux and inspect defective area thoroughly before rewelding.

   (c) Repair by welding.

   (d) Inspect repaired area by magnafluxing, or by radiographing where area is accessible.

4. Pressurize each Lock with air-freon to 10 psig and check for tightness by using Halide Leak Detector and by applying soapsuds to all welds, gaskets and shaft penetrations.

5. If any leaks are found, release pressure, repair, and retest.

6. Prior to installation, check Reference Chamber, and an attached length of tubing, for tightness by pressurizing with Freon to 50 psig and sniffing all joints and connections with a Halide Leak Detector.

7. If any leaks are found, release pressure, repair, and retest until Leak Detector does not find any leaks.

8. Field-install Test Chamber on vertical centerline inside of Containment Vessel, approximately equidistant from top and bottom, and connect tubing to bottom end of Test Chamber.

9. Connect other end of tubing to valves and manometers as schematically illustrated in Fig. 1.

   NOTE: SLOPE TUBING TO MANOMETERS, WHICH SHOULD BE LOCATED IMMEDIATELY ADJACENT TO THE SHELL OF CONTAINMENT VESSEL.

10. Open Valve "B" and close Valves "C", "D", "E" and "F".

11. Pressurize complete Reference Chamber System with freon to 50 psig.

12. Check tubing, instruments, and valves with Halide Leak Detector, stopping all leaks until system is airtight.

13. As a secondary check, hold pressure in Reference Chamber System for a minimum of 24 hours, comparing initial absolute pressure with final absolute pressure, compensated for temperature.

14. If absolute pressure data indicate a measured drop in pressure which is not related to temperature conditions, recheck tubing, valves, instruments and Test Chamber with Leak Detector.

15. Install piping and valves between:

    (a) Containment Vessel and Pressure Gages (Valves "A" and "H").

    (b) Containment Vessel and Air Supply (Valves "A", "J" and "K").

    (c) Air Locks and Air Supply Valves "M", "L", and "I".

    NOTE: THE CONTROLLING AIR VALVES AND PRESSURE GAGES ARE TO BE LOCATED AT A DISTANCE NOT LESS THAN 600 FEET FROM THE SHELL.

PART B - OVERLOAD TEST:

16. Install spring-wound recorder inside Containment Vessel for recording temperature and relative humidity.

17. Calibrate Recording and Dial Pressure Gages at 50 psig and install on Gage Line.

18. Open Shutoff Valves "A" and "M" and Blowoff Valve "I".

19. Close Blowoff Valves "H" and "J", Air Lock Valve "L", and Drain Valve "G".

20. Close or blank all other connections in Containment Vessel.

    NOTE: IF THE PRESSURIZING OF STEP 22 IS DELAYED OR POST-PONED, OPEN A LARGE ENOUGH CONNECTION IN THE SHELL TO PREVENT THE FORMATION OF A VACUUM EXCEEDING 8 OZ.

21. Close Inner Doors of Locks (Inner Equalizing Valves closed), leaving Outer Doors open.

22. Open Valve "K" and pump air into Containment Vessel to 5 psig.

23. Stop pumping and close Air Supply Valve "K".

24. Apply soapsuds to all seams of shell and nozzles, gaskets of manholes and doors, and test covers of nozzles except Outer Lock Doors and portion of Locks not pressurized.

25. If a leak in a welded seam is found during the soapsuds test at 5 psig or at any time before the overload pressure of 53 3/8 psig is reached, the procedure shall be as follows:

    (a) Release air pressure to atmospheric by opening Blowoff Valve "J".

    (b) Immediately after pressure has been released from the Containment Vessel, open a large enough connection in the shell to prevent the formation of a vacuum.

    (c) BEFORE REPARING ANY LEAKS OR DOING ANY WORK THAT MIGHT CAUSE A SPARK, TEST VAPOR SPACE TO MAKE SURE THAT IT IS GAS-FREE.

    (d) Use chipping tool or arc-air gouge to remove the defect.

(e) Magnaflux and inspect the defective area thoroughly before rewelding.

(f) Repair by welding.

(g) Radiograph the repaired weld, or inspect by magnafluxing where not accessible for radiography.

(h) Retest, starting with Step 19, except that only the repaired weld and previously untested welds shall be inspected with soapsuds at 5 psig.

26. Close Outer Doors of Locks (Outer Equalizing Valve closed) and close Valve "I".

27. Open Lock Valve "L", allowing pressure to reach approximately 5 pisg in Locks.

28. Apply soapsuds to Outer Doors and seams of Locks not previously checked during Step 24.

29. Close Lock Valve "L" and open Blowoff Valve "I" to release pressure in Locks.

30. The following clearance rules are mandatory:

(a) ALL UNAUTHORIZED PERSONS (AND ALL MOVABLE EQUIPMENT SUBJECT TO DAMAGE) MUST MAINTAIN A MINIMUM CLEARANCE IN ALL DIRECTIONS FROM THE CONTAINMENT VESSEL OF 1200 FEET OR THE DISTANCE TO THE PROPERTY LINE OF SOUTHERN CALIFORNIA EDISON, WHICHEVER DISTANCE IS SHORTER, WHILE THE VESSEL PRESSURE IS BEING INCREASED ABOVE 5 PSIG AND UNTIL THE OVERLOAD TEST AND FINAL SOAPSUDS INSPECTION SHALL HAVE BEEN SUCCESSFULLY COMPLETED. IN ADDITION, ALL EMPLOYEES OF BECHTEL, SO. CALIF. EDISON AND C.B.&I, SHALL NOT BE ALLOWED TO PARK, LOITER, OR CONGREGATE ON THE RAILROAD AND PUBLIC HIGHWAY RIGHTS-OF-WAY, OR PACIFIC OCEAN WATER FRONT, ADJOINING SAID PROPERTY LINES WITHIN THE 1200 FOOT CLEARANCE.

(b) PERSONS AUTHORIZED IN WRITING BY CHICAGO BRIDGE & IRON CO. MAY BE ADMITTED WITHIN THE AREA DEFINED IN (a) ABOVE. AUTHORIZED EMPLOYEES OF C.B.&I., BECHTEL, SO. CALIF. EDISON, AND NECESSARY OUTSIDE INSPECTION PERSONNEL HAVING WRITTEN AUTHORIZATION FROM C.B.&I, WILL BE PERMITTED AT THE C.B.&I. COMPRESSOR AND GAGE LOCATION APPROXIMATELY 500 FT. (NE)FROM THE OUTSIDE OF THE VESSEL WITH THE FOLLOWING EXCEPTIONS:

1. A MAXIMUM OF TWO BECHTEL EMPLOYEES MAY PERIODICALLY CHECK THE BECHTEL COMPRESSORS LOCATED APPROXIMATELY 400 FT. (SE) FROM THE VESSEL.

2. A MAXIMUM OF TWO BECHTEL EMPLOYEES MAY CHECK, AT SPECIFIED INTERVALS, THE BECHTEL SUMP PUMPS LOCATED ADJACENT TO THE VESSEL. THE SPECIFIED INTERVALS SHALL BE AT APPROXIMATELY EVERY HOUR UNTIL THE VESSEL PRESSURE REACHES 27 PSIG (STEP 31) AND THEREAFTER AT 5 PSIG PRESSURE INTERVALS (OR AT ANY OTHER CESSATIONS OF PUMPING AIR) UNTIL THE VESSEL PRESSURE REACHES 46.4 PSIG. THE CLEARANCE SHALL THEN BE MAINTAINED UNTIL THE VESSEL PRESSURE SHALL HAVE REACHED 53-3/8 PSIG., HELD FOR ONE HOUR, AND THEN SHALL HAVE BEEN REDUCED TO 46.4 PSIG (STEP 36).

3. THE PREVIOUSLY LISTED AUTHORIZED INDIVIDUALS MAY WITNESS THE FINAL SOAPSUDS INSPECTION, AT APPROXIMATELY 46.4 PSIG, BY C.B.&I. EMPLOYEES (STEP 37).

(c) AFTER SUCCESSFUL COMPLETION OF THE FINAL SOAPSUDS INSPECTION AND DURING THE LEAKAGE RATE TEST (PART C), ONLY AUTHORIZED PERSONNEL SHALL BE ALLOWED ON OR ADJACENT TO VESSEL AND INSTRUMENTS. NO WORK SHALL BE PERMITTED WITHIN 25 FEET OF INSTRUMENTS, VALVES AND THE SHELL OF THE VESSEL.

31. Open Valve "K" and start pumping air into Vessel to 27 psig.

32. Increase pressure from 27 psig to 53 3/8 psig in 5 psig increments.

33. Close Air Supply Valve "K" and hold 53 3/8 psig test pressure approximately 20 minutes.

34. Close Valve "I" and open Air Lock Valve "L" to interconnect Air Locks with Containment Vessel.

35. Hold 53 3/8 psig test pressure for another 40 minutes, adding or releasing air to compensate for temperature variations.

36. Open Blowoff Valve "J" to reduce pressure in the Containment Vessel and Air Locks to 46.4 psig (design pressure).

NOTE: IF IT IS MUTUALLY AGREED TO START LEAKAGE RATE TEST AT THIS TIME (PRIOR TO FINAL SOAPSUDS TEST), PRESSURE SHOULD BE FURTHER REDUCED AS DESCRIBED IN STEP 47.

37. Close Valve "J" and apply soapsuds to Outer Doors and Outer Seams of Locks, all seams of shell and nozzles, all gaskets of manholes, and all test covers of nozzles.

38. If any leak is found, the following procedure shall be followed:

(a) A leak which is considered to be of sufficient magnitude to affect the structural integrity of the vessel shall be immediately repaired as described in Step 25, including a 53 3/8 psig overload retest, but only a soapsuds test of the repaired area.

(b) A leak which is considered not to affect the structural integrity of the vessel but which might prevent a successful leakage rate test shall be temporarily sealed, if possible, or the leakage measured, and the test procedure continued. Such a leak might be in a temporary closure, which could be repaired later without the necessity for a retest. If the air pressure must be released from the vessel in order to seal or to repair such a leak, the procedure shall continue, after the repair, into the Leakage Rate Test (Part C) without repeating the 53 3/8 psig overload test.

39. Close Shutoff Valve "M" at each Lock.

40. Close Valve "L" and open Valve "I".

41. Close Shutoff Valve "A" and check with soapsuds.

42. Open OUTER Equalizing Valves and check time of blowdown of pressure from each Lock, which would permit the opening of the OUTER DOOR.

43. Open Outer Door of each Lock and apply soapsuds inside the Lock to all nozzle or shaft penetrations, to gaskets of Inner Doors, and to the welded joints of each lock wall against which air pressure is acting.

44. Close Outer Doors and Outer Equalizing Valves and open Inner Equalizing Valves to pressurize Locks.

45. Check the time required to equalize the pressure in the Locks with the Containment Vessel which would permit the opening of the Inner Doors.

46. Leave Outer Doors of Locks closed.

PART C - LEAKAGE RATE TEST

47. If the maximum expected temperature during the Leakage Rate Test exceeds the maximum temperature noted during the soapsuds test (Steps 37 to 46), reduce the Containment Vessel pressure to the following calculated gage pressure to avoid the possibility of exceeding the design pressure of 46.4 psig during the Leakage Rate Test:

$$= (46.4 + 14.7) \left[\frac{460^{\circ}\text{ F.} + \text{Maximum Temperature during Soapsuds Test at 46.4 psig}}{460^{\circ}\text{ F.} + \text{Maximum Expected Temperature during Leakage Rate Test}} \right] - 14.7$$

48. Prior to the start of the Leakage Rate Test at midnight, blow out condensate, if any, from Reference Chamber System through Valve "D" and from Containment Vessel through Condensate Drain Valve "G".

49. Open Valve "C", leaving Valves "B" and "C" open, to equalize pressure between Reference System and Containment Vessel.

50. Open Water Reservoir Valves "E" and "F" in sequence to allow water to flow into Differential Water Manometer to approximately Mid-Height of Scale, and then close Valves "E" and "F".

51. Release air from Containment Vessel until about 8 inches differential water pressure is indicated on Water Manometer.

NOTE: THE WATER DIFFERENTIAL WILL VARY WITH PRESSURE AND TEMPERATURE CHANGES IN THE CONTAINMENT VESSEL. THE WATER DIFFERENTIAL AT THE START OF THE LEAKAGE RATE TEST (USUALLY MIDNIGHT) WILL PROBABLY NOT BE 8 INCHES.

52. Close Valves "A" and check tightness of valves with soapsuds.

53. Record at hourly intervals the following data.

(a) Atmospheric Temperature, in degrees Fahrenheit.

(b) Atmospheric Barometric Pressure, in inches* of mercury.

(c) Containment Vessel Gage Pressure as indicated on Dial Gage (1 psi = 2.04 inches of mercury).

(d) Containment Vessel Absolute Pressure as determined by the sum of (b) and (c), in inches of mercury, = P.

(e) Difference in pressure between Containment Vessel and Reference Chamber System as measured by Differential Water Manometer, in inches* of water, = ΔP.

* It is intended that the readings will be made to tenths of an inch and estimated to nearest hundredths of an inch.

54. After about 30 hours (during midnight-to-dawn period of relatively uniform temperature), calculate the per cent loss (as a negative value) of total contained air by the following formula:

$$\text{Per Cent Loss} = \frac{\text{Initial } \Delta P - \text{Final } \Delta P}{\text{Initial } P \times 13.6} \times 100$$

NOTE: DURING THE NIGHT HOURS OF RELATIVELY UNIFORM TEMPERATURE (USUALLY THE MIDNIGHT-TO-DAWN PERIOD), THE TEMPERATURE IN THE TEST CHAMBER AND CONTAINMENT VESSEL WILL BECOME EQUAL. A COMPARISON OF THE MANOMETER DIFFERENCES BETWEEN THE INITIAL PERIOD OF UNIFORM TEMPERATURE AND THE FINAL PERIOD WILL ALLOW CALCULATION OF THE PER CENT LOSS OF AIR IN THE CONTAINMENT VESSEL BY THE ABOVE FORMULA.

55. If the calculated per cent loss as indicated by the Reference System is slightly within or exceeds 1/10th of 1%, continue test for another 24-30 hours and recheck loss.

56. If the calculated per cent loss substantially exceeds 1/10 of 1 per cent, recheck Containment Vessel, connections, valves, and instruments for sources of leakage, and repeat Leakage Rate Test, if necessary.

57. If the calculated per cent loss is less than 1/10th of 1% per 24 hours and is mutually acceptable, release air until Containment Vessel pressure is back to atmospheric pressure.

58. Remove Reference Chamber System, tubing, instruments and temporary test covers.

CHICAGO BRIDGE & IRON COMPANY

RVM/jl
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