ENCLOSURE TO LAC-8410

JULY 20, 1982

SARGENT & LUNDY REPORT

PROJECT 6101-32

JUNE 4, 1980

LACBWR

INFORMATION ON STRUCTURAL TOPICS

III-2 WIND AND TORNADO LOADS

QUESTION: Specify specific Tables and Sections of ASCE Paper 3269 that were used in the design consideration of wind loading of the plant.

ANSWERS: Wind Loads - The original design of LACBWR Plant has no reference to wind loads as recommended in ASCE Paper 3269. Review of all documents listed under References indicates the following design data for wind loads.

i) For LACBWR site ASCE Paper 3269 gives wind velocity of 90 MPH at 30'-0" for 100 year return period. Dynamic pressure (q) corresponding to 90 MPH is 20.72 PSF and average total pressure (p) equals 1.3 (q) i.e. 26.93 PSF.

ii) Review of design claculations for Reactor Building and Generator Building shows the following design wind loads:

Reactor Building 20 PSF V = 78 MPH

Generator Building 25 PSF V = 87 MPH

iii) Safeguard reports show that climatological data has been recorded since 1931. The highest wind velocity of record is 69 MPH in October 1949. 69 MPH wind speed corresponds to average pressure of 15.72 PSF per ASCE Paper 3269.

Tornado Loads - The effect of tornado was not considered in the original design.

Safeguard report Vol. 1 for LACBWR plant gives the probability of a tornado passing directly over the plant as 1/2000.

Gulf United Services Co. have reviewed and made "Wind and Tornado Analysis of LACBWR Reactor" Report SS-1163, February 22, 1974. This report was reviewed by Automation Industries Inc. who submitted their comments and additional analysis to Dairyland Power Cooperative with their letter no. P-5101-15 of April 5, 1974.

S&L has not reviewed these documents and can not furnish any comments at present.

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III-3.A EFFECTS ON HIGH WATER LEVEL ON STRUCTURES

QUESTION: For each of the safety-related structures state the water level that was considered for the design.

ANSWERS: Report SS-1086 Page 1 Sec. 1.2.2, details the study of the LACBWR site hydrology from 1873 to 1972. The highest recorded flood level of El. 638.4 ft. occurred in 1965. The grade elevation at the site is 639 ft.

Report SS-1086 Page 8, indicates that the probability of flood El. 639 ft. is 0.07% in any one year. Evaluation of Probable Maximum Flood PMF in Mississippi River at plant site indicates that the plant grade El. 639'-0" is about 12'-0" below maximum water elevation associated with PMF conditions.

NRC Regulatory Guide 1.102 "Flood Protection for Nuclear Power Plant" page 1.102-2 requires use of emergency operation procedures under PMF Condition.

Report SS-1086 Page 14 gives the DPC Emergency Operation Program which shows that under four conditions of operations effect of high water level will not be any problem to the plant.

All the LACBWR plant structures have been designed for hydrostatic pressures and the bouyancy effect of water level El. 639 ft.

Safeguard Report Page 6-8 shows that total containment building weight is 20,180 k. and that there will not be any uplift of reactor building due to buoyancy effect for water level at 639 ft.

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III-7-B DESIGN CODES, DESIGN CRITERIA, LOAD COMBINATION AND, REACTOR CAVITY DESIGN CRITERIA

QUESTION 1: Provide detailed description of the containment and the internal structure of the plant.

ANSWER: Detailed descriptions of the containment and internal structures of the plant are given in LACBWR Safeguard Report for Operation Authorization ACNP-65544 (Revised August 1967) Volume I, Section 6.

QUESTION 2: With regard to the design of the containment and internal structures, provide the design specifications and appropriate design reports. This information should include the information requested in Items 3 through 7 below.

ANSWER: Foundation and Building work for LACBWR Reactor Plant were designed and constructed per S&L Project Specification No. W-1735 and W-1743 respectively. Also design and construction of Reactor Containment Vessel and Traveling Bridge Crane were done per S&L Specification No. W-1752 and W-1759 respectively.

The information furnished in Items 3 through 7 have been compiled from:

S&L Project Specifications

S&L Design Calculation For Reactor Building

CB&I Design Calculation for Containment Vessel

Allis-Chalmer's Design Data for Reactor Plant

The responses to questions 3 through 7 pertain to the Containment and its internal structures only. No attempt has been made to review and classify other safety related structures.

QUESTION 3: List the Codes and Standards (including edition, date) used for each safety related structures including allowable stress used in design.

ANSWER: (Page 4)

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ANSWER: Following is the list of Codes and Standards used in the design of containment and its internal structure.

1. Reactor Containment Vessel: 1962 ASME Boiler and Pressure Vessel Code:

   Section II, Material Specifications
   Section VIII, Unfired Pressure Vessels
   Section IX, Welding Qualification

   Nuclear Code Cases:

   1270 N, General Requirements for Nuclear Vessels
   1271 N, Safety Devices
   1272 N, Containment & Intermediate Containment

2. Concrete Structure and Components:

   Building Code requirements for Reinforced Concrete ACI 318-1956 (working stress design).

3. Steel Structure and Elements:

   Manual of Steel Construction Nov. 1961. Americal Institution of Steel Construction.

QUESTION 4: List all loads and loading combinations considered in the design of each safety related structure, including any missile or pipe break effects.

ANSWER: Following is the summary of major loads considered in the design of Containment Building:

i) Reactor Enclosure:

a. Basement and miscellaneous floors

   LL = 350 PSF

b. Main floor (concrete): LL = 500 PSF

c. Main floor (removable) grating: LL = 200 PSF

d. Gallery Floors: LL = 100 PSF

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e. Wind Load = 20 PSF

f. Internal Missiles

ii) Soil Pressures (below grade):

a. Dry Sand = 30 PSF

b. Submerged Sand = 85 PSF

c. Surcharge used H-20 wheel loads

iii) Traveling Bridge Crane:

Capacity of the crane = 50 Tons with a 5 ton auxiliary hoist.

iv) Water Levels - Mississippi River

a. Normal Pool El. 620'-0"

b. High Water El. 635'-8"

c. Low Water El. 615'-4"

v) Plant Flood Protection El. 639'-0"

vi) Reactor Containment Design Conditions:

a. Maximum Internal Pressure = 52 PSIG

b. Maximum Negative Pressure = 0.5 PSIG

c. Maximum Temperature = 280°F

d. Minimum Temperature = -20°F

e. Welded Joint Efficiency = 100%

Load combinations considered in the design each structure and its component are given in the response to question # 6.

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QUESTION 5: Provide the pertinent material properties of the steel and concrete used in the design of all safety related structures (i.e. Fy, f'c, etc.)

ANSWER:

1. Concrete (S&L Standard 1715-P)

   i) Class AA (Air entrained - for concrete) f'c = 3500 psi at 90 days exposed to weather

   ii) Class A (All other concrete f'c = 3500 psi at 28 day except heavy concrete)

2. Reinforcing steel ASTM A615 Grade 50 fy = 50,000 psi

3. Structural steel ASTM A36 fy - 36,000 psi

4. Miscellaneous steel

   i) Bolts High Strength ASTM A325

   ii) Anchor Bolts ASTM A7

5. Welding Electrodes Materials E60XX

6. Welded steel wire fabric ASTM A185

7. Piles steel plate shell filled with Class A concrete and reinforced in top portion mininum bearing capacity - 50 tons per pile

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QUESTION 6: Provide the summary of stresses and strains at critical locations in all safety related structures for each load and load combination considered in the design.

ANSWER: A. REACTOR CONTAINMENT VESSEL:

The design for the reactor containment vessel was carried out by Chicago Bridge and Iron Co.

The allowable and actual stresses in the vessel at various critical points have been extracted from CB&I design calculations and summarized in the attached Table A 1.

B. 9" Thick R.C. Cylindrical Shell

Design Load: Self weight and loads transferred from crane columns. (Wind load is considered to be carried by Reactor Containment Vessel.)

R.C. Design:

	As, Min. Required	As, Provided
Vertical	0.081 sq.in./face	0.36 sq.in/face
Horizontal	0.185 sq.in./face	0.31 sq.in/face

For the 9" concrete shell the maximum depth of penetration by internal missiles was calculated to be 3.2". Sizes of these missiles generated by the rupture of the main steam piping striking the biological shield were assumed as follows:

1. Lead fragment 2"x4"x8"
2. Concrete fragment 2"x4"x8"
3. Steel fragment 1"x1"x12"

For the effect of pipe break loads, please refer to Report SS-1089 of Gulf United.

C. CONCRETE INTERNALS

1. Piers 1 through 4:

Design Load: Dead load of the supported structure.

R.C. Design: Reinforcement at 0.005 A_g = 31.5 sq.in.
Steel provided = 34.2 sq.in.

Concrete Stress: Allowable: 750 psi
Actual: 287 psi

2. RPV Concrete Support Structure:

Load: Dead Load RPV (Flooded)

Design: fs allowable = 20,000 psi

Beam No.	As Required (sq. in.)	As Provided (sq. in.)	Steel Stress fs, psi
BM1	0.145 (3.24)	3.81	761
BM2	8.1	7.8	20,769
BM3	0.686 (9.72)	10.92	1,256

Figure in parenthesis gives the nominal steel required.

3. Biological Shield:

Thickness of total 9'-0" based on shielding requirements only.

Design based on temperature gradient under normal operating conditions only i.e. 140°F on RPV side and 70°F on the outside.

Concrete assumed to take 300 psi in tension without cracking and the balance tension carried by steel.

Steel required: 0.562 sq.in.
Steel provided: 1.27 sq.in.

4. Floor Framing Plan:

Load: Dead Load + Live Load

Slabs

		As -ve sq.in.	As +ve sq.in.
7" thick Slab	Required:	0.42	0.317
	Provided:	0.49	0.49
10" thick Slab	Required:	1.275	1.39
	Provided:	1.03	1.27

Concrete Beam (B-9)

	As Required Sq. In.	As Provided Sq. In.
Bottom	13.5	14.04
Top	0.8	6.35

Shear stress in concrete: 157 psi > 90 psi allowable
Steel Stirrups: Required 0.35 sq.in. @ 5" centers
Provided 0.40 sq.in. @ 5" centers

D. Steel Internal:

1. Crane Girder:

Design Load: Dead Load + Live Load + 25% impact
Steel Design:
Compression Flange, Fb = 20.97 < 22 ksi allowable
Tension Flange, fb = 17.56 < 22 ksi allowable
Web Shear, fv = 8 ksi < 14.4 ksi allowable

2. Supporting Bracket:

Design Load: Dead Load + Live Load + 25% impact
Steel Design:
Flanges fb = 12.4 ksi < 22 ksi allowable
Web Shear fv = 7.62 < 14.4 ksi allowable

3. Crane Columns:

Design Load: Maximum Wheel load + 25% impact
Steel Design: Axial stress fa = 16.0 ksi
21.0 ksi allowable

E. Foundation:

1. Foundation Dome:

Design Load: Dead Load + Live Load + Equipment Load

Reinforcement Design:

	Required, sq.in.	Provided, sq.in.	Stress, psi
Top Steel			
Slab A	2.72	3.12	17,43[illegible]
	3.8	3.744	20,30[illegible]
	1.85	3.12	11,85[illegible]
Slab B	3.0	3.744	16,02[illegible]
Slab C	0.6 (1.08 nominal)	1.0	11,86[illegible]
Beam Band	4.14	4.16	19,90[illegible]
Circumferential	---	0.44	---
Bottom Steel			
Radial	---	1.0	---
Slab C	6.90	7.48	18,45[illegible]
Beam Band	10.59	9.36	22,62[illegible]
Circumferential	1.08 (nominal)	1.56	---

F. Concrete Piles:

Design Load: Dead Load + Live Load + Equipment Load
Pile Design: Pile design capacity: 50 tons or 100 k
Pile capacity based on driving data: 117.2[illegible]
Maximum static load: 110.93 k per pile
Addition Load due to 20 PSF wind: 5.87 k per pile

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QUESTION 7: Provide the buckling criteria used for design of the steel containment.

ANSWER: The Steel Containment was designed per ASME Boiler and Pressure Code, Unfired Pressure Vessel Code Sec. VIII-1962.

Minimum shell thickness and allowable pressure were determined from the recommendations outlined in Subsection - A UG-27 and UG-28.

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II-7.D CONTAINMENT STRUCTURAL INTEGRITY TEST

QUESTION: Provide any report that describes the procedures and results of the primary containment structural integrity test.

ANSWER: The tests were conducted in accordance with (B&I's Test Procedure, Contract 8-6902 as approved by Sargent & Lundy on September 27, 1963. The test procedure comprises three parts as below:

Part A - Preliminary (Shop Test)

Part B - Overload Test (Field Test)

Part C - Leakage Rate Test

The Test Procedure is not designated as Structural Integrity Test as such. However, the testing was done with the overload pressure of 59.8 psig which is 15% above the design pressure of 52 psig.

Attached is a copy of CB&I Form U-1A (Modified) Manufacturers' Data Report for Unfired Pressure Vessels which also included certificates of Shop Inspection and Field Assembly Inspection by Hartford Steam Boiler I & I Co. Connective.

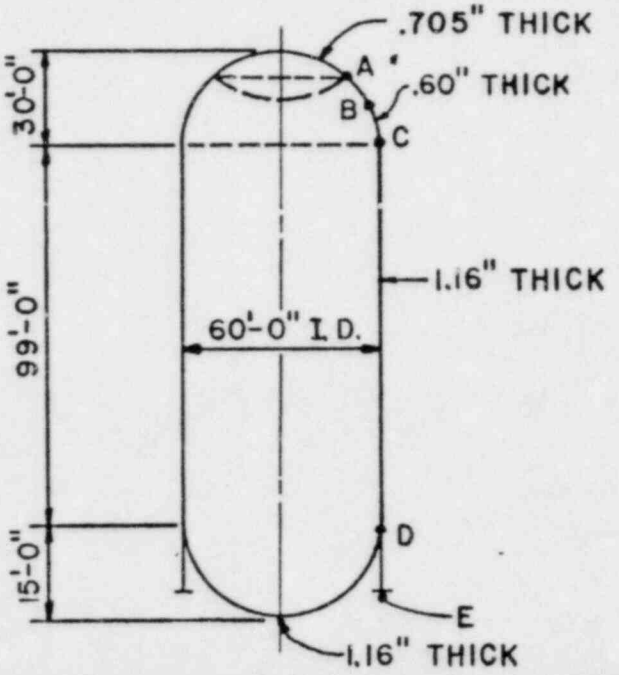
Detailed test information is given by Allis Chalmer Manufacturing Co. in their report of inspection conducted during October 8 to October 19, 1963.

TABLE A-1

Critical Point (See Sketch Below)	Load/Load Combination	Circumferential Stress PSI		Tangential Stress Compression PSI		Axial Stress Compression PSI	
		Actual	Allowable	Actual	Allowable	Actual	Allowable
A	D	5,886	15,000 C				
	D+L+H+Pe			880	1,762		
B	D+L+H+Pe			805	1,500		
	D+L+H+Pe+Pi	16,280	16,500 T				
C	D+L+H+Pe					550	1,500
	D+L+H+Pe+Pi	16,000	16,500 T				
D	D+L+H+W+E+Pe					1,617	6,730
	D+L+H+W+E+Pe+Pi	8,524	16,500 T				
E	D+L+H+W+Pe+Pi					15,280	16,350

Where;

D = Dead Load
L = Live Load
H = Hydrostatic Load
Pe = External Pressure
Pi = Internal Pressure
W = Wind Load
E = Earthquake Load
(Assumed 10% Total dead load)
C = Compression
T = Tension



CHICAGO BRIDGE & IRON COMPANY

FORM U-1A (MODIFIED)* MANUFACTURERS' DATA REPORT FOR UNFIRED PRESSURE VESSELS

1. Manufactured by CHICAGO BRIDGE & IRON COMPANY at Chicago, Illinois Contr. No. 8-6902

2. Manufactured for Allis-Chalmers Manufacturing Company, Washington, D.C.
(Name and Address of Purchaser)

3. Type Vert. (Horiz. or Vert.) Vessel No. C4256 (Mfrs. Serial) " (State & State No.) Nat'l Bd. No. " Yr. Built 1963

4. SHELL: Mat'l A201B FBX to A300 (Kind, Spec. No., Fig or Fbx) T.S. 60,000 (Spec. Min. T.S.) Nom. Thk. 1.16 In. Corr. Allow. No In. Dia. 60 Ft. 0 In. Lgth. 99 Ft. 0 In. T.L. to T.L.

5. SEAMS: Long Mat'l ____ T.S. ____ Nom. Thk. ____ In. Corr. Allow. ____ In.
Double Butt Weld (Welded, Dbl., Single, Lap, Butt) S.R. No (Yes or No) X.R. Complete (Spot or Complete) Sectioned No (Yes or No) Efficiency 100 %
If riveted or brazed describe seams fully under remarks.
Girth Double Butt Weld S.R. No X.R. Complete Sectioned No No. of Courses 10

6. HEADS: (a) Material A201B FBX to A300 T.S. 60,000 (b) Material A201B FBX to A300 T.S. 60,000

	Location (Top, bottom, ends)	Thickness	Crown Radius	Knuckle Radius	Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure (Convex or Concave)
(a)	Top	0.60" to .705"				30°-0			Concave
(b)	Bottom	1.16"			2:1				Concave

If removable, bolts used ____ (Material, Spec. No., T.S., Size, Number) Other fastening ____ (Describe or Attach Sketch)

7. Constructed for (Int.) pressure of 52 psi. Max. Temp. 280 °F. Subzero -20 °F. Pneumatic Test 59.8 psi.

8. SAFETY OR RELIEF VALVE OUTLETS: Number None Size ____ Location See Code Case 1271N

9. NOZZLES:

Purpose (Inlet) Outlet, Drain)	Number	Diam. or Size	Type	Material	Thickness	Reinforcement Material	How Attached
SEE SUPPLEMENTAL SHEET #1							

10. INSPECTION OPENINGS Manholes, No. ____ Size ____ Location SEE SUPPLEMENTAL SHEET #1
Handholes, No. ____ Size ____ Location ____
Threaded, No. ____ Size ____ Location ____

11. SUPPORTS: Skirt " (Yes or No) Lugs " (Number) Legs 10 (Number) Other " (Describe) Attached Bottom Head-Welded (Where & How)

12. SHOP WELDED ASSEMBLIES: SEE SUPPLEMENTAL SHEET #2

13. REMARKS: One 60'-0"Ø X 144'-1-1/8 OA Containment Vessel Built Under ASME Boiler & Pressure Vessel Code, Sections II, VIII & IX. NUCLEAR CODE CASES 1270N, 1271N & 1272N.
(Brief description of purpose of the vessel, as Air Tank, Water Tank, L.P.G., Etc.—State Contents)

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

Date 8-29 1963 Signed CHICAGO BRIDGE & IRON COMPANY, By Louis Bracker (Sha...

Certificate of Authorization Expires December 31 19...

SUPPLEMENTAL SHEET NO. 1

NOZZLES

PURPOSE	NO.	DIA.	TYPE	MATERIAL	TK.	REINF.	HOW ATTACHED
Manway	8	12"	Plate	A201B to A300	2-5/8"	-o-	Welded
Manhole	1	20"	Plate	Do	2-5/8	ooo	Do
Pipe Penetration	9	1"	Pipe	SA-333-C	Sch. 80	Insert Pl. A201B to A300	Do
Do	8	1-1/2"	Do	Do	Do	Do	Do
Do	4	3"	Do	Do	Sch. 40	Do	Do
Do	2	6"	Do	Do	Do	Do	Do
Do	2	10"	Do	Do	Do	Do	Welded-Full Fusion
Do	1	12"	do	Do	Do	Do	Do
Do	2	14"	Plate	A201B to A300	1/2"	Do	Do
Do	2	20"	Do	Do	1/2"	Do	Do
Do	1	24"	Do	Do	1/2"	Do	Do
Electrical Penetration	10	Obround 7" X 20"	Forging	A350-LF1	2"	--	Do
Do	264	3/4"	Threaded	--	--	--	--

NOTE: ALL OF THE ABOVE ITEMS ARE SHOP STRESS RELIEVED IN INSERT OR SHELL PLATE

HSB
CBD
LB

SUPPLEMENTAL SHEET NO. 2

SHOP WELDED ASSEMBLIES

SHIPPING PIECES	MARK	DESCRIPTION
10	3-3	Columns to Bottom Pls.
8	3-3a	1'-0Ø Manways to Bottom Pls.
1	3-1	1'-8Ø Manhole to Bottom Pl.
1	7-A	Insert Pl. with 1 - 14"Ø Nozzle
1	7-B	Insert Pl. with 2 - 6"Ø Nozzles
1	7-C	Insert Pl. with 1 - 24"Ø Nozzle
1	4-1a	Shell Plate with Insert Pl. 8-A Installed. Includes 1 - 20"Ø, 1 - 14"Ø, 2 - 10"Ø, 3 - 3"Ø, 3 - 1-1/2"Ø and 5 - 1"Ø Nozzles.
1	8-B	Insert Pl. with 1 - 20"Ø, 1 - 12"Ø, 1 - 3"Ø, 4 - 1-1/2"Ø, and 4 - 1"Ø Nozzles.
1	9A	Shell Pl. with 10 Forgings and 66 - 3/4"Ø Threaded Holes.
1	9B	Shell Pl. with 198 - 3/4"Ø Threaded Holes.
1	17-A	Freight Door Frame
1	19-A	Freight Door
1	22-A	Escape Lock Complete with Insert Pl. Attached.
1	32-A	Insert Pl. and Penetration for Personnel Lock.
1	33-A	Personnel Lock Complete.

HSB

CBI