APPENDIX F

CONTAINMENT VESSEL DESIGN SUMMARY DESIGN

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CONTAINMENT VESSEL DESIGN SUMMARY DESIGN

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CONTAINMENT VESSEL DESIGN SUMMARY REPORT

1.0 INTRODUCTION

This report has been prepared for the Atomic Energy Commission by the General Electric Company. Its purpose is to provide technical information on the design of the containment vessel. It describes design and leak test criteria and methods and contains code forms and leak test results.

Previously submitted material has generally not been duplicated and where possible, references to this material have been included.

The containment vessel consists of a drywell and pressure suppression chamber, with a vent system connecting them. Numerous previously submitted documents contain diagrams of the system. A reactor building encloses the containment vessel and acts as a secondary containment when the containment vessel is in service. Both the containment vessel (primary containment) and the reactor building are described in Section 5.

The drywell is a light bulb shaped vessel with the spherical portion at the bottom and withthe top cylindrical portion closed by a removable, flanged head.

The top head is of a type that can be easily opened. Details are such that all bolts are removable with the head and arranged so that they may be tightened using an impact wrench. A 24 inch diameter inspection opening is provided in the head. The top head closure and the inspection opening have been made leak tight by means of double compression seals with connections to permit leak testing by pressurizing the air space between the seals.

The suppression chamber is in the general form of a torus; however, in lieu of furnishing a double curved surface, the vessel is made up of 16 mitered cylindrical sections. Baffles, catwalks with steel grating floor and two manholes with ladders to the catwalks were provided. Manholes are flanged and bolted with a double compression seal with connections to permit leak testing by pressurizing the air space between the seals. Catwalks are capable of supporting a live load of 50 psf.

The vent system interconnecting the drywell and suppression chamber consists of vents between the drywell and a common header located within the suppression chamber, and downcomer pipes from the header terminating below the normal water level in the suppression chamber.

There are 8 vents equally spaced and uniformly sloped between the drywell and suppression chamber. Joints, permanently accessible, are provided in each vent to allow for relative movement due to expansion and contraction and other differential movements which may occur between the containment vessels. The common header for the vents is also in the general form of a torus and is also made up of 16 mitered cylindrical sections.

The downcomer pipes are arranged so that there are 4 in panels with vents and 8 in panels without vents. Each downcomer has an outside diameter of 24 inches and a wall thickness of 1/4”. The downcomer pipes terminate 4.0 ft below the minimum water level in the suppression chamber.

The sizes and arrangements of the drywell, suppression chamber and vent system areshown on tables and illustrations in Section 5. The suppression chamber is centered in the basement of the Reactor Building with the vertical axes of the vessels coincident.

2.0 CONTAINMENT SYSTEM CRITERIA AND DESIGN

2.1 GENERAL

The containment vessel is designed, fabricated and tested to meet applicable codes or standard requirements, in a manner that guarantees without failure the leak tightness and structural integrity of the system during all modes of plant operation or during any design accident condition. Failure of a containment barrier is defined as any failure which increases leakage rates above permissible values.

2.2 APPLICABLE CODES PRESSURE VESSELS

The design, fabrication, erection and testing of the vessels conformed to the requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Section III Class B, 1965 edition, and all applicable addenda and Code Case Interpretations, including Code Cases 1177 and 1330.

The completed vessels were inspected and marked by a recognized inspection agency certifying that the requirements of the applicable standards and codes had. been fulfilled. The vessels were stamped with the ASME Boiler and Pressure Vessel Code stamp in a permanently visible location, in accordance with Paragraph N 1500.

Other The design, fabrication, and erection of supports and bracing and like applications not within the scope of the ASME Code conformed to the requirements of the Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings, 1963 edition, of the American Institute of Steel Construction.

2.3 MATERIALS

Materials used are in accordance with applicable codes. Plate materials are A212 B FBX and A516 70 FBX to A300. Pipe materials are A333 Gr. 1 seamless, forgings are A350 LF 1, bolts are A320 L7, A194 Gr 4, and A193 B8. Miscellaneous materials are A36, A284 B, API SLX 42, and A283 C.

2.4 DESIGN

2.4.1 Pressures and Temperatures

Drywell & Vent System

Maximum Internal Pressure:	62 psig @ 281°F
Maximum External Pressure:	2 psig @ 281°F
Design Internal Pressure:	56 psig @ 281°F
Design External Pressure:	2 psig @ 281°F
Operating Internal Pressure:	0 to 1 psig @ 150°F

Operating External Pressure: 0 to 1 psig @ 150°F

Suppression Chamber

Maximum Internal Pressure:	62 psig @ 281°F
Maximum External Pressure:	2 psig @ 281°F
Design Internal Pressure:	56 psig @ 281°F
Design External Pressure:	2 psig @ 281°F
Operating Internal Pressure:	0 to 1 psig @ 50 to 100°F
Operating External Pressure:	0 to 1 Psig @ 50 to 100°F
Lowest Service Metal Temperature	30°F

2.4.2 Design Loads Normal Operating Condition

During nuclear reactor operation the vessels are subject to the specified Operating Pressures and Temperatures. The suppression chamber also is subject to the pressure associated with the storage of 75, 900 ft^3 of water distributed uniformly within the vessel.

Accident Condition

In addition to the specified Design Pressures and Temperatures, the drywell shell and closure head are designed and constructed to withstand jet forces of the following magnitudes in the locations indicated from any direction within the drywell:

Location	Jet Force (Max)	Interior Area Subjected to Jet Force
Spherical part of drywell	664, 000 pounds	3.69 sq. ft.
Cylinder and sphere to cylinder transition	256, 000 pounds	1.42 sq. ft.
Closure Head	32, 600 pounds	0.181 sq. ft.

The spherical and cylindrical parts of the drywell are backed up by reinforced concrete with space for expansion between the outside of the drywell and the concrete.

The above listed jet forces consist of steam and/or water impinging on the vessel causing a maximum metal temperature of 300°F. The jet forces listed above do not occur simultaneously. However, a jet force was considered to occur coincident with design internal pressure and a temperature of 150°F. Where the drywell shell is backed up by concrete it was assumed that local yielding will take place but it was established that a rupture will not occur. Where the shell is not backed up by concrete, the primary stresses resulting from this combination of loads did not exceed 0.90 times the yield point of the material at 300°F.

The suppression chamber was designed for the specified Design Pressures & Temperatures coincident with the loads associated with the storage of suppression pool water increased in volume to 83,700 $ft.^3$ and a jet force on each downcomer pipe of 21 kips.

Equipment Loads in Drywell

The vertical loads of the primary reactor vessel and reactor support concrete and equipment within the drywell were supported directly through the concrete fill within the drywell to continuous concrete fill below the drywell.

The design of the drywell in its final support condition included provision for the seismic shear and moments on the base of the reactor vessel support pedestal.

Gravity Loads Applied to the Drywell Vessel include:

The weight of the steel shell, jet deflectors, vents and other appurtenances.

Loads from equipment support structural members.

An allowance of 10 psf for the compressible material to he temporarily applied to the exterior of the vessel for use as concrete forms.

The live load on the equipment access opening: 20 tons.

The live load for the depth of water on the water seal at the top flange of the drywell with the drywell hemispherical head removed, or loads from refueling seals without head removed.

The weight of contained air during test.

A temporary load due to the pressure of wet concrete to be placed directly against the exterior compressible material attached to the exterior of the drywell and vents as shown on the drawings. It is intended that the concrete be placed at a rate of 18 inches in depth per hour. It is estimated that this rate of placement will result in a radial pressure on the vessel of 250 psf. Consideration was given to the residual stresses due to the unrelieved deflection of the vessel under this load, applied in successive 3 foot high horizontal bands.

Gravity Loads Applied to the Suppression Chamber include:

The weight of the steel shell including baffles, catwalks, headers, downcomers and other shell appurtenances.

The suppression pool water stored in the vessel.

The temporary load of 200 psf on the horizontal projected areas of the vessel due to the weight of wet concrete and concrete forms to be supported from the vessel during the construction of the floor above. The ASME Code allowable stresses were increased by 33 percent for the combination of this temporary load with other concurrent loads.

The weight of contained air during test.

Lateral Loads Wind Load

The drywell vessel which was exposed above grade prior to construction of the Reactor Building was designed for wind loads on the projected area of the circular shape in accordance with the height zones below in combination with other loads applicable during this stage with stresses limited to 133% of the ASME Code allowable stresses.

Height above grade (ft.)	Wind Load (psf)
0 30	15
30 100	21
Over 100	27

Earthquake Loads Drywell

A lateral force equal to the seismic coefficients indicated in Figures F.2.l and F.2.2 applied to the drywell permanent gravity loads and a vertical force equal to 4% of the permanent gravity loads were assumed as acting simultaneously with each other and were taken concurrently with the permanent gravity loads, accident pressure conditions and other lateral loads.

Suppression Chamber

A horizontal acceleration of 12%g was applied at the mass center of the suppression chamber and combined as stated above with a vertical acceleration of 4%g and the gravity loads, accident pressure, etc.

Suppression Chamber Baffles Loads

1) Horizontal: 6 psi on full area of each member of baffle, to provide support against wave action

2) Vertical: Dead load of baffle members

End Connections

Designed as slip joints so baffles do not act as ties or struts for suppression chamber shell. End connections designed for up to 50% overstress so baffle connections will fail before any damage can be done to suppression chamber shell.

Vent Thrust

The vent pipes and their connections to the drywell, the suppression chamber and the header were designed for the following loads:

Normal and Refueling Operation A force resulting from the differential horizontal and vertical movements between the drywell and suppression chamber due to changes in temperature. For this condition it was assumed that the drywell temperature is 150°F and the suppression chamber temperature is 50°F.

Initial and Final Test Conditions A force equal to design pressure times the net area of the connecting ring between the vent pipe and the expansion bellows plus a force equal to design pressure times the flow area of the vent pipe.

Accident Condition Forces similar to those above except the temperature of the drywell was taken as 281°F.

Header Loads - The weight of the containment cooling headers in the drywell, the spray header in the suppression chamber and the header on the outside suppression chamber were included in the gravity loads to be considered in the design of the vessels. The header outside the suppression chamber was flooded for all loading conditions. The spray headers in both vessels were considered as being empty except during the "Refueling" and "Accident" loading conditions.

2.4.3 Load Combinations

The vessels were designed for the loading combinations listed below.

2.4.3.1 Drywell and Vent System

2.4.3.1.1 Initial test condition at ambient temperature at time of test

Dead load of vessel
Test pressure
The weight of contained air
Lateral load due to wind or earthquake, whichever is more severe
Vent thrusts
Vertical earthquake load
Header load

2.4.3.1.2 Final test condition at ambient temperature at time of test

Dead load of vessel and appurtenances
Gravity loads from equipment supports
Gravity loads of compressible material
Dead load on welding pads
Design pressure internal and/or external
Loads due to earthquake in combination with internal pressure only
Effect of unrelieved deflection under temporary concrete load
Restraint due to compressible material
Vent thrusts
Weight of contained air
Header load

2.4.3.1.3 Normal operating condition at operating temperature range of 50°F to 150°F

Dead load of vessel and appurtenances
Gravity loads from equipment supports
Gravity load of compressible material
Loads due to earthquake in combination with 0 psig internal pressure only
Vent thrusts
Restraint due to compressible material
Dead load on welding pads
Effect of unrelieved deflection under temporary concrete load
Operating pressure internal or external
Live load on personnel air lock and equipment access opening
Loads from refueling seal
Header load

2.4.3.1.4 Refueling condition with drywell hemispherical head removed at operating temperature range of 50°F to 150°F

Dead load of vessel and appurtenances
Gravity loads from equipment supports
Gravity load of compressible material
Dead and live loads on welding pads
Water load on water seal at top flange of drywell
Effect of unrelieved deflection under temporary concrete
Restraint due to compressible material
Live load on personnel air lock
Live load on equipment access opening

2.4.3.1.5 Accident condition

Dead load of vessel and appurtenances
Gravity loads from equipment supports
Gravity load of compressible material
Dead load on welding pads
Loads due to earthquake in combination with internal pressure only
Design pressure and temperature
Effect of unrelieved deflection under temporary concrete load
Restraint due to compressible material
Vent thrusts
Jet forces
Header load

2.4.3.2 Suppression Chamber

2.4.3.2.1 Initial and final test condition at ambient temperature at time of test

Dead load of vessel and appurtenances
Suppression pool water
Loads due to earthquake in combination with internal pressure only
Design pressure internal or external
Vent thrusts
Weight of contained air
Header loads

2.4.3.2.2 Temporary condition at ambient temperature during construction

Dead load of vessel and appurtenances
Loads due to earthquake
Temporary concrete construction loading
Live load on catwalks and platforms
Headerload

2.4.3.2.3. Normal operating condition at 50°F 100°F

Dead load of vessel and appurtenances
Suppression pool water
Loads due to earthquake in combination with 0 psig internal pressure only
Header loads
Operating pressure internal or external
Live load on catwalks and platforms
Vent thrust

2.4.3.2.4 Accident Condition

Dead load of vessel and appurtenances
Suppression pool water
Loads due to earthquake in combination with internal pressure only
Design pressure
Vent thrusts
Jet forces on downcomer pipes
Header loads

2.4.4 Stresses - Primary Stresses

The enclosure was so designed that primary membrane stresses resulting from the above listed combinations of loads did not exceed those permitted by the Code.

Primary and Secondary Stresses

Secondary membrane and bending stresses in the drywell, suppression chamber and vent system resulting from distortions due to specified internal pressure, loads, and temperature were computed. In the calculation of these stresses all resistances to uniform increase in radius were considered. Combined primary and secondary stresses were within limits specified in the ASME Boiler & Pressure Vessel Code.

Earthquake Stresses

Stresses under seismic loading did not exceed the ASME Code or the AISC Code allowable stresses. Use of the 1/3 increase that is normally permitted when considering earthquake loads was not required.

2.4.5 Design Reconciliation

A design basis review of the drywell identified differences between the seismic acceleration curves shown in Figures F.2.1 and F.2.2 and those specified in Appendix A, Section A.3 and as stated in USAR Section 5.2.5.3.1. An engineering review of these differences concluded that results reported in Section 2.4 of this appendix are still valid when the seismic accelerations identified in Appendix A are considered in the analysis. 00-481

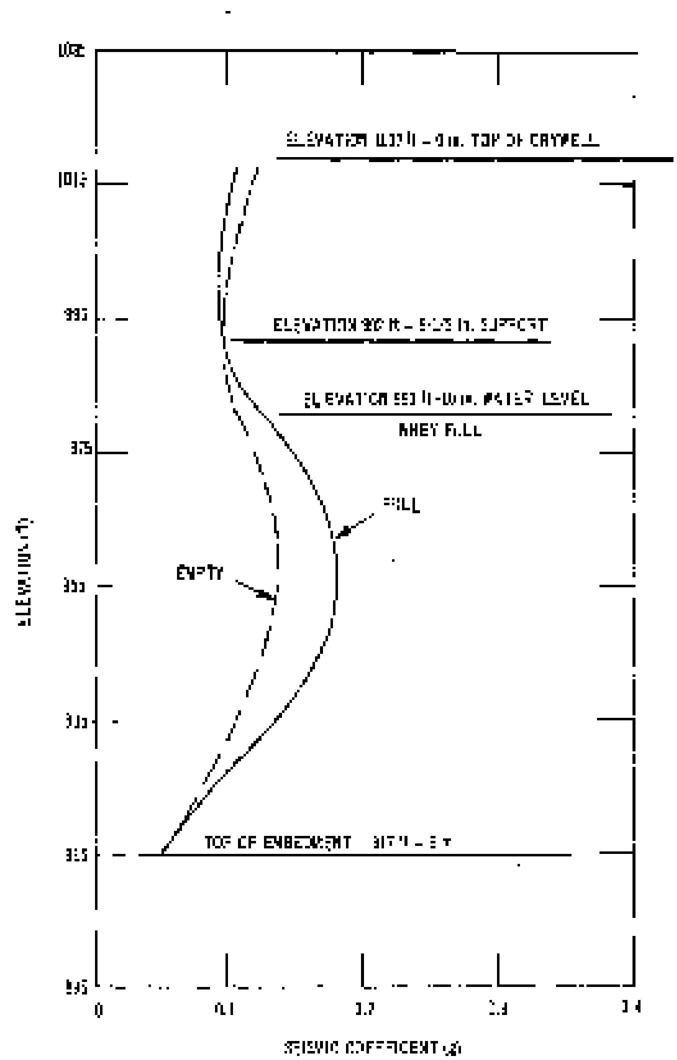

FIGURE F.2.1 DESIGN SEISMIC COEFFICIENT (TOP SUPPORTED)

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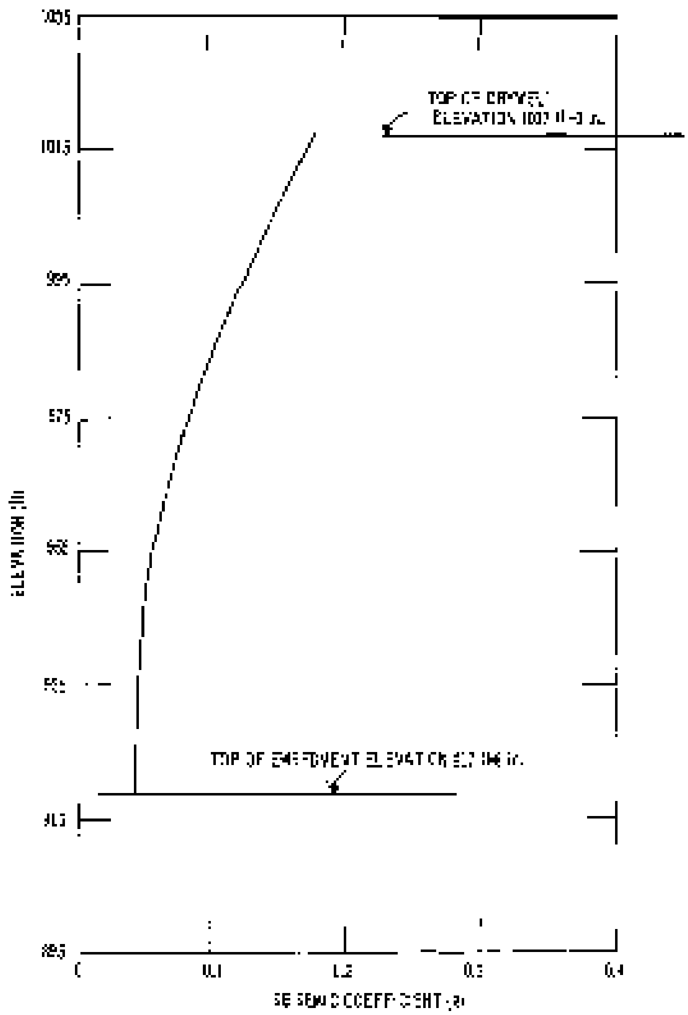

FIGURE F.2.2. DESIGN SEISMIC COEFFICIENT (TOP UNSUPPORTED)

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3.0 LEAK AND OVERLOAD TESTS

A complete report on the leak test and overload test is included herein as Attachment ”A”. This report was prepared by Chicago Bridge and Iron Company and contains the test procedure as well as the test results. All leakage rates were well within the allowable limits.

4.0 FIELD REPAIRS

4. 1 INTRODUCTION

In January, 1968, a crack was discovered where a shop assembled nozzle penetration insert plate was welded to the drywell shell of the containment vessel. Extensive inspection, magnetic particle testing and metalurgical examinations were undertaken to determine the cause and extent of cracking. These tests revealed the cracking to be the surface type and most of the cracks were found to be in the insert plate heat affected zone on the chamfered edge. The cracks discovered were longitudinal and immediately adjacent to the weld, ranging in depth from approximately 1/32 to 3/16". No subsurface cracking was detected. The major portion of the cracking occurred on the inside surface and was not confined to a particular type or size of chamfered insert plate.

The fabricator of the containment vessel (C. B.&I.) compiled a detailed report on the cracks, evaluation of the cracks, laboratory simulation of the cracks, analysis of the cause of cracking, and laboratory and field tests of the containment vessel and vessel material. Copies of this report are on file at Chicago Bridge and Iron's Oak Brook, Illinois offices and at General Electric's San Jose, California office, as well as the applicant's office. Nineteen copies of this report were unofficially distributed to the Chief, Reactor Project Branch 1, DRL, of the USAEC in March, 1968. The cracks, evaluation of the cracks, the above report and weld repair procedures were the subject of an information meeting held with the AEC on March 20, 1968. Because of this extensive reporting, only a summary of the problem and repairs are included as part of this report.

4.2 SUMMARY

A) surface cracking, ranging in depth from 1/32″ to 3/16″, was initially detected on January 18, 1968, mostly confined to the inside of the chamfered insert plates. No subsurface cracks were found.

B) An extensive field and laboratory investigation revealed that this cracking occurred as a result of the presence of hydrogen, high residual stresses, discontinuities at the surface, and high hardness. Laboratory tests simulating actual field temperature conditions resulted in similar cracks. It was concluded that such cracking could be prevented by using higher preheat and post heat temperatures which would tend to alleviate all of the above conditions, except the surface discontinuities.

C) A magnetic particle examination was made of all field welds, both inside and outside, subsequent to discovery of this cracking and prior to pneumatic testing of the vessel.

D) Cracks were traced out using carbon arc gouging and all cracks were repaired using 200° to 300°F preheat and 200° to 300°F post heat for one hour. Repaired areas were radiographed and magnetic particle examined after at least 24 hours delay.

E) All repaired and adjacent areas were again magnetic particle examined during the pneumatic test after the vessel had reached 5 psi pressure. No weld repairs were required.

F) All repaired and adjacent areas were again magnetic particle examined after the vessel had reached 26 psi pressure. Again no weld repairs were required.

G) Following the overload and leak rate test of the vessel, a magnetic particle examination was made of all the field welds around all insert fittings, both inside and outside, and spot checks were made of main vessel joints. No weld repairs were required.

4.3 CONCLUSIONS

The absence of cracking as evidenced by the extensive magnetic particle testing during and subsequent to the pneumatic testing of the vessel substantiates the adequacy of the procedures developed for examing welds and for making repairs.

MONTICELLO

APPENDIX F

Attachment "A"

C.B.&I. Report of Initial Overload Test

and

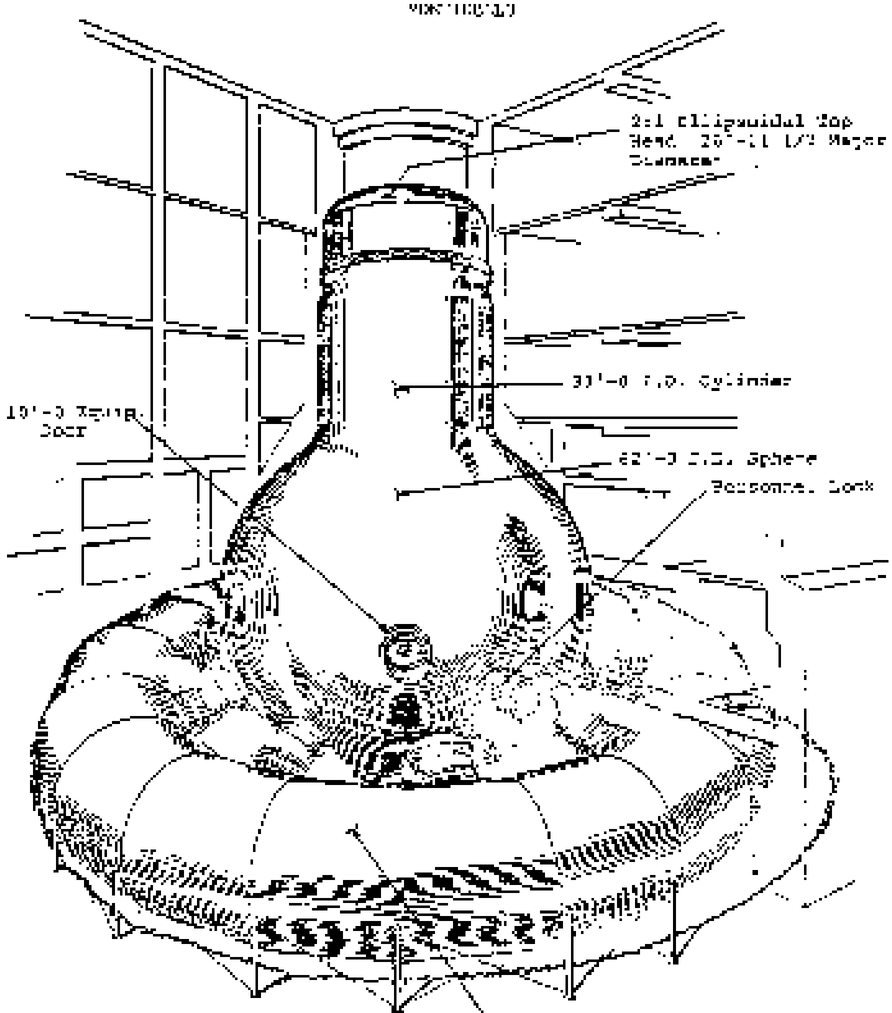
Leakage Rate Determination

of the

Pressure Suppression Containment

for the

Monticello Nuclear Generating Plant


2:1 Ellipsoidal Top
Head 20'-11 1/2 Major
Diameter
31'-0 I.D. Cylinder
10'-0 Equip.
Door
62'-0 I.D. Sphere
Personnel Lock
Toroidal Suppression Chamber
98'-0 Major Diameter
27'-8 Minor Diameter

MONTICELLO

INITIAL OVERLOAD & LEAK RATE TEST REPORT

OF THE CONTAINMENT VESSEL

MONTICELLO NUCLEAR PROJECT

MONTICELLO, MINNESOTA

INTRODUCTION

The Monticello Nuclear Power Project of the Northern States Power Company incorporates a pressure suppression containment system with a drywell having interconnecting vent lines to a suppression chamber. The system is intended to provide a leak resistant enclosure for the nuclear reactor and any steam or gases that may be released. The vessel is of the shape and size as shown on Page F.A 1.

The drywell and suppression chamber were designed, erected and tested by Chicago Bridge & Iron Company under a contract with General Electric Company and in accordance with General Electric Company specifications. The containment was designed and constructed in accordance with the rules of Section III of the ASME Code as a class "B" vessel. The containment vessel, consisting of interconnected drywell and suppression chamber, was stamped after completion and testing with the ASME symbol for the design internal pressure and design temperature.

The drywell was constructed on a skirt, but the lower portion was embedded in concrete prior to the vessel test. However, a Halogen leak test was conducted on all embedded seams to insure their leak tightness prior to this embedding operation. The suppression chamber was constructed on permanent steel columns with shear ties to resist all horizontal earthquake forces. All plate seams, excluding the embedded portion, were accessible for inspection inside and outside before and after the pressure test. All permanent connections were welded in place in the shell of each vessel.

Since outside weather conditions were severely cold at the time of test, a temporary encasement was built around the vessel. This temporary encasement was made from patented scaffolding and sheets of polyethylene, and its interior was heated to obtain an environment suitable for testing the vessel.

GENERAL PROCEDURE

The following test was made: The procedure for the overload test fulfilled the requirements of Section III of the ASME Code including Code Cases 1177 5 and 1330 1 and the latest addenda as of July 1966. The overload test was made with the suppression chamber partially filled with water to the accident condition level (83,700 cubic feet). Both the drywell and suppression chamber were simultaneously pressurized with air to 125% of the design pressure.

The leakage rate test is performed by comparing a pressure in the containment vessel to a pressure in an inner chamber which is an integral part of the reference system. The reference system was tested with a Halogen leak detector and an absolute pressure test was conductedfor 39 hours prior to the leakage rate test.

The drywell and suppression chamber were tested for leaks in accordance with General Electric Specification No. 21A5642. A general description of the reference system type of leakage test is as follows: By locating the inner chamber inside the drywell and inside the suppression chamber approximately at the center of the individual air masses, the average temperature of each air mass can be proportionately represented. Previous tests have shown that the data of successive midnight to dawn periods can be compared due to relatively uniform temperature conditions during this period.

The negligible difference in average air temperature between the inner chamber and the containment vessel eliminates the possibility of a pressure differential being caused by temperature. With the reference system tested, any relative decrease in containment vessel pressure must be considered as external leakage. A manometer is used as the pressure differential sensing device between the reference system and the vessel. Page F.A 4 describes the relationship between the differential pressure measurements to the per cent leakage.

Interior measurements of dew point and air temperatures were made and included in the calculation of the leakage rate. The results of the test are shown in Appendix F.A.E.

PRELIMINARY INSPECTION AND TESTING

Before the overload and leakage rate test at Monticello, preliminary inspection and testing was performed in the shop and field. All shop welded manholes and nozzles were magnetic particle inspected after stress relief. The personnel lock was shop assembled and tested for structural adequacy. A leak test of the lock was performed in the shop on gasket seals, valves, shaft penetrations, nozzles and piping.

At the Monticello site, the reference system was tested by pressurizing with Freon and using a Halogen leak detector. After installation, the dew cell elements and resistance bulbs were tested in position and found to be operating. The reference system was purged of Freon and pressurized with nitrogen for the absolute pressure test. This test was started at 5:00 P.M. February 7, 1968, and concluded at 8:00 A.M., February 9, 1968.

The data compiled during this time, showed the reference system to be leak tight within the accuracy of the instruments. However, at the start of the leak rate test and after the final soap film test, a leak was found to have been created at Valve B. This leak was corrected and retested prior to starting the leak rate test. A discussion was held with General Electric, and it was agreed that another hold test of the reference system was not necessary.

A 2 psig soap film leak test of the inner door and a 10 psig soap film test of the exterior door of the personnel lock was made. No detectable leaks were found in either case.

The air space between the double gasketed connection of the head flange, equipment hatch, stabilizer hatches and manholes was pressurized to approximately 100 psig and soap film tested. No detectable leaks were found.

OVERLOAD TEST

After testing of the reference system, the containment vessel was closed for the overload test. The suppression chamber had been filled with water in accordance with Step B 6 of the test instructions and at 12:00 noon on February 9, 1968, pressurizing operations were begun. The vessel was pumped to 5 psig and a complete soap film test of the vessel was ade.

Pressurizing operations were resumed and at 10:47 A.M. February 10, 1968, overload pressure (70 psig) was reached. After one hour the pressure in the vessel was reduced to design pressure (56 psig) and the soap film test was started.

LEAKAGE RATE TEST’

The leakage rate test of the vessel in the wet condition began at Midnight, February 1 10, 1968, and terminated at 7:00 A.M., February 13, 1968. Internal fans were used in the drywell and suppression chamber for the circulation of air in order to obtain uniform conditions. External heaters were turned on intermittently to maintain a reasonable outside temperature.

To obtain a dew point temperature (and a water vapor pressure) three dew cells were located in the suppression chamber and three in the drywell. Ten resistance bulbs were used for temperatures, three in the suppression chamber, one in the water, one in the vent line, and five in the drywell. These locations are illustrated in Figure B. At 7:00 A.M., February 13, 1968, the leak rate test was concluded and the vessel pressure was reduced to atmospheric.

MEASUREMENT OF LEAKAGE BY THE INNER CHAMBER METHOD

V = Geometric Volume of Containment Vessel

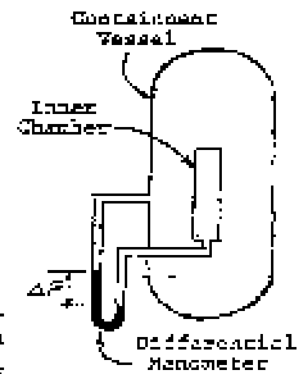
P = Absolute Pressure of Containment Vessel

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

Loss = Initial Expanded Air - Final Expanded Air

Per Cent Loss (as a positive Value) = $\dfrac{V \times \frac{\text{Int. } P}{14.7} - V \times \frac{\text{Fin. } P}{14.7}}{V \times \frac{\text{Int. } P}{14.7}} = \dfrac{\text{Initial } P - \text{Final } P}{\text{Initial } P} \times 100$

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.

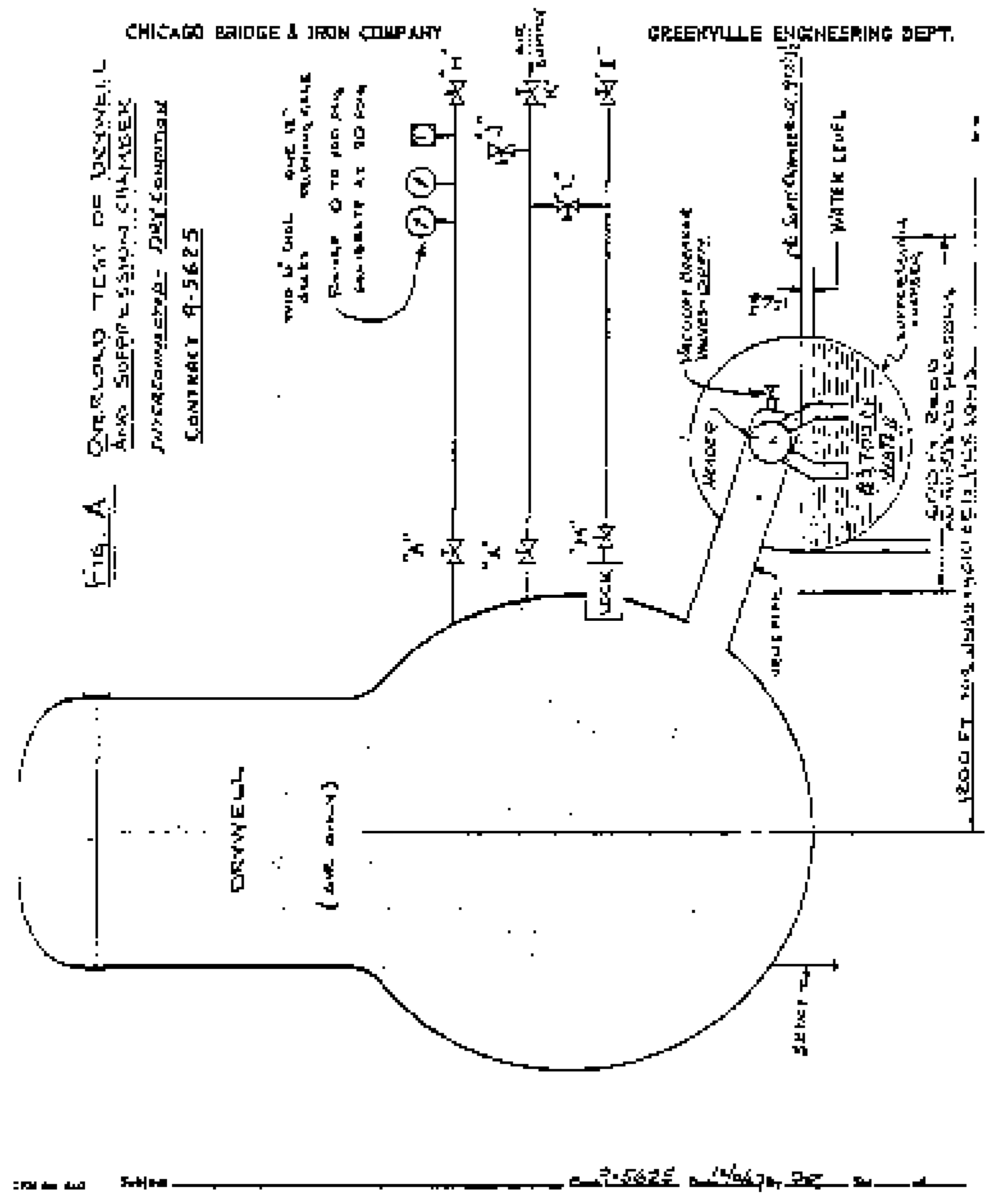


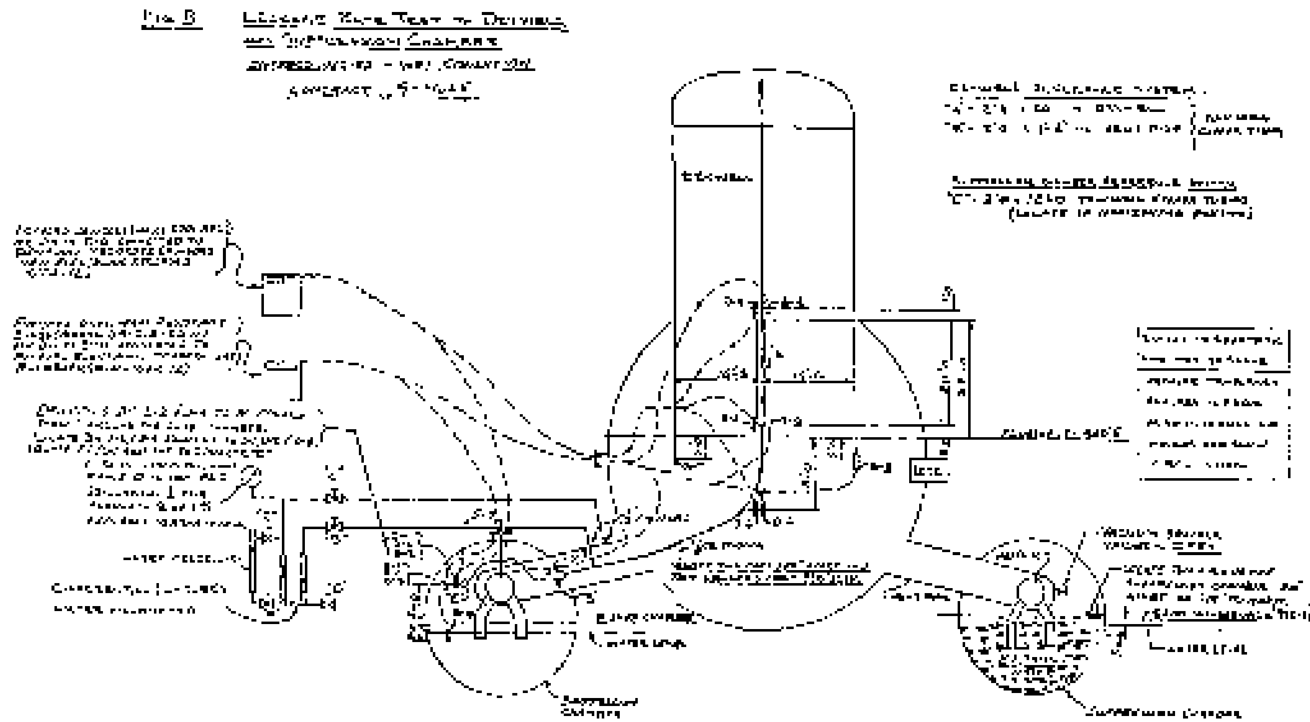
The Inner Chamber Method eliminates temperature measurements from the calculations. At periods of relatively uniform temperature throughout the Containment Vessel and the Inner Chamber, usually midnight to dawn, the temperature will cause negligible differential pressure reading on the Manometer. During 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 ΔP - Initial ΔP.

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

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

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


CHICAGO BRIDGE & IRON COMPANY
GREENVILLE ENGINEERING DEPT.
FIG. A
OVERLOAD TEST OF DRYWELL AND SUPPRESSION CHAMBER
INTERCONNECTED - DRY CONDITION
CONTRACT 9-5625
DRYWELL
WATER LEVEL
HEADER



RESULTS OF INSPECTIONS AND TESTS

PRELIMINARY CHECKS

The field magnetic particle inspection of manholes and nozzles did not find any indication of cracks or defects. The leak tests of the locks in the field at 2 psig and 10 psig were satisfactory and no leaks were found. No leaks were found in pressurizing between the two gaskets of bolted covers.

The pressure temperature data for the holding test of the reference system is tabulated in Appendix F.A.A. The results seem somewhat erratic because the internal heaters were operated intermittently during this test. However, to insure tightness a second Halogen leak test was performed on the reference system just prior to overload test. This test proved satisfactory.

OVERLOAD TEST AND SOAP FILM INSPECTION

The overload test chart is reproduced in Appendix F.A.C. The hourly pressure ambient temperature data recorded during the pump up of the containment is tabulated in Appendix F.A.D. During the overload test one temporary plug blew out of a 1" coupling on a 10" instrument line. The plug was replaced and the test resumed without incident.

The soap film test of the containment at the design pressure found several minor leaks. Several leaks were found on the temporary caps on the control rod drive penetrations. The plugs were tightened and the leaks minimized. Small leaks were found at the connection of power leads passing through the drywell. The only correction was to cut the leads and the decision was made to leave them alone and start the leak rate. Leaks were detected in four lock penetrations and these were plugged with temporary caps welded on the inside of the drywell. These plugs leaked somewhat but not sufficiently to stop the test. Also several leaks were found in the stuffing box connections on the lock door operating mechanism. These were of minor nature and were repaired after the test.

<u>LEAK RATE TEST</u>

The hourly data recorded during the February 11 13, 1968, wet leakage rate test is tabulated in Appendix F;A.E. The readings began at Midnight, February 10 and there was indication of large leaks. By 8:00 A.M. February 11, the test was halted in order to determine the location of leaks. The leaks were found to be at a 1” diameter coupling and also the power leads for heaters inside the drywell. The power leads were cut and the opening was capped by Bechtel and the 1” diameter plug was changed. At Midnight, February 11, test data gain began to be collected for the leakage rate test. Readings taken at 8:00 A.M. the following morning indicated no large leakage.

The circulating fans operated continuously during the test which helped provide a uniformity in the air vapor space. The data during the periods of 2:00 A.M. to 7:00 A.M. on February 12, and 13 proved to be the most stable, and this data is summarized below. The atmospheric temperatures are in °F, the containment vessel pressures are in lbs./sq. inch absolute, and the differential manometer readings are in inches of water.

	FEB. 12, 1968			FEB. 13, 1968		
	Int. Air	Cham.	Diff.	Int. Air	Cham.	Diff.
	Temp,	Press.	Mano.	Temp.	Press.	Mano.
Hours	°F.	PSIA	In. H_2O	°F.	PSIA	In. H_2O
2:00 A.M.	59.0	68.3	7.25	58.5	68.3	7.50
3:00	58.5	68.1	7.20	58.5	68.3	7.54
4:00	58.5	68.0	7.19	58.5	68.3	7.58
5:00	58.5	68.0	7.20	58.5	68.3	7.60
6:00	58.0	68.0	7.20	58.5	68.2	7.61
7:00	58.0	68.0	7.20	58.5	68.2	7.63
WEIGHTED AVERAGE	58.4	68.1	7.21	58.5	68.3	7.57

The change in water vapor pressure in the air vapor.space can be calculated from the temperature in dew point measurements. The internal air temperatures, the water temperatures, and the dew point temperatures all in °F are summarized below for the 2:00 A.M. to 7:00 A.M. time period.

MONTICELLO

Hours	DRYWELL Int. Air Temp. °F.	DRYWELL Dew Point °F.	SUPPRESSION CHAMBER* Int. Air Temp. °F.	SUPPRESSION CHAMBER* Water Temp. °F.	SUPPRESSION CHAMBER* Dew Point °F.	VENT LINE** Int. Air Temp. °F.
	FEB. 12, 1968					
2:00 A.M.	58.0	46.7	60.0	54.0	56.9	60.0
3:00	57.6	46.2	60.0	54.0	56.2	59.0
4:00	57.6	46.7	60.0	54.0	56.0	59.0
5:00	57.6	47.2	60.0	54.0	56.0	59.0
6:00	57.2	46.9	59.6	54.0	56.0	59.0
7:00	56.8	46.4	59.6	54.0	56.0	58.0
AVERAGE	57.5	46.7	59.9	54.0	56.2	59.0
	FEB. 13, 1968					
2:00 A.M.	57.6	49.1	60.0	55.0	57.4	59.0
3:00	57.4	49.1	60.0	55.0	56.5	59.0
4:00	57.6	49.1	60.3	55.0	57.2	59.0
5:00	57.5	49.3	60.3	55.0	56.7	59.0
6:00	57.6	49.1	60.0	55.0	56.9	59.0
7:00	57.6	48.6	60.0	55.0	57.2	59.0
AVERAGE	57.6	49.1	60.1	55.0	57.0	59.0

*Header assumed to have same temperature and dew point as suppression chamber

**Vent line assumed to have same dew point as drywell

From the above average internal air temperature and dew point temperature, the relative per cent humidity for February 12, calculates to be 68.03% and 87.91%, respectively for the drywell and suppression chamber, and 73.75% and 89.7% for February 13.

Considering that the drywell and vent lines have 68% of the total volume of the containment vessel, the average water vapor pressures are .179 psi for February 12, and .191 psi for February 13.

Correcting the above temperatures to weighted average temperatures and using the above data (without vapor pressure corrections) of the two successive 2:00 A.M. to 7:00 A.M. periods, the preliminary per cent leakage (as a negative number) per 24 hour period is as follows:

$$\text{Per Cent Loss} = \left(\frac{100}{Int. Pres. \; x \; 27.7}\right) x \; [\text{Int. } \Delta P - (\text{Final } \Delta P) \; x \left(\frac{Int. \; I.A.T.}{Fin. \; I.A.T.}\right)]$$

$$= \left[\frac{100}{(68.1) \; (27.7)}\right] \left[7.21 - 7.57 \left(\frac{518.4}{518.5}\right)\right]$$

$$= -.0190\%/24 \text{ hrs.}$$

Considering only the change in water vapor pressure, the apparent per cent loss (as a negative number) is as follows:

$$\text{Per Cent Loss} = \left(\frac{100}{Int. \; P \; x \; 27.7}\right) x \; [\text{Final W.V. } x \left(\frac{Int. \; I.A.T.}{Fin. \; I.A.T.}\right) - \text{Int. W.V.}]$$

$$= \left[\frac{100}{68.1}\right] \left[.191 \left(\frac{518.4}{518.5}\right) - .179\right]$$

$$= .0176\%/24 \text{ hrs.}$$

Combining the above calculated values the corrected per cent loss (as a negative number) is as follows:

Corrected per cent loss = preliminary per cent loss minus the apparent per cent loss

$$= .0190 \quad .0176 = .0366\%/24 \text{ hrs.}$$

$$= \left(\frac{100}{68.1}\right)\left[\frac{7.21}{27.7} + .179 - \left(\frac{7.57}{27.7} + .191\right)\left(\frac{518.4}{518.5}\right)\right]$$

$$= .0366\%/24 \text{ hrs.}$$

The corrected per cent loss of the wet test was well within the acceptable leakage rate of .2 of 1% for 24 hours. The calculated leakage from the test data was acceptable to General Electric Company and Chicago Bridge & Iron Company.

CHICAGO BRIDGE & IRON COMPANY

APPENDIX F.A.A

MONTICELLO

REFERENCE SYSTEM HOLD TEST

	Temperature of Ref. Sys.		Barometric Pressure		REFERENCE SYSTEM PRESSURE Measured	Absolute	Corrected
	Deg. Fahr	Deg. Abs.	In.				
Feb. 7	°F.	°R.	Mercury	PSIA	PSIG	PSIA	PSIA
5:00 P.M.	69	529	29.43	14.4	73.0	87.4	––
6:00	73	533	29.44	14.4	74.3	88.7	––
7:00	74	534	29.45	14.4	75.0	89.4	––
8:00	69	529	29.44	14.4	74.0	88.4	––
9.00	68	528	29.43	14.4	73.8	88.2	––
Feb. 8							
9:30 A.M.	79	539	29.29	14.4	75.6	90.0	––
11:30	80	540	29.32	14.4	75.9	90.3–	––
1:15 P.M.	81	541	29.25	14.3	76.0	90.3	––
2:30	81	541	29.20	14.3	75.8	90.1	––
3:30	80	540	29.19	14.3	75.8	90.1	––
4:30	79	539	29.18	14.3	75.6	89.9	–
5:30	78	538	29.19	14.3	75.3	89.6	88.7
7:15	74	534	29.20	14.3	74.4	88.7	–
8:0.0	72	532	29.20	14.3	74.0	88.3	––
9:00	70	530	29.20	14.3	73.7	88.0	––
10:00	69	529	29.24	14.3	73.6	87.9	
Feb, 9							
7:00 A.M.	66	526	29.30	14.4	72.9	87.3	––
8:00	66	526	29.30	14.4	72.8	87.2	––

Initial Data Selected At 6:00 P.M. Feb. 7.

Final Data Selected At 5:30 P.M. Feb. 8

Correct Pressure = (Final Abs. Press.) $\left(\frac{Init.\ \ Abs.\ \ Temp}{Fin.\ \ Abs.\ \ Temp.} \right)$

APPENDIX F.A.B

MONTICELLO

THERMOCOUPLE DATA FOR SHELL TEMPERATURES

Date	Gage 1 °F.	Gage 2 °F.	Gage 3 °F.	Gage 4 °F.	Gage 5 °F.	Gage 6 °F.	Gage 7 °F.	Gage 8 °F.
FEB. 9								
Noon	79	97	86	100	74	70	70	48
1:00 P.M.	82	88	78	94	75	76	76	49
2:00	80	94	98	94	78	80	78	53
5:00	75	81	95	78	78	78	80	55
6:00	52	61	70	49	60	60	66	40
6:15	48	57	66	48	56	58	64	38
6:30	48	54	64	44	55	58	64	38
7:05	48	54	63	44	56	63	67	44
7:32	41	43	48	36	48	48	54	30
8:20	38	43	50	40	49	52	59	33
8:40	42	45	52	42	55	57	60	34
9:00	44	47	52	44	57	57	64	37
9:30	45	48	52	45	57	59	65	37
10:00	48	49	55	51	61	61	64	39
10:30	54	56	61	60	64	66	70	44
FEB. 10								
12:30 A.M.	58	58	64	61	69	69	73	48
1:00	56	56	61	61	69	69	73	48
1:30	55	58	62	54	69	69	75	45
2:00	52	55	60	55	70	70	73	45
3:00	58	58	62	60	70	71	75	48
3:30	55	58	63	60	71	71	73	48
4:00	50	53	60	55	65	65	70	45

MONTICELLO

Date	Gage 1 °F.	Gage 2 °F.	Gage 3 °F.	Gage 4 °F.	Gage 5 °F.	Gage 6 °F.	Gage 7 °F.	Gage 8 °F.
FEB. 10								
4:30 A.M.	58	58	62	60	67	61	75	48
5:00	58	58	62	60	69	70	75	49
5:30	55	57	60	59	69	70	73	48
6:00	54	56	61	58	67	72	74	48
6:30	55	56	61	57	67	72	74	48
7:45	53	58	58	53	65	69	75	48
8:00	52	57	58	55	67	70	75	48
8:30	53	58	59	61	64	65	72	48
9:00	54	62	62	65	65	68	70	48
9:30	54	64	65	73	68	68	71	48
10:00	60	71	71	74	67	69	71	48
10:30	61	73	73	76	66	69	74	48
10:47	62	73	74	81	71	71	76	48
11:30	68	81	84	90	69	69	73	48
NOON	73	89	87	94	69	70	75	48
5:30 P.M.	62	69	79	64	*	67	79	48
6:00	59	66	73	61		71	78	48
6:30	59	65	73	59		69	79	48
7:50	55	63	63	53		71	79	48
8:37	56	56	62	52		67	80	48
10:30	51	51	57	50		67	79	48
11:53	46	50	50	45		65	79	48
FEB. 11								
12:30 A.M.	56	58	59	56	–	74	82	55
1:57	53	56	59	54	–	77	85	54

* Gage 5 was broken during the 56 PSIG soap film test

MONTICELLO

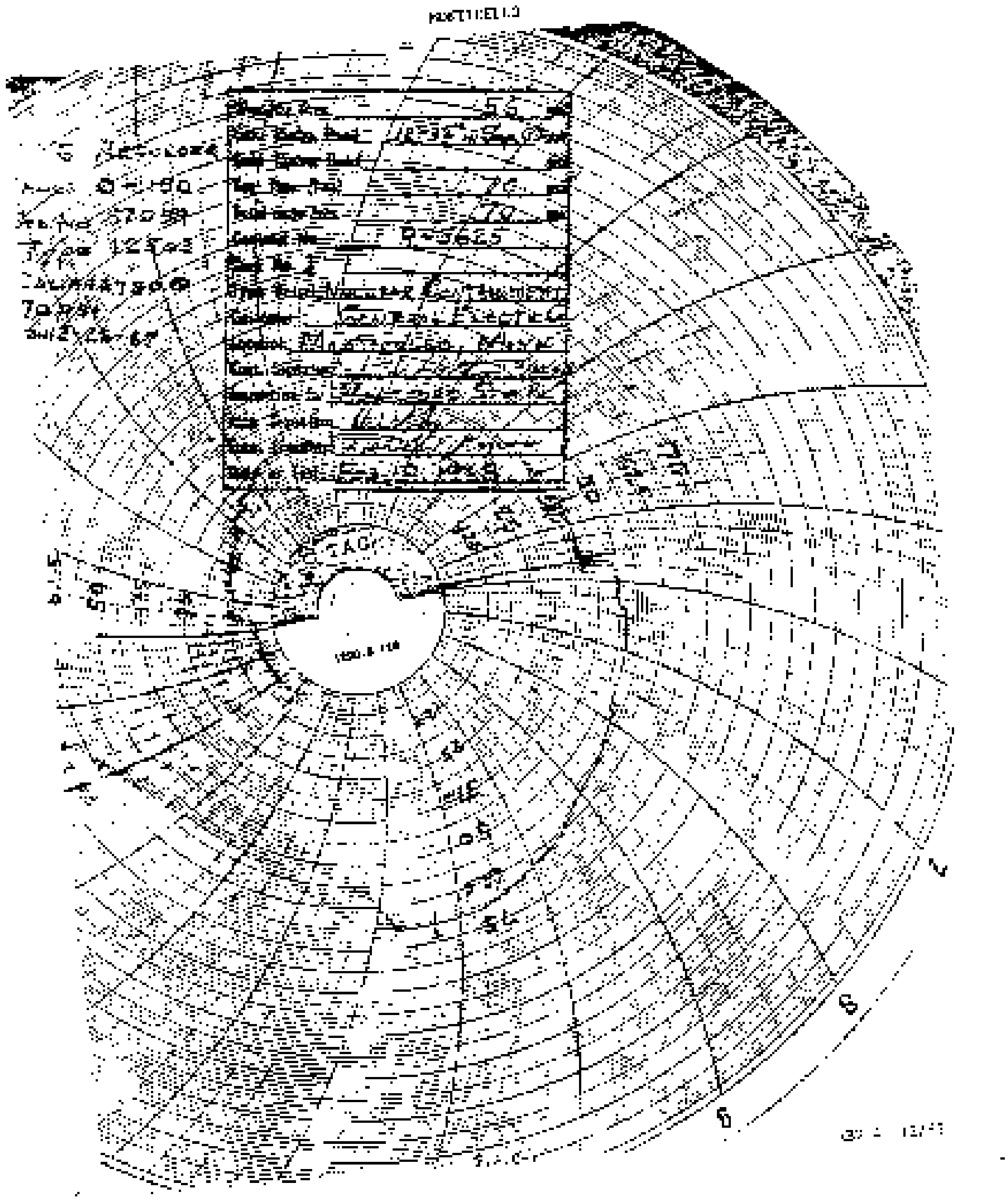
Date	Gage 1 °F.	Gage 2 °F.	Gage 3 °F.	Gage 4 °F.	Gage 5 °F.	Gage 6 °F.	Gage 7 °F.	Gage 8 °F.
FEB. 11								
3:15 A.M.	54	54	63	52		75	84	54
4:15	54	54	56	52		75	85	56
5:00	53	53	55	52		73	86	56
6:20	46	46	49	47		70	76	50
7:05	46	46	46	44		66	76	49
8:00	46	47	49	48		67	79	49
9:00	49	58	58	64		66	79	47
10:00	53	66	62	64		66	77	48
11:00	53	63	66	67		64	77	47
NOON	61	72	72	75	61	64	82	48
1:00 P.M.	67	72	79	74	60	64	79	47
2:00	68	75	86	76	60	66	81	47
3:00	68	73	85	75	60	65	81	48
4:15	67	76	86	76	63	79	84	49
5:00	66	70	80	69	62	62	79	49
6:00	64	65	74	60	61	65	76	49
7:00	55	62	67	55	61	65	80	48
8:00	55	58	62	53	62	65	79	49
9:00	52	55	61	54		69	81	48
10:00	53	56	58	51		64	81	48
11:00	52	53	55	52	63	66	81	47
MIDNIGHT	48	53	54	51	62	64	82	49
FEB. 12								
1:00 A.M.	49	51	53	48	60	65	79	46
2:00	48	49	53	51	62	65	79	49
3:15	58	58	61	57	68	73	85	56

Date	Gage 1 °F.	Gage 2 °F.	Gage 3 °F.	Gage 4 °F.	Gage 5 °F.	Gage 6 °F.	Gage 7 °F.	Gage 8 °F.
FEB. 12								
4:00 A.M.	58	58	61	57	67	73	88	56
5:35	54	54	54	54	64	72	83	52
6:10	54	54	54	54	63	71	83	52
7:10	54	54	54	54	62	60	83	52
8:00	53	53	53	54	62	68	81	48
9:00	53	58	58	60	60	70	78	50
10:00	55	59	60	60	60	70	77	48
11:00	55	62	66	69	60	69	77	48
NOON	60	70	70	70	61	66	77	49
1:00 P.M.	61	66	70	70	61	70	83	49
2:00	64	65	70	66	64	71	84	50
3:00	63	69	75	71	66	71	79	50
4:00	65	71	75	71	66	75	84	51
5:00	64	67	74	67	66	68	83	50
6:00	56	60	67	55	64	69	81	49
7:00	56	60	63	54	64	70	83	52
8:00	56	59	60	56	64	70	80	50
9:00	56	57	58	54	66	72	83	52
10:00	54	56	57	49	64	67	81	52
11:00	54	54	56	51	64	69	79	52
MIDNIGHT	52	52	54	51	63	69	79	52
FEB. 13								
1:00 A.M.	55	55	55	55	63	70	84	53
2:00	55	55	56	55	64	71	83	55
3:00	55	55	57	57	65	71	83	54
4:00	53	53	53	53	61	66	80	50

MONTICELLO

Date	Gage 1 °F.	Gage 2 °F.	Gage 3 °F.	Gage 4 °F.	Gage 5 °F.	Gage 6 °F.	Gage 7 °F.	Gage 8 °F.
FEB. 13								
5:00	53	53	53	53	61	67	80	49
6:00	56	56	56	56	63	70	84	50
7:00	56	56	56	56	64	70	86	50

APPENDIX F.A.C



APPENDIX F.A.D

MONTICELLO

CHICAGO BRIDGE & IRON COMPANY

CONTAINMENT VESSEL

OVERLOAD & SOAP FILM TESTS

Vessel Pressure

Time	Outside Air Temp. °F	Gage 1	Gage 2	Rec.	Remarks
Feb. 9 1968					
12: 00 PM		0			Cold, clear, sunny
1:15		5			M.P. − Soap tested
5:30	0	2.5	5		Cold & Clear
6:00		4	6	6	
6:15		6	10	6.5	
6:30	2	10	12	10	Colder
6:38		10.5	12	12	Stopped pumping going into tent to block up leak in tent and to turn on outside heaters.
7:04		10.5	12	12	Opened valves pumping
7:30		13	14	12.5	in tank
7:47		14	15	13	Shut comp. down to tank turned on inside heaters.
8:18		14	15	13	Tied compression into
9:00		19	19.5	19.5	chamber. Shut pumping down 2 min.
9: 30		21	22	22	
10:15		24	25	25	Recorder froze worked on it
10:30		26	27	26	and got it unstuck.
10:33		26	27	26	Blowing off
10:37		25	26	26	Closed Valve M.P. fitting and some weld seams

MONTICELLO

CHICAGO BRIDGE & IRON COMPANY

CONTAINMENT VESSEL

OVERLOAD & SOAP FILM TESTS

Vessel Pressure

Time	Outside Air Temp. °F	Gage 1	Gage 2	Rec.	Remarks
Feb. 10 1968					
1:00 AM	2	25	26	26	Pumping on chamber 1 heater
1:30		27	26	28	on in vessel 4 outside
2:00		30	26	31	4 in supp. chamber area
2:15		32		33	Stop pumping for elec.
3:00	9				Resume pumping
3:30		35	36	36	
4:00		38	39	39	
4:30		40	39	40	
4:50		42	40	42	2 min. hold
5:30		45	40	46	Recorder was frozen.
6:00	11	48	49	49	5 min hold.
6:30		51	51	51	
7:00		51			1” plug Blew Shut Down
7:30		51			Resume Pumping
8:00		54	54	54	
8:30		57	57	57	5 min. hold Shut down for last look at boiler.
9:00		58	58	59	
9:30		61	61	62	Shut Down 1 heater inside.
9:40		63	63	63	Short hold for 634 increment
10:00		64	65	65	Shut Down 2nd inside heater– All off.
10:30		67	68	68	

MONTICELLO

CHICAGO BRIDGE & IRON COMPANY

CONTAINMENT VESSEL

OVERLOAD & SOAP FILM TESTS

Vessel Pressure

Time	Outside Air Temp. °F	Gage 1	Gage 2	Rec.	Remarks
Feb. 10 1968					
10: 47 AM		70	70	70	Overlaod test pressure.
11:07		70	70	70	Transfer pressure on lock.
11:47		70	70	70	Start pressure reduction.
12:17		56	56	56	Down to W.P.

APPENDIX F.A.E

APPENDIX F.A.F

APPENDIX F.A.F

MONTICELLO

LEAKAGE RATE TEST DATA

Time	Ves.Ga. Press.	Barom. in.Hg	Barom. psi	Absol. Press.	Manometer Vessel	Manometer Ref Sy.	ΔP	Avg. Dew* Pt. Temp.	Avg.* Dew Pt.	%Rel Humid	W. V. Press.	I.A.T. (Rank)
FEB. 11 1968												
1:45 AM	54.0	29.18	14.3	68.3	2.60	0.92	1.68	118.5	49.5	73.8	0.175	518
3:00	53.75	28.80	14.1	67.9	2.61	0.89	1.72	117.5	48.8	75	0.170	517
4:00	53.6	29.20	14.3	67.9	2.64	0.89	1.75	117.5	48.8	76.3	0.170	516.5
5:00	53.6	29.18	14.3	67.9	2.78	0.72	2.06	116.5	48.1	75	0.166	516
6:00	53.5	29.22	14.3	67.8	2.83	0.62	2.21	116.5	48.1	77.5	0.166	515
7:00	53.4	29.20	14.3	67.7	2.87	0.53	2.34	117.5	48.8	80	0.170	515
8:00	53.4	29.20	14.3	67.7	3.02	0.40	2.62	117	48.4	80	0.168	514.5
9:00	53.5	29.20	14.3	67.8	3.05	0.35	2.70	117.5	48.8	80	0.170	515
10:00	53.7	29.21	14.3	68.0	3.80	0.00	3.80	118	49.1	77.5	0.172	516
11:00	53.9	29.23	14.3	68.2	4.40	0.50	4.90	119	49.8	77.5	0.177	517
12:00	54.1	29.20	14.3	68.4	5.18	1.10	6.28	120	50.5	77.5	0.181	517.5
1:00	54.2	29.05	14.2	68.4	5.35	1.78	7.13	120.5	50.9	73.8	0.184	519.5
2:00	54.3	29.10	14.3	68.6	6.45	2.80	9.25	121	51.2	71.3	0.186	520.5
3:00	54.5	29.10	14.3	68.8	6.62	3.02	9.64	121.5	51.6	70	0.189	521.5
4:00	54.6	29.10	14.3	68.9	7.21	3.08	10.29	122.5	52.3	71.3	0.194	522
5:00	54.9	29.10	14.3	69.2	7.33	3.10	10.43	123	52.6	68.8	0.196	523
6:00	54.9	29.10	14.3	69.2	7.18	3.00	10.18	123	52.6	68.8	0.196	523
7:00	54.6	29.10	14.3	68.9	7.18	3.10	10.28	124	53.2	70	0.200	523
8:00	54.6	29.10	14.3	68.9	6.41	2.45	8.86	123.5	52.9	72.5	0.198	522
9:00	54.4	29.07	14.3	68.7	6.09	2.20	8.29	123	52.6	72.5	0.196	521.5

*All averages shown in Appendix E are straight arithmetical and have not been weighted.

MONTICELLO

LEAKAGE RATE TEST DATA

Time	Ves.Ga. Press.	Barom. in.Hg	Barom. psi	Absol. Press.	Manometer Vessel	Manometer Ref Sy.	ΔP	Avg. Dew* Pt. Temp.	Avg.* Dew Pt.	%Rel Humid	W. V. Press.	I.A.T. (Rank)
FEB. 11 1968												
10:00 PM	54.25	29.08	14.3	68.6	5.90	2.05	7.95	123	52.6	73.8	0.196	521
11:00	54.25	29.09	14.3	68.6	5.75	1.98	7.73	122.5	52.3	75	0.194	520.5
12:00	54.2	29.10	14.3	68.5	5.62	1.88	7.50	123	52.6	76.5	0.196	520
FEB. 12 1968												
1:00 AM	54.0	29.08	14.3	68.3	5.54	1.87	7.41	122.5	52.3	78	0.194	519.5
2:00	54.0	29.1014.3		68.3	5.48	1.77	7.25	122	51.9	78	0.191	519
3:00	53.8	29.14	14.3	68.1	5.45	1.75	7.20	121	51.2	76.5	0.186	518.5
4:00	53.7	29.13	14.3	68.0	5.45	1.74	7.19	121.5	51.6	78	0.189	518.5
5:00	53.7	29.14	14.3	68.0	5.45	1.75	7.20	121.5	51.6	78	0.189	518.5
6:00	53.7	29.13	14.3	68.0	5.45	1.75	7.20	121.5	51.6	79.5	0.189	518
7:00	53.7	29.13	14.3	68.0	5.45	1.75	7.20	121	51.2	78	0.186	518
8:00	53.8	29.16	14.3	68.1	5.43	1.75	7.18	121.5	51.6	79.5	0.189	518
9:00	53.9	29.19	14.3	68.2	5.50	1.75	7.25	122.5	52.3	81	0.194	518.5
10:00	54.0	29.19	14.3	68.3	5.55	1.90	7.45	122.5	52.3	79.5	0.194	519
11:00	54.0	29.14	14.3	68.3	5.60	2.20	7.80	122.5	52.3	76.5	0.194	520
12:00	54.0	29.20	14.3	68.3	5.90	2.42	8.32	124	53.2	76.5	0.200	520.5
1:00 PM	54.0	29.18	14.3	68.3	6.34	2.96	9.30	125	53.9	76.5	0.206	521.5
3:00	54.0	29.18	14.3	68.3	5.90	2.65	8.55	125	53.9	76.5	0.206	521.5
4:00	54.1	29.18	14.3	68.4	6.20	2.81	9.01	125.5	54.3	76.5	0.209	522
5:00	54.1	29.20	14.3	68.4	6.70	3.40	10.10	125.5	54.3	76.5	0.209	522
6:00	54.1	29.22	14.3	68.4	7.05	3.50	10.55	124	53.2	72.5	0.200	522

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Time	Ves.Ga. Press.	Barom. in.Hg	Barom. psi	Absol. Press.	Manometer Vessel	Ref Sy.	ΔP	Avg. Dew* Pt. Temp.	Avg.* Dew Pt.	%Rel Humid	W. V. Press.	I.A.T. (Rank)
FEB. 12 1968												
7:00 PM	54.1	29.24	14.3	68.4	6.10	2.45	8.55	125.5	54.3	79.5	0.209	521
8:00	54.0	29.29	14.4	68.4	5.95	2.25	8.20	124.5	53.6	78	0.203	520.5
9:00	54.0	29.31	14.4	68.4	5.80	2.10	7.90	124.5	53.6	79.50.203		520
10:00	54.0	29.32	14.4	68.4	5.81	1.98	7.79	124	53.2	78	0.200	520
11:00	54.0	29.34	14.4	68.4	5.69	1.93	7.62	124.5	53.6	81	0.203	519.5
FEB. 13 1968												
12:00	54.0	29.34	14.4	68.4	5.59	1.89	7.48	124	53.2	81	0.200	S.9
1:00 AM	53.9	29.137	14.4	68.3	5.68	1.86	7.54	123	52.6	81	0.196	518.1
2:00	53.9	29.40	14.4	68.3	5.68	1.82	7.50	124	53.2	82,5	0.200	518.1
3:00	53.9	29.42	14.4	68.3	5.73	1.81	7.54	123.5	52.9	82.5	0.198	518.1
4:00	53.9	29.42	14.4	68.3	5.75	1.83	7.58	124	53.2	82.5	0.200	518.1
5:00	53.9	29.46	14.4	68.3	5.80	1.80	7.60	123.5	52.9	82.5	0.198	518.
6:00	53.8	29.45	14.4	68.2	5.77	1.84	7.61	123.5	52.9	82.5	0.198	518.
7:00	53.8	29.45	14.4	68.2	5.73	1.90	7.63	123.5 5	2.9	82.5	0.198	518.

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	Resistance Bulbs											Dew Cells						
Time	B−1	B−2	B−3	B−4	B−5	B−6	B−7	B−8	B−9	B−10	Avg.	D−1	D−2	D−3	D−4	D−5	D−6	Avg.
FEB. 111968																		
1:45 AM	60	59	60	56	57	57	58	57.5	58.5	52	58	126	127	126	110	109	112	118.5
3:00	59	58.5	59	55	55.5	56	56.5	56.5	57.5	52	57	126	127	126	108	108	110	117.5
4:00	59	58	59	54	54.25	55.5	56	55.5	57	52	56.5	127	127	127	107	107	110	117.5
5:00	59	58	59	53.5	53.5	54	55	55	56	52	56	126	127	126	105	107	109	116.5
6:00	58	59	58	52.5	53	53.5	54	54	55	52	55	127	127	125	106	106	109	116.5
7:00	59	58.5	59	52	52.5	53	53.5	53.5	54.5	53	55	127	127	125	109	107	110	117.5
8:00	58	57	58	52	52	53	53	53	54	53	54.5	126	126	127	108	106	110	117
9:00	58	57	58	53	53	53	54	54	54	53	55	127	127	127	108	107	110	117.5
10:00	58	57	58	55	55	56	55	56	56	53	56	126	126	128	110	108	112	118
11:00	58	58	58	57	56	57	56	57	58	52	57	127	127	126	113	109	113	119
12:00	58	58	58	60	58	57	56	55	58	52	57.5	128	127	126	113	112	115	120
1:00 PM	58	58	59	62	60	62	59	58	59	52	59.5	128	128	125	114	112	117	120.5
2:00	59	59	59	64	61	61	60	60	61	53	60.5	125	128	127	115	114	118	121
3:00	60	59	59	66	62	62	62	61	62	53	61.5	126	128	127	116	115	118	121.5
4:00	60	59	60	68	63	63	62	62	63	53	62	128	128	127	117	116	119	122.5
5:00	61	60	61	69	64	64	63	63	63	53	63	129	128	126	118	117	121	123
6:00	60	61	61	68	64	64	63	64	64	53	63	128	128	127	117	117	120	123
7:00	61	60	61	65	64	64	63	64	64	53	63	129	129	129	118	118	122	124
8:00	61	60	61	62	62	63	63	63	64	53	62	129	129	129	119	116	120	123.5

*NOTE B 10 reads temperature of H_2O not in avg.

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Time	Resistance Bulbs											Dew Cells						
Time	B−1	B−2	B−3	B−4	B−5	B−6	B−7	B−8	B−9	B−10	Avg.	D−1	D−2	D−3	D−4	D−5	D−6	Avg.
FEB. 11 1968																		
9:00 PM	61	60	61	61	62	62	62	62	63	53	61.5	129	128	127	117	117	119	123
10:00	61	60	61	60	60	61	61	61	62	53	61	128	128	129	118	116	119	123
11:00	61	60	61	60	60	60	61	61	61	54	60.5	129	128	129	116	116	118	122.5
12:00	61	60	61	59	59	60	60	60	61	53	60	128	129	129	117	117	119	123
FEB. 12 1968																		
1:00 AM	61	60	60	58	58	59	59	60	60	54	59.5	129	129	128	115	115	119	122.5
2:00	60	60	60	57	58	58	58	59	60	54	59	130	128	130	114	114	116	122
3:00	60	60	60	57	57	58	58	58	59	54	58.5	129	128	128	115	112	116	121
4:00	60	60	60	57	57	58	58	58	59	54	58.5	128	128	128	115	113	116	121.5
5:00	60	60	60	57	57	58	58	58	59	54	58.5	128	128	128	116	115	115	121.5
6:00	60	59	60	57	56	57	58	58	59	54	58	128	128	128	117	113	115	121.5
7:00	60	59	60	56	56	57	57	58	58	54	58	128	128	128	114	112	117	121
8:00	60	59	60	56	56	57	57	57	58	54	58	128	128	127	116	114	116	121.5
9:00	60	60	60	57	57	58	58	58	59	54	58.5	129	128	130	116	115	118	122.5
10:00	60	60	60	58	58	59	59	59	60	54	59	129	129	129	116	115	118	122.5
11:00	60	60	60	60	60	60	60	60	60	54	60	129	129	127	117	116	118	122.5
12:00	60	60	60	61	61	61	61	61	61	54	60.5	130	130	128	118	118	121	124

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	Resistance Bulbs											Dew Cells						
Time	B−1	B−2	B−3	B−4	B−5	B−6	B−7	B−8	B−9	B−10	Avg.	D−1	D−2	D−3	D−4	D−5	D−6	Avg.
FEB. 11 1968																		
1:00 PM	60	60	61	63	62	62	61	61	62	54	61.5	130	130	130	120	118	121	125
2:00	61	60	61	62	62	62	61	62	62	54	61.5	130	130	128	120	118	122	124.5
3:00	61	60	61	62	62	63	62	62	62	54‘	61.5	130	130	131	120	118	121	125
4:00	61	61	61	64	63	63	62	62	63	54	62	130	130	128	122	119	123	125.5
5:00	61	60	61	64	63	63	62	62	63	54	62	130	130	131	121	119	122	125.5
6:00	61	60	61	63	62	63	62	62	63	54	62	130	130	128	118	118	121	124
7:00	61	60	61	61	61	62	61	61	62	54	61	130	130	130	121	119	122	125.5
8:00	61	60	61	60	60	61	60	61	62	54	60.5	130	130	130	118	118	120	124.5
9:00	61	60	61	59	59	60	60	60	61	54	60	130	129	129	118	119	123	124.5
10:00	61	60	61	58	59	59	60	60	60	55	60	130	130	128	118	118	121	124
11:00	61	60	61	58	58	59	59	59	60	55	59.5	130	130	130	119	119	119	124.5
FEB. 13 1968																		
12:00	61	60	61	57	57	58	58	58	59	55	59	130	130	129	118	117	119	124
1:00AM	60	60	60	57	57	58	58	58	59	55	59,5	130	129	127	118	116	117	123
2:00	60	60	60	57	57	58	58	58	59	55	58.5	130	129	131	119	117	118	124
3:00	60	60	60	57	57	57	58	58	59	55	58.5	130	129	127	117	117	120	123.5
4 00	61	60	60	57	57	58	58	58	59	55	58.5	130	129	130	118	116	120	124
5:00	60.5	60	60.5	57	57	57.5	58	58	59	55	58.5	130	129	128	119	117	119	123.5
6:00	60	60	60	57	57	58	58	58	59	55	58.5	130	129	129	118	116	120	123.5
7:00	60	60	60	57	57	58	58	58	59	55	58.5	130	130	129	117	116	119	123.5

NOTE B−10 reads temp. of H_2O not in avg.

APPENDIX F.A.F

CHICAGO BRIDGE & IRON COMPANY

INITIAL TEST PROCEDURE
PRESSURE SUPPRESSION CONTAINMENT
CONTRACT 9-6825
MONTICELLO, MINNESOTA

PART A - PRELIMINARY

A-1 SHOP - [illegible] in accordance with Para. [illegible] of ASME Section [illegible] as noted on the [illegible] drawings. The inspection will be made [illegible] to Post Weld Heat Treatment of the completed assemblies.

A-2 SHOP - [illegible] 70 psig and a [illegible] Tightness Test at 56 psig design pressure. Testing to be performed in accordance with the Shop Testing Instructions.

NOTE - Install temporary holding devices on Inner Door of Lock before increasing the pressure above 2 psig.

A-3 [illegible] (Part C) [illegible] to 70 psig and testing the assembly with a Halogen Leak Detector.

A-4 [illegible] Panel Board Assembly [illegible] 70 psig [illegible] minimum of 24 hours. [illegible] or barometric change [illegible] 24 hour [illegible] Halogen Leak Detector.

A-5 [illegible] all manholes and nozzles above 40" in diameter, inside and outside.

A-6 If any [illegible] are found:
(a) [illegible] to remove defect.
(b) Magnaflux and inspect defective area thoroughly before rewelding.
(c) Repair by welding.
(d) Inspect the repaired area by magnafluxing, or by [illegible] when [illegible] acceptable.

A-7 [illegible] Drywell, [illegible] Drywell and [illegible] 1 1/2" [illegible] Drawing 53, by applying air pressure between [illegible].

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A-9 Field pressurize the Personnel Lock with air to 2 psig and check the tightness of the inner door with a soap film. Release the pressure to 0 psig.

NOTE - Install temporary holding devices on inner door [illegible] Step A-9 [illegible] 2 psig [illegible] inner door.

A-9 Field pressurize the Personnel Lock to 10 psig and check for leakage by applying a soap film to all welds, gaskets and lock penetrations.

A-10 If any leaks are found, release the pressure, repair and retest.

A-11 After successful completion of the Preliminary Test of the Personnel Lock, release the air pressure from the lock. Remove the holding devices from the inner door.

A-12 Prior to field installation, check for tightness each reference chamber and attached lengths of tubing, by pressurizing with freon to about 10 psig and testing all joints and connections with a Halogen Leak Detector.

A-13 If any leaks are found, [illegible] repair and retest until no leaks are found with the Halogen Leak Detector. The sensitivity of the Leak Detector must be 1 x 10^{-5} ATM cc/sec or better.

A-14 Field install Reference Chambers inside of Drywell and inside of Suppression Chamber as shown on Fig. B. Reactor Vessel in place will not facilitate this installation of drywell Ref. Chamber.

A-15 Connect the tubing from the Reference Chambers to the valving and manometers as schematically shown on Fig. E for the Drywell Reference System [illegible] for the Suppression Chamber Reference System. Connect [illegible] water to [illegible] differential water manometer [illegible] Step C-1 in Part "C".

NOTE - THE EXTERIOR INSTRUMENTS FOR THE LEAKAGE RATE TEST SHOULD BE LOCATED ADJACENT TO NOZZLES WHERE TUBING CONNECTS TO DRYWELL. EXTERIOR TUBING SHOULD BE MINIMIZED. BOTH TUBING AND INSTRUMENTS SHOULD BE PROTECTED FROM WEATHER. INTERIOR TUBING SHOULD BE KEPT AT LEAST 12 INCHES FROM STEEL SHELL EXCEPT FOR PENETRATIONS. RESISTANCE BULBS AND TEMPERATURE RECORDER LISTED IN B-1 OF PART "B" MAY BE INSTALLED AT THIS TIME IF DESIRED, FOR TEMPERATURE READINGS AND RESULTS FOR STEPS A-20 & A-21.

INITIAL TEST PROCEDURE CONTRACT 9-5025

A-16 Open Valves "B" and "D", closing Valves "C", "E" and "F".

A-17 Pressurize complete Reference Chamber System with freon to about 70 psig through Valve "D". Close Valve "D".

A-18 Check tubing, instruments, and valves with Halide Leak Detector, [illegible] all leaks until System is [illegible].

A-19 Purge the Reference System with dry nitrogen [illegible] and [illegible] to approximately 70 psig, using dry nitrogen gas.

A-20 As an approximate [illegible] hold pressure in Reference System for a minimum of 24 hours, comparing initial absolute pressure with final absolute pressure, compensated for temperature.

NOTE – AIR TEMPERATURES ADJACENT TO EACH REFERENCE CHAMBER SHOULD BE MEASURED AND A WEIGHTED AVERAGE AIR TEMPERATURE OBTAINED BY CONSIDERING THE RELATIVE SIZE OF EACH CHAMBER.
FOR DRYWELL – CHAMBER "A" = 60%
"B" = 4[illegible]
FOR SUPPRESSION CHAMBER – "C" = 100%

A-21 If absolute pressure data indicates a [illegible] in pressure which is not related to temperature conditions, recheck tubing, valves, and instruments in Reference System with Leak Detector.

A-22 If no leakage is [illegible], [illegible] Valve "G" and [illegible] valves "B" and "C" open for the overload test in Procedure Part B.

A-23 As schematically illustrated on Fig. A for the Drywell and Suppression Chamber, [illegible] piping and valve network:

(a) Drywell and Pressure Gages (Valves "A" and "H")
(b) Drywell and Air Supply (Valves "A", "J" and "K")
(c) Air Locks and Air Supply (Valves "M", "L" and "I")

NOTE – THE CONTROLLING VALVES FOR THE AIR SUPPLY AND THE GAGES ON THE GAGE LINE ARE TO BE LOCATED AT A DISTANCE NOT LESS THAN 500 FT. FROM THE OUTSIDE OF THE DRYWELL.

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INITIAL TEST PROCEDURE — CONTRACT 9-5525

PART B - HYDROSTATIC-PNEUMATIC OVERLOAD TEST OF THE SUPPRESSION CHAMBER AND PNEUMATIC OVERLOAD TEST OF THE DRYWELL.
DRYWELL AND SUPPRESSION CHAMBER INTERCONNECTED.
WET CONDITION
(SEE FIG. A & B)

B-1 INSTALL THE STRAIN GAGES B-1 TO B-10 IN LOCATIONS SHOWN ON FIG. B AND CONNECT TO INSTRUMENTATION RECORDER LOCATED NEAR PANEL BOARDS.

B-2 INSTALL THERMOCOUPLES D-1 TO D-6 IN LOCATIONS SHOWN ON FIG. B AND CONNECT TO [illegible]-POINT RECORDER LOCATED NEAR PANEL BOARDS.

B-3 (a) INSTALL TWO FANS IN THE DRYWELL LOCATED DIAMETRICALLY OPPOSITE AND TILTED UPWARD AT ABOUT 930'-0" ELEVATION.

(b) INSTALL TWO FANS IN THE SUPPRESSION CHAMBER ON THE PLATFORM DIAMETRICALLY OPPOSITE, TO CIRCULATE THE AIR AROUND THE SUPPRESSION CHAMBER.

B-4 CALIBRATE RECORDING AND DIAL PRESSURE GAGES AT 70 PSIG AND INSTALL ON DRYWELL AND SUPPRESSION CHAMBER GAGE LINE. (SEE FIG. A)

B-5 OPEN THE VACUUM BREAKER VALVES (10 TOTAL @ 3 IN., 220) [illegible] THE DRYWELL AND THE SUPPRESSION CHAMBER THRU THE VACUUM BREAKER VALVES AND BLOCK OPEN FOR [illegible] AND LEAKAGE RATE TESTS.

B-6 FILL THE SUPPRESSION CHAMBER WITH WATER TO AN ELEVATION 1'-6 3/4" BELOW THE [illegible] (APPROXIMATELY 53,700 CU. FT.) AND CLOSE THE WATER CONNECTION.

B-7 INSPECT [illegible] THE SUPPRESSION CHAMBER FOR ANY LEAKAGE OR DISTORTION FROM WATER LOADING.

B-8 CLOSE THE MANHOLE IN SUPPRESSION CHAMBER AND LEAK CHECK BETWEEN GASKETS.

B-9 OPEN SHUTOFF VALVES "A" AND "M" AND BLOWOFF VALVE "I".

B-10 CLOSE BLOWOFF VALVES "H", AND "J", AND LOCK VALVE "L" (VALVE "C" [illegible] TO REFERENCE SYSTEMS.)

B-11 CLOSE OR BLANK ALL OTHER CONNECTIONS IN THE DRYWELL AND SUPPRESSION CHAMBER.

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B-12 [illegible] DRYWELL [illegible]

NOTE - IMMEDIATELY AFTER CLOSING LAST CONNECTION IN DRYWELL AND SUPPRESSION CHAMBER OPEN VALVE "K" AND START PUMPING AIR TO AVOID POSSIBILITY OF A VACUUM OCCURRING INSIDE OF VESSELS.

B-13 OPEN AIR SUPPLY VALVE "K" AND PRESSURIZE [illegible] 5 [illegible]

B-14 [illegible] AIR SUPPLY VALVE "K".

B-15 ON THE DRYWELL, APPLY SOAP FILM [illegible] (EXCEPT OUTER [illegible]), TEST COVERS OF NOZZLES, AND [illegible]

B-16 ON THE SUPPRESSION CHAMBER, APPLY SOAP FILM TO ALL SEAMS OF THE [illegible] ABOVE THE WATER LINE, ALL GASKETS OF MANHOLES AND [illegible]

B-17 [illegible] DURING THE SOAP FILM TEST AT 5 PSIG [illegible] OVER-LOAD PRESSURE OF 70 [illegible] SHALL BE AS FOLLOWS:

(a) RELEASE PRESSURE TO ATMOSPHERE BY OPENING [illegible] VALVE "[illegible]"

NOTE - IMMEDIATELY AFTER PRESSURE HAS BEEN RELEASED. OPEN A LARGE ENOUGH CONNECTION TO PREVENT THE FORMATION OF A VACUUM IN THE VESSELS.

(b) [illegible]
(c) USE [illegible] TO REMOVE [illegible]
(d) MAGNAFLUX AND INSPECT THE DEFECTIVE AREA [illegible]
(e) REPAIR BY WELDING.
(f) RADIOGRAPH THE REPAIRED WELD [illegible]
(g) REPEAT, STARTING WITH STEP B-11, EXCEPT THAT ONLY THE [illegible] 5 PSIG.

B-18 Close [illegible] outer door of the lock (outer equalizing valve closed) and [illegible] valve "T".

B-19 Open lock valve "L", allowing pressure to reach approximately 5 psig in [illegible].

B-20 Apply soap film to [illegible] door and seams of lock not previously checked during Step B-15.

B-21 Close lock valve "L" and open [illegible] valve "T" to [illegible] pressure in the [illegible].

B-22 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 DRYWELL OF 1200 FEET WHILE THE PRESSURE IS BEING INCREASED ABOVE 5 PSIG AND UNTIL THE OVERLOAD TEST AND FINAL SOAP FILM INSPECTION SHALL HAVE BEEN SUCCESSFULLY COMPLETED.

(b) PERSONS AUTHORIZED IN WRITING BY CHICAGO BRIDGE & IRON COMPANY MAY BE ADMITTED WITHIN THE AREA DEFINED IN (a) ABOVE. AUTHORIZED EMPLOYEES OF CB&I, GENERAL ELECTRIC, NORTHERN STATES POWER COMPANY AND NECESSARY OUTSIDE INSPECTION PERSONNEL HAVING WRITTEN AUTHORIZATION FROM CB&I WILL BE PERMITTED AT THE LOCATIONS OF THE CONTROLLING VALVES AND OF THE GAGES APPROXIMATELY 800 FEET FROM THE OUTSIDE OF THE DRYWELL.

(c) THE PREVIOUSLY LISTED AUTHORIZED INDIVIDUALS MAY WITNESS THE FINAL CB&I SOAP FILM INSPECTION BY CB&I EMPLOYEES (STEP B-23).

(d) AFTER SUCCESSFUL COMPLETION OF THE FINAL SOAP FILM INSPECTION AND DURING THE LEAKAGE RATE TEST ON THE DRYWELL, ONLY AUTHORIZED PERSONNEL SHALL BE ALLOWED ON OR ADJACENT TO THE DRYWELL AND THE INSTRUMENTS. NO WORK SHALL BE PERFORMED WITHIN 25 FEET OF INSTRUMENTS, [illegible] VALVES AND THE OUTSIDE OF THE DRYWELL OR SUPPRESSION CHAMBER.

WARNING - Before pressurizing containment vessel above 22 psig, vessel temperature must be 30°F or higher. Should vessel temperature start to drop during test, blowdown should be started in adequate time to reduce vessel pressure to 22 psig before vessel temperature drops below 30°F.

B-23 Open Valve "E" and pump air into vessels to 35 psig.

B-24 Increase pressure from 35 psig to 70 psig in 7 psig increments.

NOTE - AT THE PRESSURE INCREMENTS AND AT HOURLY INTERVALS, THE PRESSURE READINGS OF THE DIAL AND RECORDING GAGES SHOULD BE RECORDED ON THE TEST DATA SHEET.

B-25 Close Valve "E" and hold 70 psig test pressure approximately 40 minutes.

B-26 Close Valve "I" and open lock Valve "L" to interconnect air lock with drywell.

B-27 Hold 70 psig test pressure for another 40 minutes, adding or releasing air to compensate for temperature variations.

B-28 Open Blowoff Valve "O" to reduce pressure in the vessels and air lock to 56 psig (design pressure).

NOTE - IF IT IS MUTUALLY AGREED TO START LEAKAGE RATE TEST AT THIS TIME (COINCIDENT WITH FINAL SOAP FILM TEST) PRESSURE SHOULD BE FURTHER REDUCED AS DESCRIBED IN STEP C-1. BEFORE STARTING THE LEAKAGE RATE TEST COMPLY WITH THE FOLLOWING:
1) STEP B-29(a) PERTAINING TO THE LOCK AND STEPS B-[illegible] THRU B-37 MUST BE PERFORMED.
2) ANY HEATERS INSIDE VESSEL MUST BE TURNED OFF AND THE VESSEL ALLOWED TO REACH TEMPERATURE EQUILIBRIUM BEFORE PROCEEDING WITH LEAK TEST.

B-29 Close Valve "O".
(a) On the drywell apply a soap film to outer door and outer seams of the lock, all seams of the drywell shell and nozzles, all gaskets of manholes, and bolted covers, all test covers of nozzles and vent pipes.

(b) On the suppression chamber apply a soap film to all seams and nozzles above the water line, all gaskets of manholes and test covers of nozzles. Also make a visual inspection of the suppression chamber below the water line.

B-30 If any leaks are 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 B-17, including a 70 psig overload test, but only a soap film 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. [illegible] which could be repaired later without the necessity for a retest. If the air [illegible] such a leak, the procedure shall continue, after the repair, into the Leakage Rate Test of the Drywell and Suppression Chamber (Part C) without repeating the 70 psig overload test.

B-31 Close Shutoff Valve "M" at Lock.

B-32 Close Valve "L" and open Bleedoff Valve "I".

B-33 Close Vessel Shutoff Valves "A".

B-34 Open Outer Equalizing Valve and check and record the time of blowdown of air from the Lock, which would permit opening of the Outer Door of the Lock.

B-35 Open Outer Door of the Lock and apply soap film [illegible] the Lock to all nozzle or shaft penetrations, and to gasket of Inner Door.

B-36 Leave Outer Door of the Lock open.

B-37 Close the shutoff Valves "A" on the Drywell and disconnect gauge lines at Valves "A". Check valves with soap film.

PART C – THE LEAKAGE RATE TEST OF THE DRYWELL AND THE SUPPRESSION CHAMBER INTERCONNECTED – WET CONDITION (SEE FIG. "A" & "B")

C-1 If the maximum expected temperature during the Leakage Rate Test exceeds the maximum temperature noted during the soap film inspection (Steps B-29 to B-37 of Part "B"), adjust the pressure in the vessels to the following calculated gage pressure, to avoid the possibility of exceeding the design pressure of 56 psig during the Leakage Rate Test of the vessels:

$$= (56 + 14.7)\left[\frac{(460^{\circ}F + \text{Maximum Temperature during Soap Film Test at 56 psig})}{(460^{\circ}F + \text{Maximum Expected Temperature during Leakage Rate Test})}\right] - 14.7$$

C-2 Valves "B" and "C" are open from Step A-22 and B-10. The pressure in the vessels and reference systems will be [illegible].

C-3 Open water reservoir valves "E" and "F" in sequence to allow the water to flow into differential water manometer to approximately mid-height of scale, and close valves "E" and "F".

C-4 Release air from the vessels by opening valve "A" until about 6 inch differential water pressure is indicated on the Water Manometer. Recheck valve "A" for leakage with soap suds.

NOTE – THE WATER DIFFERENTIAL WILL VARY WITH PRESSURE AND TEMPERATURE CHANGES IN THE VESSELS. THE WATER DIFFERENTIAL AT THE START OF THE LEAKAGE RATE TEST (USUALLY MIDNIGHT) WILL PROBABLY NOT BE 6 INCHES.

C-5 Start the fans in the Drywell and the Suppression Chamber.

C-6 Record at hourly intervals the following data:
(a) Atmospheric temperature in degrees Fahrenheit.
(b) Atmospheric Barometric pressure in psia.*
(c) Vessel gage pressure as indicated in dial gage in psig.
(d) Vessel absolute pressure as determined by sum of (b) and (c), in psia = P.

*If air supported structure is used to enclose vessel for testing, barometer must be located inside the enclosure to measure barometric difference between vessel and enclosure.

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(e) Difference in pressure 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.

(f) Internal air temperatures (I.A.T.) in degrees Rankine. (°F + 460)

(g) Internal water temperature (in Suppression Chamber only) (I.W.T.) in degrees Fahr.

(h) Internal Dew point temperatures (D.P.T.) in degrees Fahr.

C-7 After two consecutive midnight to dawn periods (approximately 30 hours) of relatively uniform temperature, calculate the per cent loss (as a negative value) of total contained air for both the Drywell and Suppression Chamber by the following formula:

Preliminary Per Cent Loss (Without Vapor Pressure Correction)

$$= \left[\frac{100}{\text{Initial P} + 27.7}\right]\left[\text{Initial } \Delta P - (\text{Final } \Delta P)\frac{\text{Initial I.A.T.}}{\text{Final I.A.T.}}\right]$$

C-8 From the Internal Dew Point Temperatures, determine the Water Vapor Pressures – W.V., in psi.

NOTE – THE WATER VAPOR PRESSURE IS THE SATURATION PRESSURE OF STEAM AT THE DEW POINT TEMPERATURE (SEE STEAM TABLES)

C-9 Calculate the apparent per cent loss (as a negative number) due to a change in Water Vapor Pressure by the following:

Apparent Per Cent Loss

$$= \left[\frac{100}{\text{Initial P}}\right]\left[\text{Final W.V.}\left(\frac{\text{Initial I.A.T.}}{\text{Final I.A.T.}}\right) - \text{Initial W.V.}\right]$$

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C-10 Calculate the corrected per cent loss (as a negative number) by the following;

Corrected Per Cent Loss = Actual Per Cent Loss − Apparent Per Cent Loss

NOTE – COMBINING THE EXPRESSIONS IN PAR. C-7 AND C-9 INTO ONE EXPRESSION RESULTS IN THE FOLLOWING;

$$\text{Corrected Per Cent Loss} = \left[\frac{100}{\text{Initial P}}\right]\left[\frac{\text{Initial } \Delta P + \text{Initial W.V.}}{27.7} - \left(\frac{\text{Final } \Delta P + \text{Final W.V.}}{27.7}\right)\left(\frac{\text{Initial I.A.T.}}{\text{Final I.A.T.}}\right)\right]$$

C-11 The calculated per cent loss of Step C-10 shall be presented to General Electric and the test shall thereupon be terminated unless CB&I is not satisfied that additional testing is required. In the latter case, the additional testing shall be the subject of mutual agreement between CB&I and General Electric.

C-12 Open Valve "J" to exhaust pressure from Suppression Chamber and from Drywell until both are at atmospheric pressure.

C-13 Open manholes in Suppression Chamber and open a large enough connection in Drywell to prevent formation of a vacuum.

C-14 Withdraw water from Suppression Chamber.

C-15 Remove all overload and leakage rate test equipment from Drywell and Suppression Chamber.

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(c) Difference in pressure [illegible] as measured on 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.

(d) Internal air temperatures (I. A. T.) in degrees Rankine. (°F + 460)

(e) Internal water temperature (in Suppression Chamber only) (I. W. T.) in degrees Fahr.

(f) Internal Dew point temperatures (D. P. T.) in degrees Fahr.

C-7 After two consecutive midnight to dawn periods (approximately 30 hours) of relatively uniform temperature, calculate the per cent loss (as a negative value) of total contained air for [illegible] Drywell and Suppression [illegible] the following formula:

$$\text{Preliminary Per Cent Loss (Without Vapor Pressure Correction)} = \left[\frac{100}{\text{Initial P} + 27.7}\right]\left[\text{Initial } \Delta P - \left(\text{Final } \Delta P\right)\frac{\text{Initial I.A.T.}}{\text{Final I.A.T.}}\right]$$

C-8 From the Internal Dew Point Temperatures, determine the Water Vapor Pressures - W.V., in psi.

NOTE - THE WATER VAPOR PRESSURE IS THE SATURATION PRESSURE OF STEAM AT THE DEW POINT TEMPERATURE (SEE STEAM TABLES)

C-9 Calculate the [illegible] per cent loss (as a negative number) due to a change in Water Vapor Pressure by the following:

$$\text{Additional Per Cent Loss} = \left[\frac{100}{\text{Initial P}}\right]\left[\text{Final W.V.}\left(\frac{\text{Initial I.A.T.}}{\text{Final I.A.T.}}\right) - \text{Initial W.V.}\right]$$

C-10 Calculate the corrected per cent loss (as a negative number) by the following;

Corrected Per Cent Loss = Preliminary Per Cent Loss − Apparent Per Cent Loss

NOTE - COMBINING THE EXPRESSIONS IN PAR. C-7 AND C-9
INTO ONE EXPRESSION RESULTS IN THE FOLLOWING;

$$\text{Corrected Per Cent Loss} = \left[\frac{100}{\text{Initial P}} \right] \left[\frac{\text{Initial } \Delta P}{27.7} + \text{Initial W.V.} - \left(\frac{\text{Final } \Delta P}{27.7} + \text{Final W.V.} \right) \left(\frac{\text{Initial I.A.T.}}{\text{Final I.A.T.}} \right) \right]$$

C-11 The calculated per cent loss of Step C-10 shall be presented to General Electric and the test shall thereupon be terminated unless CB&I [illegible] additional testing [illegible]. In the latter case, the additional testing shall be the subject of mutual agreement between CB&I and General Electric.

C-12 Open Valve "J" to exhaust [illegible] from Suppression Chamber and from Drywell until both are at atmospheric pressure.

C-13 Open manholes in Suppression Chamber and open a large enough connection in Drywell to prevent formation of a vacuum.

C-14 Withdraw water from Suppression Chamber.

C-15 Remove all overload and leakage rate test equipment from Drywell and Suppression Chamber.

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APPENDIX F

Attachment "B"

Code Certification Forms and Drawings

Code Form N-1 - Drywell and Suppression Chamber

Code Form N-2 - Air Lock

C.B.&I. Drawing 9-7 - Drywell Shell Stretchout

C.B.&I. Drawing 10-3 - Penetration Schedule and Orientation for Suppression Chamber

MONTICELLO

FORM N-1 MANUFACTURERS DATA REPORT FOR NUCLEAR VESSELS
As Required by the Provisions of the ASME Code Rules

1. Manufactured by Chicago Bridge & Iron Company — Chicago, Illinois
2. Manufactured for Northern States Power Company — Minneapolis, Minnesota
3. Type Vert. Tank C-4430 1968

DRYWELL

.25, .53, .6875, .75, 1.0, 1.25, 1.3125, 1.5, 2.5

4. Shell: Material SA516 Gr. 70 Firebox A300 T.S. 70,000 Corrosion Allowance 0 Diam. 62 ft 0 in. Length 105 ft 11 in.

5. Seams: Long. Dbl. Butt Weld, H.T. See Note 1 Below, R.T. Yes 100%, Efficiency 100%

Girth Dbl. Butt Weld, H.T. See Note 1 Below, R.T. Yes 100%

6. Heads: (a) Material SA516 Gr. 70 Firebox A300 T.S. 70,000 (b) Material SA516 Gr. 70 Firebox A300 T.S. 70,000

Location	Thickness	Crown Radius	Knuckle Radius	Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure
(a) Top	1.3125			2 - 1				Concave
(b) Bottom	1.25							Concave

If removable, bolts used SA 320-L7 (125,000) 2" Ø (84)

7. Jacket Closure

8. Constructed for max. allowable working pressure 56 psi at max. temp. 281 °F. Charpy Impact 20 ft-lb. Min. temp. 0 °F. Hydrostatic, pneumatic, or combination test pressure 70 psi

9. Tube Sheets: Stationary, Material ... Floating, Material ...

10. Tubes: Material ...

Items 11 to 14 inc. to be completed for inner chambers of jacketed vessels, or channels of heat exchangers.

SUPPRESSION CHAMBER

.5, .531, .4375, 1.0625

11. Shell: Material SA516 Gr. 70 Firebox A300 T.S. 70,000 Corrosion Allowance 0 Diam. 27 ft 8 in.

12. Seams: Long. Dbl. Butt Weld, H.T. See Note 1 Below, R.T. Yes 100%, Efficiency 100%

Girth Dbl. Butt Weld, H.T. See Note 1 Below, R.T. Yes 100%, No. of Courses 2

13. Heads: (a) Material None T.S. (b) Material T.S.

Location	Thickness	Crown Radius	Knuckle Radius	Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure
(a) Top, bottom, ends								
(b) Channel								
(c) Floating								

If removable, bolts used ...

14. Constructed for max. allowable working pressure 56 psi at max. temp. 281 °F. Charpy Impact 20 ft-lb. Min. temp. 0 °F. Hydrostatic, pneumatic, or combination test pressure 70 psi

NOTE 1. Vessel Sub-Assemblies ... PWHT ...
A. ... Upper & Lower 26.35 Ø Flange Assemblies ... Heat Treated.
B. All Penetrations ... Category "D" ... PWHT ... (2461 1/2" ...) ... the Shell.

NOTE 2. Lock subjected ... as a separate unit — Shop Test.
During ... Drywell ... test. Outer Door of Lock is open. ...
Inner Door ... is subjected to test pressure.

FORM N-1 (back)

15. Safety Valve Outlets: Number [illegible] ASME [illegible] Size [illegible] Location [illegible]

16. Nozzles: [illegible]

17. Inspection Manholes, No. 1 Size 34" Location [illegible]

18. Supports: Skirt Yes [illegible]

19. Remarks: Pressure Suppression Containment System [illegible] Containment Vessel (Drywell) [illegible] to provide storage for a water pool to condense steam which may be released in the event of an [illegible] are a part of this system. [illegible]

CERTIFICATION OF DESIGN

Design specifications on file at Chicago Bridge & Iron Company [illegible]

Stress analysis report on file at Chicago Bridge & Iron Company [illegible] Oak Brook, Illinois

Design specifications certified by T. C. Brown [illegible] Prof. Eng. [illegible] Reg. No. 10572

Stress analysis report certified by [illegible] Prof. Eng. [illegible] Reg. No. 25910

We certify that the statements made in this report are correct and that all details of design, material, construction, and workmanship of this vessel conform to the ASME Code for Nuclear Vessels.

Date [illegible] Signed Chicago Bridge & Iron Company [illegible]

Certificate of Authorization Expires [illegible]

CERTIFICATE OF SHOP INSPECTION

Vessel made by Chicago Bridge & Iron Company at [illegible]

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State of [illegible] and employed by Hartford Steam Boiler Insp. & Ins. Co. of Hartford, Conn. have inspected the pressure vessel described in this Manufacturers' Data Report on [illegible] and state that to the best of my knowledge and belief, the manufacturer has constructed this pressure vessel in accordance with the ASME Code for Nuclear Vessels.

By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturers' Data Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date [illegible]

[illegible] Commissions [illegible]

CERTIFICATE OF FIELD ASSEMBLY INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State of [illegible] and employed by [illegible] have compared the statements in this Manufacturers' Data Report with the described pressure vessel and state that [illegible] [illegible] in accordance with the ASME Code for Nuclear Vessels. [illegible]

By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturers' Data Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date [illegible]

[illegible] Commissions [illegible]

FORM N-2 MANUFACTURERS' PARTIAL DATA REPORT

A Part of a Nuclear Vessel Fabricated by One Manufacturer for Another Manufacturer

As required by the Provisions of the ASME Code Rules

1 (a) Manufactured by: Chicago Bridge & Iron Company – Greenville, Pennsylvania

(b) Manufactured for: Chicago Bridge & Iron Company – Chicago, Illinois

2 Identification—Manufacturer's Serial No. of Part: C4430 – 100A

101, 102, 142,

(a) Constructed According to Drawing No. 138, 137 Drawing Prepared by Chicago Bridge & Iron Co. 9-5025

(b) Description of Part Inspected: [illegible]

3 Remarks: The part is to serve as an Access Lock for a Nuclear Containment Vessel and is designed and constructed under the rules of Section III of the ASME Code for Nuclear Vessels.

(Brief description of service for which vessel was designed)

We certify that the statements made in this report are correct and that all details of material, design, construction, and workmanship of this part conform to the ASME Code for Nuclear Vessels.

Date [illegible] Signed [illegible] (Manufacturer) By [illegible]

Certificate of Authorization Expires [illegible]

CERTIFICATION OF DESIGN

Design information on file at: Chicago Bridge & Iron Company – Greenville, Pennsylvania

Stress analysis report on file at: Chicago Bridge & Iron Company – Greenville, Pennsylvania

Design specifications certified by: Theodore O. Brown Prof. Eng. State Calif. Reg. No. C15628

Stress analysis report certified by: [illegible] W. LaBrache Prof. Eng. State [illegible] Reg. No. 25612

CERTIFICATE OF SHOP INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State or Province of [illegible] and employed by [illegible] of [illegible] have inspected the part of a pressure vessel described in this Manufacturers' Partial Data Report on [illegible], and state that to the best of my knowledge and belief, the Manufacturer has constructed this part in accordance with the ASME Code for Nuclear Vessels.

By signing this certificate, neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the part described in this Manufacturers' Partial Data Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date [illegible] 19[illegible]

[illegible] Commissions [illegible]

Inspector's Signature — National Board, State, Province and No.

FORM NIS-1 (Back)

[illegible]

4. Shell: Material SA 516 Gr. 70 ... T.S. 70,000 ... Nominal Thickness 1 3/4 ... Corrosion Allowance ... Diameter 5 ft ... in. Length ... ft ... in.

5. Seams: Long. Dbl. Butt Weld ... Complete ... Efficiency 100 %

Girth Dbl. Butt Weld ... Complete

6. Heads: (a) Material SA 516 Gr. 70 (A300) ... T.S. 70,000

(a) Top, bottom, ends ... 1 5/8" ... 8'-3 5/8"

(b) ... 1" ... 8'-4 3/8"

If removable, bolts used ... Other fastening Bolted ...

7. Jacket Closure ...

8. Constructed for maximum allowable working pressure ... 50 ... psi at max. temp. ... 281 ... °F ... Hydrostatic test pressure ... psi

9. Tubesheets: Stationary, Material ... Diam. ... Thickness ...

Floating: Material ... Diam. ... Thickness ...

10. Tubes: Material ... O.D. ... in. Thickness ...

11. Shell: Material ... T.S. ... Nominal Thickness ... Corrosion Allowance ... Diam. ... Length ...

12. Seams: Long. ... Efficiency ...

Girth ...

13. Heads: (a) Material ... T.S. ... (b) Material ... T.S. ...

Location	Thickness	Crown Radius	Knuckle Radius	Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure (Convex or Concave)
(a) Top, bottom, ends								
(b) Channel								

If removable, bolts used ... Other fastening ...

14. Constructed for maximum allowable working pressure ... psi at max. temp. ... °F ... Hydrostatic test pressure ... psi

15. Safety Valve Outlets: Number ... Size ... Location ...

16. Nozzles:

Purpose (Inlet, Outlet, Drain)	Number	Diam. or Size	Type	Material	Thickness	Reinforcement Material	How Attached

17. Inspection Openings: Manholes, No. ... Size ... Location ...

Handholes, No. ... Size ... Location ...

Threaded, No. ... Size ... Location ...

18. Supports: Skirt ... Lugs ... Legs ... Other ... Attached ...

[illegible]