GO 64 REV 8-72

CBI

Location Memphis Design

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VESSEL TEST INSTRUCTIONS

ENRICO FERMI ATOMIC POWER PLANT

UNIT NO. 2

RECEIVED
MAR 1 - 1973
THE RALPH M. PARSONS CO.

PREPARED FOR

THE DETROIT EDISON COMPANY

PREPARED BY

CHICAGO BRIDGE & IRON COMPANY

INFORMATION ONLY

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SUBJECT	MADE BY	CHKD BY	REV			CHARGE NO.
VESSEL TEST INSTRUCTIONS	CRS			By		69-5562
	DATE	DATE		Chkd		
				Date		SHT 1 OF 2

CBI

Location Memphis Design

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CBI

IDENTIFICATION
VCI - 69-5562

TITLE VESSEL CONTRACT INSTRUCTION FOR STRENGTH, LEAK AND LEAKAGE RATE TESTING
PRODUCT NUCLEAR CONTAINMENT VESSEL
CUSTOMER THE DETROIT EDISON COMPANY

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1.0 SCOPE

This vessel contract instruction (VCI) outlines the test sequence and specifies the contract requirements and the instrumentation for field testing of the containment vessel for this contract. It provides the chronological listing of all preparations, examinations, and tests necessary to perform the overload test as specified by the Code and the leak and/or leakage rate test (s) as specified by the contract specification.

2.0 REFERENCES

2.1 Contract Specifications: 3071-9

2.2 ASME Boiler and Pressure Vessel Code, Section III, Subsection B, 1968 Edition, with Summer 1969 Addenda.

2.3 Applicable CBI testing procedures attached and used to perform the required tests:

2.3.1 Vessel Solution Film Test Procedure VST-69-5562

2.3.2 Vessel Overload Test Procedure VOT-695562

2.3.3 Vessel Leakage Rate Test Procedure VLT-69-5562

3.0 PERSONNEL

3.1 The Project Foreman, or his delegate shall be responsible for the test(s) performed under this procedure.

3.2 The project welding and quality assurance supervisor, or his delegate shall witness, evaluate, and assist in conducting the tests performed under this procedure.

4.0 DESIGN AND TEST CONDITIONS

4.1	Design Internal Pressure	56 psi
4.2	Overload Pressure	70 psi
4.3	Leakage Rate Test Pressure	56 psi Nominal
4.4	Specified lowest service metal or test temperature	30°F
4.5	Specified Allowable Leakage Rate	0.2% per day

5.0 APPARATUS

5.1 Vessel Overload Test and Solution Film Test

5.1.1 Two 6"Ø dial gages graduated over a range of about 140 psi.

5.1.2 One 12"Ø recording gage graduated over a range of about 140 psi.

NOTE: All dial gages shall be calibrated against a standard dead-weight tester or a calibrated master gage in accordance with the Construction Quality Assurance Program for Nuclear Vessels and parts.

5.1.3 Detector Solution:

"Seamtest Concentrate" as manufactured by Winton Products Company.

5.1.4 Valves, piping, hose in accordance with sketch on page 4 of VOT-69-5562.

5.2 Vessel Leakage Rate Test

NOTE: All equipment calibration will be documented. Temperature Recorder, Dewpoint Recorder, Associated Dewpoint Equipment, Manometer, Pressure Gage and Barometer will be mounted in a single enclosure.

5.2.1 Temperature Measuring System

5.2.1.1 Esterline Angus Model #1124F Multipoint Temperature Recorder
a) Dual Range, Automatic Switching
Range A: 35-75° Dry Bulb
Range B: 70-110°F Dry Bulb
with 2 non-selective adjustable alarms and one right hand event pen.
b) Dual Range linear scale 35-75°F on top and 70-110°F on bottom.
c) 200 division linear chart
d) Accuracy of recorder is within 0.25% of 40°F span (0.1°F)
Smallest chart division 0.2°F
Readability 0.1°F

5.2.1.2 10 Platinum Resistance Bulbs
Burns Engineering Model (Special)
Accuracy of 0.075°F

5.2.1.3 Extension cable for resistance bulbs
Three conductor, 18 ga. copper wire.

Complete Temperature Measuring System accuracy is within 0.175°F.

5.2.2 Dew Point Measuring System

5.2.2.1 Esterline Angus Model #1124F
Multi-Point Temperature Recorder
a) Range 0-10 DC millivolts linear from Vap-Air Dew Point Hygrometer Probes
b) Scale 0-100°F Dew Point

c) 200 division linear chart
d) Accuracy of recorder within 0.25% of 100°F span (0.25°F)
Smallest chart division 0.5°F
Readability 0.25°F.

5.2.2.2 Vap-Air PN2684 0822 Model 84A Moisture Analyst housed in a JIC enclosure Range 0-100°F Dew Point, Output of 0-10 DC Millivolts.

5.2.2.3 Vap-Air PN 2694 0896 Automatic Probe Selector Switch for either manual or automatic monitoring.

5.2.2.4 6 Vap-Air PN 2683 0791 Dew Point Sensors.

5.2.2.5 Extension cable for Dew Point Sensors Vap-Air #PN 2692 0897.

Complete Dew Point Measuring System accuracy: If instrument is in +60 to +100°F ambient temperature range accuracy is 1°F. If instrument goes down to -20°F or up to +140° ambient temperature accuracy is 2°F.

5.2.3 Reference System Equipment

5.2.3.1 Wallace and Tiernan Model FA-139 Aneroid Barometer; Range 710 to 785 mm Hg; 0.2 mm Minimum Graduations; Sensitivity 0.02% of full scale (0.0150 mm Hg). Accuracy 0.3% of full scale (0.225 mm Hg). Readability 0.1 mm Hg.

5.2.3.2 Wallace and Tiernan Model 62A-2A-0100 8 1/2"Ø pressure gauge Range 0-100 psig; 0.1 psig Graduations; Repeatability 0.03% of full scale (0.03 psig); Accuracy 0.066% of full scale readability ± 0.01 psig. Reproducible readability of .02 psig.

5.2.3.3 Meriam Model 207A10 FF 36" Tube Flush Mount Manometer with precision bore tubing and full range vernier; scale graduated in inches and tenths; Readability 0.01" H_2O.

5.2.3.4 Five Nupro B-6BK-SW 3/8"Ø brass valves with a replaceable bellows stem seal and KEL-F seat assembly and socket weld connections.

5.2.3.5 2"Ø manometer reservoir and miscellaneous 3/8"Ø copper tubing.

5.4 Three Red Spirit Filled Thermometers with Armored Enclosure
Range 4°F to 220°F
Smallest Graduation 1°F

5.5 4 fans with 3/4 HP motor capable of running under 60 psig (use #12 wire, 3 conductor, min. suggested length 100' each).

5.6 Valves, piping, hose in accordance with sketch on page 9 of this procedure.

5.7 Brooks Hi-Accuracy Full-view Rotameter with calibrated accuracy of ± 1% of reading from 100% to 10% of full scale and reproducibility of 1/4% of instantaneous reading. Scale length is 600 mm with maximum flow rate of 3.38 scfm at 14.7 psia and 70°F and with special calibration curve for 56 psig.

5.8 Hoke needle valve with micrometer vernier handle.

6.0 CLEARANCE RULES AND PRECAUTIONARY MEASURES FOR SAFETY OF PERSONNEL AND EQUIPMENT

6.1 All unauthorized persons and all moveable equipment subject to damage must maintain a minimum clearance in all directions from the drywell of 600 feet while the pressure is being increased above 5 psi and until the overload test has been successfully completed.

6.2 Persons authorized in writing by Chicago Bridge & Iron Company and The Detroit Edison Company may be admitted within the area defined in 6.1 above. Authorized employees of CBI, Detroit Edison Co. and authorized inspection personnel will be permitted at the locations of the controlling valves

6.2 (Continued)

and gages approximately 300 feet from the outside of the drywell.

6.3 No one will be permitted within 300 feet of the vessel while the pressure is being increased above 5 psi for the first time or while the vessel pressure exceeds the design pressure.

6.4 If there is any urgent need that authorized employees of CBI Company inspect the vessel:

6.4.1 For vessel pressures below 56 psi reduce the pressure 1 psi before approaching the vessel.

6.4.2 For vessel pressures above 56 psi reduce the pressure to 56 psi.

6.5 Enforcement of the above clearance requirements shall be a joint responsibility of The Detroit Edison Company and Chicago Bridge & Iron Company.

6.6 Safety requirements found in Sections 8.7 and 8.9 must be observed during the solution film and leakage rate tests.

7.0 TEST AREAS

7.1 Drywell

7.1.1 Accessible circumferential and longitudinal welds.

7.1.2 Welds in penetrations including test covers.

7.1.3 Insert to shell welds.

7.1.4 Welds in vent line.

7.1.5 Equipment door gaskets.

7.1.6 Top flange gaskets.

7.1.7 Gaskets on penetration closures having a double gasket detail.

7.1.8 Personnel lock door gaskets (interior & exterior doors).

7.1.9 Expansion joints on vent lines.

7.2 Suppression Chamber

NOTE: All welds on outside of torus, below water level, to be suitably dried as necessary for visual inspection of any water leakage.

7.2.1 Accessible circumferential and longitudinal welds.

7.2.2 Welds in penetrations including test covers.

7.2.3 Insert to shell welds.

7.2.4 Gaskets on penetration closures having a double gasket detail.

8.0 TEST SEQUENCE AND REQUIREMENTS

8.1 Install the instrumentation and reference system and conduct the initial testing of the reference system per procedure EIP-69-5562.

NOTE: The instrumentation is listed in Paragraph 5.0. Page 9 of this procedure shows the location of the reference chambers and instrumentation.

The drywell reference chamber represents 59% and the torus reference chamber 41% of the total air volume of the containment vessel.

8.2 Perform the closure gasket interspace test per procedure VST-69-5562.
Test pressure = 56 psi.
Test areas: 7.1.5, 7.1.6, 7.1.7, 7.2.4.

8.3 Fill the suppression chamber with water per procedure VOT-69-5562 Paragraphs 2.2 and 2.2.1.

8.4 Connect the air lines, gage lines, dial gages and recording gage per procedure VOT-69-5562, Paragraph 2.1 and Paragraphs 2.3 through 2.6 and pressurize the vessel to 5 psi.

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CUSTOMER THE DETROIT EDISON COMPANY

8.5 Perform the 5 psi solution film test of the containment vessel per procedure VST-69-5562. Vessel pressure = 5 psi. Test area: 7.1 and 7.2.

8.6 Perform the vessel overload test per procedure VOT-69-5562 Paragraph 2.7 through Paragraph 4.2.

8.7 If the maximum temperature during the leakage rate test is expected to increase above the ambient temperature at the start of the test, reduce the pressure in the vessel to the following calculated gauge pressure (P_T) to avoid the possibility of exceeding the specified leakage rate test pressure.

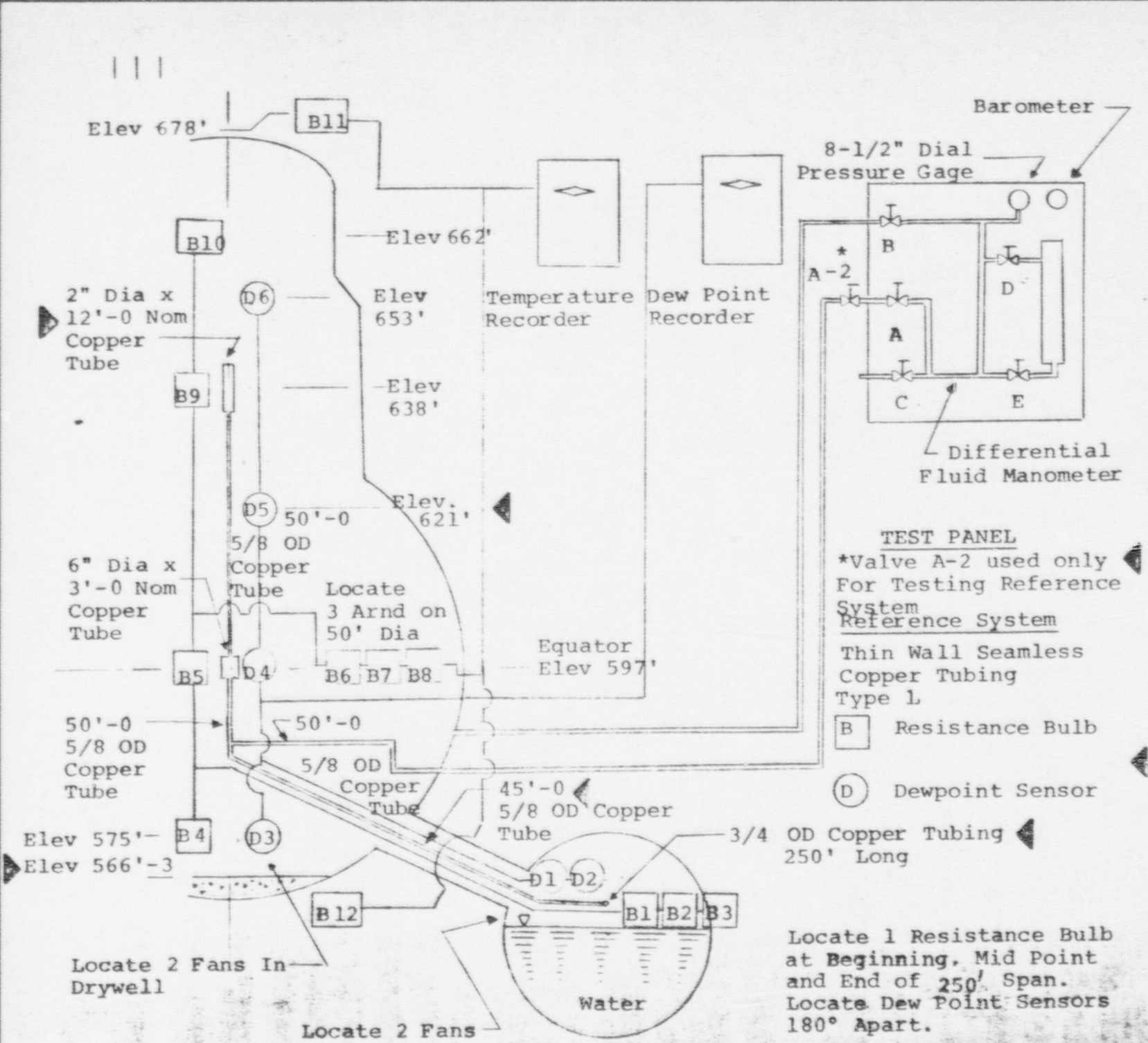
$$P_T = \left[56 + 14.7 \right] \left[\frac{(460 + \text{ambient temp. °F at start of leakage rate test})}{(460 + \text{maximum expected temp °F during leakage rate test})} \right] - 14.7$$

8.8 With the vessel pressure at P_T, conduct a solution film test of the vessel per procedure VST- 69-5562. Test Area:7.1 & 7.2.

8.9 Disconnect the air and gage lines and blank all valves adjacent to the vessel. Test these valves for leakage with detector solution.

8.10 Perform the vessel leakage rate test per procedure VLT-69-5562. Leakage rate test pressure P_T in Step 8.8. Lock exterior door is to be open.

8.11 Remove all overload and leakage rate test equipment.



LEAK RATE TEST LAYOUT

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TITLE VESSEL CONTRACT INSTRUCTION FOR STRENGTH, LEAK AND LEAKAGE RATE TESTING

PRODUCT NUCLEAR CONTAINMENT VESSEL

CUSTOMER THE DETROIT EDISON COMPANY

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CBI

IDENTIFICATION VST 69-5562

TITLE VESSEL SOLUTION FILM TEST PROCEDURE

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PRODUCT NUCLEAR CONTAINMENT VESSEL

CUSTOMER THE DETROIT EDISON COMPANY

REV. NO. 0

BY CRS DATE 12/27/72

REVIEWED	OB ENGR	MEM ENGR	GEN WELD	INSP TEST	CORP NU QA	REG CONST QA	REG MFG QA				BY	DATE
	GMT	RLB		CNS GM CH	RS AHB	VMY				PREPARED CHECKED AUTHORIZED TYPED	CRS WWL WWL FC	12/27/72 12/27/72 1/22/73 12/27/72

1.0 SCOPE

This procedure applies to solution film testing of vessels and vessel components.

2.0 TEST PROCEDURE

2.1 Remove weld slag, dirt and debris from areas to be leak tested.

2.2 Pressurize the test areas to the required test pressure.

2.2.1 On double gasketed enclosures apply test pressure of 56 psi between the gaskets.

2.2.2 Vessel Pressure = 5 psi for solution film test before overload test.

2.2.3 Vessel Pressure = P_T (from VCI Step 8.10) after overload test.

2.3 Apply a solution film in a continuous film free of bubbles to all test areas.

2.4 Evaluation of leaks:

2.4.1 Any leak detected that does not affect the structural

integrity of the vessel as agreed between CBI and the customer, but which might prevent a successful Leakage Rate Test shall be temporarily sealed. An example is a leak in a temporary closure.

2.4.2 Any leak detected that affects the structural integrity of the vessel shall be repaired.

2.5 To make repairs to the vessel or personnel lock interior bulkhead proceed as follows:

2.5.1 Release the pressure to atmosphere by opening the the pressure release valve.

2.5.2 Immediately after the pressure has been released, open a large enough connection to prevent the formation of a vacuum in the vessel.

2.5.3 Before making weld repairs or doing any work that might cause a spark, check vapor space to make sure that it is free from any explosive mixture.

2.5.4 Weld repairs are to be made and recorded in accordance with the Construction Quality Assurance Program.

2.5.5 Retest repaired areas and previously untested areas.

2.6 To make repairs to the personnel lock barrel or exterior bulkhead, proceed as follows:

2.6.1 Close the lock inner equalizing valve and open the outer equalizing valve to release the pressure from the lock.

2.6.2 Before making weld repairs or doing any work that might cause a spark, check vapor space to make sure that it is free from any explosive mixture.

2.6.3 Weld repairs are to be made and recorded in accordance with the Construction Quality Assurance Program.

2.6.4 Retest repaired areas and previously untested areas.

CBI

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PRODUCT	NUCLEAR CONTAINMENT VESSEL	REV. NO. 0
CUSTOMER	THE DETROIT EDISON COMPANY	BY CRS DATE 12/27/72

3.0 ACCEPTANCE CRITERIA

3.1 No detectable leakage as outlined in Step 2.4.

4.0 DOCUMENTATION

4.1 The satisfactory completion of this test shall be recorded on the Shop or Field QA Check List in accordance with the requirements of the applicable revision of the Construction or Shop Quality Assurance Program.

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CBI

IDENTIFICATION VOT-69-5562

TITLE VESSEL OVERLOAD TEST PROCEDURE

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PRODUCT NUCLEAR CONTAINMENT VESSEL

REV. NO. 0

CUSTOMER THE DETROIT EDISON COMPANY

BY CRS DATE 12-27-72

REVIEWED	OB ENGR	MEM ENGR	GEN WELD	INSP TEST	CORP NU QA	REG CONST QA	REG MFG QA				BY	DATE
	GMT	RLB		CNS GM CH	RS AHB	VMY				PREPARED CHECKED AUTHORIZED TYPED	CRS WWL WWL	12/27/72 12/27/72 1/22/72

1.0 SCOPE

This procedure covers the Hydro-Pneumatic overload test of the drywell and suppression chamber.

2.0 TEST PROCEDURE

NOTE: CBI TESTING PERSONNEL SHALL INSTALL TWO TEMPERATURE DEVICES TO MEASURE THE SHELL TEMPERATURE. SHOULD THE VESSEL TEMPERATURE START TO DROP DURING THE TEST, BLOWDOWN SHOULD BE STARTED IN TIME TO REDUCE THE VESSEL PRESSURE TO 22 1/2 PSI BEFORE THE VESSEL TEMPERATURE DROPS BELOW 30° F.

2.1 Connect air and gage lines, with dial gages and recording gage, to the vessel as shown on sheet 5.

NOTE: THE CONTROLLING VALVES FOR THE AIR SUPPLY AND THE GAGES ON THE GAGE LINE ARE TO BE LOCATED AT A MINIMUM DISTANCE OF 300 FEET FROM THE OUTSIDE OF THE DRYWELL (VALVES 2, 3, 4, 5, 6, 7, 8, & 9)

2.2 Fill the suppression chamber with water to an elevation 3 inches above the centerline [approximately 133,360 cu-ft (997,000 gallons)].

2.2.1 Inspect the exterior of the suppression chamber for any leakage or distortion from water loading.

2.3 Open shutoff valves 1, 1A & 10; isolation valves 2,3 & 4; air supply valve 5, and valve 9

2.4 Close blow-off valves 6 & 7; and valve 8

2.5 Close or blank all other connections in the drywell and Suppression Chamber.

2.6 Close the inner and outer door and equalizing valves of the personnel lock.

NOTE: IMMEDIATELY AFTER CLOSING THE LAST OPENING IN THE DRYWELL AND SUPPRESSION CHAMBER START PUMPING AIR TO AVOID THE POSSIBILITY OF A VACUUM OCCURING INSIDE THE VESSEL.

Maintain the mandatory CBI safety & clearance rules.

2.7 With valve 5 open, pressurize the vessel to 35 psi. Then increase the vessel pressure in 7 psi increments until the required test pressure of 70 psi has been reached.

NOTE: AT THE PRESSURE INCREMENTS AND AT HOURLY INTERVALS, THE PRESSURE READINGS OF THE DIAL AND RECORDING GAGES SHALL BE RECORDED ON THE TEST DATA SHEET. INCREMENT HOLDING TIME SHALL BE 10 MINUTES, OBSERVING THE VESSEL PRESSURE.

2.8 Close valve 5 and hold the 70 psi test pressure for 20 minutes, adding or releasing air to compensate for temperature variations. Open valve 5 to increase pressure or open valve 7 to decrease pressure.

2.9 Close valve 9 and open valve 8 to interconnect the locks with the drywell.

2.10 Hold the 70 psi test pressure for another 40 minutes, adding or releasing air to compensate for temperature variations, such that the 70 psi overload pressure is maintained for a total of not more than one hour. Open valve 5 to increase pressure or open valve 7 to decrease pressure.

2.11 Open blowoff valve 7 and reduce the pressure in the vessel and airlock to the design pressure of 56 psi and hold for sufficient time to permit inspection of the air lock exterior bulkhead and door for visible permanent distortion. If any defects are detected, release pressure make the necessary corrections, and retest.

2.11.1 Weld repairs are to be made and recorded in accordance with the Construction Quality Assurance Program.

2.12 Close valve 8 and open valve 9 or the lock exterior equalizing valve. Reduce the pressure in the lock to atmospheric. Inspect the vessel and airlock interior bulkhead and door for visible permanent distortion. If any defects are detected, release pressure, make the necessary corrections, and retest.

2.12.1 Weld repairs are to be made and recorded in accordance with the Construction Quality Assurance Program.

3.0 ACCEPTANCE CRITERIA

3.1 No visible, permanent distortion of the vessel as judged by the personnel under 4.1.

4.0 DOCUMENTATION

4.1 Mark the following data on the face of the recording chart:

Design Pressure	56 psi
Specified Test Pressure	70 psi
Contract Number	69-5562
Test Procedure Number	VOT-69-5562 Rev.
Date of Test:	

The CB&I Project Foreman, the CB&I Welding and Quality Assurance Supervisor, the Authorized Inspector and Customer's Inspector with their respective signatures.

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CBI

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PRODUCT	NUCLEAR CONTAINMENT VESSEL	REV. NO. 0	
CUSTOMER	THE DETROIT EDISON COMPANY	BY CRS	DATE 12/27/72

4.2 The satisfactory completion of this test shall be recorded on the Field Quality Assurance Check List. The Authorized Inspector shall be requested to sign the Field Quality Assurance Check List to signify that the test has been completed to his satisfaction.

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CBI

IDENTIFICATION VOT-69-5562

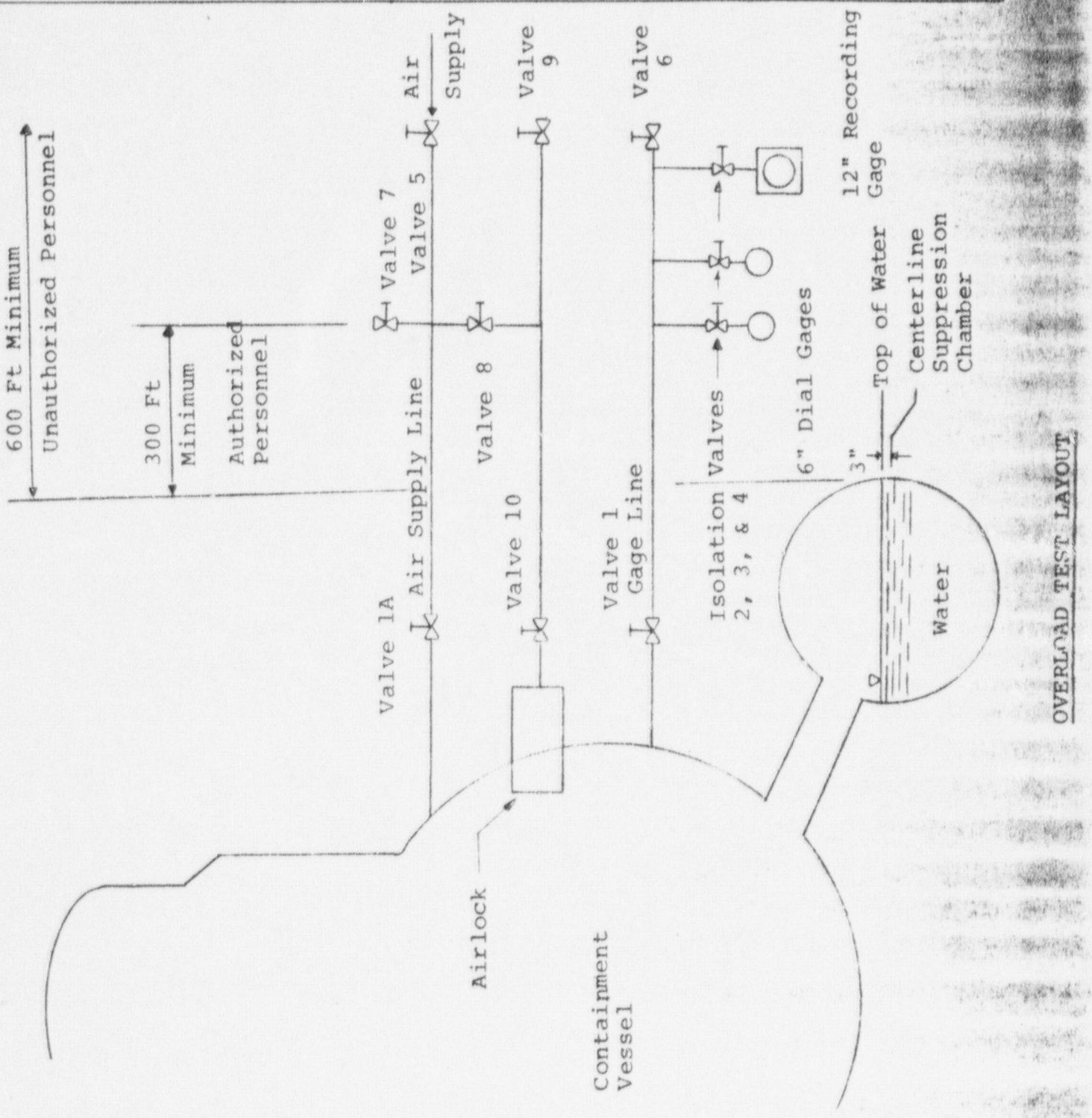
TITLE VESSEL OVERLOAD TEST PROCEDURE

PRODUCT NUCLEAR CONTAINMENT VESSEL

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OVERLOAD TEST LAYOUT

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CBI

IDENTIFICATION VLT 69-5562

TITLE VESSEL LEAKAGE RATE TEST PROCEDURE

PRODUCT NUCLEAR CONTAINMENT VESSEL
CUSTOMER THE DETROIT EDISON COMPANY

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BY CRS DATE 2/16/73

REVIEWED	OB ENGR	MEM ENGR	GEN WELD	INSP TEST	CORP NU QA	REG CONST QA	REG MFG QA				BY	DATE
	GMT	RLB		CNS GM CH	RS AHB	VMY				PREPARED CHECKED AUTHORIZED TYPED	CRS WWL WWL FC	12/27/72 12/27/72 2/16/73 12/27/72

1.0 SCOPE

This procedure details the requirements of the leakage rate tests noted in VCI-69-5562.

2.0 TEST PROCEDURE

NOTE: DURING THE LEAKAGE RATE TEST OF THE VESSEL, ONLY AUTHORIZED PERSONNEL SHALL BE ALLOWED ON OR ADJACENT TO THE VESSEL AND INSTRUMENTS. NO WORK SHALL BE PERFORMED WITHIN 25 FEET OF INSTRUMENTS, VALVES OR THE OUTSIDE OF THE VESSEL.

CBI TESTING PERSONNEL SHALL INSTALL TWO TEMPERATURE DEVICES TO MEASURE THE SHELL TEMPERATURE.

SHOULD THE VESSEL TEMPERATURE START TO DROP DURING THE TEST, BLOWDOWN SHOULD BE STARTED IN TIME TO REDUCE THE VESSEL PRESSURE TO 22 1/2 PSIG BEFORE THE VESSEL TEMPERATURE DROPS BELOW 30° F. IF THE VESSEL PRESSURE EXCEEDS 56 PSIG DURING THE PEAK PRESSURE TEST, THE EXCESS PRESSURE ABOVE 56 PSIG MUST BE BLOWN OFF AND THE LEAKAGE TEST RERUN.

2.1 Open valve B to equalize the pressure in the vessel and reference system.

2.2 Open fluid reservoir valves D and E in sequence to allow the fluid to flow into the manometer to approximately mid-height. Close valves E and D in that order. Use Meriam Unity oil D-2969 or equal. (Specific Gravity = 1.0).

2.3 Release air from the vessel by opening a vessel valve until about 6" differential water pressure is indicated on the manometer. Close the valve and leak test it with solution film. Repair if required.

2.4 Start the fans in the vessel.

2.5 After vessel conditions have been allowed to stabilize a minimum of 4 hours, record the following data at hourly intervals:

(A) Instrument enclosure temperature t_e (Deg F)
(B) Barometric Pressure (mm Hg)
(C) Vessel Gage Pressure (psi)
(D) Individual Resistance Bulb Readings, B. (Deg F)
(E) Individual Dewpoint Sensor Readings, D. (Deg F)
(F) Ambient Temperature at Top of Vessel (Deg F)
(G) The Pressure Differential Between the Vessel and the Reference System as indicated by the Panel Manometer, ΔP (in. H_2O*)

*Readings will be to the nearest hundredth of an inch on both columns of manometer.

2.6 Calculate the following on an hourly basis:

(A) Corrected Barometric Pressure (mm Hg)
Corrected Barometric Pressure = Barometric Pressure $- (.004)(t_e - 75)$

(B) Vessel Absolute Pressure (psia)

P = Vessel Gage Pressure + Corrected Barometric Pressure (.01933677)

(C) Weighted Average Internal Air Temperature (°R)

$$T = \frac{.37}{3}(B1 + B2 + B3) + \frac{.46}{5}(B4 + B5 + B6 + B7 + B8) + \frac{.17}{2}(B9 + B10)$$

(D) Weighted Average Internal Dewpoint Temperature (°F)

$$DPT = \frac{.37}{2}(D1 + D2) + \frac{.63}{4}(D3 + D4 + D5 + D6)$$

(E) The partial pressure of water vapor, P_V, in psi the average dewpoint temperature, use standard steam tables to make this conversion.

(F) The hourly percent leakage rates corrected for the change of containment water vapor pressure. Positive values indicate containment in leakage, and negative values indicate containment out leakage.

$$\text{Percentage Leakage Rate/Hr} = L = \frac{100}{P_1 - P_{v1}}\left[\left(\frac{\Delta P_1}{27.7} + P_{v1}\right) - \left(\frac{\Delta P_2}{27.7} + P_{v2}\right)\frac{T_1}{T_2}\right]$$

P_1, P_{v1}, ΔP_1, T_1: Initial variables (immediately preceeding current data)

ΔP_2, P_{v2}, T_2 : Current variables

(G) The cumulative leakage rate: ΣL

2.7 Perform a linear regression analysis and deviation analysis for the least mean square calculation using the point slope equation of a straight line where:

$$y = mx + b$$

Where
- $y = \Sigma L$ = Cumulative percentage leakage rate
- x = Elapsed time in hours from first test measurement after stabilization
- N = Number of data points
- m = Slope
- b = y intercept
- S_m = Variance of slope

$$m = \frac{N\Sigma xy - \Sigma x\Sigma y}{N\Sigma x^2 - (\Sigma x)^2}$$

$$b = \frac{\Sigma y\Sigma x^2 - \Sigma x\Sigma xy}{N\Sigma x^2 - (\Sigma x)^2}$$

$$S_m = \sqrt{\frac{1}{N-2}\left[\frac{N\Sigma y^2 - (\Sigma y^2)}{N\Sigma x^2 - (\Sigma x)^2} - m^2\right]}$$

2.8 After a minimum test period of 24 hours calculate the 24 hour containment vessel leakage rate and submit it to the customer representative at the site. The test shall be concluded unless CBI is notified that additional testing is required. In the latter case, the additional testing shall be the subject of mutual agreement between CBI and the customer representative.

$$L_m = 24 \times m \pm t_{0.95} \times S_m$$

L_m : Calculated 24 hour leakage rate

m : as in Step 2.7

S_m : as in Step 2.7

$t_{0.95}$: 95% confidence factor for N degrees of freedom

2.9 Install a flowmeter into a blowdown line and establish a leakage rate (scfm) equivalent to 75% of the specified allowable leakage rate per 24 hours using a free vessel volume of 346000 cu. ft.

$$L_{o(scfm)} = 346000 \times \frac{.75\ L}{24 \times 60} \times \frac{P}{Pstd} \times \frac{Tstd}{T}$$

$L_{o(scfm)}$: Vessel leakage in scfm equivalent to 75% of the specified allowable leakage rate per 24 hours

P : Pressure at start of verification test (psi)

T : Temperature at start of verification test (°R)

Tstd : Standard temperature (°R)
Pstd : Standard pressure (°R)
L : Specified allowable leakage rate

2.10 Continue steps 2.5 through 2.7 and record the flowmeter reading hourly.

2.11 After a period of 10 to 12 hours calculate the average 24 hour leakage rate, L_o through the flowmeter using the readings of flowmeter as a function of time.

2.12 Calculate the percent error between the calculated and the actual flowrates during the verification test.

$$\% \text{ Error} = \frac{(L_C - L_O) - L_m}{L_m}$$

L_C : Calculated 24 hour composite leakage rate during verification test
L_O : Percent leakage rate per 24 hours imposed on vessel per flowmeter readings
L_m : Measured 24 hour leakage rate during vessel test (without variance) from Step 2.8

2.13 Open a vessel valve to release pressure from the vessel until atmospheric pressure is reached.

2.14 Open a large enough connection in the vessel to prevent the formation of a vacuum.

2.15 Remove all leakage rate test equipment.

3.0 ACCEPTANCE CRITERIA

3.1 The calculated 24 hour leakage rate shall demonstrate a 95% confidence that the calculated leakage is less than 75% on the maximum allowable containment leakage rate.

3.2 The calculated 24 hour leakage rates for the vessel test and the supplemental verification test shall demonstrate an agreement within $\pm$ 25%.

GO 168A REV 4-72

CBI

IDENTIFICATION
VLT - 69-5562

TITLE VESSEL LEAKAGE RATE TEST PROCEDURE

PAGE NO. 6 OF 6
REV. NO. 1
PRODUCT NUCLEAR CONTAINMENT VESSEL
CUSTOMER THE DETROIT EDISON COMPANY
BY CRS DATE 2/16/73

4.0 DOCUMENTATION

4.1 A Leakage Rate Test Report containing actual data, leakage rate calculations and conclusions will be prepared.

GO 168 REV 4-72

CBI

IDENTIFICATION
EIP - 69-5562

TITLE LEAKAGE RATE TEST EQUIPMENT INSTALLATION PROCEDURE
PRODUCT NUCLEAR CONTAINMENT VESSEL
CUSTOMER THE DETROIT EDISON COMPANY

PAGE NO. 1 OF 4
REV. NO. 1
BY CRS DATE 2/16/73

REVIEWED	OB ENGR	MEM ENGR	GEN WELD	INSP TEST	CORP NU QA	REG CONST QA	REG MFG QA				BY	DATE
	GMT	RLB		CNS GM CH	RS AHB	VMY				PREPARED CHECKED AUTHORIZED TYPED	CRS WWL WWL FC	12/27/72 12/27/72 1/22/73 12/27/72

1.0 SCOPE

This procedure applies to the installation of equipment for the performance of the vessel leakage rate test by the reference system method.

2.0 INSTALLATION PROCEDURE

2.1 Test each reference chamber in the shop prior to shipment. Test by pressurizing with an air refrigerant mixture to about 70 psi and sniffer test all joints with a halogen leak detector or test by evacuating and helium probe all joints with a helium mass spectrometer connected to the system.

2.2 If any leaks are detected, release the pressure, repair, and retest until no leaks are indicated with the leak detector. The leak detector shall be capable of detecting leaks in the reference chambers of 5×10^{-6} std cc/sec or larger.

2.3 Assemble the reference chamber (s) and connecting tubing at the construction site. Do not connect tubing to the reference system panel.

NOTE: THE EXTERIOR INSTRUMENTS FOR THE LEAKAGE RATE TEST SHOULD BE LOCATED AS NEAR AS PRACTICABLE TO THE NOZZLES WHERE THE TUBING CONNECTS TO THE VESSEL. EXTERIOR TUBING SHOULD BE MINIMIZED. BOTH TUBING AND INSTRUMENTS SHOULD BE PROTECTED

FROM THE WEATHER. INTERIOR TUBING SHOULD BE KEPT AT LEAST 12 INCHES FROM STEEL EXCEPT FOR THE PENETRATIONS. INSTALL TEMPERATURE MEASURING EQUIPMENT FOR TEMPERATURE READINGS DURING STEPS 2.7 AND 2.8. CONNECTIONS SHOULD BE MADE THROUGH THE TEMPORARY TEST CAPS OF "NON-SPARE" PENETRATIONS. THE LOCATION OF THE INSTRUMENTATION AND THE PENETRATIONS TO BE USED ARE TO BE DETERMINED BY CBI. APPROVAL OF THE PENETRATIONS AND LOCATION OF THE INSTRUMENTATION SHALL BE OBTAINED FROM THE ENGINEER.

2.4 Pressurize the reference chamber system with nitrogen gas to about 70 psi through the valve A-2 at the vessel penetration.

2.5 Leak test tubing and chamber joint connections with a solution film. Repair and retest and repeat as necessary until no leakage is detectable.

2.6 Vent the reference system.

2.7 Connect temperature sensor devices through the vessel wall to the temperature measuring instrument, calibrate and install in the locations required.

2.8 Connect dewpoint sensors through the vessel wall to the dewpoint measuring instrument, calibrate above an ice bath and install in the locations required.

2.9 Install reference system in final position. Connect the reference system at the vessel penetration valve A-2 to a vacuum pump and gage. Evacuate the reference system so that after isolating the vacuum pump and allowing time for pressure equalization, the system pressure will be 200 microns Hg or less.

2.10 Conduct an absolute pressure test of the evacuated portion of the reference system for a minimum period of 24 hours, recording data periodically. Plot absolute pressure and temperature versus time in order to determine for similar temperature periods the rate of pressure rise caused by both out-gassing and in-leakage.

$$\text{Temperature of Reference System} = .37\,\frac{(B1 + B2 + B3)}{3} + .46(B5) + .17(B9)$$

2.11 As determined in 2.10 the rate of pressure rise caused by both out-gassing and in-leakage only shall not exceed 400 microns Hg per 24 hours. If the system exceeds this allowable retest the reference system with a solution film.

2.12 Data from 2.10 and 2.11 and the absolute pressure data for the reference system panel shall be submitted to the customer for review and approval. If it is mutually agreed by the customer and CBI that leakage indicated is within the allowable for the reference system, the absolute pressure test of the reference system may be concluded and the system shall be vented to atmospheric pressure with nitrogen.

2.13 Connect the tubing from the reference system to the reference system panel as shown on Page 4. Do not admit fluid to the differential manometer until after the pressure is equalized between the reference system and the vessel. (See VLT - 69-5562).

2.14 Open valves "A" and "C" and close valves "B", "D" and "E" in the reference system panel.

2.15 Pressurize the reference panel and reference system with nitrogen gas to about 70 psi through valve "C". Close valve "C".

2.16 Leak test the tubing connection to the reference system panel with a solution film. Repair and retest and repeat as necessary until no leakage is detectable in this connection.

2.17 Remove the nitrogen supply line.

2.18 Install fans in the vessel.

3.0 TEMPORARY VACUUM TEST EQUIPMENT

3.1 Welch Duo-Seal Mechanical Vacuum Pump.

3.2 CVC Pirani Vacuum Gage.

Range: 0-50 microns Hg
0-2000 microns Hg

4.0 DOCUMENTATION

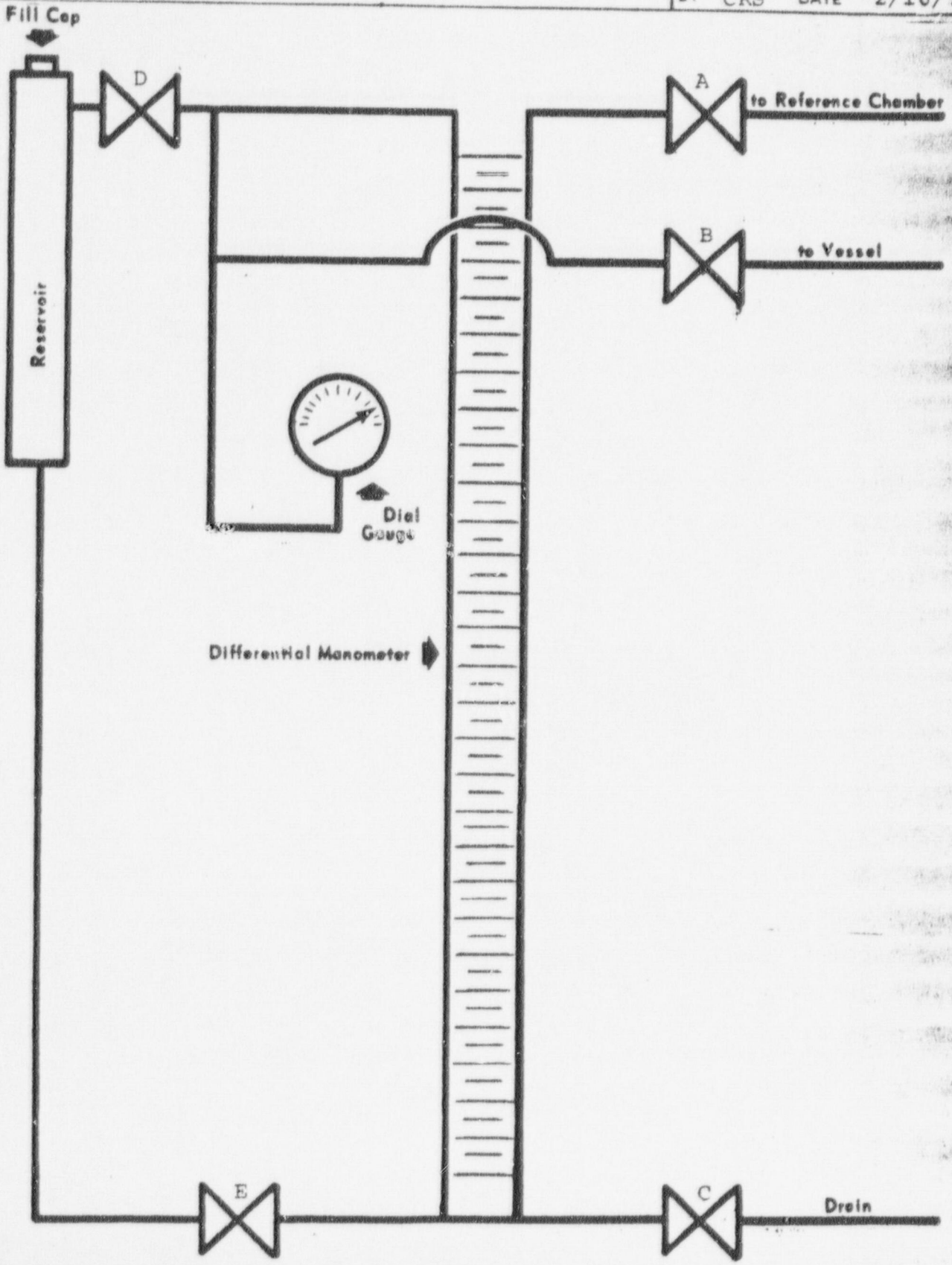
4.1 The data recorded during the vacuum testing of the reference system along with the Pressure and Temperature Plots and Pressure Rise Calculations will be included in the Leakage Rate Test Report.

10948-063-

CBI

IDENTIFICATION
EIP - 69-5562

TITLE LEAKAGE RATE TEST EQUIPMENT INSTALLATION PROCEDURE
PRODUCT NUCLEAR CONTAINMENT VESSEL
CUSTOMER THE DETROIT EDISON COMPANY



GENERATION ENG.

Approval Control

J. I. HASKIN

264

ENRICO FERMI A.P.P. UNIT 2

Documentation No.			
Location		Approval X	
P.O.	ICTOLO	Installation	
B/M	B2-1C	DECo File No.	B2-288
Transmittal Date	2-21-73	Vendor	JBF
Engineering		Approved	As Noted
Approved	As Noted	Quality Assurance Dir.	
AC RBauer			
M [illegible]		System Engineer	
E [illegible]		[illegible]	
IC [illegible]		Proj Director-Operations	
QA			
Project Engineer			
Approved	As Noted	Rel. For Fab. Or Constr.	
R. Vance/cb			

69-5562

RECEIVED
MAR 1 - 1973
THE RALPH M. PARSONS CO.

B34-X063

ARMS INDEXED
DTC: ~~TPTEST~~ TDDATA
DSN: 69 55621

MUST BE COMPLETED

10948-034

GENERATION ENG.
Approval Control

J. T. HASKIN

RECEIVED
JUL 8 1974
The Ralph M. Parsons Co.

FIRST SUBMITTAL

10948-0801

ENRICO FERMI A.P.P. UNIT 2

Documentation No. T23-01-V-900-BA-004				
Location			Approval X	
P.O. IC70020			Installation	
B/M B2-1C			DECo File No. B2-288	
Transmittal Date 5-15-74			Vendor CB&I	
Engineering			Approved	As Noted
Approved		As Noted	Quality Assurance Dir.	
A/C	K A Boyer			
M			System Engineer	
E			MILBrtl	
IC			Proj Director-Operations	
QA				
Project Engineer				
Approved		As Noted	Rel. For Fab. Or Constr.	
R. Vance/CB				

69-5562

Sd-113
ARMS INDEXED
DTC: TDDATA
DSN: 69 55624

DE FORM DS 193 10-73 CS

10948-082

CBI

Location Birmingham Design

DOCUMENT CONTROL
T23-01-V-900-BA004
MAY 16 1974
ERRMIS STATUS
CO. C&E
LTR. NC. DME DEC 303

UPPER BEAM SEAT ANALYSIS

TABLE OF CONTENTS

SHEET	REVISION	DESCRIPTION
BM-1	0	Method and Summary
BM-2	0	Loading Conditions
BM-3	0	Input-Load Condition A-OBEQ
BM-4	0	"
BM-5	0	Output Load Condition A-OBEQ
BM-6	0	"
BM-7	0	"
BM-8	0	Input Load Condition B-DBEQ
BM-9	0	"
BM-10	0	Output Load Condition B-DBEQ
BM-11	0	"
BM-12	0	"
BM-13	0	Input Load Condition D-OBEQ
BM-14	0	"
BM-15	0	Output Load Condition D-OBEQ
BM-16	0	"
BM-17	0	"
BM-18	0	Load Condition E & F - Introduction
BM-19	0	"
BM-20	0	"
BM-21	0	"
BM-22	0	Load Condition E-DBEQ
BM-23	0	"
BM-24	0	"
BM-25	0	"
BM-26	0	"
BM-27	0	Load Condition F-OBEQ
BM-28	0	"
BM-29	0	"
BM-30	0	"
BM-31	0	"

ARMS INDEXED
DISC: TDDATA
ITEM: 69 5562 4

RECEIVED
JUL 8 1974
The Ralph M. Parsons Co.

INFORMATION ONLY

B2-288

SUBJECT	MADE BY	CHKD BY	REV			CHARGE NO.
Upper Beam Seats	LDF			By		69-5562
Table of Contents	DATE 5-10-74	DATE		Chkd		
				Date		SHT BM-0 OF

GO 64 REV 4-73

CBI

Location Birmingham Design

UPPER BEAM SEATS

The upper beam seats and ring girder are analyzed for the permanent loads and loading combinations per Sargent and Lundy's loading combination on sheet BM-2 of this report.

The analysis is performed assuming all beam seats and the ring girder are reduced in section properties per previous analysis performed by CBI and approved per Detroit Edison letter EF2-22,054, dated December 7, 1973.

For the loading condition A & B a live load of 42.5 kip is included. This is applied at the maximum loaded beam seat. This load will occur only during refueling.

Loading conditions C thru F include a rupture load. Therefore, the 42.5 kip live load could not occur during these conditions.

Loading condition B, with the 42.5 kip live load included, resulted in a worse loading condition than loading condition C. Therefore, this condition was not investigated.

Loading condition E and F require a rupture force acting upward, the CBI computer program used for the previous analysis was not designed to handle an upward force on the beam seat and ring girder. See sheets BM-18 thru BM-31 for these conditions.

The analyses were performed with both seismic conditions (OBEQ and DBEQ). The beam seats and ring girder were found to be adequate to carry all loads.

Buckling allowables of the shell for DBEQ loading is not defined in the code. A factor of safety against buckling = 1.5 is used.

SUBJECT	MADE BY	CHKD BY	REV			CHARGE NO.
Upper Beam Seats	LDF	CRS		By		69-5562
	DATE 5-7-74	DATE 5-10-74		Chkd		SHT BM-1 OF
				Date		

GO 64 REV 4-73

SARGENT & LUND ENGINEERS

DESIGN BY D. DENISEWICZ DATE 1-14-1974

CHECKED BY K. FUS DATE 1-16-74 SHEET 1 OF 1

CALCS. FOR BEAM SEATS AT DRYWELL

LOADING COMBINATION AND ALLOWABLE STRESSES FOR BEAM SEATS DESIGN.

FOR REF. SEE S&L DWG. B-2 REV. C LOADS IN KIPS

BEAM SEAT	LOADING COMB-1 STATIC + O.B.E	LOAD. COMB-2 STATIC + D.B.E	LOADING COMB-3 STATIC+D.B.E+RUPT.	LOAD. COMB-4 R.L-DL=TOTAL UP.
P_1	15.4	16.8	—	—
P_2	18.7	20.4	—	—
P_3	16.5	18.0	37.4	13.4
P_4	37.4	40.8	80.8	15.0
P_5	34.1	37.2	—	—
P_6	25.3	27.6	—	—
P_7	29.7	32.4	47.4	-13.4
P_8	30.8	33.6	73.6	19.0

NOTE-1 ANY INDIVIDUAL BEAM SEAT SHOULD BE CHECKED FOR ALL OF THE LOADING COMBINATIONS LISTED BELOW:

LOADING COMBINATION -1 USE CODE ALLOWABLE STRESSES

LOADING COMBINATION -2, -3, -4 } USE CODE YIELD STRESSES

NOTE-2 RING GIRDER SHOULD BE DESIGNED FOR THE FOLLOWING LOADING CONDITIONS:

ALLOW. STRESSES AS ABOVE

A) LOADING COMBINATION -1

B) LOADING COMBINATION -2

C) P_4 FROM LOADING COMB-3 AND ALL OTHER BEAM SEAT FORCES FROM LOADING COMBINATION -2 EXCEPT P_4

D) P_4 FROM LOAD. COMB-3 AND ALL OTHER BEAM SEAT FORCES FROM LOADING COMB-1 EXCEPT P_4

E) P_8 FROM LOADING COMB-4 AND ALL OTHER BEAM SEAT FORCES FROM LOADING COMB-2 EXCEPT P_8

F) P_8 FROM LOAD. COMB-4 AND ALL OTHER BEAM SEAT FORCES FROM LOAD. COMB-1 EXCEPT P_8

64-5562 L
SHT 2M2 OF

INPUT FOR UPPER BEAM SEAT ANALYSIS: LOADING CONDITION A

OBE

ELEVATIONS OF		
EQUATOR =	597.0000	FT.
TOP OF STEEL(TOP OF GIRDER)=	607.0000	FT.
RADIUS OF SPHERE	408.00	IN.
SHELL THICKNESS	0.A750	IN.
MODULUS OF ELASTICITY	27400000.	PSI
FACTOR OF SAFETY(BUCKLING)	2.0	
ALLOWABLE TENSILE STRESS	17500.	PSI
VERTICAL SEISMIC FACTOR	.100	
AISC BENDING ALLOWABLE	20280.	PSI

LOADS

GIVEN DEAD AND EARTHQUAKE LOADS ON THE BEAMS

NO	AZIMUTH (DEG.)	LOAD (LBS)	EQ LOAD (LBS)
1	122.60	34000.	3400.
2	147.40	31000.	3100.
3	171.00	23000.	2300.
4	189.00	23000.	2300.
5	212.60	27000.	2700.
6	237.40	28000.	2800.

A GIVEN LIVE LOAD OF 42500. LBS ACTING AT 122.60 DEGREES

INPUT CONTINUED LOAD CONDITION A -OBE

STRESSES DUE TO LOADS ABOVE BEAM SEATS (SEE SECTION 1C)

MAX. TENS. CIRCUMF. STRESS RESULT.	12310.	LB/IN
MAX. COMP. CIRCUMF. STRESS RESULT.	-800.	LB/IN
MAXIMUM COMPRESSIVE MERIDIONAL STRESS	-2450.	PSI

WIDTH OF GIRDER 12.00 IN

BEAM SEAT DIMENSIONS IN INCHES

B1 =	14.0000
D1 =	1.0000
B2 =	1.0000
D2 =	6.0000

RING GIRDER DIMENSIONS IN INCHES

BH =	10.0000
TH =	1.0000
BV =	10.0000
TV =	1.5000

OUTPUT FOR UPPER BEAM SEAT ANALYSIS LOAD CONDITION A -OBEQ

ANGLE THETA = 17.25163 DEG

COMPONENTS OF BEAM LOADS ACTING ON SHELL AND RING GIRDER

NO	AZIMUTH (DEG)	VERT LOAD (LBS)	SHELL COMP (LBS)	RING COMP (LBS)
1	122.60	37400.	39162.	11614.
2	147.40	34100.	35706.	10589.
3	171.00	25300.	26492.	7857.
4	189.00	25300.	26492.	7857.
5	212.60	29700.	31099.	9223.
6	237.40	30800.	32251.	9565.

PROPERTIES OF RING GIRDER

WIDTH OF SHELL ACTING WITH GIRDER =	29.5	IN
AREA OF SHELL ACTING WITH GIRDER =	25.8	IN-2
AREA OF THE ATTACHED GIRDER =	25.0	IN-2
TOTAL AREA OF RING GIRDER =	50.79	IN-2
MOMENT OF INERTIA ABOUT Y AXIS =	1170.17	IN-4
SECTION MODULUS OF INSIDE =	179.86	IN-3
SECTION MODULUS OF OUTSIDE =	148.79	IN-3

LOADING CONDITION A (OBEQ)

CIRCUMFERENTIAL STRESSES DUE TO MAXIMUM POSITIVE MOMENT

TYPE LOAD	DUE TO	AMT LOAD	INS STRESS (PSI)	OUTS STRESS (PSI)
MOMENT	(DEAD LOAD	648972 IN-LB	3608.	-4362.
THRUST	ON BEAMS)	6541. LBS	129.	129.
MOMENT	(LIVE LOAD	1102329 IN-LB	6129.	-7409.
THRUST	ON BEAMS)	-3443. LBS	-68.	-68.
CIRCUM	(OTHER LOAD	12310. LB/IN OR	7144.	
STRESS	ABOVE BEAM)	-800. LB/IN		-464.
		TOTAL	16942. PSI	-12174. PSI

ALLOWABLE STPESS = 20280. PSI

CIRCUMFERENTIAL STRESSES DUE TO MAXIMUM NEGATIVE MOMENT

TYPE LOAD	DUE TO	AMT LOAD	INS STRESS (PSI)	OUTS STRESS (PSI)
MOMENT	(DEAD LOAD	-762622 IN-LB	-4240.	5126.
THRUST	ON BEAMS)	-9361. LBS	-184.	-184.
MOMENT	(LIVE LOAD	-518453 IN-LB	-2883.	3485.
THRUST	ON BEAMS)	-4699. LBS	-93.	-93.
CIRCUM	(OTHER LOAD	12310. LB/IN OR		7144.
STRESS	ABOVE BEAM)	-800. LB/IN	-464.	
		TOTAL	-7864. PSI	15477. PSI

ALLOWABLE STRESS = 20280. PSI

BUCKLING STRESS = -184. +(-93.)+(-464.)= -741. PSI

$$\text{ALLOWABLE BUCKLING STRESS} = \frac{3EI}{2R^2A} = \frac{3(27400000.)(1170.17)}{2(408.00)^2(50.79)} = 5688.\ \text{PSI}$$

CHICAGO BRIDGE AND IRON CO. BIRMINGHAM ENG
UPPER BEAM SEATS; CONTRACT 69-5562U; DATE 04-09-74; BY LDF; SHT BM-6 REV 0
5-10-74 CRS

LOADING CONDITION A (OBEQ)

SHELL MERIDIONAL STRESSES

MAXIMUM LOAD ON BEAM SEAT= 79900.0 LBS

CONSIDER LOAD TO ACT ON A CIRCUMFERENTIAL ARC AT THE BOTTOM OF THE BEAM SEAT EQUAL TO 107.58 INCHES.

MERIDIONAL STRESS FROM LOADS ABOVE BEAMS = -2450. PSI

LOCAL BEAM SEAT MERIDIONAL STRESS = -889. PSI

TOTAL = -3339. PSI

ALLOWABLE MERIDIONAL STRESS = SNN

$$SNN = 1800000. \frac{(T)}{R} = 1800000. \frac{(0.8750)}{(408.0)} = 3860.3 \text{ PSI}$$

SEAT BENDING STRESSES

SECTION MODULUS TOP = 45.56 IN-3

SECTION MODULUS BOTTOM = 12.96 IN-3

MOMENT DUE TO GIRDER = 179775. IN-LBS

STRESS AT TOP = 3946. PSI < 20280. PSI

STRESS AT BOTTOM = 13875. PSI < 20280. PSI

WELD LOADS (LOADS FOR WELDS C AND E ARE THOSE ON EA OF THE 2 WELDS C AND ON EA OF THE 2 WELDS E)
(UNIT SHEARS ARE GIVEN FOR EA OF THE 2 FILLETS ASSUMED AT EA WELD)

WELD A:	V= 24812. LBS	UNIT SHR= V*Q/(2*I)=	796. LBS/IN
WELD B:	V= 24812. LBS	UNIT SHR= V*Q/(2*I)=	955. LBS/IN
WELD C:	P= 19975. LBS	UNIT SHR= P/(2*L) =	710. LBS/IN
WELD D:	V= 39950. LBS	UNIT SHR= V*Q/(2*I)=	4158. LBS/IN
WELD E:	P= 19975. LBS	UNIT SHR= P/(2*L) =	3329. LBS/IN

INPUT FOR UPPER BEAM SEAT ANALYSIS: LOAD CONDITION B
LOAD

ELEVATIONS OF

EQUATOR =	597.0000	FT.
TOP OF STEEL(TOP OF GIRDER)=	607.0000	FT.

RADIUS OF SPHERE	408.00	IN.
SHELL THICKNESS	0.8750	IN.
MODULUS OF ELASTICITY	27400000.	PSI
FACTOR OF SAFETY(BUCKLING)	1.5	
ALLOWABLE TENSILE STRESS	33800.	PSI
VERTICAL SEISMIC FACTOR	.200	
AISC BENDING ALLOWAPLE	33800.	PSI

LOADS

GIVEN DEAD AND EARTHQUAKE LOADS ON THE BEAMS

NO	AZIMUTH (DEG.)	LOAD (LBS)	EQ LOAD (LBS)
1	122.60	34000.	6800.
2	147.40	31000.	6200.
3	171.00	23000.	4600.
4	189.00	23000.	4600.
5	212.60	27000.	5400.
6	237.40	28000.	5600.

A GIVEN LIVE LOAD OF 42500. LBS ACTING AT 122.60 DEGREES

INPUT CONTINUED LOAD CONDITION B -DBE

STRESSES DUE TO LOADS ABOVE BEAM SEATS (SEE SECTION 1C)

MAX. TENS. CIRCUMF. STRESS RESULT.	12510.	LB/IN
MAX. COMP. CIRCUMF. STRESS RESULT.	-1000.	LB/IN
MAXIMUM COMPRESSIVE MERIDIONAL STRESS	-2680.	PSI

WIDTH OF GIRDER 12.00 IN

BEAM SEAT DIMENSIONS IN INCHES

B1 =	14.0000
D1 =	1.0000
B2 =	1.0000
D2 =	6.0000

RING GIRDER DIMENSIONS IN INCHES

BH =	10.0000
TH =	1.0000
BV =	10.0000
TV =	1.5000

OUTPUT FOR UPPER BEAM SEAT ANALYSIS LOAD CONDITION B - DBE Q

ANGLE THETA = 17.25163 DEG

COMPONENTS OF BEAM LOADS ACTING ON SHELL AND RING GIRDER

NO	AZIMUTH (DEG)	VERT LOAD (LBS)	SHELL COMP (LBS)	RING COMP (LBS)
1	122.60	40800.	42722.	12670.
2	147.40	37200.	38952.	11552.
3	171.00	27600.	28900.	8571.
4	189.00	27600.	28900.	8571.
5	212.60	32400.	33926.	10061.
6	237.40	33600.	35183.	10434.

PROPERTIES OF RING GIRDER

WIDTH OF SHELL ACTING WITH GIRDER =	29.5	IN	
AREA OF SHELL ACTING WITH GIRDER =	25.8	IN-2	
AREA OF THE ATTACHED GIRDER =	25.0	IN-2	
TOTAL AREA OF RING GIRDER =	50.79	IN-2	
MOMENT OF INERTIA ABOUT Y AXIS =	1170.17	IN-4	
SECTION MODULUS OF INSIDE =	179.86	IN-3	
SECTION MODULUS OF OUTSIDE =	148.79	IN-3	

CHICAGO BRIDGE AND IRON CO. BIRMINGHAM ENG
UPPER BEAM SEATS; CONTRACT 69-5562U; DATE 04-08-74; BY LDF; SHT BM-10REV
5-10-74 CRS

LOADING CONDITION B (DBEQ)

CIRCUMFERENTIAL STRESSES DUE TO MAXIMUM POSITIVE MOMENT

TYPE LOAD	DUE TO	AMT LOAD	INS STRESS (PSI)	OUTS STRESS (PSI)
MOMENT	(DEAD LOAD	707970 IN-LB	3936.	-4758.
THRUST	ON BEAMS)	7136. LBS	140.	140.
MOMENT	(LIVE LOAD	1102329 IN-LB	6129.	-7409.
THRUST	ON BEAMS)	-3443. LBS	-68.	-68.
CIRCUM	(OTHER LOAD	12510. LB/IN OR	7260.	
STRESS	ABOVE BEAM)	-1000. LB/IN		-580.
		TOTAL	17398. PSI	-12675. PSI

ALLOWABLE STRESS = 33800. PSI

CIRCUMFERENTIAL STRESSES DUE TO MAXIMUM NEGATIVE MOMENT

TYPE LOAD	DUE TO	AMT LOAD	INS STRESS (PSI)	OUTS STRESS (PSI)
MOMENT	(DEAD LOAD	-831951 IN-LB	-4625.	5592.
THRUST	ON BEAMS)	-10212. LBS	-201.	-201.
MOMENT	(LIVE LOAD	-518453 IN-LB	-2883.	3485.
THRUST	ON BEAMS)	-4699. LBS	-93.	-93.
CIRCUM	(OTHER LOAD	12510. LB/IN OR		7260.
STRESS	ABOVE BEAM)	-1000. LB/IN	-580.	
		TOTAL	-8382. PSI	16042. PSI

ALLOWABLE STRESS = 33300. PSI

BUCKLING STRESS = -201. +(-93.)+(-580.)= -874. PSI

$$\text{ALLOWABLE BUCKLING STRESS} = \frac{3EI}{1.5R^2A} = \frac{3(27400000.)(1170.17)}{1.5(408.00)^2(50.79)} = 7584 \text{ PSI}$$

LOADING CONDITION B (DBEQ)

SHELL MERIDIONAL STRESSES

MAXIMUM LOAD ON BEAM SEAT= 83300.0 LBS

CONSIDER LOAD TO ACT ON A CIRCUMFERENTIAL ARC AT THE BOTTOM OF THE BEAM SEAT EQUAL TO 107.58 INCHES.

MERIDIONAL STRESS FROM LOADS ABOVE BEAMS = -2680. PSI

LOCAL BEAM SEAT MERIDIONAL STRESS = -927. PSI

TOTAL = -3607. PSI

ALLOWABLE MERIDIONAL STRESS = SNN

$$SNN = 1800000. \frac{(T)}{R} = 1800000. \frac{(0.8750)}{(408.0)} = 3860.3 \text{ PSI}$$

SEAT BENDING STRESSES

SECTION MODULUS TOP = 45.56 IN-3

SECTION MODULUS BOTTOM = 12.96 IN-3

MOMENT DUE TO GIRDER = 187425. IN-LBS

STRESS AT TOP = 4114. PSI < 33800. PSI

STRESS AT BOTTOM = 14465. PSI < 33800. PSI

WELD LOADS (LOADS FOR WELDS C AND E ARE THOSE ON EA OF THE 2 WELDS C AND ON EA OF THE 2 WELDS E)
(UNIT SHEARS ARE GIVEN FOR EA OF THE 2 FILLETS ASSUMED AT EA WELD

WELD A: V=	25868. LBS	UNIT SHR= V*Q/(2*I)=	830. LBS/IN
WELD B: V=	25868. LBS	UNIT SHR= V*Q/(2*I)=	996. LBS/IN
WELD C: P=	20825. LBS	UNIT SHR= P/(2*L) =	740. LBS/IN
WELD D: V=	41650. LBS	UNIT SHR= V*Q/(2*I)=	4335. LBS/IN
WELD E: P=	20825. LBS	UNIT SHR= P/(2*L) =	3471. LBS/IN

INPUT FOR UPPER BEAM SEAT ANALYSIS: 10940-093

LOAD CONDITION M D-OBEQ

ELEVATIONS OF
EQUATOR = 597.0000 FT.
TOP OF STEEL(TOP OF GIRDER)= 607.0000 FT.

RADIUS OF SPHERE	408.00	IN.
SHELL THICKNESS	0.8750	IN.
MODULUS OF ELASTICITY	27400000.	PSI
FACTOR OF SAFETY(BUCKLING)	2.0	
ALLOWABLE TENSILE STRESS	17500.	PSI
VERTICAL SEISMIC FACTOR	.100	
AISC BENDING ALLOWABLE	20280.	PSI

LOADS
GIVEN DEAD AND EARTHQUAKE LOADS ON THE BEAMS

NO	AZIMUTH (DEG.)	LOAD (LBS)	EQ LOAD (LBS)
1	122.60	34000.	3400.
2	147.40	31000.	3100.
3	171.00	23000.	2300.
4	189.00	23000.	2300.
5	212.60	27000.	2700.
6	237.40	28000.	2800.

A GIVEN LIVE LOAD OF 43400. LBS ACTING AT 122.60 DEGREES

INPUT CONTINUED LOAD CONDITION D - ORE Q

STRESSES DUE TO LOADS ABOVE BEAM SEATS (SEE SECTION 1C)

MAX. TENS. CIRCUMF. STRESS RESULT.	12310.	LB/IN
MAX. COMP. CIRCUMF. STRESS RESULT.	-800.	LB/IN
MAXIMUM COMPRESSIVE MERIDIONAL STRESS	-2450.	PSI

WIDTH OF GIRDER 12.00 IN

BEAM SEAT DIMENSIONS IN INCHES

B1 =	14.0000
D1 =	1.0000
B2 =	1.0000
D2 =	6.0000

RING GIRDER DIMENSIONS IN INCHES

BH =	10.0000
TH =	1.0000
BV =	10.0000
TV =	1.5000

CHICAGO BRIDGE AND IRON CO. BIRMINGHAM ENG
UPPER BEAM SEATS; CONTRACT 69-5562U; DATE 04-22-74; BY LDF; SHT BM-4 REV 0

5-10-74 CRS

OUTPUT FOR UPPER BEAM SEAT ANALYSIS LOAD CONDITION D-OBEQ

ANGLE THETA = 17.25163 DEG

COMPONENTS OF BEAM LOADS ACTING ON SHELL AND RING GIRDER

NO	AZIMUTH (DEG)	VERT LOAD (LBS)	SHELL COMP (LBS)	RING COMP (LBS)
1	122.60	37400.	39162.	11614.
2	147.40	34100.	35706.	10589.
3	171.00	25300.	26492.	7857.
4	189.00	25300.	26492.	7857.
5	212.60	29700.	31099.	9223.
6	237.40	30800.	32251.	9565.

PROPERTIES OF RING GIRDER

WIDTH OF SHELL ACTING WITH GIRDER =	29.5	IN
AREA OF SHELL ACTING WITH GIRDER =	25.8	IN-2
AREA OF THE ATTACHED GIRDER =	25.0	IN-2
TOTAL AREA OF RING GIRDER =	50.79	IN-2
MOMENT OF INERTIA ABOUT Y AXIS =	1170.17	IN-4
SECTION MODULUS OF INSIDE =	179.86	IN-3
SECTION MODULUS OF OUTSIDE =	148.79	IN-3

CHICAGO BRIDGE AND IRON CO. BIRMINGHAM ENG
UPPER BEAM SEATS; CONTRACT 69-5562U; DATE 04-22-74; BY LDF; SHT BM-15 REV 0
5-10-74 CRS

10946-050

LOADING CONDITION D (OBEQ)

CIRCUMFERENTIAL STRESSES DUE TO MAXIMUM POSITIVE MOMENT

TYPE LOAD	DUE TO	AMT LOAD	INS STRESS (PSI)	OUTS STRESS (PSI)
MOMENT	(DEAD LOAD	648972 IN-LB	3608.	-4362.
THRUST	ON BEAMS)	6541. LBS	129.	129.
MOMENT	(LIVE LOAD	1125672 IN-LB	6259.	-7566.
THRUST	ON BEAMS)	-3515. LBS	-69.	-69.
CIRCUM STRESS	(OTHER LOAD ABOVE BEAM)	12310. LB/IN OR -800. LB/IN	7144.	-464.
		TOTAL	17070. PSI	-12332. PSI

ALLOWABLE STRESS = 20280. PSI

CIRCUMFERENTIAL STRESSES DUE TO MAXIMUM NEGATIVE MOMENT

TYPE LOAD	DUE TO	AMT LOAD	INS STRESS (PSI)	OUTS STRESS (PSI)
MOMENT	(DEAD LOAD	-762622 IN-LB	-4240.	5126.
THRUST	ON BEAMS)	-9361. LBS	-184.	-184.
MOMENT	(LIVE LOAD	-529431 IN-LB	-2944.	3558.
THRUST	ON BEAMS)	-4799. LBS	-94.	-94.
CIRCUM STRESS	(OTHER LOAD ABOVE BEAM)	12310. LB/IN OR -800. LB/IN	-464.	7144.
		TOTAL	-7927. PSI	15549. PSI

ALLOWABLE STRESS = 20280. PSI

BUCKLING STRESS = -184. +(-94.)+(-464.)= -743. PSI

$$\text{ALLOWABLE BUCKLING STRESS} = \frac{3EI}{2R^2A} = \frac{3(27400000.)(1170.17)}{2(408.00)^2(50.79)} = 5688.\ \text{PSI}$$

CHICAGO BRIDGE AND IRON CO. BIRMINGHAM ENG
UPPER BEAM SEATS; CONTRACT 69-5562U; DATE 04-22-74; BY LDF; SHT BM-16 REV 0
5-10-74 CRS

10948-099

SHELL MERIDIONAL STRESSES LOADING CONDITION D (QBEQ)

MAXIMUM LOAD ON BEAM SEAT= 80800.0 LBS

CONSIDER LOAD TO ACT ON A CIRCUMFERENTIAL ARC AT THE BOTTOM OF THE BEAM SEAT EQUAL TO 107.58 INCHES.

MERIDIONAL STRESS FROM LOADS ABOVE BEAMS = -2450. PSI

LOCAL BEAM SEAT MERIDIONAL STRESS = -899. PSI

TOTAL = -3349. PSI

ALLOWABLE MERIDIONAL STRESS = SNN

$$SNN = 1800000. \frac{(T)}{R} = 1800000. \frac{(0.8750)}{(408.0)} = 3860.3 \text{ PSI}$$

SEAT BENDING STRESSES

SECTION MODULUS TOP = 45.56 IN-3

SECTION MODULUS BOTTOM = 12.96 IN-3

MOMENT DUE TO GIRDER = 181800. IN-LBS

STRESS AT TOP = 3990. PSI < 20280. PSI

STRESS AT BOTTOM = 14031. PSI < 20280. PSI

WELD LOADS (LOADS FOR WELDS C AND E ARE THOSE ON EA OF THE 2 WELDS C AND ON EA OF THE 2 WELDS E)
(UNIT SHEARS ARE GIVEN FOR EA OF THE 2 FILLETS ASSUMED AT EA WELD)

WELD A:	V=	25092. LBS	UNIT SHR=	V*Q/(2*I)=	805. LBS/IN
WELD B:	V=	25092. LBS	UNIT SHR=	V*Q/(2*I)=	966. LBS/IN
WELD C:	P=	20200. LBS	UNIT SHR=	P/(2*L) =	718. LBS/IN
WELD D:	V=	40400. LBS	UNIT SHR=	V*Q/(2*I)=	4205. LBS/IN
WELD E:	P=	20200. LBS	UNIT SHR=	P/(2*L) =	3367. LBS/IN

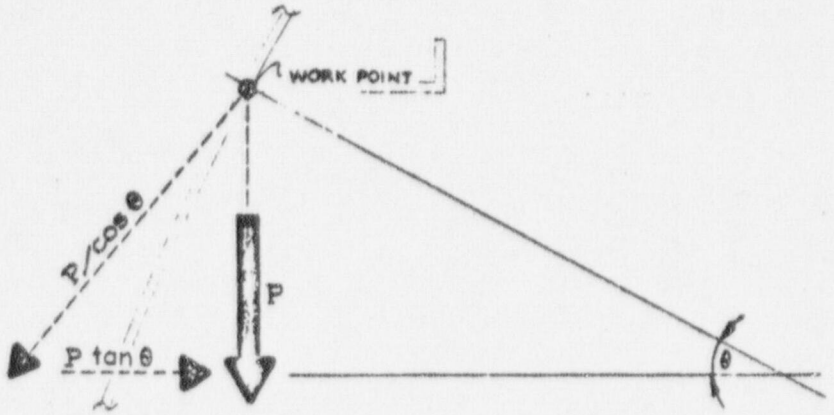
CHICAGO BRIDGE AND IRON CO. BIRMINGHAM ENG
UPPER BEAM SEATS; CONTRACT 69-5562U; DATE 04-22-74; BY LDF; SHT BM-17 REV 0
5-10-79 CRS

CBI

BIRMINGHAM DESIGN

Location

LOAD CONDITION E & F - RING GIRDER EFFECT



P = Given load on beam seat in pounds

With the above load P transposed into its components, we can for purposes of analysis, assume the beam seat to be momentless, the tangential loads (P/Cosθ) are carried directly by the shell, and the horizontal loads (P Tan θ) are carried directly by a continuous ring girder.

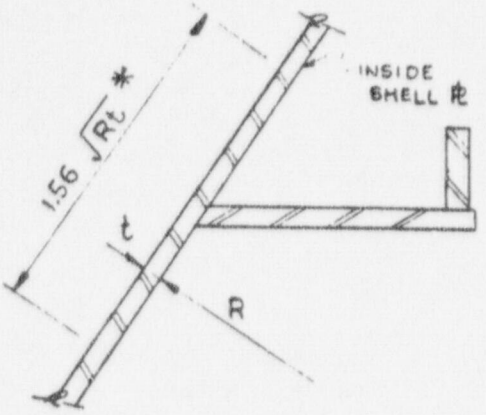
IF THE GIVEN LOAD P IS ACTING UPWARD, THE HORIZONTAL LOAD (P TAN θ), WILL BE ACTING RADIALLY OUTWARD ON THE RING GIRDER.

SUBJECT	MADE BY	CHKD BY	REV			CHARGE NO.
UPPER BEAM SEATS	LDF	CRS		By		69-5562
	DATE 5-7-74	DATE 5-10-74		Chkd		
				Date		SHT BM-18 OF

GD 64 REV 4-73

The girder section properties are computed in the normal manner about the vertical neutral axis, and are calculated by considering the girder as follows:

*Per Code Case 1290



The properties found are:

I	= moment of inertia (in^4)
Z_{shell}	= section modulus (shell side) (in^3)
Z_{flg}	= section modulus (flange side) (in^3)
A	= area of girder (incl. shell) (in^2)
L	= length of shell acting as girder ($1.56\sqrt{Rt}$) (in)

After applying the loads, the ring girder's maximum positive and negative moments are found. The method used to analyze the ring is as follows. The horizontal components of the given beam loads act as radial loads on the ring girder using the given azimuths.

THESE LOADS ARE INPUT INTO CBI PROGRAM 405. THIS PROGRAM ANALYZES THE RING AS FOLLOWS:

The analysis of the ring assumes a constant moment of inertia and modulus of elasticity. The mathematics are based upon the Hardy-Cross column analogy for rings as referenced in Theory of Modern Steel Structures, Vol. 2 by Grinter, page 259. This analysis gives the bending moments and the thrust in the ring due to the radial loads.

The stresses in the ring are the summation of the following stresses:

$\sigma_m = M/Z$ where σ_m = stresses due to moments (PSI)

M = moment (in-lbs)

Z = section modulus - shell or flg (in^3)

$\sigma_t = N_\theta/A$ where σ_t = stress from circumferential thrust in ring due to radial loads (PSI)

N_θ = circumferential thrust in ring due to radial loads (lbs.)

A = area of ring girder (in^2)

$\sigma_o = \frac{N_\theta \times L}{A}$ where σ_o = stress in ring girder due to stress in shell from all loads above work point (psi)

N_θ = circumferential stress in shell from all loads above work point (lbs/in)

L = length of shell acting with ring (in)

A = area of ring girder (in^2)

In addition to the bending analysis of the girder, the girder is checked for buckling. This condition would occur as the loads approach an infinite number, i.e., the ring would be in compression across the full cross section.

(3)

The loads considered are the thrust stresses (σ_t) plus the circumferential stresses due to all other loads (σo). The thrust loads are the maximum negative and the maximum stresses due to other loads are generally the refueling stresses.

The allowable buckling stress can be found by considering the critical load to be:

$$p^1 = \frac{3EI}{r^3}$$

From Roark "Formulas for Stress and Strain" 4th ed. Case 12 pg.342

p^1 = critical radial load (lbs/in)

E = modulus of elasticity (psi)

I = moment of inertia (in^4)

r = radius of ring (in)

The circumferential stress for a ring with a uniform radial load can be shown to be

$$\sigma = \frac{Pr}{A}$$ where σ = stress (psi)

P = radial load (lbs/in)

r = radius of ring (in)

A = area of ring (in^2)

The allowable buckling stress can be found by substituting the critical for the radial load and using a factor of safety of 2.

$$\sigma = \frac{3\ EI}{2\ r^2 A}$$ FOR OBEQ

$$\sigma = \frac{3\ EI}{1.5\ r^2 A}$$ FOR DBEQ (FACTOR OF SAFETY = 1.5)

(4)

CBI

Location BIRMINGHAM DESIGN

PROGRAM 405

4.-5562 UPPER BEAM SEAT-DBEQ-LOAD CONDITION E LDF 5-6-74

N(R)	N(T)	N(M)	DATA SHEET NO.	PLOT CODE
6	0	0	1	0

RADIUS	MOD-ELAS	MOM-INER	AREA	C(1)	C(2)
385.72	27400000.0	1170.17	50.79	6.50	7.87

EQUILIBRIUM LOADS	FV	FH	M/R
INPUT	-38785.00	16448.00	0.0
COMPUTED	-38786.34	16447.64	0.0

INPUT LOADS AND THEIR LOCATIONS

RADIAL LOADS AND ANGLES

LOADS	12670.00	11552.00	8571.00	8571.00	10061.00
ANGLES	122.60	147.40	171.00	189.00	212.60
LOADS	-5900.00				
ANGLES	237.40				

NO TANGENTIAL LOADS

NO MOMENT/R LOADS

UNIT STRESS VALUES FOR CIRCULAR RINGS

PRINTOUT AT EQUAL ANGLE INCREMENTS

X	V/A	T/A	M(FORCE-LG)
0.0	-5.9418E+01	1.4232E+02	8.2086E+05
6.00	-7.3359E+01	1.2325E+02	6.8432E+05
12.00	-8.5096E+01	1.0029E+02	5.2137E+05
18.00	-9.4243E+01	7.3872E+01	3.3694E+05
24.00	-1.0046E+02	4.4459E+01	1.3669E+05
30.00	-1.0347E+02	1.2587E+01	-7.3073E+04
36.00	-1.0303E+02	-2.1163E+01	-2.8550E+05
42.00	-9.8993E+01	-5.6170E+01	-4.9336E+05
48.00	-9.1248E+01	-9.1784E+01	-6.8914E+05
54.00	-7.9772E+01	-1.2734E+02	-8.6520E+05
60.00	-6.4605E+01	-1.6214E+02	-1.0139E+06
66.00	-4.5863E+01	-1.9552E+02	-1.1278E+06
72.00	-2.3728E+01	-2.2682E+02	-1.1998E+06
78.00	1.5461E+00	-2.5537E+02	-1.2230E+06
84.00	2.9640E+01	-2.8058E+02	-1.1915E+06
90.00	6.0174E+01	-3.0187E+02	-1.0998E+06
96.00	9.2709E+01	-3.1873E+02	-9.4324E+05
102.00	1.2676E+02	-3.3069E+02	-7.1833E+05
108.00	1.6173E+02	-3.3737E+02	-4.2248E+05
114.00	1.9722E+02	-3.3846E+02	-5.4243E+04
120.00	2.3247E+02	-3.3373E+02	3.8660E+05
126.00	1.7889E+01	-3.3783E+02	6.0923E+05
132.00	5.3805E+01	-3.4707E+02	6.8260E+05
138.00	9.0354E+01	-3.4989E+02	8.3042E+05

SUBJECT	MADE BY	CHKD BY	REV			CHARGE NO.
UPPER BEAM SEATS	LDF	CRS		By		69-5562
	DATE 5-7-74	DATE 5-11-74		Chkd		
				Date		SHT BM-22 OF

GO 64 REV 4-73

CBI

Location BIRMINGHAM DESIGN

X	V/A	T/A	M(FORCE-LG)
144.00	1.2686E+02	-3.4614E+02	1.0533E+06
150.00	-6.4594E+01	-3.4609E+02	1.1483E+06
156.00	-2.7937E+01	-3.5288E+02	1.0533E+06
162.00	9.0772E+00	-3.5292E+02	1.0339E+06
168.00	4.5741E+01	-3.4620E+02	1.0903E+06
174.00	-8.7168E+01	-3.4169E+02	1.0479E+06
180.00	-5.1445E+01	-3.3950E+02	9.0576E+05
186.00	-1.6286E+01	-3.3094E+02	8.3644E+05
192.00	-1.5087E+02	-3.2504E+02	6.6512E+05
198.00	-1.1694E+02	-3.2206E+02	3.9047E+05
204.00	-8.3620E+01	-3.1336E+02	1.8490E+05
210.00	-5.1498E+01	-2.9926E+02	4.6552E+04
216.00	-2.1886E+02	-2.9188E+02	-2.5768E+05
222.00	-1.8842E+02	-2.8881E+02	-6.7540E+05
228.00	-1.5853E+02	-2.8134E+02	-1.0311E+06
234.00	-1.2963E+02	-2.6986E+02	-1.3265E+06
240.00	1.3911E+01	-2.4950E+02	-1.4608E+06
246.00	3.8474E+01	-2.1916E+02	-1.4065E+06
252.00	5.9725E+01	-1.8637E+02	-1.3052E+06
258.00	7.7443E+01	-1.5178E+02	-1.1639E+06
264.00	9.1476E+01	-1.1609E+02	-9.8997E+05
270.00	1.0174E+02	-7.9964E+01	-7.9113E+05
276.00	1.0823E+02	-4.4093E+01	-5.7510E+05
282.00	1.1101E+02	-9.1389E+00	-3.4959E+05
288.00	1.1020E+02	2.4258E+01	-1.2208E+05
294.00	1.0600E+02	5.5495E+01	1.0025E+05
300.00	9.8673E+01	8.4010E+01	3.1071E+05
306.00	8.8521E+01	1.0930E+02	5.0318E+05
312.00	7.5910E+01	1.3091E+02	6.7223E+05
318.00	6.1245E+01	1.4847E+02	8.1324E+05
324.00	4.4967E+01	1.6167E+02	9.2242E+05
330.00	2.7545E+01	1.7029E+02	9.9695E+05
336.00	9.4677E+00	1.7417E+02	1.0350E+06
342.00	-8.7046E+00	1.7325E+02	1.0357E+06
348.00	-2.6650E+01	1.6755E+02	9.9926E+05
354.00	-4.3693E+01	1.5718E+02	9.2692E+05
360.00	-5.9414E+01	1.4233E+02	8.2089E+05
360.00	-5.9418E+01	1.4232E+02	8.2086E+05

SUBJECT	MADE BY	CHKD BY	REV			CHARGE NO.
UPPER BEAM SEATS	LDF	CRS		By		69-5562
	DATE 5-7-74	DATE 5-10-74		Chkd		SHT BM-23 OF
				Date		

GO 64 REV 4-73

CBI

Location BIRMINGHAM DESIGN

PRINTOUT AT LOAD AND/OR MOMENT POINTS

X	V/A	T/A	M(FORCE-LG)
122.60	-1.9287E+00	-3.2983E+02	6.0000E+05
122.59	2.4747E+02	-3.2985E+02	5.9915E+05
147.40	-8.0188E+01	-3.4108E+02	1.2127E+06
147.39	1.4720E+02	-3.4109E+02	1.2122E+06
171.00	-1.0503E+02	-3.4035E+02	1.1465E+06
170.99	6.3667E+01	-3.4037E+02	1.1463E+06
189.00	-1.6787E+02	-3.2433E+02	8.2857E+05
188.99	8.2268E-01	-3.2435E+02	8.2857E+05
212.60	-2.3617E+02	-2.9156E+02	6.7444E+03
212.59	-3.8135E+01	-2.9159E+02	6.8769E+03
237.40	2.3142E+00	-2.6172E+02	-1.4680E+06
237.39	-1.1390E+02	-2.6174E+02	-1.4677E+06

PRINTOUT OF MAXIMUM AND MINIMUM VALUES OF SHEAR, THRUST, AND MOMENT VALUES TAKEN FROM BOTH OF THE TABLES ABOVE

MAXIMUM V/A=	2.4747E+02	AT	122.59	DEGREES
MINIMUM V/A=	-2.3617E+02	AT	212.60	DEGREES
MAXIMUM T/A=	1.7417E+02	AT	336.00	DEGREES
MINIMUM T/A=	-3.5292E+02	AT	162.00	DEGREES
MAXIMUM M(FORCE-LG)=	1.2127E+06	AT	147.40	DEGREES.
MINIMUM M(FORCE-LG)=	-1.4680E+06	AT	237.40	DEGREES.

SUBJECT	MADE BY	CHKD BY	REV			CHARGE NO.
UPPER BEAM SEATS	LDF	CRS		By		69-5562
	DATE 5-7-74	DATE 5-10-74		Chkd		
				Date		SHT BM-24 OF

QO 64 REV 4-73

CBI

Location BIRMINGHAM DESIGN

LOAD CONDITION E (DBEQ) - RING GIRDER

CIRCUMFERENTIAL STRESSES DUE TO MAXIMUM POSITIVE MOMENT.

TYPE LOAD	DUE TO	AMT. LOAD	INS. STRESS (PSI)	OUTS. STRESS (PSI)
MOMENT	(DEAD LOAD	1212700 IN-lb	6736	-8156
THRUST	+ LIVE LOAD)	-17320 lb	-341	-341
CIRC. STRESS	(OTHER LOAD ABOVE BEAM)	12510 lb/IN OR -1000. lb/IN	7260	-580
		TOTAL	13655 PSI	-9077 PSI

ALLOWABLE STRESS = 33800 PSI

CIRCUMFERENTIAL STRESSES DUE TO MAXIMUM NEGATIVE MOMENT.

TYPE LOAD	DUE TO	AMT. LOAD	INS. STRESS (PSI)	OUTS. STRESS (PSI)
MOMENT	(DEAD LOAD	-1468000 IN-lb	-8154	9873
THRUST	+ LIVE LOAD)	-13293 lb	-262	-262
CIRC. STRESS	(OTHER LOAD ABOVE BEAM)	12510 lb/IN OR -1000 lb/IN	-580	7260
		TOTAL	-8996 PSI	16871 PSI

ALLOWABLE STRESS = 33800 PSI

BUCKLING STRESS = -341 + (-580) = -921

ALLOW. BUCKLING STRESS = 7564 PSI (SEE SHT BM-11)

SUBJECT	MADE BY	CHKD BY	REV			CHARGE NO.
UPPER BEAM SEATS	LDF	CRS		By		69-5562
	DATE 5-7-74	DATE 5-10-74		Chkd		
				Date		SHT BM-25 OF

GO 64 REV 4-73

LOAD CONDITION E (DBE Q)

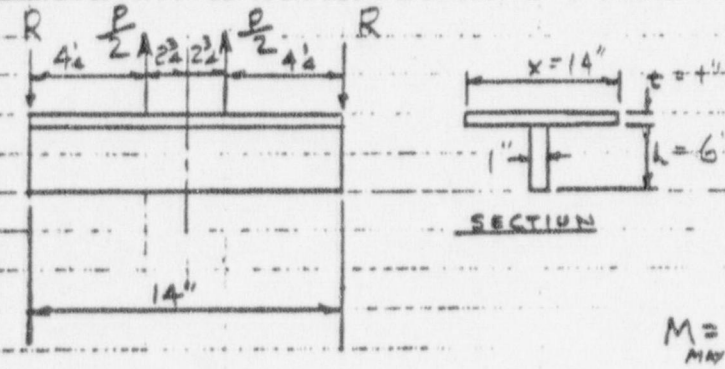
SHELL MERIDIONAL STRESSES

FROM LOAD CONDITION B THE STRESS WAS FOUND TO BE −3607 psi. THE MAXIMUM LOAD ON AN INDIVIDUAL BEAM SEAT UNDER LOAD CONDITION E IS LESS THAN THAT OF LOAD CONDITION B. THEREFORE, THE SHELL MERIDIONAL STRESS IS LESS THAN LOAD CONDITION B.

GIRDER SEATS

THE GIRDER SEATS WERE FOUND TO BE ADEQUATE, UNDER LOAD CONDITION B, FOR A MAXIMUM BEAM SEAT LOAD OF 83300 lbs. ACTING DOWN.

THE GIRDER SEAT AT P_8 WILL BE ANALYZED AS A SIMPLY SUPPORTED BEAM WITH THE RUPTURE LOAD ACTING UPWARD. IT IS ASSUMED BOLTS ARE ADEQUATE TO TRANSFER THE TOTAL UP LOAD TO THE GIRDER SEAT. FOR THIS CONDITION THE TOTAL UP LOAD ON THE GIRDER SEAT IS APPLIED AT THE BOLTS.



P = 19000 lb ; R = 9500 lb

FROM PRINTOUT FOR LOAD CONDITION A:

S_{TOP} = 45.56 IN³

S_{BOTT} = 12.96 IN³

$$M_{MAX} = \frac{P}{2}(4.25) = \frac{19000}{2}(4.25) = 40375 \text{ IN-lb}$$

$$f_{b\,(TOP)} = \frac{M}{S_{TOP}} = \frac{40375}{45.56} = 888 \text{ psi} < 33800 \text{ psi}$$

$$f_{b\,(BOTT.)} = \frac{M}{S_{BOTT.}} = \frac{40375}{12.96} = 3118 \text{ psi} < 33800 \text{ psi}$$

SUBJECT	MADE BY	CHKD BY	REV			CHARGE NO.
UPPER BEAM SEATS	LDF	CRS		By		69-5562 U
	DATE 5-3-74	DATE 5-10-74		Chkd		
				Date		SHT BM-26 OF

GD 64 REV 4-73

CBI

Location BIRMINGHAM DESIGN

PROGRAM 405

69-5562 UPPER BEAM SEAT-OBEQ-LOAD CONDITION F LDF 5-6-74

N(R)	N(T)	N(M)	DATA SHEET NO.	PLOT CODE
6	0	0	1	0

RADIUS	MOD-ELAS	MOM-INER	AREA	C(1)	C(2)
385.72	27400000.0	1170.17	50.79	6.50	7.87

EQUILIBRIUM LOADS	FV	FH	M/R
INPUT	-35289.00	15489.00	0.0
COMPUTED	-35289.71	15490.68	0.0

INPUT LOADS AND THEIR LOCATIONS

RADIAL LOADS AND ANGLES

LOADS	11614.00	10589.00	7857.00	7857.00	9223.00
ANGLES	122.60	147.40	171.00	189.00	212.60
LOADS	-5900.00				
ANGLES	237.40				

NO TANGENTIAL LOADS

NO MOMENT/R LOADS

UNIT STRESS VALUES FOR CIRCULAR RINGS

PRINTOUT AT EQUAL ANGLE INCREMENTS

X	V/A	T/A	M(FORCE-LG)
0.0	-5.5945E+01	1.3052E+02	7.5589E+05
6.00	-6.8708E+01	1.1262E+02	6.2771E+05
12.00	-7.9409E+01	9.1186E+01	4.7539E+05
18.00	-8.7696E+01	6.6607E+01	3.0354E+05
24.00	-9.3264E+01	3.9323E+01	1.1743E+05
30.00	-9.5955E+01	9.8300E+00	-7.7094E+04
36.00	-9.5265E+01	-2.1336E+01	-2.7369E+05
42.00	-9.1348E+01	-5.3603E+01	-4.0569E+05
48.00	-8.4021E+01	-8.6370E+01	-6.4617E+05
54.00	-7.3263E+01	-1.1902E+02	-8.0809E+05
60.00	-5.9119E+01	-1.5093E+02	-9.4445E+05
66.00	-4.1699E+01	-1.8148E+02	-1.0484E+06
72.00	-2.1179E+01	-2.1005E+02	-1.1134E+06
78.00	2.2035E+00	-2.3606E+02	-1.1334E+06
84.00	2.8151E+01	-2.5894E+02	-1.1026E+06
90.00	5.6309E+01	-2.7819E+02	-1.0163E+06
96.00	8.6271E+01	-2.9332E+02	-8.7035E+05
102.00	1.1758E+02	-3.0394E+02	-6.6143E+05
108.00	1.4976E+02	-3.0967E+02	-3.8731E+05
114.00	1.8226E+02	-3.1026E+02	-4.6747E+04
120.00	2.1455E+02	-3.0549E+02	3.6037E+05
126.00	1.7788E+01	-3.0881E+02	5.6738E+05
132.00	5.0597E+01	-3.1683E+02	6.3738E+05
138.00	8.3939E+01	-3.1897E+02	7.1534E+05

SUBJECT	MADE BY	CHKD BY	REV			CHARGE NO.
UPPER BEAM SEATS	LDF	CRS		By		69-5562
	DATE 5-7-74	DATE 5-10-74		Chkd		
				Date		SHT BM-27 OF

QD 64 REV 4-73

CBI

Location BIRMINGHAM DESIGN

X	V/A	T/A	M(FORCE-LG)
144.00	1.1719E+02	-3.1511E+02	9.8173E+05
150.00	-5.8547E+01	-3.1467E+02	1.0704E+06
156.00	-2.5235E+01	-3.2051E+02	9.8440E+05
162.00	8.3661E+00	-3.2021E+02	9.6711E+05
168.00	4.1614E+01	-3.1376E+02	1.0185E+06
174.00	-8.0615E+01	-3.0938E+02	9.7859E+05
180.00	-4.8280E+01	-3.0719E+02	8.4642E+05
186.00	-1.6479E+01	-2.9922E+02	7.8013E+05
192.00	-1.4029E+02	-2.9376E+02	6.1946E+05
198.00	-1.0963E+02	-2.9104E+02	3.6315E+05
204.00	-7.9517E+01	-2.8315E+02	1.6928E+05
210.00	-5.0494E+01	-2.7038E+02	3.6145E+04
216.00	-2.0432E+02	-2.6385E+02	-2.4991E+05
222.00	-1.7678E+02	-2.6134E+02	-6.4078E+05
228.00	-1.4972E+02	-2.5487E+02	-9.7558E+05
234.00	-1.2353E+02	-2.4479E+02	-1.2557E+06
240.00	1.7477E+01	-2.2619E+02	-1.3801E+06
246.00	3.9705E+01	-1.9793E+02	-1.3209E+06
252.00	5.8854E+01	-1.6748E+02	-1.2193E+06
258.00	7.4728E+01	-1.3547E+02	-1.0817E+06
264.00	8.7194E+01	-1.0251E+02	-9.1499E+05
270.00	9.6186E+01	-6.9224E+01	-7.2629E+05
276.00	1.0170E+02	-3.6246E+01	-5.2272E+05
282.00	1.0381E+02	-4.1811E+00	-3.1134E+05
288.00	1.0263E+02	2.6387E+01	-9.9032E+04
294.00	9.8354E+01	5.4908E+01	1.0764E+05
300.00	9.1220E+01	8.0871E+01	3.0256E+05
306.00	8.1522E+01	1.0382E+02	4.8017E+05
312.00	6.9596E+01	1.2334E+02	6.3553E+05
318.00	5.5820E+01	1.3911E+02	7.6446E+05
324.00	4.0602E+01	1.5084E+02	8.6357E+05
330.00	2.4376E+01	1.5834E+02	9.3036E+05
336.00	7.5926E+00	1.6147E+02	9.6321E+05
342.00	-9.2880E+00	1.6019E+02	9.6145E+05
348.00	-2.5804E+01	1.5452E+02	9.2535E+05
354.00	-4.1502E+01	1.4458E+02	8.5613E+05
360.00	-5.5941E+01	1.3053E+02	7.5593E+05
360.00	-5.5945E+01	1.3052E+02	7.5589E+05

SUBJECT	MADE BY	CHKD BY	REV			CHARGE NO.
UPPER BEAM SEATS	LDF	CRS		By		69-5562
	DATE 5-7-74	DATE 5-10-74		Chkd		
				Date		SHT EM-28 OF

GO 64 REV 4-73

CBI

Location BIRMINGHAM DESIGN

PRINTOUT AT LOAD AND/OR MOMENT POINTS

X	V/A	T/A	M(FORCE-LG)
122.60	-3.3342E-01	-3.0173E+02	5.5727E+05
122.59	2.2828E+02	-3.0175E+02	5.5649E+05
147.40	-7.2727E+01	-3.1024E+02	1.1288E+06
147.39	1.3570E+02	-3.1025E+02	1.1283E+06
171.00	-9.6788E+01	-3.0826E+02	1.0696E+06
170.99	5.7854E+01	-3.0828E+02	1.0694E+06
189.00	-1.5566E+02	-2.9312E+02	7.7121E+05
188.99	-1.0134E+00	-2.9314E+02	7.7122E+05
212.60	-2.1997E+02	-2.6342E+02	-3.3482E+03
212.59	-3.8421E+01	-2.6345E+02	-3.2147E+03
237.40	6.9564E+00	-2.3760E+02	-1.3910E+06
237.39	-1.0925E+02	-2.3762E+02	-1.3906E+06

PRINTOUT OF MAXIMUM AND MINIMUM VALUES OF SHEAR, THRUST, AND MOMENT VALUES TAKEN FROM BOTH OF THE TABLES ABOVE

MAXIMUM V/A=	2.2828E+02	AT	122.59	DEGREES
MINIMUM V/A=	-2.1997E+02	AT	212.60	DEGREES
MAXIMUM T/A=	1.6147E+02	AT	336.00	DEGREES
MINIMUM T/A=	-3.2051E+02	AT	156.00	DEGREES
MAXIMUM M(FORCE-LG)=	1.1288E+06	AT	147.40	DEGREES
MINIMUM M(FORCE-LG)=	-1.3910E+06	AT	237.40	DEGREES

SUBJECT	MADE BY	CHKD BY	REV			CHARGE NO.
UPPER BEAM SEATS	LDF	CRS		By		69-5562
	DATE 5-7-74	DATE 5-10-74		Chkd		
				Date		SHT BM-29 OF

GO 64 REV 4-73

CBI

Location BIRMINGHAM DESIGN

LOAD CONDITION F (OBEQ) - RING GIRDER

CIRCUMFERENTIAL STRESSES DUE TO MAXIMUM POSITIVE MOMENT.

TYPE LOAD	DUE TO	AMT. LOAD	INS. STRESS (PSI)	OUTS. STRESS (PSI)
MOMENT	(DEAD LOAD	1128800 IN-lb	6270	-7591
THRUST	LIVE + LOAD)	- 15745 lb	- 310	- 310
CIRC. STRESS	(OTHER LOAD ABOVE BEAM)	12310 lb/IN OR -800 lb/IN	7144	-464
		TOTAL	13104 psi	-8365 psi

ALLOWABLE STRESS = 20280 psi

CIRCUMFERENTIAL STRESSES DUE TO MAXIMUM NEGATIVE MOMENT.

TYPE LOAD	DUE TO	AMT. LOAD	INS. STRESS (PSI)	OUTS. STRESS (PSI)
MOMENT	(DEAD LOAD	-1391000 IN/lb	-7734	9349
THRUST	LIVE + LOAD)	- 12088 lb	- 238	- 238
CIRC. STRESS	(OTHER LOAD ABOVE BEAM)	12310 lb/IN OR -800 lb/IN	-464	7144
		TOTAL	-8436 psi	16255 psi

ALLOWABLE STRESS = 20280 psi

BUCKLING STRESS = -310 + (-464) = -774 psi

ALLOW. BUCKLING STRESS = 5688 psi (SEE SHT BM-6)

SUBJECT	MADE BY	CHKD BY	REV			CHARGE NO.
UPPER BEAM SEATS	LDF	CRS		By		69-5562
	DATE 5-7-74	DATE 5-10-74		Chkd		SHT BM-30 OF
				Date		

GO 64 REV 4-73

CBI

Location BIRMINGHAM DESIGN

LOAD CONDITION F (OBEQ)

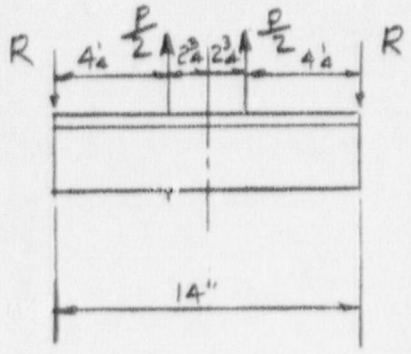
SHELL MERIDIONAL STRESSES

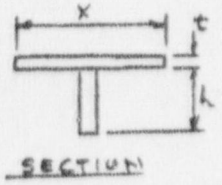
FROM LOAD CONDITION D THE STRESS WAS FOUND TO BE -3347 psi. THE MAXIMUM LOAD ON AN INDIVIDUAL BEAM SEAT UNDER LOAD CONDITION F IS LESS THAN THAT OF LOAD CONDITION D. THEREFORE, THE SHELL MERIDIONAL STRESS IS LESS THAN LOAD CONDITION A.

GIRDER SEATS

THE GIRDER SEATS WERE FOUND TO BE ADEQUATE, UNDER LOAD CONDITION D, FOR A MAXIMUM BEAM SEAT LOAD OF 80800 lbs. ACTING DOWN.

THE GIRDER SEAT AT P_8 WILL BE ANALYZED AS A SIMPLY SUPPORTED BEAM WITH THE RUPTURE LOAD ACTING UPWARD. IT IS ASSUMED BOLTS ARE ADEQUATE TO TRANSFER THE TOTAL UP LOAD TO THE GIRDER SEAT. FOR THIS CONDITION THE TOTAL UP LOAD ON THE GIRDER SEAT IS APPLIED AT THE BOLTS.





SECTION

$P = 19000$ lb ; $R = 9500$ lb

FROM PRINTOUT FOR LOAD CONDITION A:

$S_{TOP} = 45.56$ in^3
$S_{BOTT} = 12.96$ in^3

$$M_{MAX} = \frac{P}{2}(4.25) = \frac{19000}{2}(4.25) = 40375 \text{ in-lb}$$

$$f_{b\,(TOP)} = \frac{M}{S_{TOP}} = \frac{40375}{45.56} = 888 \text{ psi} < 20280 \text{ psi}$$

$$f_{b\,(BOTT.)} = \frac{M}{S_{BOTT.}} = \frac{40375}{12.96} = 3118 \text{ psi} < 20280 \text{ psi}$$

SUBJECT	MADE BY	CHKD BY	REV			CHARGE NO.
UPPER BEAM SEATS	LDF	CRS		By		69-5562 L
	DATE 5-3-74	DATE 5-10-74		Chkd		
				Date		SHT BM-31 OF

GD 64 REV 4-73

GENERATION ENG.
Approval Control

J. T. HASKIN

ENRICO FERMI A.P.P. UNIT 2

Documentation No.		732D2900BA001	
Location			Approval X
P.O.		IC70020	Installation
B/M		B2-1C	DECo File No. B2-288
Transmittal Date		7-27-73	Vendor CBT
Engineering			Approved / As Noted
Approved		As Noted	Quality Assurance Dir.
EC	K.A. Borgese		
M	J.E. Buchanan		System Engineer
E			O. Dieterich
IC			Proj Director-Operations
QA			
Project Engineer			
Approved		As Noted	Rel. For Fab. Or Constr.
R. Varano			

67-5562

RECEIVED
SEP 4 1973
THE RALPH M. PARSONS CO.

ARMS INDEXED X64-067
DTC: TDDATA
DSN: 69 5562 2

10948-064

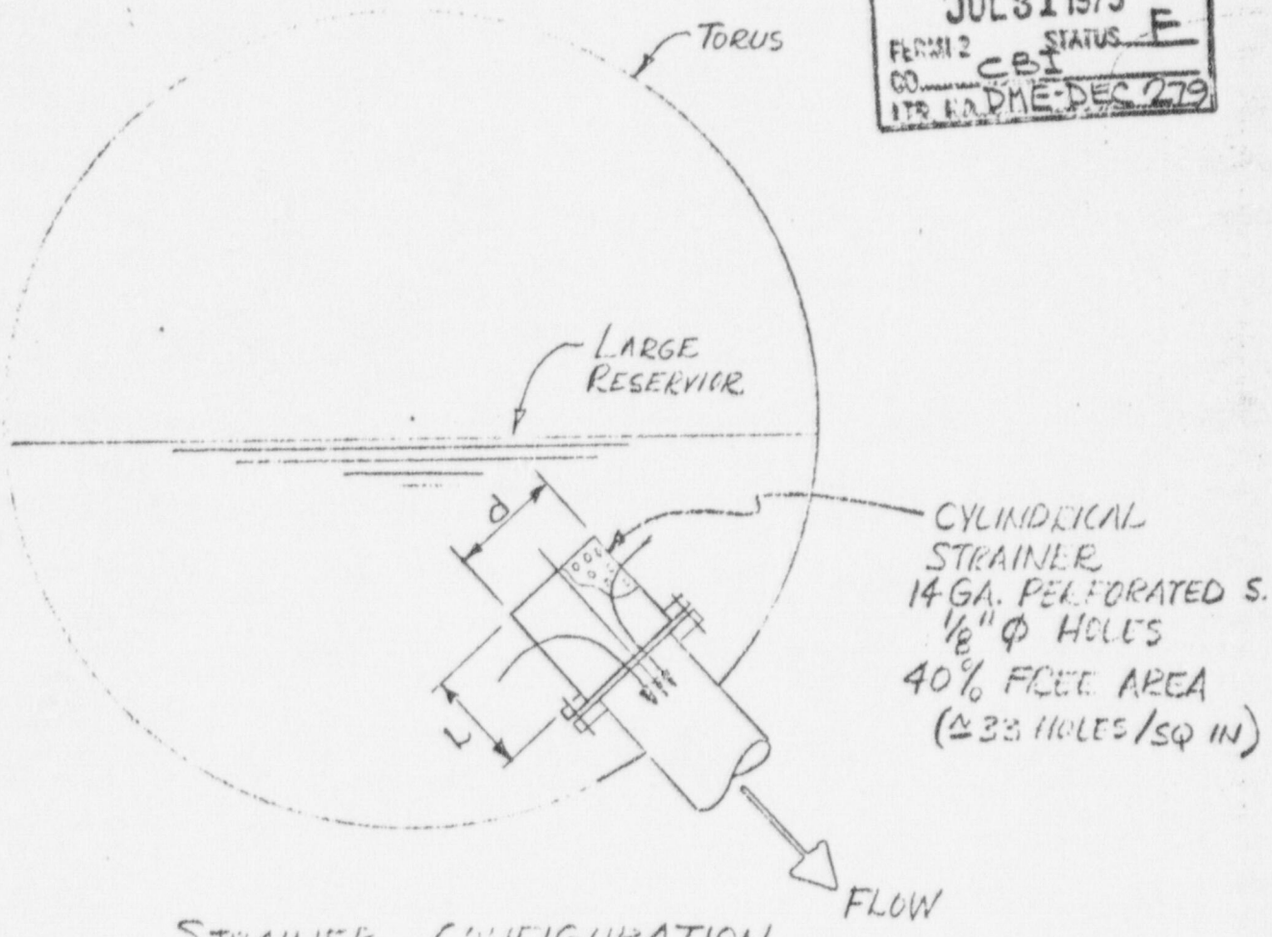
10948-065

CHICAGO BRIDGE & IRON COMPANY

Location MEMPHIS

STRAINERS FOR PLUGGED CONDITIONS

DOCUMENT CONTROL
T23-02-D-900-BA-001
JUL 31 1973
FERMI 2 STATUS E
CO. CBI
ITR NO. DME-DEC 279



STRAINER CONFIGURATION

INFORMATION ONLY
RECEIVED
SEP 4 1973
THE RALPH M. PARSONS CO.

B2-288

SUBJECT	MADE BY	CHKD BY	REV			CHARGE NO.
TORUS STRAINER DESIGN	LWP	HCI	BY			69-55-2
	DATE 7-26-73	DATE 7-26-73	CHKD			SHT OF
			DATE			

BOX 8 REV 5-70

GO 84 REV 8-72

CBI

Location MEMPHIS

TORUS SUCTION STRAINERS

STRAINERS MUST PASS THE SPECIFIED FLOW WITH A MAXIMUM HEAD LOSS OF 1.0 FT. ACROSS THE STRAINER NOT INCLUDING ENTRANCE LOSS.

LOSSES THROUGH THE STRAINERS CAN BE SEPERATED INTO TWO PARTS:

1. LOSSES DUE TO FLOW THROUGH EACH INDIVIDUAL ORFICE HOLE.
2. LOSSES DUE TO DIVERTING THE FLOW STREAM INTO THE PIPE.

THE SECOND LOSS FACTOR HAS BEEN ACCOUNTED FOR AS A PIPE ENTRANCE LOSS IN THE CUSTOMERS ANALYSIS AND WILL NOT BE CONSIDERED HERE.

CHECK LOSS THROUGH EACH HOLE ACTING AS AN ORIFICE

$$q_o = .0438\, d_o^2\, C \sqrt{h_L}$$

or $$h_L = \left(q_o / .0438\, d_o^2\, C\right)^2$$

REF: CRANE TECHNICAL PAPER NO. 410 EQUATION 3-21 PAGE 3-5

$C \geq .60$ FOR $R_c > 20$

d_o = HOLE DIAMETER (IN)

q_o = FLOW PER HOLE (ft^3/sec)

$$= \frac{GPM}{No.\ of\ Holes} \times .133\ \frac{ft^3}{G.}\ ,\ \frac{.Min}{60\ sec}$$

$$= 2.22 \times 10^{-3}\ \frac{GPM}{N}$$

DOCUMENT CONTROL
JUL 31 1973
PERM-2 STATUS
CO:
LTR. NO.

RECEIVED
SEP 4 1973
THE RALPH M. PARSONS CO.

B2-288

SUBJECT	MADE BY	CHKD BY	REV			CHARGE NO.
TORUS STRAINER DESIGN	AWP	HCT		By		69-556-2
	DATE 7-17-73	DATE 7-25-73		Chkd		
				Date		SHT 1 OF 3

10948-067

CHICAGO BRIDGE & IRON COMPANY

Location MEMPHIS

STRAINER	PENETRATION NUMBER	DIAM. d (in.)	LENGTH L (in)	SURF AREA A (in^2)	d_o (in.)	C
RHR		26	36	3470	.125	.60
CSS		22	26	2175	.125	.60

DOCUMENT CONTROL
JUL 31 1973
STATUS

	% PLUGGED	FLOW (GPM)	No. of Holes N=33xA x% Plgd	q_o ft^3/sec	ACTUAL HEAD LOSS h_L	ALLOWABLE HEAD LOSS
RHR	0	13,500	114,510	2.62×10^{-4}	.4'	1.0'
	50	10,000	57,255	3.88×10^{-4}	.9'	1.0'
CSS	0	6,350	71,775	1.97×10^{-4}	.23'	1.0'
	50	6,350	35,888	3.93×10^{-4}	.92'	1.0'

RECEIVED
SEP 4 1973
THE RALPH M. PARSONS CO.

BZ-288

SUBJECT	MADE BY	CHKD BY	BY	CHARGE NO.
TRASH STRAINER DESIGN	LMP	HCI	CHKD	69-4562
	DATE	DATE 7-26-73	DATE	SHT 3 OF 5

CO-EA FORM 5-70

GENERATION ENG.

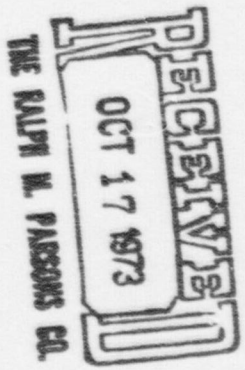
Approval Control

J. T. HASKIN

ENRICO FERMI A.P.P. UNIT 2

Documentation No.				
Location			Approval X	
P.O. IC70020			Installation	
B/M 32			DECo File No. B2-288	
Transmittal Date 9-14-73			Vendor CB&I	
Engineering			Approved	As Noted
Approved		As Noted	Quality Assurance Dir.	
AC	R.A. Bruno			
M	A.P. Buchanan		System Engineer	
E			D.S. Nichols	
IC			Proj Director-Operations	
QA				
Project Engineer				
Approved		As Noted	Rel. For Fab. Or Constr.	
R. Vance/CB				

69-5562



068-080

ARMS INDEXED

DTC: TDDATA

DSN: 69 5562 3

890-8484-001

10048-069

ARMS INDEXED
DTC: EDATA
DSN: 6955623

CHICAGO BRIDGE & IRON COMPANY

Location Oak Brook Eng.

DOCUMENT CONTROL
T23-02-X-212-BA-001
T23-02-X-220-BA-001
SEP 18 1973
FERMI-2 STATUS F
CO. CBI
LTR. NO. DME-DEC-285

STRESSES IN TORUS CYLINDER DUE TO LOADINGS FROM 24" DIA. HPCI PIPE AND 12" DIA. RCIC PIPE

The torus cylinder is analyzed for the thrust due to blowdown of the HPCI and RCIC discharge lines.

The loads for the HPCI pipe system is a thrust of 9.1 kips acting perpendicular to the exit plane of the 45° elbow, while for the RCIC pipe the thrust is 2.2 kips perpendicular to the exit plane. (Refer to DECO letter EF2-18523, dated 7-12-73).

Stress intensities are determined based on a circular insert 4'-9" dia. by 2" thick of HPCI pipe and 6'-2" dia. by 2" thick for the RCIC pipe.

The stresses in the shell due to the penetration loadings have been calculated by CBI Computer Program 1027,"Stress Intensities at Loaded Attachments in Cylinders and Spheres." This program uses the methods and nomenclature of Welding Research Council Bulletin #107. See Sheet 4DA90 of Stress Report for program write-up.

The program printout includes a tabulation of the stresses caused by the penetration loads excluding any initial stresses present in the shell and also a tabulation of the combined effect of the penetration loads and the functional loads (initial stresses).

INFORMATION ONLY

RECEIVED
OCT 17 1973
THE RALPH M. PARSONS CO.

B2-288

SUBJECT	MADE BY HDB	CHKD BY GMT	BY		CHARGE NO. 69-5562
	DATE 8-1-73	DATE 8/7/73	CHKD		SHT 1 OF 10
			DATE		

QD 787

CHICAGO BRIDGE & IRON COMPANY

Location Oak Brook Eng.

ALLOWABLE STRESSES

The total stress intensities at a point have been compated to the following allowable stress intensities from Table N-413 and Figure N-414 of Section III of the ASME Code: (Refer to Table on page 4).

At attachment-to-shell junction

Membrane - $P_L \leq 1.5\ S_m = 26250$ psi

Surface - $Q \leq 3\ S_m = 52500$ psi

At $.5\sqrt{Rt}$ from attachment-to-shell junction

Membrane - $P_m \leq 1.1\ S_m = 19250$ psi

Surface - $Q \leq 3\ S_m = 52500$ psi

At edge of reinforcement

Membrane - $P_m \leq 1.1\ S_m = 19250$ psi

Surface - $Q \leq 3\ S_m = 52500$ psi

TOTAL STRESS IN SUPPRESSION CHAMBER

The total stresses in the suppression chamber shell due to the combination of the functional loads and the specified penetration loadings have been determined for the accident condition.

SUBJECT	MADE BY HDB	CHKD BY GMT	REV	BY		CHARGE NO. 69-5562
	DATE 8-1-73	DATE 8/7/73		CHKD		SHT 2 OF 12
				DATE		

CHICAGO BRIDGE & IRON COMPANY

Location Oak Brook Eng.

STRESSES DUE TO FUNCTIONAL LOADS

It is assumed that a membrane condition exists at the edge of the insert and that the surface stress due to the functional loads equals the membrane stress at that point. Stresses are taken as Sm in the circumferential direction and Sm/2 in the meridional direction. The initial membrane stresses are also used at $.5\sqrt{Rt}$ whenever $.5\sqrt{Rt}$ falls within the edge of reinforcing.

At the attachment-to-shell junction, the stresses due to the functional loads may be assumed to equal Sm (17500 psi) per Par. N-451(a) of Section III of the ASME Code. Surface stresses at this location are conservatively taken as 150% of the membrane stresses. These initial surface stresses are also used at $.5\sqrt{Rt}$ whenever $.5\sqrt{Rt}$ falls within the edge of reinforcing.

E2-288

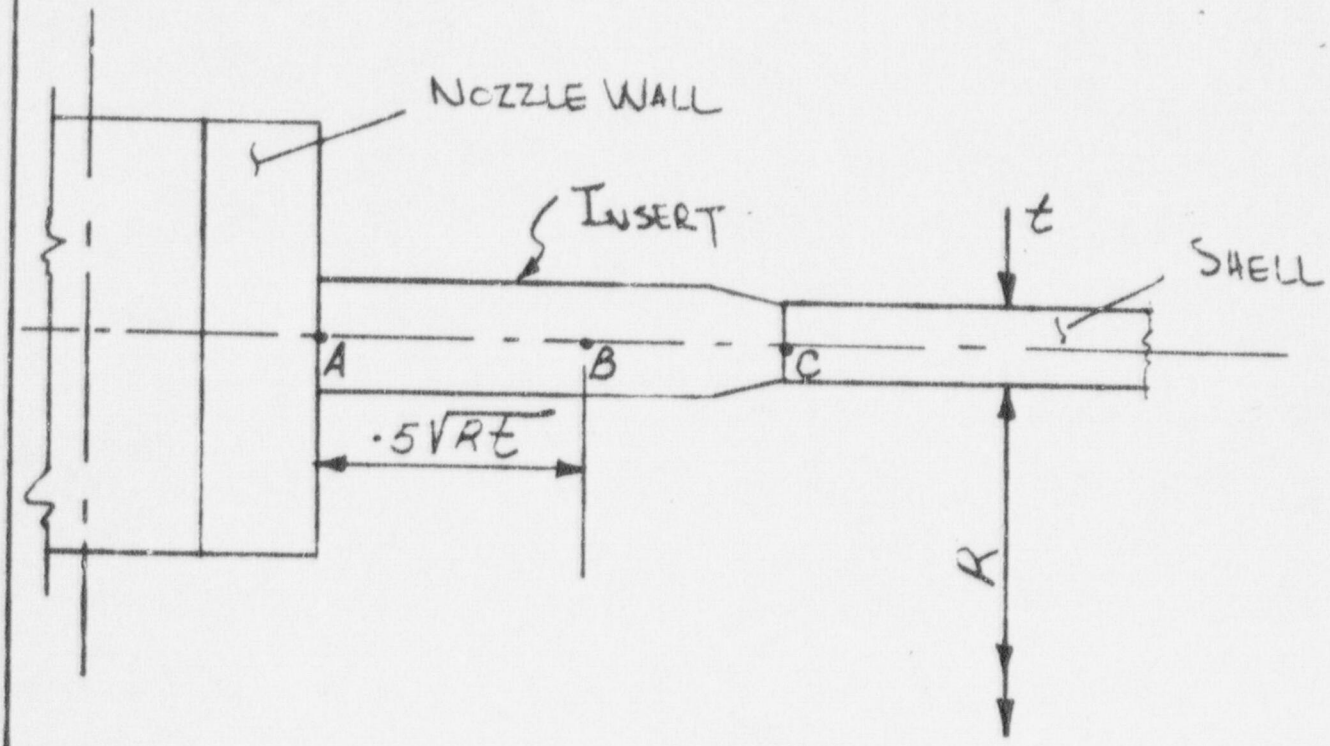
SUBJECT	MADE BY	CHKD BY	REV	BY		CHARGE NO.
	H.R.B.	GMT		CHKD		60-552
	DATE 8-1-72	DATE 8/7/72		DATE		SHT 3 OF 12

30 787

CHICAGO BRIDGE & IRON COMPANY

Location _____

POINT	TYPE OF STRESS	24" DIA HPCI PIPE	10" DIA. RCIC PIPE	ALLOWABLE S.I. (PSI)
A	MEMBRANE	20137 Psi	17624 Psi	$1.5S_M$=26250
	SURFACE	35325 Psi	29164 Psi	$3S_M$=52500
B	MEMBRANE	18516 Psi	17601 Psi	$1.1S_M$=19250
	SURFACE	31046 Psi	27387 Psi	$3S_M$=52500
C	MEMBRANE	19756 Psi	17784 Psi	$1.1S_M$=19250
	SURFACE	36354 Psi	20221 Psi	$3S_M$=52500



SUBJECT

MADE BY HDB DATE 7-30-73
CHKD BY GMT DATE 8/1/73
BY
CHKD
DATE
CHARGE NO. 69-2502
SHT 4 OF 12

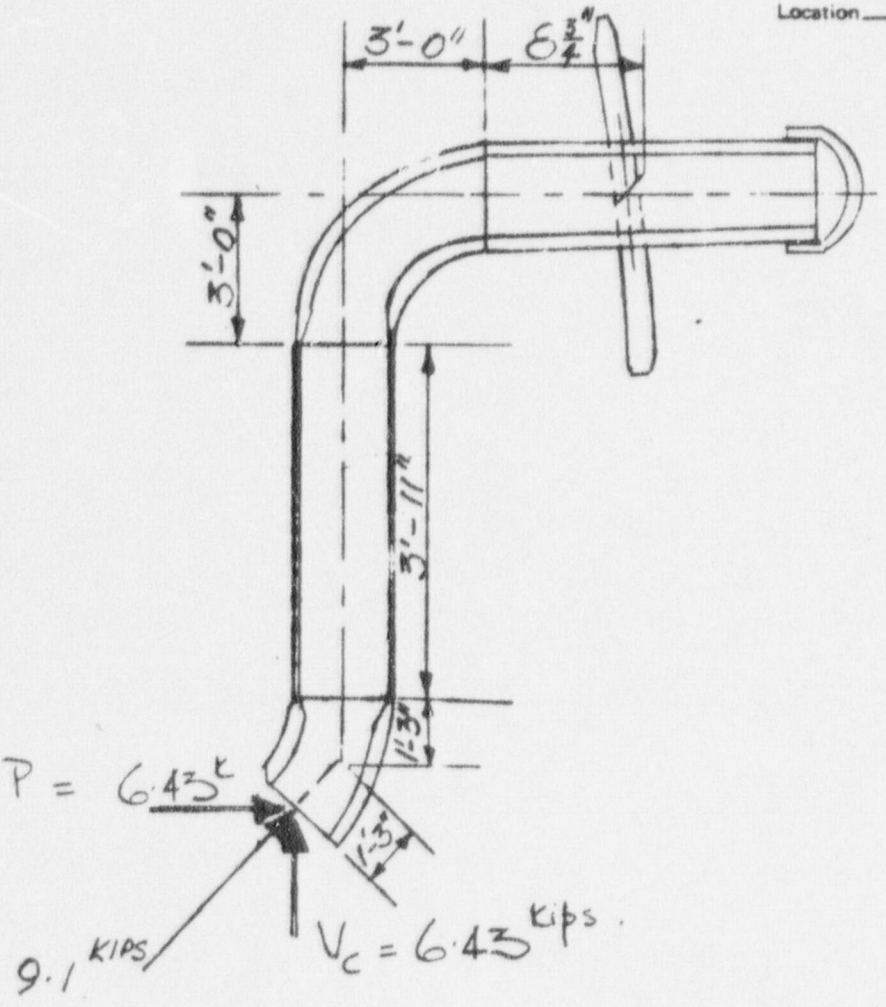
E2-288

10948-073

GO 64 REV 8-72

CBI

Location _____



Circ. Moment $M_c = 6.43\left[\{1.25\times.707+1.25+3.916+3\}-\{1.25\times.707+3+.73\}\right]$

$M_c = 28.528$ KIPS-FT. $= .3423\times10^6$ INCH-LBS.

SUBJECT	MADE BY	CHKD BY	REV			CHARGE NO.
HPCI TURBINE EXHAUST.	HDB	TJA		By		60-5562
PENETRATION X-220	DATE 7-30-73	DATE 8/2/73		Chkd		SHT 5 OF 12
				Date		

B2-288

PROG 1027, REV 4/73
EXCEPT AS NOTED ON INPUT DATA SHT, NOTATION AGREES WITH THAT IN WRC107

INPUT

KN	KB	RM	T	LOC	
1.00	1.00	183.294	0.587	0.5000	1.

RO	TI	TP	h
12.000	2.000	0.0	16.500

P	VL	VC	MC	ML
-6430.	0.	6430.	-342300.	0.

INITIAL STRESSES NEXT TO ATTCHMNT

SX(AU)	SO(AU)	SX(CU)	SO(CU)	SX(AM)	SO(AM)	SX(CM)	SO(C
26250.	26250.	26250.	26250.	17500.	17500.	17500.	1750

INITIAL STRESSES AT LOC*SQRT(R*T)

SX(AU)	SO(AU)	SX(CU)	SO(CU)	SX(AM)	SO(AM)	SX(CM)	SO(C
26250.	26250.	26250.	26250.	8750.	17500.	8750.	1750

INITIAL STRESSES AT EDGE OF REINF

SX(AU)	SO(AU)	SX(CU)	SO(CU)	SX(AM)	SO(AM)	SX(CM)	SO(C
8750.	17500.	8750.	17500.	8750.	17500.	8750.	1750

OUTPUT

BIJLAARD COEFICIENTS

	NEXT TO ATTCHMNT	AT LOC*SQRT(R*T)	AT EDGE OF REINF
NX/P	48.065	37.908	31.992
MX/P	0.104	0.056	0.015
NX/MC	20.168	27.415	27.235
MX/MC	0.057	0.044	0.021
NX/ML	11.355	12.302	9.546
MX/ML	0.080	0.047	0.015
NO/P	35.971	20.008	13.177
MO/P	0.145	0.090	0.037
NO/MC	12.306	13.438	11.513
MO/MC	0.097	0.084	0.052
NO/ML	35.770	28.573	22.186
MO/ML	0.050	0.033	0.010

ENRICO FERMI ATOMIC POWER PLANT UNIT #2
CBI CONTRACT #69-5562,
ROUND ATTCHMT HPCI TURBINE EXHAUST ON A CYLINDRICAL VESSEL

HDB 8-1-73 CAL. GMT 8/7/73 B2-288 6/10

OUTPUT EXCLUDING INITIAL STRESSES

NEXT TO ATTCHMNT (U=OUTS; L=INS; M=CTRL);
RO= 12.000;

	(AU)	(AL)	(BU)	(BL)	(CU)	(CL)	(DU)	(DL)
SX	2050.	-363.	2050.	-363.	7172.	-1899.	-3073.	1172.
SO	2309.	-1048.	2309.	-1048.	9075.	-5624.	-4456.	3529.
TAU	85.	85.	-85.	-85.	0.	0.	0.	0.
SI	2335.	1058.	2335.	1058.	9075.	5624.	4456.	3529.

	(AM)	(BM)	(CM)	(DM)
SX	843.	843.	2637.	-950.
SO	631.	631.	1725.	-463.
TAU	85.	-85.	0.	0.
SI	873.	873.	2637.	950.

AT LOC*SQRT(R*T) (U=OUTS; L=INS; M=CTRL);
RO= 21.573;

	(AU)	(AL)	(BU)	(BL)	(CU)	(CL)	(DU)	(DL)
SX	1307.	22.	1307.	22.	4106.	-64.	-1492.	109.
SO	1392.	-690.	1392.	-690.	4796.	-2764.	-2011.	1383.
TAU	47.	47.	-47.	-47.	0.	0.	0.	0.
SI	1414.	719.	1414.	719.	4796.	2764.	2011.	1383.

	(AM)	(BM)	(CM)	(DM)
SX	665.	665.	2021.	-691.
SO	351.	351.	1016.	-314.
TAU	47.	-47.	0.	0.
SI	672.	672.	2021.	691.

AT EDGE OF REINF (U=OUTS; L=INS; M=CTRL);
RO= 28.500;

	(AU)	(AL)	(BU)	(BL)	(CU)	(CL)	(DU)	(DL)
SX	3565.	259.	3565.	259.	12166.	-1393.	-5035.	1910.
SO	4880.	-3305.	4880.	-3305.	18854.	-14341.	-9094.	7732.
TAU	122.	122.	-122.	-122.	0.	0.	0.	0.
SI	4891.	3572.	4891.	3572.	18854.	14341.	9094.	7732.

	(AM)	(BM)	(CM)	(DM)
SX	1912.	1912.	5386.	-1563.
SO	787.	787.	2256.	-681.
TAU	122.	-122.	0.	0.
SI	1925.	1925.	5386.	1563.

, ENRICO FERMI ATOMIC POWER PLANT UNIT #2
CBI CONTRACT #69-5562,
ROUND ATTCHMT HPCI TURBINE EXHAUST ON A CYLINDRICAL VESSEL

HDB 8-1-73 GMT 8/7/73

OUTPUT INCLUDING INITIAL STRESSES

NEXT TO ATTCHMNT (U=OUTS; L=INS; M=CTRL);
RO= 12.000;

	(AU)	(AL)	(BU)	(BL)	(CU)	(CL)	(DU)	(DL)
SX	28300.	8387.	28300.	8387.	33422.	6851.	23177.	9922.
SO	28559.	7702.	28559.	7702.	35325.	3126.	21794.	12279.
TAU	85.	85.	-85.	-85.	0.	0.	0.	0.
SI	28585.	8397.	28585.	8397.	35325.	6851.	23177.	12279.

	(AM)	(BM)	(CM)	(DM)
SX	18343.	18343.	20137.	16550.
SO	18131.	18131.	19225.	17037.
TAU	85.	-85.	0.	0.
SI	18373.	18373.	20137.	17037.

AT LOC*SQRT(R*T) (U=OUTS; L=INS; M=CTRL);
RO= 21.573;

	(AU)	(AL)	(BU)	(BL)	(CU)	(CL)	(DU)	(DL)
SX	27557.	-8728.	27557.	-8728.	30356.	-8814.	24758.	-8641.
SO	27642.	8060.	27642.	8060.	31046.	5986.	24239.	10133.
TAU	47.	47.	-47.	-47.	0.	0.	0.	0.
SI	27664.	16787.	27664.	16787.	31046.	14800.	24758.	10774.

	(AM)	(BM)	(CM)	(DM)
SX	9415.	9415.	10771.	8059.
SO	17851.	17851.	18516.	17186.
TAU	47.	-47.	0.	0.
SI	17851.	17851.	18516.	17186.

AT EDGE OF REINF (U=OUTS; L=INS; M=CTRL);
RO= 28.500;

	(AU)	(AL)	(BU)	(BL)	(CU)	(CL)	(DU)	(DL)
SX	12315.	9009.	12315.	9009.	20916.	7357.	3715.	10660.
SO	22380.	14195.	22380.	14195.	36354.	3159.	8406.	25232.
TAU	122.	122.	-122.	-122.	0.	0.	0.	0.
SI	22381.	14198.	22381.	14198.	36354.	7357.	8406.	25232.

	(AM)	(BM)	(CM)	(DM)
SX	10662.	10662.	14136.	7187.
SO	18287.	18287.	19756.	16819.
TAU	122.	-122.	0.	0.
SI	18289.	18289.	19756.	16819.

Local Membrane Stress @ This Point Exceeds Allowable of 19250 psi by 506 psi which represents 2.6% over. However this is within the accuracy method of analysis

, ENRICO FERMI ATOMIC POWER PLANT UNIT #2
CBI CONTRACT #69-5562,
RCUND ATTCHMT HPCI TURBINE EXHAUST ON A CYLINDRICAL VESSEL

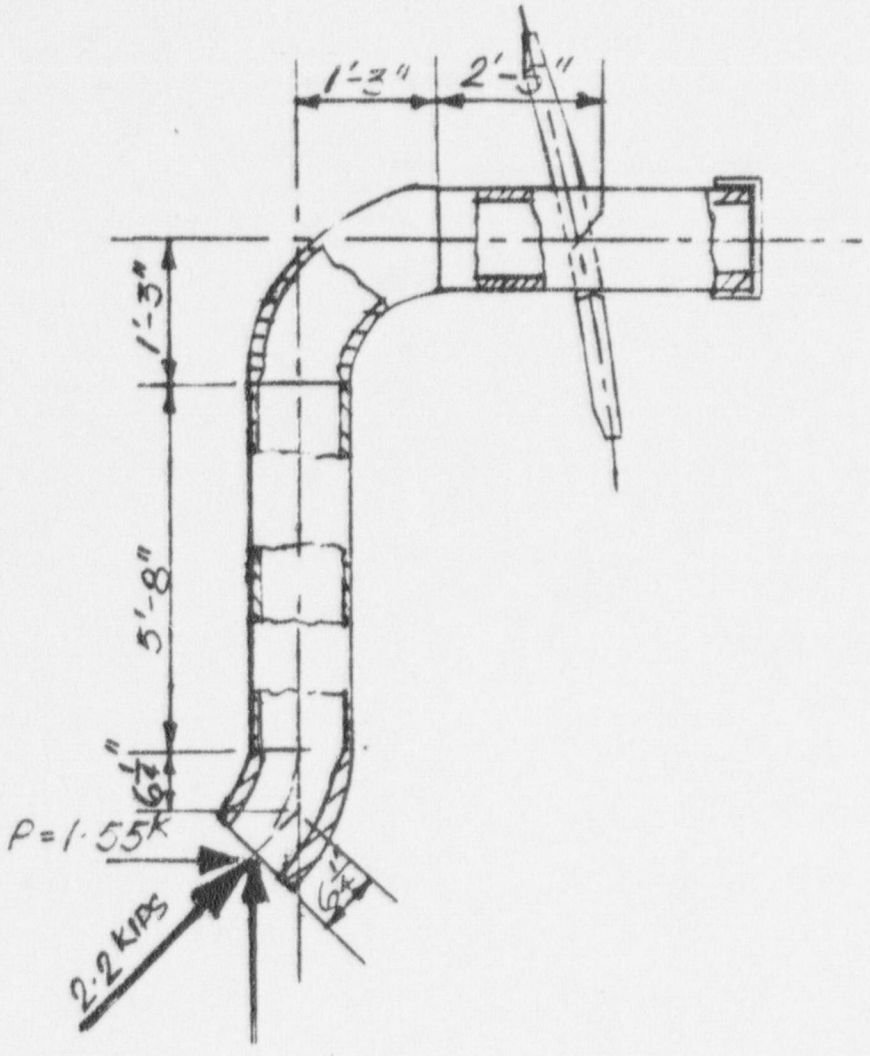
HDB 8-1-78
GMT 8/7/78

EZ-288 8/12

GO 54 REV 8-72

CBI

Location _____



$V_c = 1.55^K$

$$M_c = 1.55\left[\left\{.521\times.707+.521+5.66+1.25\right\}-\left\{.707\times.521+1.25+2.416\right\}\right]$$

$$M_c = 5.845 \text{ KIPS-FT.} = 70.14\times10^3 \text{ INCH-LBS.}$$

SUBJECT	MADE BY	CHKD BY	REV			CHARG. NO.
RCIC TURBINE EXHAUST	HDB	GMT		By		69-5562
PENETRATION X-212	DATE 7-26-73	DATE 8/7/73		Chkd		SHT 9 OF 12
				Date		

B2-288

PROG 1C27, REV 4/73
EXCEPT AS NOTED ON INPUT DATA SHT, NOTATION AGREES WITH THAT IN WRC107

INPUT

KN	KB	RM	T	LOC
1.00	1.00	183.294	0.587	0.5000

RO	TI	TP	h
5.375	2.000	0.0	31.625

P	VL	VC	MC	ML
-1550.	0.	1550.	-70140.	0.

INITIAL STRESSES NEXT TO ATTCHMNT

SX(AU)	SO(AU)	SX(CU)	SO(CU)	SX(AM)	SO(AM)	SX(CM)	SO(C
26250.	26250.	26250.	26250.	17500.	17500.	17500.	1750

INITIAL STRESSES AT LOC*SQRT(R*T)

SX(AU)	SO(AU)	SX(CU)	SO(CU)	SX(AM)	SO(AM)	SX(CM)	SO(C
26250.	26250.	26250.	26250.	8750.	17500.	8750.	1750

INITIAL STRESSES AT EDGE OF REINF

SX(AU)	SO(AU)	SX(CU)	SO(CU)	SX(AM)	SO(AM)	SX(CM)	SO(C
8750.	17500.	8750.	17500.	8750.	17500.	8750.	1750

OUTPUT

BIJLAARD COEFICIENTS

	NEXT TO ATTCHMNT	AT LOC*SQRT(R*T)	AT EDGE OF REINF
NX/P	17.333	15.433	25.935
MX/P	0.183	0.085	0.009
NX/MC	1.003	4.232	25.907
MX/MC	0.060	0.053	0.018
NX/ML	0.983	2.840	6.836
MX/ML	0.101	0.069	0.011
NO/P	19.482	13.908	8.073
MO/P	0.225	0.123	0.025
NO/MC	0.888	2.878	8.341
MO/MC	0.102	0.093	0.046
NO/ML	3.860	9.387	16.288
MO/ML	0.064	0.045	0.007

, ENRICO FERMI ATOMIC POWER PLANT UNIT #2
CBI CONTRACT #69-5562,
ROUND ATTCHMT RCIC TURBINE EXHAUST ON A CYLINDRICAL VESSEL

HOB 8-1-73. GMT 8/7/73
B2-288 12

OUTPUT EXCLUDING INITIAL STRESSES

NEXT TO ATTCHMNT (U=OUTS; L=INS; M=CTRL);
RO= 5.375;

	(AU)	(AL)	(BU)	(BL)	(CU)	(CL)	(DU)	(DL)
SX	498.	-352.	498.	-352.	1868.	-1660.	-891.	956.
SO	605.	-440.	605.	-440.	2914.	-2677.	-1703.	1796.
TAU	46.	46.	-46.	-46.	0.	0.	0.	0.
SI	622.	460.	622.	460.	2914.	2677.	1703.	1796.

	(AM)	(BM)	(CM)	(DM)
SX	73.	73.	114.	32.
SO	82.	82.	118.	46.
TAU	46.	-46.	0.	0.
SI	124.	124.	118.	46.

AT LOC*SQRT(R*T) (U=OUTS; L=INS; M=CTRL);
RO= 14.948;

	(AU)	(AL)	(BU)	(BL)	(CU)	(CL)	(DU)	(DL)
SX	262.	-132.	262.	-132.	750.	-496.	-226.	232.
SO	344.	-226.	344.	-226.	1137.	-935.	-449.	483.
TAU	17.	17.	-17.	-17.	0.	0.	0.	0.
SI	347.	229.	347.	229.	1137.	935.	449.	483.

	(AM)	(BM)	(CM)	(DM)
SX	65.	65.	127.	3.
SO	59.	59.	101.	17.
TAU	17.	-17.	0.	0.
SI	79.	79.	127.	17.

AT EDGE OF REINF (U=OUTS; L=INS; M=CTRL);
RO= 37.000;

	(AU)	(AL)	(BU)	(BL)	(CU)	(CL)	(DU)	(DL)
SX	622.	126.	622.	126.	1814.	-23.	-571.	274.
SO	800.	-567.	800.	-567.	2721.	-2153.	-1122.	1019.
TAU	23.	23.	-23.	-23.	0.	0.	0.	0.
SI	803.	694.	803.	694.	2721.	2153.	1122.	1019.

	(AM)	(BM)	(CM)	(DM)
SX	374.	374.	895.	-148.
SO	116.	116.	284.	-52.
TAU	23.	-23.	0.	0.
SI	376.	376.	895.	148.

, ENRICO FERMI ATOMIC POWER PLANT UNIT #2
CBI CONTRACT #69-5562,
ROUND ATTCHMT RCIC TURBINE EXHAUST ON A CYLINDRICAL VESSEL

HDB 8-1-73 GMT 8/7/73 11/
82-28810

OUTPUT INCLUDING INITIAL STRESSES

NEXT TO ATTCHMNT (U=OUTS; L=INS; M=CTRL);
RO= 5.375;

	(AU)	(AL)	(BU)	(BL)	(CU)	(CL)	(DU)	(DL)
SX	26748.	8398.	26748.	8398.	28138.	7090.	25359.	9706.
SO	26855.	8310.	26855.	8310.	29164.	6073.	24547.	10546.
TAU	46.	46.	-46.	-46.	0.	0.	0.	0.
SI	26872.	8418.	26872.	8418.	29164.	7090.	25359.	10546.

	(AM)	(BM)	(CM)	(DM)
SX	17573.	17573.	17614.	17532.
SO	17582.	17582.	17618.	17546.
TAU	46.	-46.	0.	0.
SI	17624.	17624.	17618.	17546.

AT LOC*SQRT(R*T) (U=OUTS; L=INS; M=CTRL);
RO= 14.948;

	(AU)	(AL)	(BU)	(BL)	(CU)	(CL)	(DU)	(DL)
SX	26512.	-8882.	26512.	-8882.	27000.	-9246.	26024.	-8518.
SO	26594.	8524.	26594.	8524.	27387.	7815.	25801.	9233.
TAU	17.	17.	-17.	-17.	0.	0.	0.	0.
SI	26597.	17406.	26597.	17406.	27387.	17061.	26024.	17750.

	(AM)	(BM)	(CM)	(DM)
SX	8815.	8815.	8877.	8753.
SO	17559.	17559.	17601.	17517.
TAU	17.	-17.	0.	0.
SI	17559.	17559.	17601.	17517.

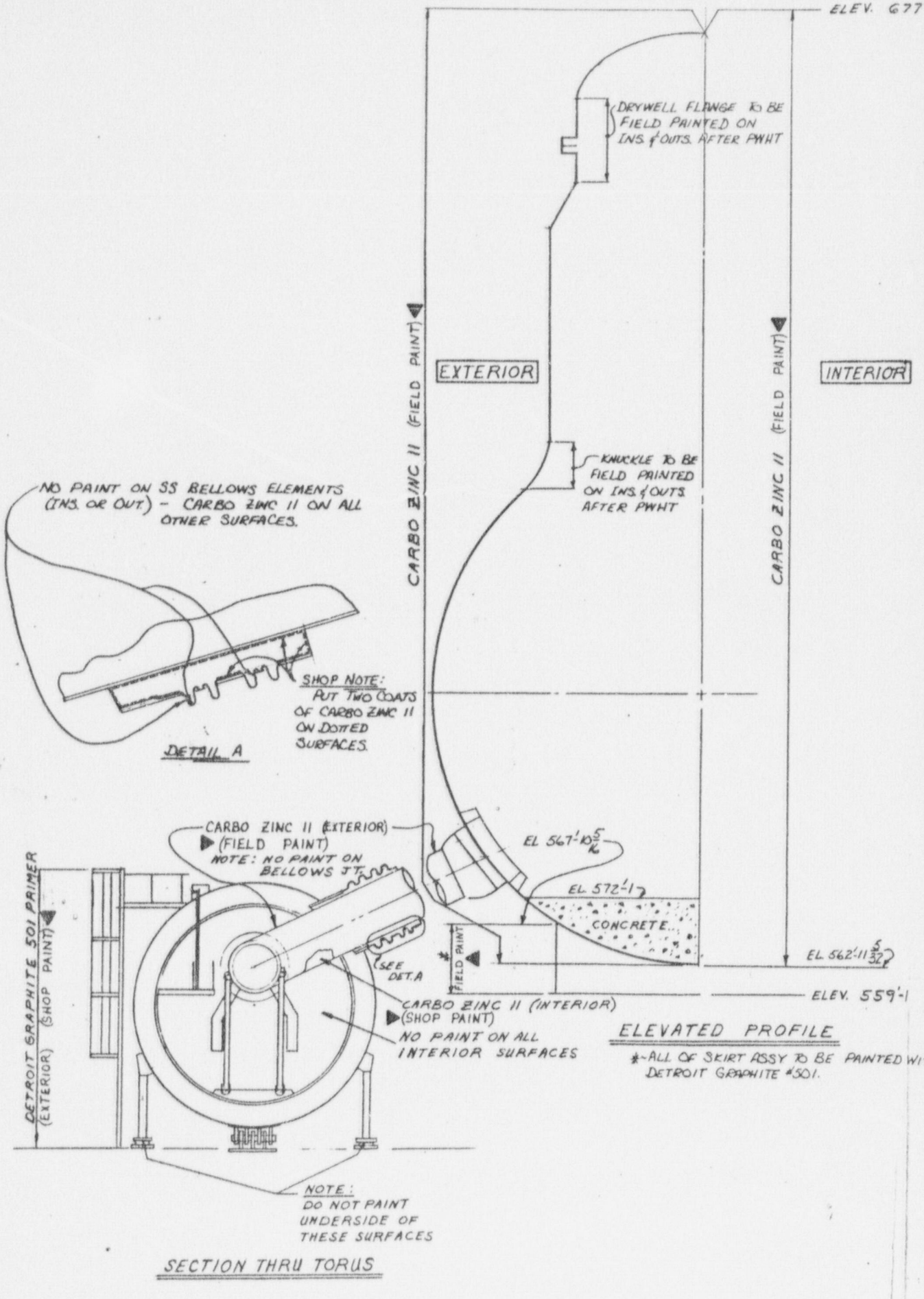
AT EDGE OF REINF (U=OUTS; L=INS; M=CTRL);
RO= 37.000;

	(AU)	(AL)	(BU)	(BL)	(CU)	(CL)	(DU)	(DL)
SX	9372.	8876.	9372.	8876.	10564.	8727.	8179.	9024.
SO	18300.	16933.	18300.	16933.	20221.	15347.	16378.	18519.
TAU	23.	23.	-23.	-23.	0.	0.	0.	0.
SI	18300.	16933.	18300.	16933.	20221.	15347.	16378.	18519.

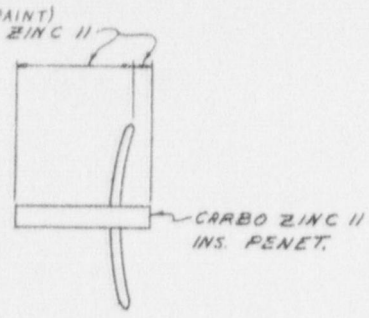
	(AM)	(BM)	(CM)	(DM)
SX	9124.	9124.	9645.	8602.
SO	17616.	17616.	17784.	17448.
TAU	23.	-23.	0.	0.
SI	17616.	17616.	17784.	17448.

, ENRICO FERMI ATOMIC POWER PLANT UNIT #2
CBI CONTRACT #69-5562,
ROUND ATTCHMT RCIC TURBINE EXHAUST ON A CYLINDRICAL VESSEL

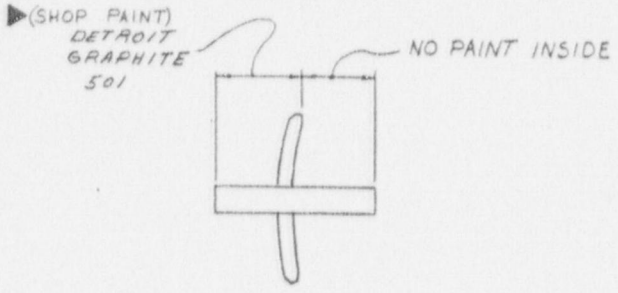
HOB 8-1-73 GMT 8/7/73 19


ELEV. 677'-
DRYWELL FLANGE TO BE FIELD PAINTED ON INS. & OUTS. AFTER PWHT
CARBO ZINC 11 (FIELD PAINT)
EXTERIOR
INTERIOR
CARBO ZINC 11 (FIELD PAINT)
KNUCKLE TO BE FIELD PAINTED ON INS. & OUTS. AFTER PWHT
NO PAINT ON SS BELLOWS ELEMENTS (INS. OR OUT) - CARBO ZINC 11 ON ALL OTHER SURFACES.
SHOP NOTE: PUT TWO COATS OF CARBO ZINC 11 ON DOTTED SURFACES.
DETAIL A
CARBO ZINC 11 (EXTERIOR) (FIELD PAINT)
NOTE: NO PAINT ON BELLOWS JT.
EL 567'-10 5/16
EL 572'-1
CONCRETE
EL 562'-11 5/32
DETROIT GRAPHITE 501 PRIMER (EXTERIOR) (SHOP PAINT)
(SEE DET. A
FIELD PAINT
ELEV. 559'-1
CARBO ZINC 11 (INTERIOR) (SHOP PAINT)
NO PAINT ON ALL INTERIOR SURFACES
NOTE: DO NOT PAINT UNDERSIDE OF THESE SURFACES
SECTION THRU TORUS
ELEVATED PROFILE
*-ALL OF SKIRT ASSY TO BE PAINTED WIT
DETROIT GRAPHITE #501.

9 13/16 (INS.)



TYPICAL DRYWELL PENETRATION INSERT ASSY
(INCLUDING VENT LINE INSERT ASSY)



TYPICAL TORUS PENET.

* SHOP AND FIELD NOTE:
NO CARBO ZINC PAINT
ALLOWED ON STAINLESS STEEL.

RECEIVED
MAR 22 1971
THE RALPH M. PARSONS CO.

GENERAL NOTES.

1. SHOP PAINT ALL SURFACES OF PERSONNEL LOCK AND EQUIPMENT HATCH WITH CARBO ZINC II.
2. SEE PAINT BILL SHEETS P1 THRU P4.

DOCUMENT CONTROL
No. T23-00-0-000-DA-007
FEB 1 1971
FERMI-2 STATUS I

B2-93
1-27-71

REVIEWED PER CORPORATE Q.A. PLAN
RELEASED FOR USE
R.L. Beutler 8-24-70
CERTIFIED BY DATE
UPDATED BY ROR REV. 2 DATE 1-26-71

TI
APERTURE
CARD

Also Available On
Aperture Card

INFORMATION ONLY

ENRICO FERMI POWER PLANT
UNIT #2 - MONROE, MICHIGAN

BY	CHKD	DATE	REMARKS
	C.F.H.		NOTED "SHOP" OR "FIELD" PAINT AREAS.
	ROR	1-26-71	
	S.B.M.		GENERAL
	C.J.W.	8-25-70	

CHICAGO BRIDGE & IRON COMPANY

PAINT DETAIL

PURCHASER'S NO. 10-70020
DRAWN BY RCP DATE 5-27-70
CHECKED BY RLG DATE
R.L. Beutler
ENGINEERING COORDINATOR

CONTRACT NO. 69-5562
DWG NO. P1 REV 2

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SEE APERTURE CARDS

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