GULF STATES UTILITIES COMPANY

RIVER BEND STATION POST OFFICE BOX 220 ST FRANCISVILLE, LOUISIANA 70775

AREA CODE 504 635-6094 346-8651

January 3, 1990
RBG- 32048
File Nos. G9.5

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555

Gentlemen:

River Bend Station - Unit 1
Docket No. 50-458

In response to a request by Mr. W. A. Paulson concerning additional information on ponding of rainwater on building roofs at River Bend Station (RBS), attached is a submittal providing the requested information.

Specifically requested were copies of two (2) structural calculations referred to in previous submittals. Also included are copies of the reinforcing steel drawings applicable to the roof slabs of the diesel generator building and standby cooling tower pump house.

The NRC structural representative requested clarification of the detail section on page 7 of calculation C29.0.1-3B. This detail is a simplified representation of a 12 inch wide section of the diesel generator building roof slab. Though the detail only illustrates the presence of tension reinforcing steel, the design drawing, EC-29H, included in this submittal clearly indicates the presence of both compression and tension steel. This should therefore resolve the concern regarding this matter.

To eliminate any possible confusion, the attached submittal contains both copies of the original calculations and the design drawings previously transmitted to the NRC. The attachment to this letter lists each enclosure included in this submittal.

A001 1/1 Drawings To: Files

If you have any questions concerning this document or this issue in general contact L. L. Dietrich at (504) 381-4866.

Sincerely,

J. E. Booker

J. E. Booker
Manager-River Bend Oversight
River Bend Nuclear Group

JEB/LAE/LLD/WJS/ns

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Walt Paulson
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Attachment

ATTACHMENT

Enclosure	Description	Number
1	Standby Service Water Cooling Tower Roof and Wall design calculations	C47.540-OB C47.540
2	Diesel Generator Building Slab design calculations	C29.0.1-3B C29.0.1
3	Station Design Criteria	200.010 page 3-4
4	Station Design Criteria	200.010 page 4-6
5	Station Design Criteria	200.010 page 2-1
6	Diesel Generator Building Floor Plan Drawings	EC-29G-3 EC-29H-3
7	Standby Cooling Tower Pumphouse Drawings	EC-47DA-2 EC-47BA-3

CALCULATION TITLE PAGE
ENGINEERING DEPARTMENT

1. CALCULATION NUMBER		REV
C47.	540	- 0B
JB NO.	[redacted]	
PAGE 1 OF 14		

2. CALCULATION TITLE: Standby S.W. Cooling Tower - Design of Roofs @ EL. 152'-6" & 163'-4" and Walls From EL. 152'-6" to EL. 163'-4"

3. SUPERCEDES CALC. OR REVISION NO: 12210-C47.540-0A

4. OBJECTIVE OF CALCULATION:
The objective of this calculation is to prove the adequacy of the roof slab at elev. 152'-6" to support a maximum height of ponded rainwater, assuming that the scupper drains provided in the surrounding parapet wall are blocked. (Note: This is a very conservative approach since the drains will not completely prevent the flow of water.)

5. CALCULATION METHOD/ASSUMPTIONS:
The method employed in this calculation, for determining the adequacy of the roof slab, involves the simple comparison of existing ultimate design moments in each section of the slab, to a revised moment based upon the additional loadings imposed by the ponded rainwater. If the revised ultimate moment is less than that originally calculated, no additional review is required. However, if the revised moment exceeds the original design, additional calculations and/or justification for acceptability will be provided.

6. SOURCES OF DATA/EQUATIONS (REFERENCES):

1. Calculation 12210-C47.540 Rev. 0; "Standby S.W. Cooling Tower - Design of Roofs @ EL. 152'-6" & 163'-4" and Walls From EL. 152'-6" to EL. 163'-4". "
2. Structural Design Criteria - Doc. No. 200.010, Rev. 5, dated 3/15/85
3. Design Handbook, ACI 318-71, Publication SP-17(73)
4. Drawing EA-59C-1; "Partial Roof Plans & Dets STBY SVCE WTR CLG Tower"
5. HVAC Calculation G13.18.2.1*28
6. Modification Request (MR) No. 85-0445 (Welding of doors SP154-1 & 2)
7. Drawing EC-47DA-2; Plan Elev. 152'-6", Reinforcing plan.
8. "Standard Handbook for Civil Engineers"; Merritt; Second Edition; 1968

7. CONCLUSIONS:
Since the revised ultimate design moments for each section of the roof slab at elev. 152'-6" are enveloped by the original design, the additional loading imposed by the maximum height of ponded rainwater will not compromise the structural integrity of the roof slab.

8. REASON FOR REVISION (IF APPLICABLE):
The reason for this addendum is to provide a technical review of the adequacy of the roof slab at elev. 152'-6" to support the maximum potential height of ponded rainwater. Though the slab design is adequate to support the rainwater, the specific loading imposed by water was not individually identified in the original calculation.

9. RELATED DOCUMENTS: N/A

10. QA CATEGORY
X I-NUCLEAR SAFETY RELATED
_ II
_ III

11. PREPARER / DATE	12. CHECKER/REVIEWER / DATE	13. INDEPENDENT REVIEWER / DATE
[signature] 7/5/89	[signature] 7/06/89	[signature] 7/06/89

14 DATA REQUIRING CONFIRMATION:

N/A

DATA CONFIRMED BY: DATE

EDP-012 1/87

FOR INFORMATION ONLY

CALCULATION REVIEW SHEET

1. CALCULATION NUMBER		REV
C47..	540	- 0B
JBI NO.	[redacted]	
PAGE 2	OF 14	

ITEM	CALC PAGE	COMMENT	RESPONSE/RESOLUTION
		NONE	

COMMENTS PROVIDED BY	COMMENTS RESOLVED	RESOLUTION ACCEPTED
Gerhold J. Keron Jr. 7/06/89		
REVIEWER DATE	PREPARER DATE	REVIEWER DATE

EDF-014 1/87

F000017

	REF	PAGE

OBJECTIVE:

As stated on page 1, the objective of this calculation is to confirm the adequacy of the roof slab of the Standby Cooling Tower Pumphouse, at elevation 152'-6", to support the loading imposed by the maximum potential height of ponded rainwater.

METHOD and SOLUTION:

An outline of the configuration of the roof slab at elevation 152'-6" is shown on page 5 of this calculation. In this outline of the slab, it can be seen that the overall roof structure is divided into several different sections for which an analysis was performed to determine the design loading and subsequently the reinforcing requirements for the overall slab. (These sections are specifically identified on page 8.)

On pages 6 and 7 of this calculation, an outline of the roof slab is provided showing the physical layout of the roof area with all scupper drain locations, the directional slope of the slab, and the height of the surrounding parapet wall. The purpose of the outline on page 6 is to indicate the maximum height of rainwater that could be contained within the parapet wall on the Pumphouse roof. Since the top elevation of the parapet wall is 154'-10" and the low-point elevation of the roof slab is 152'-6", the maximum depth of ponded rainwater that will be contained on the roof slab prior to breaching the top of the parapet wall, is 2'-4".

A. The method employed by this calculation, to verify the adequacy of the roof slab, will be to extract the design loading determined from the original calculation for that portion of the slab design being considered; apply the revised loadings, based upon the assumptions stated below and the additional loading from the ponded rainwater, to determine the ultimate applied moment (M_u) for each section; compare this moment with the one originally calculated; if the new moment is less than the original, the roof slab is acceptable, if the new moment exceeds the original, a justification/analysis will be provided.

B. The following assumptions/credits are taken in this calculation:

1. The originally applied Live Loading of 30 pounds per square foot (psf) will be deleted from the overall loading condition. The justification for this is due to the absence of any equipment loading in this area and the elimination of general personnel access to the roof area itself. Since the only Live loading possible on the roof slab would be from rainwater, the additional 30 psf loading can be eliminated from consideration as a simultaneous loading. (REF 6, PAGE -; REF 7)

2. The temperature gradient (T_o) specified in the Structural Design Criteria (Ref. #2) of 50°F will be reduced to 20°F due to actual HVAC system design (Ref. #5). The 50°F gradient specified in the Design Criteria was an overall conservative number used in most structural calculations prior to the final design of the building HVAC systems. In this particular case, an actual differential of 20°F is applicable. (REF 2, PAGE 3-4; REF 5, PAGE -)

REF | PAGE

C. It should be noted that the approach defined above is very conservative in nature due to the low probability that the scupper drains in the surrounding parapet wall will become totally blocked. Though some blockage may occur, it is more likely that the drains will allow the passage of some water and the maximum height of ponded rainwater, 2'-4", will be reduced.

ANALYSIS:

To adequately review the entire slab design for the additional loading imposed by a conservative, uniform depth, of ponded rainwater, we will analyze each individual section of the roof slab as it was broken down in the original design calculation.

Referring to page 8 of this calculation, each analyzed section of the roof slab is identified by the letters "A" thru "E".

To simplify this analysis, we will first determine the revised ultimate moment due to the temperature gradient (M_{ut}), as indicated on page 3 of this calculation. Then a distributed load due to a ponded rainwater height of 2'-4" shall be determined, which will be added to the ultimate applied moment (M_u) for each slab section. Upon calculating the revised ultimate moments for each section, a comparison will be made with the originally determined moment to illustrate that the revised condition is enveloped by the original design.

I. Revised Temperature Gradient Moment (M_{ut}):

As indicated on page 3 of this calculation, the actual temperature gradient for the upper elevations of the Standby Cooling Tower Pumphouse is 20°F. (This was provided in Reference #5.) Therefore, based upon an original factored moment, M_{ut}, of 21 ft.-kips, the revised moment will be: 5 — 1 5

$$M_{ut} = 21 \text{ ft-kips} \times \frac{20°F}{50°F} = 8.4 \text{ ft-kips}$$

This revised moment will be utilized throughout the remainder of this calculation for the determination of ultimate applied moments for each section of the roof slab.

II. Distributed Load Due to Ponded Rainwater (W_w):

As stated on page 3 of this calculation, the maximum depth of rainwater than can pond on the roof of the Standby Cooling Tower Pumphouse prior to breaching the top of the parapet wall, is 2'-4". Therefore, based upon this depth, the resultant loading will be: (The water load is considered to be dead weight. Therefore, the weight will be factored as Dead Load and the loading due to the seismic acceleration of the weight will be added to determine the total distributed load.)

(continued on page 9)

CALCULATION WORK SHEET

CALCULATION NUMBER		REV
C47.	540	-08
JEI NO.		
PAGE 5	OF 14	

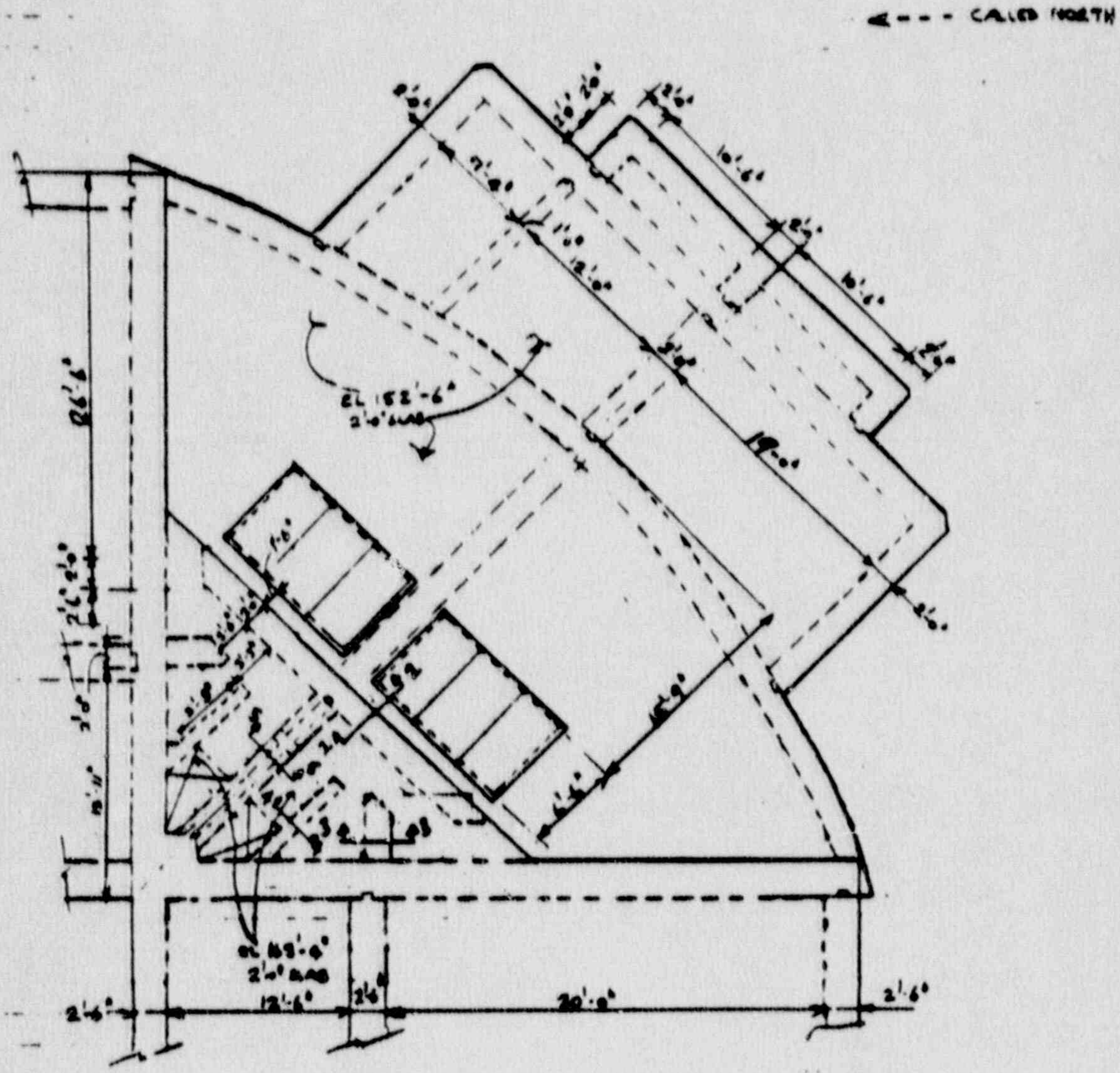
CALCULATION SHEET

J.O./W.O./CALCULATION NO.	REVISION	PAGE	REF	PAGE
12210 / C47.540	0	C47.540.4	1	4

PREPARER/DATE	REVIEWER/CHECKER/DATE	INDEPENDENT REVIEWER/DATE
10-28-81	11.16.81	11.16.81

SUBJECT/TITLE: STANDBY SERVICE WATER COOLING TOWER DESIGN OF SLABS EL. 163'-4" & 152'-6"

QA CATEGORY/CODE CLASS: I



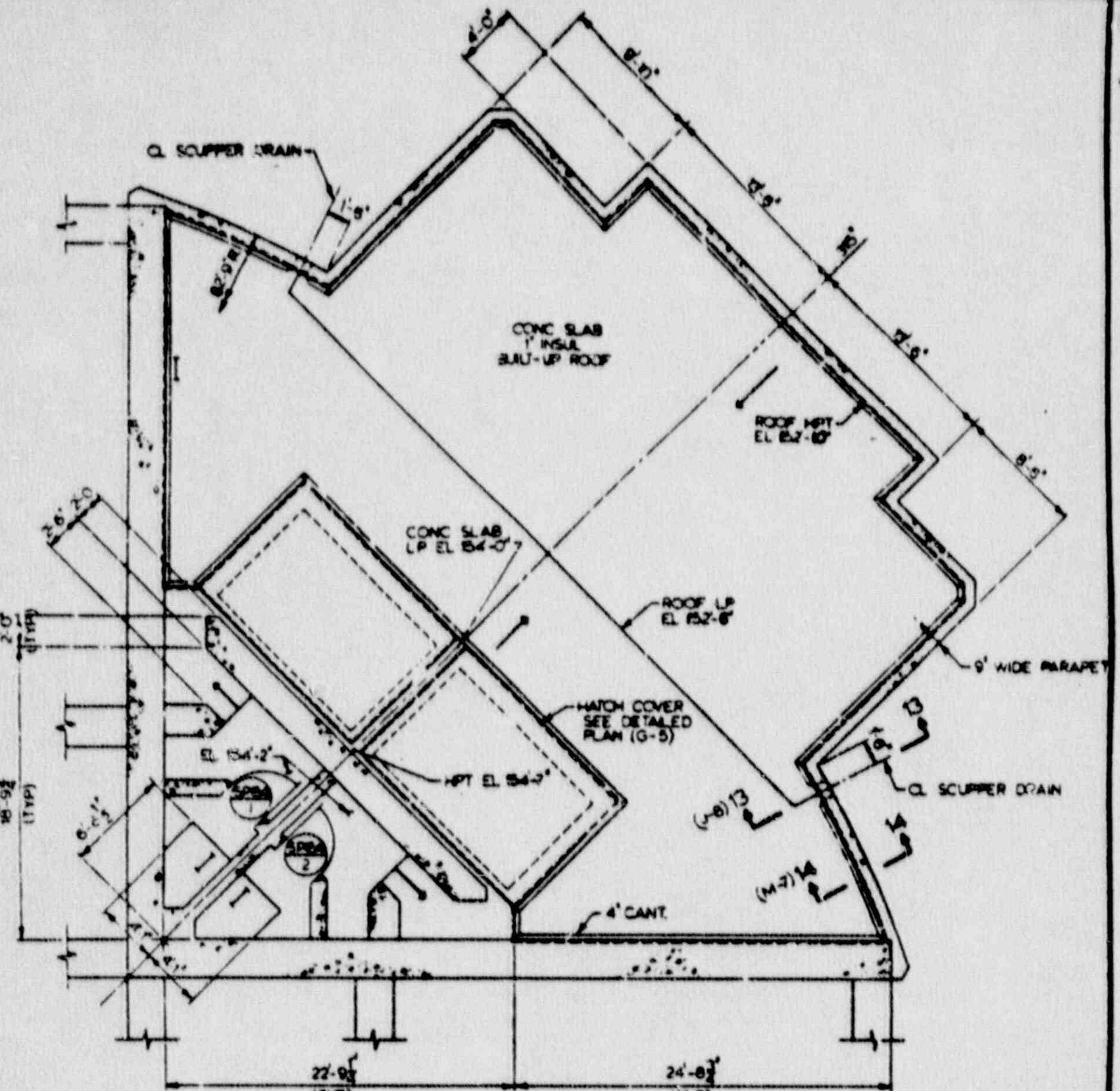
PARTIAL PLAN EL. 152'-6" & 163'-4" (EC 47EJ-1)

SCALE: 3/32" = 1'-0"

ESP-013 1/77

FOR INFORMATION ONLY

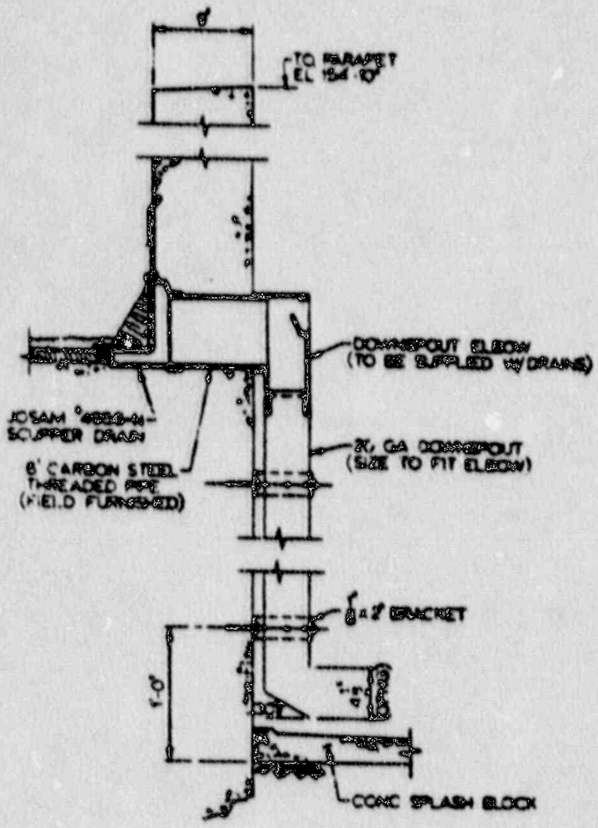
REF	PAGE
4	-



PUMPHOUSE ROOF
PLAN-OUTLINE

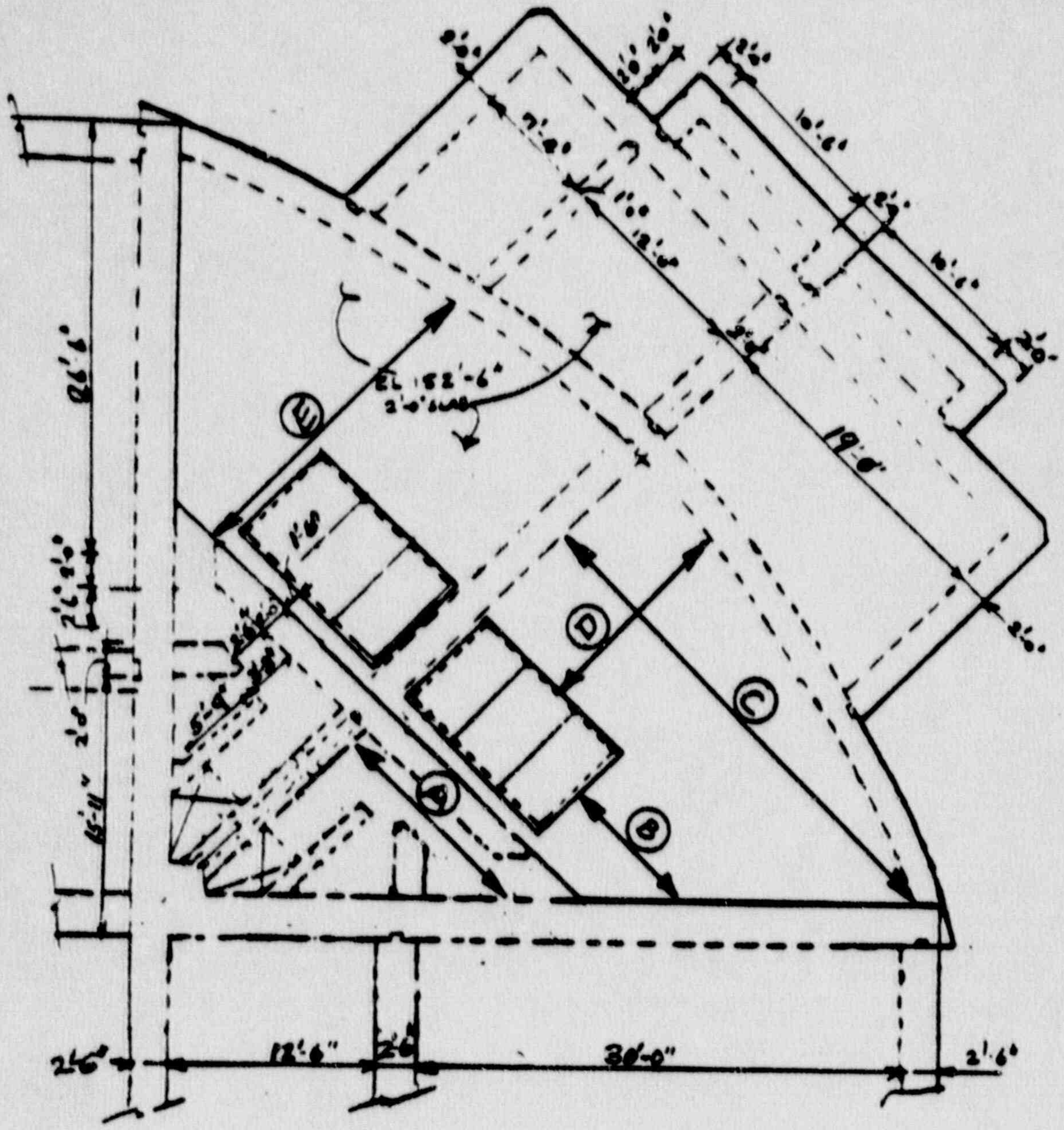
Note: Doors SP154-1 and 2 were welded closed in accordance with Modification Request (MR) No. 85-0445. Therefore, access to the roof area of the pumphouse has been eliminated.

	REF	PAGE
	4	-



13-13
(D-4)
1/2"=1'-0"

REF	PAGE
1	4



PARTIAL PLAN EL. 152'-6"

	REF	PAGE
<u>II. (continued from page 4):</u>		
$W_w = 1.4$ D.L. + $1.9(g_v)$ D.L.	2	4-6
(Density of Water = 62.4 lb/ft^3)	8	15-9
g_v = OBE vert. accel. = 0.162	1	8

W_w = 1.4 (62.4 x 2.33') + 1.9 (0.162) (62.4 x 2.33') = 248.4 psf

(Note: 2.33' = 2'-4" the depth of the water)

**Referring to page 8 of this calculation, the following slab sections are analyzed:

<u>III. Roof Slab Section 'A':</u> — 8

From the original calculation, the slab section is approx. 4'-6" wide by 18' long. The depth (d) of the reinforcing steel (distance from extreme compression fiber to the centroid of the reinforcing) was determined to be 39.885" in the original calculation. (Ref 1, Page 8)

In addition to the dead weight of the slab, an additional Dead Load due to the wall on top of the slab (see page 8) must be added. Therefore, the loadings are:

Dead Load (DL) = Wall Load + Wt. of Slab =
= 4.9 kips/ft + (4.5' x 44"/12 x 150 pcf/1000)
= 7.38 kips/ft (Ref 1, Page 7&8)

Live Load (LL) = 0.23 kips/ft (this load comes strictly from the wall on top of the slab. There are no additional live loads as defined on page 3 of this calculation.) (Ref 1, Page 8)

Seismic Load = g_v (DL + LL) = 0.162 (7.38 k/ft)+ 0.23 k/ft = 1.23k/ft (Ref 1, Page 8)
(Note: g_v = 0.162 is conservative in the original calc.; actually g_v=0.160)
Therefore, the total loading (U) is:

U = 1.4DL + 1.7LL + 1.9 OBE (Ref 2, Page 4-6)
= 1.4 (7.38) + 1.7 (0.23) + 1.9 (1.23) = 13.06 kips/ft

The resultant bending moment in the slab, utilizing the equation given in the orginal calculation which best approximates the support conditions of the slab is:(Note: '9' is used as a denominator to be conservative, fixed end beams usually use 12.)

$$M = \frac{wl^2}{9} = \frac{(13.06k/ft)(18')^2}{9} = 470.2 \text{ ft-kips/4.5' width}$$

$$\text{Moment due to ponded water} = \frac{(248/1000)(18')^2}{9} = 8.9 \text{ ft-kips}$$

$$M_u = 470.2 + 8.9 = 479.1 + M_{ut} = 479.1 + 8.4 \text{ ft-kips/ft } (4.5')$$
$$= 487.5 \text{ ft-kips/4.5'}$$

REF | PAGE

III. (continued from page 9):

As indicated in the original calculation, an additional moment is added to the overall loading to compensate for pipe supports and cable trays. This loading will simply be transferred to this calculation and is unchanged. Therefore, the total ultimate applied moment to slab section 'A' is:

M_u = 487.5 ft-kips + 65 ft-kips = 552.5 ft-kips/4.5' width — 1 | 8

The originally calculated M_u for the slab was 640.5 ft-kips/4.5' width. Since this moment was utlized to design the reinforcing requirements for the slab and it is greater than the revised moment determined here, it can be concluded that the additional loading imposed by the ponded rainwater will not affect the structural integrity of slab section 'A'. — 1 | 8

IV. Roof Slab Section 'B':

As can be seen from the drawing on page 8 of this calculation, and as defined in the original calculation, slab section 'B' is essentially a cantilevered member fixed on one end by the vertical wall of the structure and extending to the edge of the concrete plug opening. — 1 | 8&9

From the original calculation, the Dead Load contribution from the concrete plugs is 1.65 kips. Therefore, neglecting the Live Load, as stated on page 3 of this calculation, and applying the same loading combination equation utilized throughout this design:

1. The loading on the slab due to the concrete plugs is:

   P_u (point load @ end of cantilever) = 1.4DL + 1.9 g_v (DL) — 1 | 9

   = 1.4 (1.65 kips) + 1.9 (0.162) (1.65 kips) = 2.82 kips

   The additional loading on the cantilever due to the curbing around the concrete plugs, from the original calculation, is

   P = 0.53 kips

   Therefore, the total applied point load at the end of the cantilever is:

   P_u = 2.82 kips + 0.53 kips = 3.35 kips

2. From the original calculation, the Dead Load of the slab for section 'B' is:

   D.L. = 2' thick x 1' width x 150 pcf/1000 = 0.3 pounds per foot — 1 | 9

   Neglecting the Live Load, but including the seismic loading, the distributed loading along the length of the slab section is:

   W_u = 1.4DL + 1.9 g_v (DL) = 1.4(0.3) + 1.9(0.162)(0.3) = 0.51 K/ft

REF	PAGE

IV. (continued from page 10):

As indicated in the original calculation, an additional loading is added to account for pipe supports and cable trays. This loading will simply be transferred here, thereby making the total distributed loading on the slab section:

$W_u = 0.51\ k/ft + 0.4\ k/ft = 0.91\ k/ft$ — 1 | 9

Utilizing the loadings calculated above and an overall length of slab section of 11.5 ft, as stated in the original calculation, the ultimate revised moment applied to slab section 'B' will become: — 1 | 9

$$M_u = P_u \times 11.5\ ft + \frac{W_u(L)^2}{2} + M_{ut} + \frac{W_w(L)^2}{2}$$

$$= 3.35\ k \times 11.5\ ft + \frac{0.91k/ft(11.5ft)^2}{2} + 8.4\ ft\text{-}k/ft + \frac{(0.248\ ksf)(11.5ft)^2}{2}$$

$M_u = 123.5$ ft-kips

Since the originally calculated ultimate moment was 126.5 ft-kips and the revised moment determined in this calculation was found to be less, 123.5 ft-kips, it can be concluded that the additional loading imposed by the ponded rainwater will not affect the structural integrity of slab section 'B'. — 1 | 9

V. Roof Slab Section 'C':

As can be seen from the drawing on page 8 of this calculation, slab section 'C' is the longest clear span on the roof. In addition, the distributed loading applied to section 'C' is the same as that applied to section 'B'. That is:

The distributed loading as a result of the weight of the slab is:

$W_u = 0.51\ k/ft$ (from page 10 of this calculation) — - | 10

Added to that is the loading from pipe supports and cable trays of 0.4 k/ft, thereby making the total distributed load:

$W_u = 0.51\ k/ft + 0.4\ k/ft = 0.91\ k/ft$

Utilizing the equations provided in the original calculation for the bending moment in the slab that conservatively approximates the support conditions, the ultimate moment applied to the slab section is:

$$M_u = \frac{W_u(L)^2}{9} + M_{ut} + \frac{W_w(L)^2}{9}$$

$$= \frac{(0.91k/ft)(30\ ft)^2}{9} + 8.4\ ft\text{-}k/ft + \frac{(0.248ksf)(1\ ft)(30ft)^2}{9}$$

	REF	PAGE

V. (continued from page 11):

$$M_u = 91 \text{ ft-k} + 8.4 \text{ ft-k/ft (1 ft width)} + 24.8 \text{ ft-k}$$
$$= 124.2 \text{ ft-kip}$$

The resulting applied ultimate moment from the original calculation was 118 ft-kips. However, this moment was compared with that utilized for the design of slab section 'B', which was 126.5 ft-kips. Therefore, since the revised moment calculated here is 124.2 ft-kips and is less than the governing design moment of 126.5 ft-kips, it can be concluded that the additional loading imposed by the ponded rainwater will not affect the structural integrity of slab section 'C'. (Ref. 1, p. 9; Ref. 1, p. 9)

VI. Roof Slab Section 'D':

Based upon a review of the original calculation, slab section 'D' was found to be the most critical section due to the highest applied ultimate moment. (Ref. 1, p. 9)

Slab section 'D' is a cantilevered section with a span of 13'-0". Therefore, the analysis performed here will be similar to that performed for slab section 'B'. (Ref. 1, p. 9)

1. Referring to the original calculation, the effective width of the concrete plugs which contribute to a point load at the end of the cantilevered section is 2.29 ft. Therefore, the Dead Load of the plugs (2 ft. thick) is: (Ref. 1, p. 9; Ref. 7, p. -)

   $$D.L. = 2 \text{ ft.} \times 2.29 \text{ ft.} \times 150 \text{ pcf}/1000 = 0.687 \text{ k/ft}$$

   Therefore, the factored point load from the concrete plugs is:

   $$P_u = 1.4 \, D.L. + 1.9 \, g_v \, (D.L.)$$ (neglecting live load, as stated on page 3) (Ref. 1, p. 9)

   $$= 1.4(0.687 \text{ k/ft}) + 1.9\,(0.162)(0.687 \text{ k/ft})$$

   $$P_u = 1.17 \text{ k/ft}$$

   The additional loading on the cantilever due to the curbing around the concrete plugs, from the original calculation, is:

   $$P = 0.53 \text{ kips/ft}$$ (Ref. 1, p. 9)

   Therefore, the total applied point load at the end of the cantilever is:

   $$P_u = 1.17 \text{ k/ft} + 0.53 \text{ k/ft} = 1.70 \text{ k/ft or } 1.70 \text{ kips for 1 ft. width}$$

2. The ultimate moment for slab section 'D' is calculated as follows:

   $$M_u = P_u(L) + \frac{W_u(L)^2}{2} + \frac{W_w(L)^2}{2} + M_{ut}$$

	REF	PAGE

VI. (continued from page 12):

P_u = 1.7 kips

W_u = 0.91 kips same as that determined for slab section 'C' — 11

W_w = 0.248 ksf or 0.248 k/ft for 1 ft. width of slab analyzed — 9

M_{ut} = 8.4 ft-k/ft or 8.4 ft-kip for 1 ft. width of slab analyzed — 4

Therefore, the total applied ultimate moment for slab section 'D' is:

$$M_u = (1.7)(13\text{ ft}) + \frac{(0.91)(13)^2}{2} + \frac{(0.248)(13)^2}{2} + 8.4\text{ ft-k}$$

$$M_u = 128.35\text{ ft-k}$$

Since this revised moment is slightly higher than the originally calculated moment of 126.9 ft-k, the remainder of the analysis will be performed to determine the area of reinforcing steel required, as compared to that provided in the original design. — 1 9

1. From reference #3, "Flexure 1.1", page 105; — 3 105

$$F = \text{flexural coeff.} = \frac{bd^2}{12000}$$

b = 12 inches (width of slab being analyzed)

d = 19.885 inches ('d' was previously defined on page 9, however this area of the roof is 2 ft. thick thereby reducing 'd' to 19.885" from 39.885") — 1 9

$$F = \frac{(12")(19.885")^2}{12000} = 0.395$$

From ref. #3, page 105,

$$K_u = \text{strength coeff. of resistance} = \frac{M_u}{F} = \frac{128.35\text{ ft-k}}{0.395} = 324.94$$

therefore, from the table on page 105: (by interpolation) using f'_c = 3000 psi and f_y = 40,000 psi — 2 2-1

ρ = tension reinf. ratio = 0.0098

Therefore, the Area of Steel required is:

from ref. #3, page 105 — 3 105

A_s = pbd = 0.0098 x 12" x 19.885" = 2.338 sq. in.

The Area of Steel provided in the original design was:

#11 bars @ 8" Top & Bottom = 2.34 sq.in. — 3 160

Therefore, sufficient steel is provided as required by the revised moment.

	REF	PAGE

VI. (continued from page 13):

Therefore, since sufficient steel area is provided in the slab to satisfy the requirements of the revised moment determined herein, it can be concluded that the additional loading imposed by the ponded rainwater will not affect the structural integrity of slab section 'D'.

(Note: Since the applied loadings from P_u and W_u are smaller than those originally calculated, the check for shear is acceptable by observation. including the small amount of loading added by ponded water.) 1 9

VII. Roof Slab Section 'E':

The analysis for slab section 'E' is similar to that performed for section 'C' (see page 11 of this calculation).

Referring to pages 5 and 8 of this calculation and page 10 of the original calculation, the span of section 'E' is 22'-4". The distributed loading on the slab is the same as that applied to slab section 'C', that is:

W_u = 0.91 k/ft (representing slab weight, cable tray and pipe support loads) - 11

$$M_u = \frac{W_u(L)^2}{9} + M_{ut} + \frac{W_w(L)^2}{9}$$

W_w = 0.248 ksf (page 9)

M_{ut} = 8.4 ft-k (page 4)

Therefore:

$$M_u = \frac{(0.91\ k/ft)(22.33ft)^2}{9} + 8.4\ ft\text{-}k + \frac{(0.248ksf)(1ft)(22.33ft)^2}{9}$$

$$M_u = 72.56\ ft\text{-}k$$

Since the ultimate applied moment determined here of 72.56 ft-k is less than the design governing moment of 126.5 ft-k to which slab section 'C' (1 9) was compared, and since the reinforcing steel design is the same as section (1 10) 'C', the slab loading is acceptable. (7 -) The additional loading imposed by the ponded rainwater will not affect the structural integrity of the slab.

VIII. Conclusion:

As determined by this calculation, it can be seen that the additional loading imposed by the maximum height of ponded rainwater that may occur, 2'-4", will not affect the structural integrity of the roof slab at elevation 152'-6". The original design calculation (reference #1) provided more than adequate reinforcing steel, so that the conditions reviewed herein are enveloped by the original design parameters.

(Note: The remaining slab sections of the roof structure that were not identified and were not analyzed in the original calc. or here, are sections which are considered to be enveloped by those sections that were analyzed.) 1 -

RIVER BEND STATION
GULF STATES UTILITIES COMPANY

DESIGN DOCUMENT NO. Calculation C47.540-08

DESIGN REVIEW CHECKLIST (REF. EDP-AA-58)

	YES	NO	N/A
1. Were the inputs correctly selected and incorporated into the design?	X	☐	☐
2. Are the assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are the assumptions identified for subsequent reverifications when the detailed design activities are completed?	X	☐	☐
3. Are the appropriate quality and quality assurance requirements specified?	☐	☐	X
4. Are the applicable codes, standards, and regulatory requirements, including issue and addenda, properly identified and are their requirements for design met?	X	☐	☐
5. Have applicable construction and operating experience been considered?	☐	☐	X
6. Have the design interface requirements been satisfied?	☐	☐	X
7. Was an appropriate design method used?	X	☐	☐
8. Is the output reasonable compared to inputs?	X	☐	☐
9. Are the specified parts, equipment, and processes suitable for the required application?	☐	☐	X
10. Are the specified materials compatible with each other and with the design environmental conditions to which the material will be exposed?	☐	☐	X
11. Have adequate maintenance features and requirements been specified?	☐	☐	X
12. Are accessibility and other design provisions adequate for the performance of needed maintenance and repair?	☐	☐	X
13. Has adequate accessibility been provided to perform the in-service inspection expected to be performed during the plant life?	☐	☐	X
14. Has the design properly considered radiation exposure to the public and to plant personnel?	☐	☐	X
15. Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfactorily accomplished?	X	☐	☐
16. Have adequate pre-operational and subsequent peridic test requirements been appropriately specified?	☐	☐	X
17. Are adequate handling, storage, cleaning and shipping requirements specified?	☐	☐	X
18. Are adequate identification requirements specified?	☐	☐	X
19. Are requirements for record preparation, review, approval, retention, etc. adequately specified?	☐	☐	X
20. Have environmental, safety, and seismic adequacy been considered?	X	☐	☐
21. Have recommended spare parts been specified?	☐	☐	X
22. Have fire hazard analysis impacts been considered?	☐	☐	X

Verifier's Summary:

DESIGN VERIFIED Rudolph J Keran Jr. — Verifying Engineer — 7/06/89 — Date

F0000080

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION TITLE PAGE

*SEE INSTRUCTIONS ON REVERSE SIDE

5010.64 (FRONT)

CLIENT & PROJECT	PAGE 1 OF 25 (INCL. ATT.)
GULF STATES UTILITIES CO. RIVER BEND	C47.540

CALCULATION TITLE (Indicative of the Objective):	QA CATEGORY (✓)
STANDBY S.W. COOLING TOWER DESIGN OF ROOFS @ EL. 152'-6" & 163'-4" AND WALLS FROM EL. 152'-6" TO EL. 163'-4"	☒ I - NUCLEAR SAFETY RELATED ☐ II ☐ III ☐ ____ OTHER

CALCULATION IDENTIFICATION NUMBER				
J.O. OR W.O. NO.	DIVISION & GROUP	CURRENT CALC. NO.	OPTIONAL TASK CODE	OPTIONAL WORK PACKAGE NO.
12210	STRUCTURAL	C47.540	N/A	N/A

* APPROVALS - SIGNATURE & DATE			REV. NO. OR NEW CALC NO.	SUPERSEDES * CALC. NO. OR REV. NO.	CONFIRMATION * REQUIRED (✓)	
PREPARER(S)/DATE(S)	REVIEWER(S)/DATE(S)	INDEPENDENT REVIEWER(S)/DATE(S)			YES	NO
K. E. Durani 11-18-81	T. Patel 11-19-81 (T.C. PATEL)	T. Patel 11-19-81 (T.C. PATEL)	0	N/A		✓

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DESIGN ENGINEERING CONTROL COPY SDC

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RECORDS MGT. FILES (OR FIRE FILE IF NONE)	D. MARTIN - 4R	✓			

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CALCULATION SHEET

STONE & WEBSTER ENGINEERING CORPORATION

J.O./W.O./CALCULATION NO.	REVISION	PAGE
12210 / C47.540	0	C47.540

PREPARER/DATE	REVIEWER/CHECKER/DATE	INDEPENDENT REVIEWER/DATE
J.E. Onarol 11-18-81	R. Cobel 11-19-81	R. Cobel 11-19-81

SUBJECT/TITLE: STANDBY S.W. COOLING TOWER DESIGN OF ROOF SLABS @ EL. 152'-6" + 163'-4" AND WALLS FROM 152'-6" TO 163'-4"

QA CATEGORY/CODE CLASS: I

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C47.540.3	DESIGN CHECKLIST
C47.540.4 TO C47.540.10 + 10A	DESIGN OF ROOFS (EL. 152'-6") AND DES. OF WALLS (152'-6" TO 163'-4")
C47.540.11 + C47.540.12	" " " " SKETCHES OF REINFORCEMENT
C47.540.13	PARTIAL PLAN OF ROOF (EL. 163'-4")
C47.540.14 - 16	DESIGN OF ROOF SLAB (EL. 163'-4")
C47.540.17, 18	SKETCHES OF REINF. (ROOF @ 163'-4")
C47.540.19	EMB. PLATES FOR MONORAIL (163'-4")
—	LIST OF ATTACHMENTS (INCL. ATTC. #1)

FOR INFORMATION ONLY

NOTE:- WORK THIS SHEET WITH HISTORICAL DATA SHEET.

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

J.O. OR W.O. / CALCULATION NO.	REVISION	PAGE
12210/C47.540	0	C47.540.1.1

PREPARER/DATE	REVIEWER/CHECKER/DATE	INDEPENDENT REVIEWER/DATE
T.E. Daniel 11-18-81	[illegible] 11-19-81	[illegible] 11-19-81

SUBJECT/TITLE	QA CATEGORY/CODE CLASS
STANDBY S.W. COOLING TOWER DESIGN OF SLABS & WALLS (EL. 152'-6" ~ 163'-4")	I

HISTORICAL DATA - REVISION 1

REASON FOR CHANGE AND SOURCE OF INFORMATION:

PAGE	DESCRIPTION

PREPARER/DATE	REVIEWER/CHECKER/DATE	INDEPENDENT REVIEWER/DATE
[illegible] 11-18-81	[illegible] 11.19.81	[illegible] 11.19.81

SUBJECT/TITLE: STANDBY S.W. COOLING TOWER DESIGN OF ROOFS @ EL. 152'-6" + 163'-4" AND WALLS BETWEEN 152'-6" & 163'-4"

QA CATEGORY/CODE CLASS: I

CALCULATION SUMMARY

PURPOSE:

TO DETERMINE THE SIZE AND REINFORCEMENT FOR THE SLABS @ EL. 152'-6" & 163'-4" AND THE WALLS BETWEEN EL. 152'-6" & 163'-4"

REFERENCES:

- STRUCTURAL DESIGN CRITERIA FOR RIVER BEND UNITS 1 & 2 DOC. # 200.010, REV. 1
- SEISM. ANALYSIS OF STANDBY COOLING TOWER BY ENG'G MECH. DATE: 7-20-80 CALC. # 201.130
- ACI-318-71
- ENG'G MONOGRAPHS # 27 BY BUREAU OF RECLAMATION. U.S. GOVERN. PRINTING OFFICE WASHINGTON D.C. 1970
- PCA NOTES ON ACI 318-71.
- AISC - 7TH EDITION.
- ACI SP 17-73

CONCLUSION:

SEE PAGES: C47.540.11, 12 ; C47.540.17, 18

CALCULATION STATUS:

PRELIMINARY ____

FINAL ✓

SUPERSEDED ____

CODE CLASS: N/A

SOURCE OF DATA:

12210 EC-47 SERIES.
CALC No. MC 2.1
" " S 70.373

FOR INFORMATION ONLY

DESIGN CHECKLIST

LOAD CONSIDERATIONS	✓
DEAD	✓
LIVE	✓
EQUIPMENT	✓
PIPE	
WIND	
TORNADO	✓
POSITIVE PRESSURE	
NEGATIVE PRESSURE	
SEISMIC	✓
THERMAL	✓
HYDROSTATIC	
EARTH PRESSURES	
MISSILE	
CONSTRUCTION	
SNOW AND ICE	

MATERIAL	GRADE/ STRENGTH
CONCRETE	f'_c = 3000 psi
REINFORCEMENT	f_y = 40000 psi
STRUCTURAL STEEL	—
HIGH STRENGTH BOLTS	—
COMMON BOLTS	—
WELD RODS	—
ANCHOR BOLTS	A-307
STUDS	—

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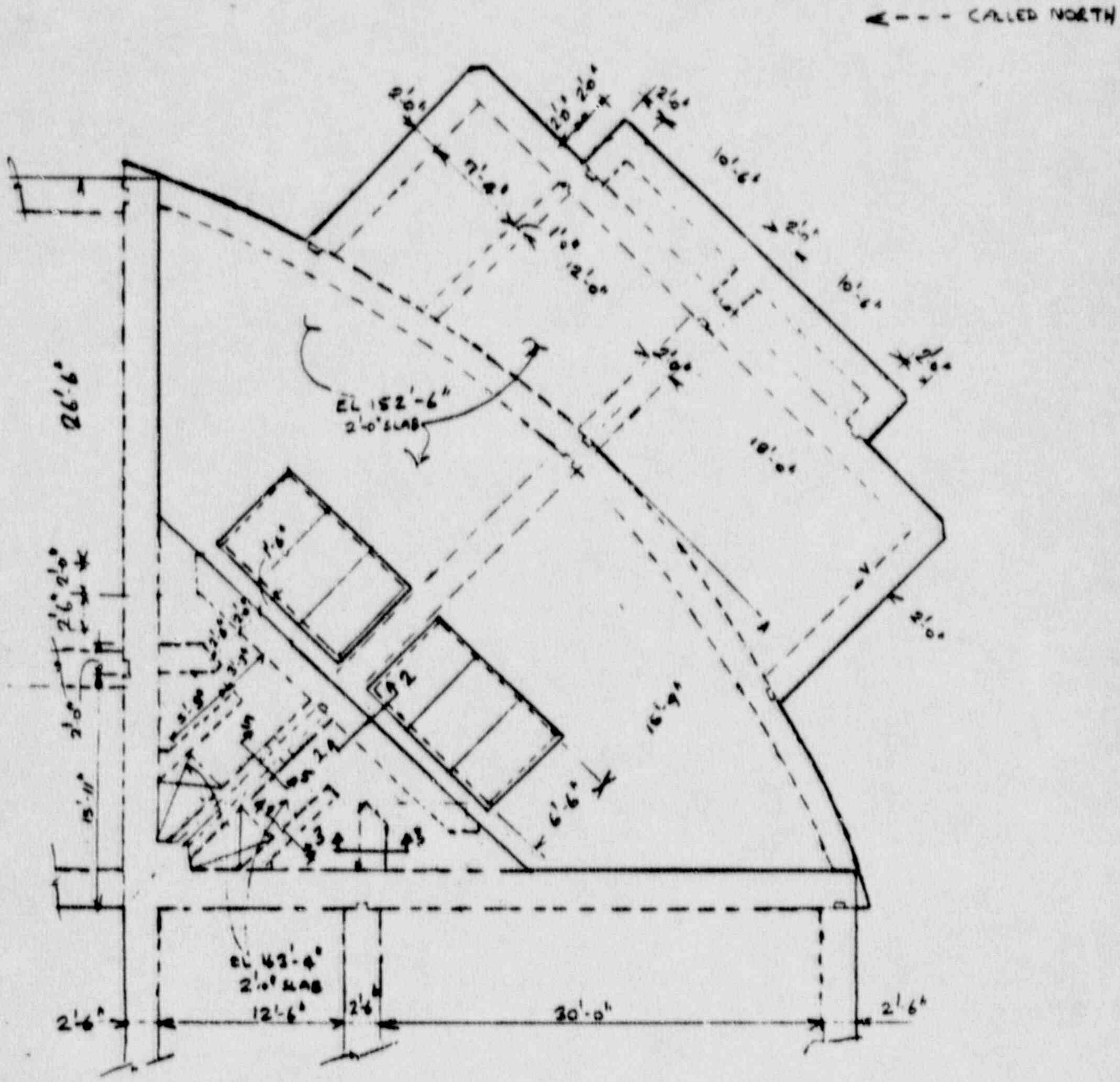
CALCULATION SHEET

A5010.81

J.O./W.O./CALCULATION NO.	REVISION	PAGE
12210 / C47.540	0	C47.540.4

PREPARER/DATE	REVIEWER/CHECKER/DATE	INDEPENDENT REVIEWER/DATE
[signature] 10-28-81	[signature] 11.16.81	[signature] 11.16.81

SUBJECT/TITLE	QA CATEGORY/CODE CLASS
STANDBY SERVICE WATER COOLING TOWER, DESIGN OF SLABS EL. 163'-4' & 152'-6"	I



PARTIAL PLAN EL. 152'-6" & 163'-4' (EC 47BJ-1)
SCALE: 3/32" = 1'-0"

FOR INFORMATION ONLY

TEMPERATURE MOMENT: (FOR 2'-0" SLABS)

$\Delta T = 50°F$

$\alpha = 0.55 \times 10^{-5} /F$

$E_c = 57000\sqrt{f_c'} = 57000\sqrt{3000} = 4.5 \times 10^5$ ksf → ACI-318-71 SECT. 8.3

$\gamma = 0.2$

$n = 9$ ($f_c' = 3000$)

ASSUMING #11 BARS

$H = 2' = 24"$

$d = 24 - 2 - 1.5 \times 1.41 = 19.885$

$d' = 24 - 4 - 3 \times 1.41 = 15.77"$

$$K_1 = \frac{K_1 H}{H} = \frac{19.885}{24} = 0.83$$

$$K_2 = K_2 H/H = \frac{15.77}{24} = 0.66$$

* STRUCTURAL DESIGN CRITERIA FOR RIVER BEND UNITS 1 & 2 SECT.: 3B. (ATT. # 3.8-1) DOC. # 200.010

Assuming #11 @ 10" @ E.F

$$\rho = \frac{1.87}{12 \times 24} = 0.0065 \qquad \rho' = \frac{1.87}{12 \times 24} = 0.0065$$

$$^{*}N = -n(\rho + 2\rho') \pm \sqrt{n^2(\rho + 2\rho')^2 + 2n[2\rho'(K_1 - K_2) + K_1 \rho]}$$

$$= -9(0.0195) \pm \sqrt{81(0.0195)^2 + 18[0.0130(0.83 - 0.66) + 0.83 \times 0.0065]}$$

$$= -0.1755 \pm 0.4095$$

$N = 0.234$

$$^{*}M_T' = (\alpha N^2 H^2 \Delta T E_c)/2 \left[\left(K_1 - \frac{N}{3}\right) + \left(4n(N - K_1 + K_2)\rho' K_2\right)/N^2 \right]$$

$$= 0.55 \times 10^{-5} (0.234)^2 \times (2)^2 \times 50 \times \frac{4.5 \times 10^5}{2} \left[\left(0.83 - \frac{0.234}{3}\right) + \left(36(0.234 - .83 + .66)(.0065).66\right)/(.234)^2 \right]$$

$M_T' = 12.64$ k-ft

$M_T = M_T'/(1-\gamma) = 12.64/(1-0.2) = 15.8$ k-ft

$1.3 M_T = 1.3 \times 15.8 = \underline{20.54}$ k-ft SAY 21 k-ft

SPAN is ~ 28' (SCALED)

HEIGHT = 10'-10" THICK = 2'

ASSUME IT TAKES 5'-6" WIDE 163'-4" SLAB

DL = 2 × 5.5' × 0.15 + 10.83 × 2 × 0.15 = 4.90 k/l

LL = 7.6 × 0.03 = 0.23 k/l

5.13 k/l

* Seismic Profiles For OBE G = 24 ksi)

Seismic = 5.13 × 0.162* 0.83 k/l

W_U = 1.4 × DL + 1.7 LL + 1.9 × seism.

W_U = 1.4 × 4.9 + 1.7 × 0.23 + 1.9 × 0.83 = 8.83 k/l

$M = \frac{wl^2}{8}$ (conserv.) = 8.83 × 28²/8 = 865.34 k-l

Assume deep beam d = 0.75 × 10.83' ⇒ 8.12' ⇒ 97.5'

F = bd²/12000 = 24 × 97.75² / 12000 = 19.11

K = M_u/F = 865.34 / 19.11 = 45 ⇒ ρ = 0.0015

As = 0.0015 × 24 × 97.75 = 3.5 in²

As/FT/FACE = 3.5 / (5.42 × 2) = 0.32 in²

SHEAR V_c = V / (0.85 bd) = (8.83 × 14' × 1000) / (0.85 × 24 × 97.5) = 62 psi < 110 psi O.K

Min A_s = 0.0025 × 12 × 24 = 0.72 in² < 1.87 in²

∴ USE #11 @ 10" E.F. H (min req'd for missile protection)

VERTICAL REINFORCEMENT

Seismic force: 2' × 0.15 × 0.439 × 0.13 k/l, 1.9 × 0.13 = 0.25 k/l

M_T = 21 k-l (ASSUME SAME AS 2' SLAB)

M_u = 0.25 × 10.83²/8 + 21 = 25 k-l

K_u = M/F = 25/.395 = 63 ⇒ a_u = 2.95

$A_s = \frac{M_u}{a_u d} = \frac{25}{2.95 \times 22''} = 0.39 in^2$

USE #11 @ 10" E.F.V. (1.87 in² > 0.39 in²)

→ MIN REQ'D for MISSILE PROTECTION

PORTION OF THE SLAB BETWEEN OPENINGS — FOR INFORMATION ONLY

SLAB IS 4'-6" WIDE @ 18' LONG (SCALED) — $d = 44 - 2 - 1.5 \times 1.41 = 39.885''$

$DL = 4.9 + 4.5 \times 3.67 \times 0.15 = 4.9 + 2.48 = 7.38\ k/'$

$LL = 0.23 + 0.03 \times 4.5 = 0.37\ k/'$

$Seism. = 0.162 \times (7.38 + 0.37) = 1.26\ k/'$

$9.01\ k/'$

$w_u = 1.4DL + 1.7 \times LL + 1.9 \times Seism.$

$w_u = 1.4 \times 7.38 + 1.7 \times 0.37 + 1.9 \times 1.26 = 13.36\ k/'$

$M = w\ell^2/9 = 13.36 \times 18^2/9 = 480.96\ k\text{-}'$

Total $M = 480.96 + M_T = 480.96 + 21 \times 4.5 = 575.5^{k\text{-}'}$

additional moment due to pipe & cable tray ⇒ $[(1.7 \times 0.200 + 1.9 \times 0.162 \times 0.200) \times 4.50] \frac{\times 18^2}{9} = 65^{k\text{-}'}$ ⇒ $M_u = 575.5 + 65 = 640.$

$\frac{M_u}{\phi f'_c b d^2} = \frac{640.5 \times 12}{0.85 \times 3 \times 54 \times (39.885)^2} = 0.0351 \Rightarrow \omega = 0.036$ (PCA NOTES ON ACI 318-77, Pg 9-?)

$\rho = \omega \frac{f'_c}{f_y} = 0.036 \frac{3}{40} = 0.0027$

$A_s = \rho b d = 0.0027 \times 54 \times 39.885 = 5.82\ in^2$

$A_s/FT = 5.82/4.5 = 1.29\ in^2$

USE #11 @ 8" E.W. T & B (2.34 > 1.29 in² O.K.)

CHECK ON SHEAR ⇒ $v_u = \frac{13.36 \times 9 \times 1000}{0.85 \times 54 \times 39.885} = 65.7 < 110\ psi$ OK

CHECK ON CANTILEVER PORTION:

Assume it takes 1/2 of Conc. plug. load

$D.L. = \underbrace{2 \times 5.5 \times 0.15}_{P} = 1.65^k$ $LL = 0.03 \times 5.5 = 0.165$

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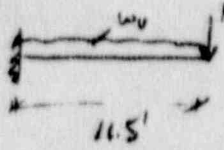
$P_u = 1.4 \times 1.65^k + 1.7 \times 0.165 + 1.9 \times 0.162(1.65 + 0.165)$

$P_u = 3.15^k$ Additional P_u due to curb $= (1.25 \times 2' \times 0.15)1.4 = 0.53^k$ (ignore seismic)

Tot $P_u = 3.6^k$

SLAB ⇒ $D = 2 \times 1 \times 0.15 = 0.3$ $L = 0.03 \times 1 \times 1 = 0.03$



$w_u = 1.4 \times 0.3 + 1.7 \times 0.03 + 1.9 \times 0.162 \times 0.36 = 0.57$

$w_{equipment} = 0.200 \times 1.7 + 1.9 \times 0.162 \times 0.200 = 0.400$ } $w = 0.97$

$M_u = 3.6 \times 11.5 + 0.97 \times 11.5^2/2 + 21. = 126.5^{k\text{-}ft} \Rightarrow M/F = \frac{126.5}{.395} = 320$

$A_s = 0.0097 \times 12 \times 19.885 = 2.31 \text{ in}^2$ $\rho = 0.0097$

USE #11 @ 8" T&B. E.W (2.34 > 2.31)

Longest span = 30'

$M_u \cong wl^2/9 + M_T \Rightarrow M_u = \frac{0.97 \times 30^2}{9} + 21. = 118^{k\text{-}ft} < 126.5^{k\text{-}ft}$ (conservative)

USE #11 @ 8" T&B

Check on cantilever portion (N-S)   Span = 13.0'

$P_u = 1.4(2 \times 2.29 \times 0.15) + 1.7(0.03 \times 2.29) + 1.9 \times 0.162(0.75) = 1.31$

$w_u = 0.97$ Total $P_u = 1.31 + 0.53 = 1.84$

$M_u = 1.84 \times 13.0 + 0.97 \times 13.0^2/2 + 21 = 126.9^{k\text{-}ft}$

$(4.5 + 11)/2 = 7.75$
$7.75/11 = 0.704$
E width $= 3.25 \times 0.704 = 2.29'$

$K_u = \frac{M}{F} = \frac{126.9}{.395} = 321 \Rightarrow \rho = 0.0097$

$\therefore A_s = 0.0097 \times 12 \times 19.885 = 2.31 \text{ in}^2$

USE #11 @ 8" T&B (2.34 > 2.31 in² O.K.

CHECK ON SHEAR

$v_c = \frac{V}{0.85 \times b \times d} = \frac{(1.84 + 0.97 \times 13.) \times 1000}{0.85 \times 12 \times 19.885} = 71.3 \text{ psi} < 110 \text{ psi}$

O.K.

RECTANGULAR PORTION OF 152'-6" SLAB

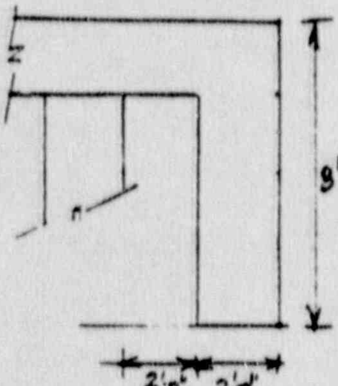
MAX SPAN = 22'-4" Assume simple supported

$M_{u\,max} = w_u l^2/8 = 0.97 \times \frac{22.33^2}{8}$

$= 53.74$ k-ft

∴ USE #11 @ 8" E.W. T&B

CANTILEVER WALL PORTION



DESIGN OF SLAB:

$P_u = 1.4(6 \times 2 \times 0.15) + 1.9 \times 1.8 \times 0.162$

$= 3.1^k$

$w_u = 0.97^{k/ft}$

$M_u = 0.97 \times \frac{4^2}{2} + 3.1 \times 4 = 20.2^{ft\text{-}k}$

$M_u = 20.2$ k-ft

USE #11 @ 8" E.W. T&B

SINCE WALL WILL CARRY ONLY ITS OWN WEIGHT

USE #11 @ 10" E.F.H & VERTICAL FOR WALL

FOR 1' THICK INTERIOR WALLS; USE MIN. REINF.

$A_s = \rho bd = 0.002 \times 12 \times 10.5" = 0.25$ in²

USE #8 @ 12" E.F. E.W. (FOR 1' TH WALLS

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CALCULATION TITLE PAGE
ENGINEERING DEPARTMENT

Job #G13.1.2

12210-C29.	0.1	- 3B
JDI NO.		
PAGE 1	OF 9	

2. CALCULATION TITLE:

Diesel Generator Bldg. - Slab Design

3. SUPERSEDES CALC. OR REVISION NO:

C29.0.1 Rev. 3, Add. A

4. OBJECTIVE OF CALCULATION:

The objective of this calculation is to prove the adequacy of the roof slab at elev. 126'-0" to support a maximum height of ponded rainwater, assuming that the scupper drains provided in the West wall of the building are clogged. (Note: This is a very conservative approach since the drains will not completely block and water will drain.)

5. CALCULATION METHOD/ASSUMPTIONS:

The method employed in this calculation for determining the adequacy of the slab is a simple determination of the reserve capacity of the slab based upon designed loading, as compared to the maximum potential loading from ponded rainwater. If the reserve capacity of the slab exceeds the potential water loading, the slab is acceptable. If the reserve capacity does not exceed the rainwater loading, additional analysis and/or justification is provided to insure the adequacy of the existing slab design.

6. SOURCES OF DATA/EQUATIONS (REFERENCES):

1. Calculation 12210-C29.0.1 Rev. 3; "Diesel Generator Bldg. - Slab Design"
2. Structural Design Criteria - Doc. No. 200.010, Rev. 5, dated 3/15/85
3. Design Handbook ACI 318-71, Publication SP-17(73)
4. Drawing EC-29G-3; "Floor Plan EL. 126'-0", Outline, Diesel Generator Bldg."
5. "Standard Handbook for Civil Engineers"; Merritt; Second Edition; 1968

7. CONCLUSIONS:

Based upon the reserve capacity of the existing roof slab at elevation 126'-0", the additional loading imposed by the maximum potential height of ponded rainwater will not compromise the structural integrity of the slab.

8. REASON FOR REVISION (IF APPLICABLE):

The reason for this addendum is to provide a technical review of the adequacy of the roof slab at elev. 126'-0" to support the maximum potential height of ponded rainwater. Though the slab design is adequate to support the rainwater, the specific loading imposed by water was not individually identified in the original calculation.

9. RELATED DOCUMENTS:

N/A

10. QA CATEGORY

X I-NUCLEAR SAFETY RELATED
_ II
_ III

11.	12.	13.
[signature] 6/27/89	Tim Rowe 6/27/89	Tim Rowe 6/27/89
PREPARER DATE	CHECKER/REVIEWER DATE	INDEPENDENT REVIEWER DATE

14. DATA REQUIRING CONFIRMATION:

N/A

DATA CONFIRMED BY: DATE

EDP-012 1/87

CALCULATION REVIEW SHEET

CALCULATION NUMBER		REV
C29	0.1	-3B
JBI NO.	[redacted]	

ITEM	CALC PAGE	COMMENT	RESPONSE/RESOLUTION
		None	

COMMENTS PROVIDED BY	COMMENTS RESOLVED	RESOLUTION ACCEPTED
Tim Rocen 6/27/89		
REVIEWER DATE	PREPARER DATE	REVIEWER DATE

EDF-014 1/87

F000017

FOR INFORMATION ONLY

REF PAGE

OBJECTIVE:

As stated on page 1, the objective of this calculation is to confirm the adequacy of the roof slab of the Diesel Generator Bldg. at elev. 126' to support the loading imposed by the maximum potential height of ponded rainwater.

METHOD and SOLUTION:

An outline of the configuration of the roof slab at elevation 126'-0" is shown on page 4 of this calculation. In this outline the slab is divided into sections, S1, S2, and S3, for which an original analysis was performed to determine the design loading and subsequently the slab reinforcing requirements for the overall slab.

On page 5 of this calculation, an outline of the roof slab at elev. 126'-0" is provided showing the physical layout of the roof cubicles with all passageway openings and the scupper drain locations in the West wall of the building. The purpose of this page is to indicate the maximum height of rainwater that could be contained within each cubicle of the roof slab, 7 inches, prior to the water draining into the adjacent cubicle and eventually off the roof through the opening in the North wall of the roof. (See page 8, conclusions, for additional explanation.)

A. The method employed by this calculation, to verify the adequacy of the roof slab, will be to extract the design loading determined from the original calculation; determine the actual capacity of the slab based upon the reinforcing steel provided; determine the reserve capacity of the slab; and compare the reserve capacity to the loading imposed by the maximum potential height of ponded rainwater.

B. It should be noted that the approach defined above is very conservative in nature for the following reasons:

1. This method of review assumes that the scupper drains in the West wall of the roof structure are totally clogged and do not allow any drainage of water. Since this condition is extremely unlikely, the maximum ponded height of rainwater, 7 inches, will more than likely be reduced due to drainage.

2. Though the potential for simultaneous loadings,from the full value of the original design loads,for Live and Temperature Differential, are potentially reduced during a max. height of ponded rainwater, no reductions in these loads will be considered.

3. In this calculation we are analyzing the effect of the ponded rainwater on slab section "S2" as compared to section "S1". Since the slabs are sloped in the direction of slab S1, the ponded depth will actually occur on top of S1. However, the original calc. determined that the max. stresses occurred in slab S2. In addition, the unsupported span length of section S1 is shorter than that of section S2. Therefore, it is very conservative to analyze section S2 and distribute the maximum depth of ponded water over the entire section to determine structural adequacy. 1 C29.9

CALCULATION WORK SHEET

CALCULATION NUMBER		REV
C29.	0.1	-33
JBI NO.	[redacted]	
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CALCULATION SHEET

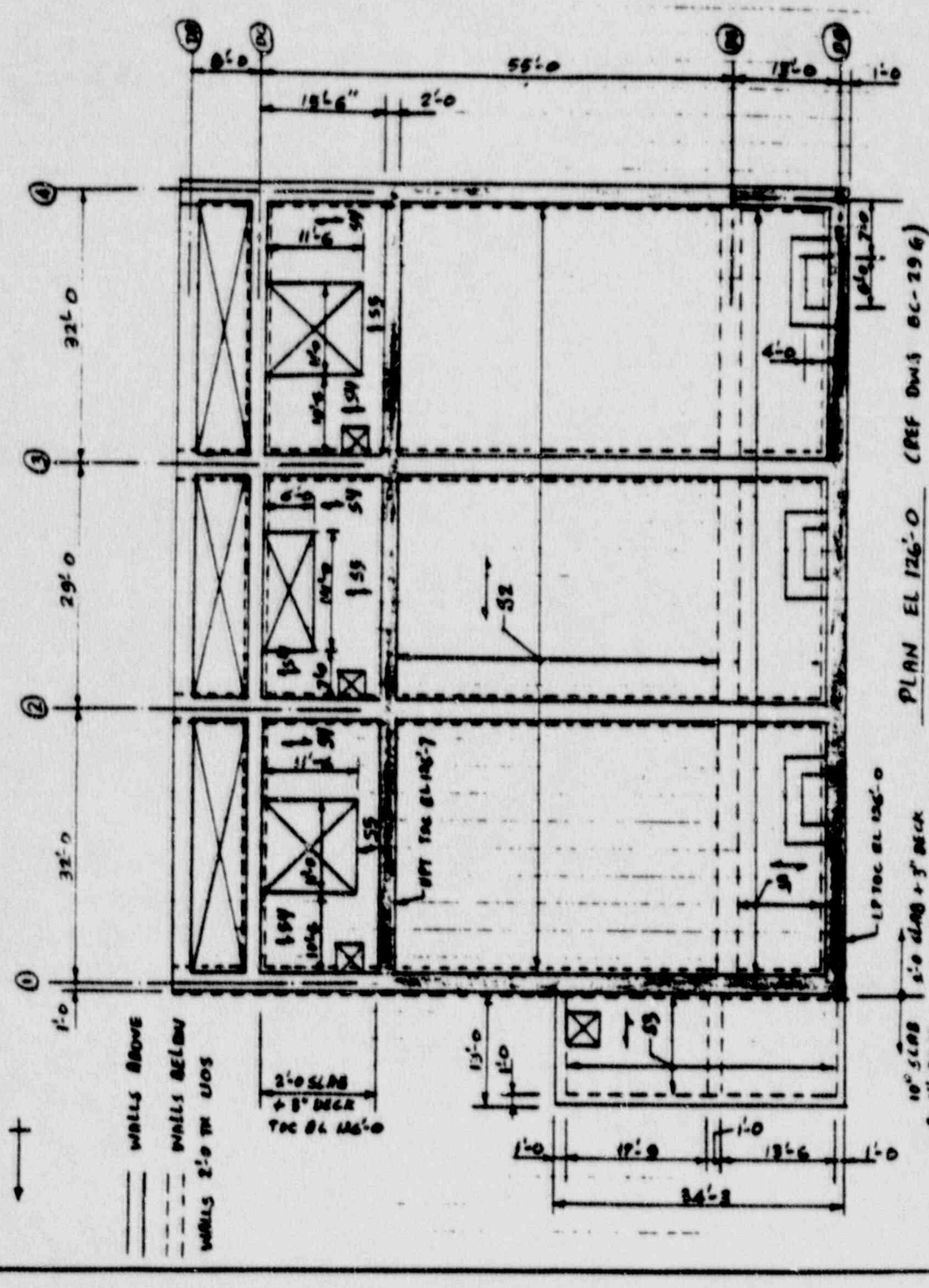
STONE & WEBSTER ENGINEERING CORPORATION

J.O./W.O./CALCULATION NO.	REVISION	PAGE	REF	PAGE
12210	3	C29-9	1	C29. 9

PREPARER/DATE	REVIEWER/CHECKER/DATE	INDEPENDENT REVIEWER/DATE
K. B. Shah / 1-18-85	M. Ahmad / 1-21-85	M. Ahmad / 1-21-85

SUBJECT/TITLE: DIESEL GENERATOR BLDG FLOOR SLAB DESIGN EL 126'-0

QA CATEGORY/CODE CLASS: I



FDP-113 1/87

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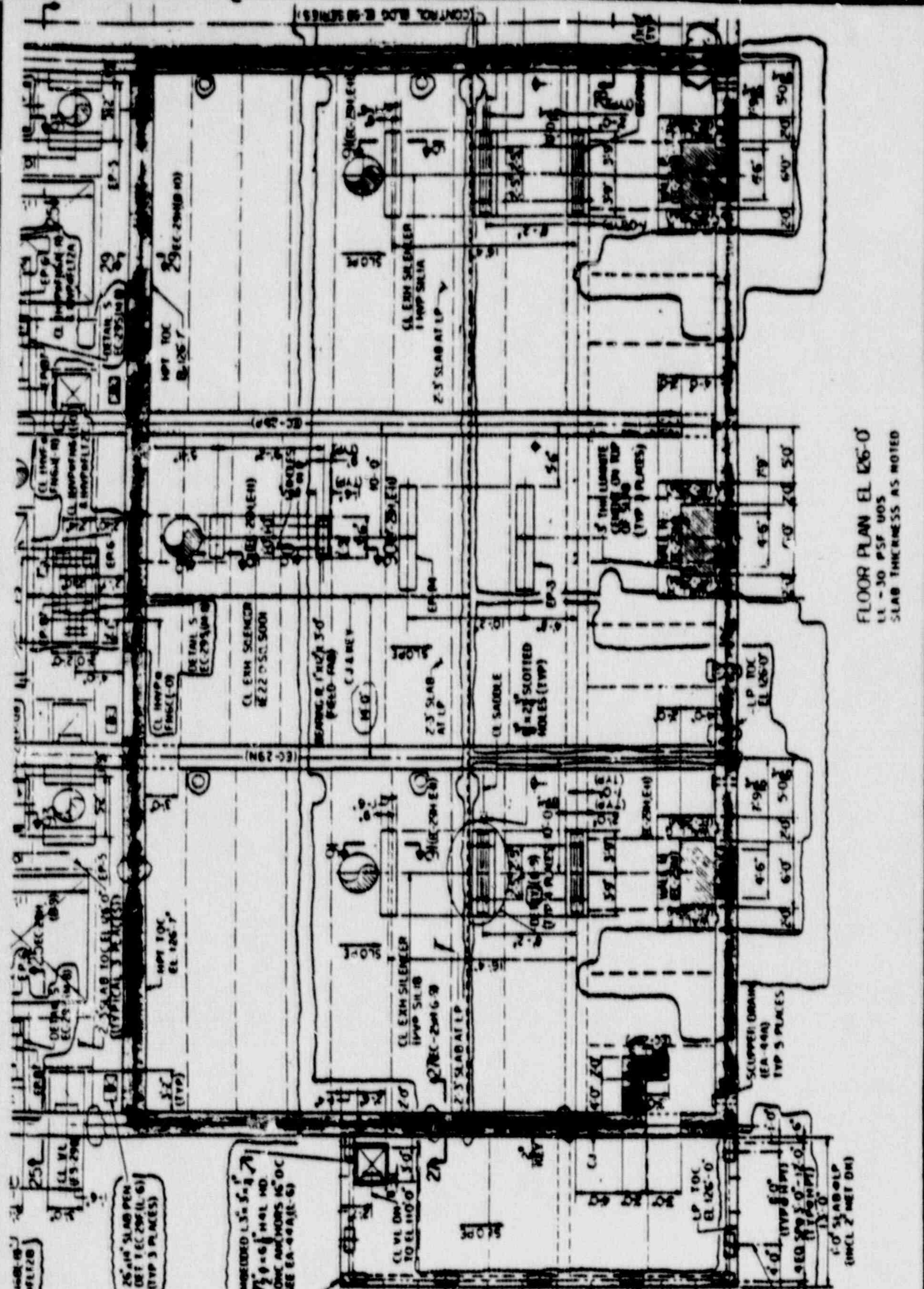
CALCULATION WORK SHEET

CALCULATION NUMBER		REV
C29.	0.1	-3B
JBI NO.		
PAGE 5 OF 9		

REF	PAGE
4	



EDP-013 1/87

FOR INFORMATION ONLY

	REF	PAGE
Referencing Page 4 of this calculation, which is page C29.9 of the original design calculation for the slab at elev. 126'-0";		
From the original calculation performed, it is found that the most critical slab section exhibiting the highest stresses was section "S2".		
The maximum applied moment (M_u) for slab S1 is :		
M_u = 66.0 KFT + 19.8 KFT/FT (diff. temp. T_o)	1	C29. 10 & 11
The maximum applied moment (M_u) for Slab S2 is:		
M_u = 86.0 KFT + 19.8 KFT/FT (diff. temp. T_o)	1	C29. 13 & 11

Slab "S3" is not considered in this review since it is located outside of the "containment" area of the roof. The slab area identified as "S3" is located on the North end of elev. 126'-0" and is bounded on the South side only. The remaining edges of the slab are open and therefore permit runoff of rainwater.

Since the maximum applied moment for the slab at elev. 126'-0" is found to exist in section "S2", we will utilize this section for the determination of structural adequacy to support ponded rainwater loads.
To clarify the origin of the loading on this section of the slab, we will re-state the loading combination equation and results found in the original calculation on pages C29.12 and C29.13:

The load combination equation utilized in the original calculation is:

$$U = 1.4D + 1.7L + 1.9\ OBE + 1.3\ T_o \quad \text{(EQ. \#3, Ref. 2, Pg. 4-6)}$$

D = Dead Load; L = Live Load; OBE = Operational Basis Earthquake;
T_o = Loads due to Temp. Gradient

From page C29.13 of the original calculation: (Ref. 1)

1.4D = 1.4(372 psf) = 520.8 psf g_v = OBE Vert. Accel.
1.7L = 1.7(100 psf) = 170 psf
1.9OBE = 1.9[(g_v)(DL + LL)] = 1.9[(.164)(372 + 100) = 147.08 psf
$1.3T_o$ = 1.3(15.25) = 19.8 KFT/FT = M_{ut} (moment from temp.)

U = 838 psf excluding temp. loads which are added separate

The distributed load as a result of the temp. gradient moment (M_{ut}) is:

From page C29.13, Ref. 1;

$$M_{ut} = \frac{w_u L^2}{10} \qquad w_u = \frac{M_{ut} \times 10}{L^2} = \frac{19.8 \times 10 \times 1000}{32^2} = 193.4 \text{ psf}$$

(Note: L = 32 ft. from the section diagram in the orig. calc. on page C29.13)

REF | PAGE

Therefore, the total distributed loading on slab "S2" is:

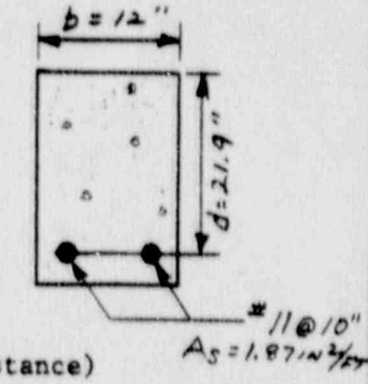
W_u = 838 psf + 193.4 = 1031.4 psf

As indicated on page C29.13 of the original calculation, the area of steel (A_s) provided in the slab is equal to 1.87sq.in/ft(#11 bars @ 10" spacing). In addition, "d" in the original calculation is given as 21.9".

Using the slab design, determine the maximum allowable distributed loading:

For A_s = 1.87 sq.in., d = 21.9", and b = 12" (one foot sect. of slab)

From Ref. #3, "Flexure 1.1", page 105: 3 | 105



$$p = \frac{A_s}{bd} = \frac{1.87}{(12 \times 21.9)} = 0.0071$$

$$F = \frac{bd^2}{12000} = \frac{12(21.9)^2}{12000} = 0.48$$

using f'_c = 3000 psi and f_y = 40,000 psi: 2 | 2-1

K_u = 240 by interpolation from Flex. 1.1 3 | 105
(K_u is the strength coefficient of resistance)

$M_u = F\,K_u$ = 0.48 (240) = 115 KFT 3 | 105

Therefore, the maximum moment capacity of the slab is 115 KFT.

From this capacity, we determine the maximum allowable distributed load on the slab;

From the original calc., page C29.13:

$$W_u = \frac{M_u \times 10}{L^2} = \frac{115 \times 10 \times 1000}{32^2} = 1123 \text{ psf}$$ 1

Therefore, comparing the max. allowable dist. load to the actually applied loading, we can determine the reserve capacity of the slab as being:

W_u margin = W_u capacity - W_u applied = 1123 psf - 1031 psf = 92 psf

Determine the max. allowable head of water based upon the margin of dist. load remaining in the slab:

Since the head of water will act as a dead load and as a live load during a seismic event, the dist. load margin will be divided by the combined unit loading of the two cases to determine the permissible head of water:

$$\text{Allow. Head} = \frac{W_u \text{ margin}}{(\text{water den})1.4 + (\text{water den})(g_v)1.9}$$

(Density of water = 62.4 lb/ft³) 5 | 15-9

	REF	PAGE

$$\text{Allow. Head} = \frac{92 \text{ psf}}{(62.4)1.4 + (62.4)(0.164)1.9} = 0.86 \text{ ft.}$$

The allowable head of ponded rainwater that can be distributed over the roof slab at elevation 126'-0" is 0.86 ft.

Reviewing the designed configuration of the roof structure at elevation 126', as shown on page 5 of this calculation, it can be seen that the slab is sloped from East to West with a difference in elevation of 7 inches. In addition, it can be seen that the slab itself is divided into three (3) cubicles with a passageway opening connecting each cubicle. It can be seen that the center and South bays represent the worse case locations for the ponding of rainwater, which, due to the slope of the slab, the existance of passageways and the opening to an unrestricted roof on the North end of elev. 126', the maximum ponding that can occur is a depth of 7 inches. 4

Therefore, since the maximum permissbile depth of water on the slab is 10 inches based upon a distributed loading and the maximum possible depth of ponded rainwater that the slab can contain on one end is 7 inches, the roof slab at elevation 126'-0" of the Diesel Generator Building is structurally adequate to support ponded rainwater.

RIVER BEND STATION
GULF STATES UTILITIES COMPANY

DESIGN DOCUMENT NO. Calculation C29.0.1-38
Page 9 of 9

DESIGN REVIEW CHECKLIST (REF. EDP-AA-58)

	YES	NO	N/A
1. Were the inputs correctly selected and incorporated into the design?	X	☐	☐
2. Are the assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are the assumptions identified for subsequent reverifications when the detailed design activities are completed?	X	☐	☐
3. Are the appropriate quality and quality assurance requirements specified?	☐	☐	X
4. Are the applicable codes, standards, and regulatory requirements, including issue and addenda, properly identified and are their requirements for design met?	X	☐	☐
5. Have applicable construction and operating experience been considered?	X	☐	☐
6. Have the design interface requirements been satisfied?	☐	☐	X
7. Was an appropriate design method used?	X	☐	☐
8. Is the output reasonable compared to inputs?	X	☐	☐
9. Are the specified parts, equipment, and processes suitable for the required application?	☐	☐	X
10. Are the specified materials compatible with each other and with the design environmental conditions to which the material will be exposed?	☐	☐	X
11. Have adequate maintenance features and requirements been specified?	☐	☐	X
12. Are accesibility and other design provisions adequate for the performance of needed maintenance and repair?	☐	☐	X
13. Has adequate accessibility been provided to perform the in-service inspection expected to be performed during the plant life?	☐	☐	X
14. Has the design properly considered radiation exposure to the public and to plant personnel?	☐	☐	X
15. Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfactorily accomplished?	X	☐	☐
16. Have adequate pre-operational and subsequent peridic test requirements been appropriately specified?	☐	☐	X
17. Are adequate handling, storage, cleaning and shipping requirements specified?	☐	☐	X
18. Are adequate identification requirements specified?	X	☐	☐
19. Are requirements for record preparation, review, approval, retention, etc. adequately specified?	☐	☐	X
20. Have environmental, safety, and seismic adequacy been considered?	X	☐	☐
21. Have recommended spare parts been specified?	☐	☐	X
22. Have fire hazard analysis impacts been considered?	☐	☐	X

Verifier's Summary:

DESIGN VERIFIED Timothy Cowan 6/27/89
Verifying Engineer Date

F000080

CALCULATION TITLE PAGE
*SEE INSTRUCTIONS ON REVERSE SIDE

L8205130001

CLIENT & PROJECT	GULF STATES UTILITIES CO. RIVER BEND	PAGE 1 OF 101 INCL. ATTACH. C29.0.1
CALCULATION TITLE (indicative of the Objective):	DIESEL GENR BLDG SLAB DESIGN	QA CATEGORY (✓) ☑ I - NUCLEAR SAFETY RELATED ☐ II ☐ III ☐ ____ OTHER

CALCULATION IDENTIFICATION NUMBER

J.O. OR W.O. NO.	DIVISION & GROUP	CURRENT CALC. NO.	OPTIONAL TASK CODE	OPTIONAL WORK PACKAGE NO.
12210	STRUCTURAL ENGG / DESIGN	C29.0.1	N/A	N/A

* APPROVALS - SIGNATURE & DATE

PREPARER(S)/DATE(S)	REVIEWER(S)/DATE(S)	INDEPENDENT REVIEWER(S)/DATE(S)	REV. NO. OR NEW CALC NO.	SUPERSEDES * CALC NO OR REV. NO.	CONFIRMATION *REQUIRED (✓) YES	NO
S.V. MODI 7-18-80	K B Shah/3-19-80	K. B. Shah/3-19-80	1	0		✓
K B Shah/3-16-81	[illegible] 3-27-81	[illegible] 3-27-81	1	0		✓
G. C Shah 7-4-81	K. B. Shah/ 9-5-81	K B Shah / 9-5-81	1	0		✓
K. B. Shah/5-8-82 * G C Shah 5-7-82 *FOR LIST OF ATTACH & ATTACH #10 ONLY	G C Shah 5/10/82 K. B. Shah/5-8-82	G C Shah 5/10/82 K. B. Shah/5-8-82	2	1		✓
K. B. Shah/4-10-85	M. Ahmed/4-11-85	M. Ahmed/4-11-85	3	2		✓

RECEIVED
JUN 0 0 1989
SDC

NOTE:- FOR REV. 0 PREP/REV/IND REVR SEE P. C29.2.2 REV 2
FOR REV 1 " " " P. C29.2.3 REV 2

DISTRIBUTION*

GROUP	NAME & LOCATION	COPY SENT (✓)	GROUP	NAME & LOCATION	COPY SENT (✓)
RECORDS MGT. FILES (OR FIRE FILE IF NONE)	D. MARTIN - 4R	✓			

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DESIGN ENGINEERING CONTROL COPY SDC

CALCULATION SHEET

STONE & WEBSTER ENGINEERING CORPORATION

6501061

J.O./W.O./CALCULATION NO.	REVISION	PAGE
12210	3	C29.0.2

PREPARER/DATE	REVIEWER/CHECKER/DATE	INDEPENDENT REVIEWER/DATE
K.B. Shah / 3-13-81	Molionas 3-27-81	Molionas 3-27-81

SUBJECT/TITLE	QA CATEGORY/CODE CLASS
DIESEL GENR BLDG SLAB DESIGN	I

TABLE OF CONTENTS AND HISTORICAL DATA

TABLE OF CONTENTS

NOTE: WORK THIS SHEET WITH HISTORICAL DATA SHEETS & VOID PAGES (ATTACHMENT #10)

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

J.O./W.O./CALCULATION NO. 12210 | REVISION 1 | PAGE C29.03

PREPARER/DATE: C.C. Shah 9-4-81 | REVIEWER/CHECKER/DATE: K. J. Shah / 9-15-81 | INDEPENDENT REVIEWER/DATE: K.G. [illegible]

QA CATEGORY/CODE CLASS: I

SUBJECT/TITLE: DIESEL GENE. BUILDING. SLAB DESIGN.

TABLE OF CONTENTS AND HISTORICAL DATA

HISTORICAL DATA

PAGE NOS.	DESCRIPTION	REVISION NO.	REVISION DATE	REMARKS
C29.01	TITLE PAGE	1	3-27-81	ADDED AS REQD BY EAP 5.3 REV 3, & STP 11.5.0
C29.0.2	TABLE OF CONTENTS AND HISTORICAL DATA	1	3-27-81	
C29.0.3	"	1	9-4-81	
C29.1	CALCULATION SUMMARY	1	9-2-81	ADDED CALC. NO. REF.
C29.21	SEISMIC LOAD	1	3-6-81	PAGE ADDED TO CHECK REVISED G VALUES.
C29.3, C29.8	ROOF AT EL. 141'-0	1	3-6-81	ROOF REVISED FOR MISSILE PROTECTION. SUPERSEDES C29.3, & C29.8 REV. 0.
C29.8.1, C29.8.2 C29.8.3	SLAB DESIGN. AT EL 141'-0	1	3-6-81	PAGES ADDED. REF. FOR SILENCER MISSILE PROTECT
C29.9	SLAB DESIGN AT EL. 126'-0	1	3-6-81	ADDED NOTES. REVISED WALL LAYOUT.
C29.24	SLAB DESIGN. AT EL. 98'-0	1	9-2-81	ADDED ATTACHMENT NOTE REF.
C29.44	" " " "	1	9-3-81	" "
C29.55	SKETCH REINF. AT EL. 96'-0	1	11-2-79	ADDED. TO SHOW REIN. ARRANGEMENT.
C29.81, 82	SLAB @ EL. 98'-0 ELECT. DUCT.	1	12-21-79	ADDED. CHECK FOR ELECT. DUCT. SEE DWG. 12179-EE 37A
C29.83 TO C29.86	SLAB EL. 98'-0 AT DE LINE	1	3-19-80	ADDED. ADDITIONAL CHECK FOR WALL LOAD
C29.87 TO C29.89	SLAB EL. 98'-0 & EL. 126'-0. ADDITIONAL WALL LOAD	1	3-19-80	" " "
—	LIST OF ATTACHMENT. INCL. #1, & 10	1	9-4-81	ADDED AS REQ. BY EAP 5.3, REV. 3 & STP 11.5.0

CALCULATION SHEET

STONE & WEBSTER ENGINEERING CORPORATION

J.O./W.O./CALCULATION NO.	REVISION	PAGE
12210	2	C29.0.4

PREPARER/DATE	REVIEWER/CHECKER/DATE	INDEPENDENT REVIEWER/DATE
K. B. Chak / 5-8-82	G. C. Shah 5-10-82	G. C. Shah 5-10-82

SUBJECT/TITLE	QA CATEGORY/CODE CLASS
DIESEL GENR BLDG. — SLAB DESIGN	I

TABLE OF CONTENTS AND HISTORICAL DATA

HISTORICAL DATA

PAGE NOS.	DESCRIPTION	REVISION NO.	REVISION DATE	REMARKS
C29.0.2	TABLE OF CONTENTS	2	5-10-82	ADMINISTRATIVE CHANGE
C29.0.4	HISTORICAL DATA	2	5-10-82	ADMIN. CHANGE - PAGE ADDED
C29.2.1	SEISMIC LOADS	2	5-7-82	SUPERSEDES P. C29.2.1 REV 1 REVISED SEISMIC LOADS
C29.2.2, .2.3	PREP/REV/IND REV'R BREAKDOWN FOR REV 0 & 1	2	51082	ADMIN CHANGES. PAGES ADD
—	LIST OF ATTACHMENTS	2	5-10-82	ADMIN. CHANGES
—	LIST OF VOID PAGES (ATTACHMENT #10)	2	5-10-82	ADMIN. CHANGES

PREPARER/DATE	REVIEWER/CHECKER/DATE	CALCULATION NO. 12210	REVISION 3	PAGE C29.0.5
K. B. Shah / 4-10-85	M. Ahmad / 4-11-85	INDEPENDENT REVIEWER/DATE M. Ahmad / 4-11-85		
SUBJECT/TITLE DIESEL GENERATOR BLDG SLAB DESIGN			QA CATEGORY/CODE CLASS I	

HISTORICAL DATA - REVISION 3

REASON FOR CHANGE AND SOURCE OF INFORMATION:

1. ADMINISTRATIVE CHANGES
2. CALC UPDATE
3. REVISED FLOOR LAYOUT

PAGE	DESCRIPTION
C29.0.2	TABLE OF CONTENT PAGE REVISED (1)
C29.0.5	HISTORICAL DATA PAGE ADDED (1)
C29.9 - .13	SLAB DESIGN EL 186'-0 - SUPERSEDES Pg C29.9 - .13 REV 0/1 (2)
C29.20.1	SLAB EL 97'-6" PAGE ADDED (3)
C29.55.1	SLAB EL 97'-6 PAGE ADDED (3)
—	LIST OF ATTACHMENT - REVISED (1)
	VOID PAGES ATTACHMENT #13 - REVISED (1)
	ADDED ATTACHMENT #2 (COMPUTER RUN)
C29.1	COMPUTER RUN NOTE ADDED

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STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

Page No. C29.1 Rev. | Preliminary 1 of 2 | Item C29

GULF STATES UTILITIES CO

Client: RIVER BEND | Location: W. FELICIANA, LA | Est. No. | J.O. No. 1221

Subject: DIESEL GENR BLDG. SLAB DESIGN. | Date 3-22-77 By K.R.Sh. | Checked 3-24-77 By K.B.Sh.

Based on | Revised 9-2-81 By B.C.Sh. | Ch'd 9-3-81 By K.B.Sh.

(3) By: K.B.Shah (3) CH'D: M. Ahmed / 6-11-85

RIVER BEND STATION UNIT-1

DIESEL GENERATOR BLDG. - SLAB DESIGN

PURPOSE: TO DESIGN FLOOR SLABS FOR GIVEN LOADS AND DETERMINE REBAR SIZE & SPACING

REFERENCE: REFER SHT C29.E (CALC. C29A, REV. 1) (1) ADDED

CONCLUSION: REINFORCEMENT SIZE & SPACING AS CALLED OUT ON SHT C29.03, C29.09, C29.16, C29.55, C29.78, (C29.7) (3) ADDED (C29.8.3, 8.3, 9, 55.81, 85) (1) ADDED

Q. A. CAT: I

CALCULATION STATUS:

PRELIMINARY:

FINAL: ✓

SUPERSEDED BY:

CODE CLASS: N/A

(3) ADDED: FLOOR SLAB EL 98'0 COMPUTER RUN (ATT. 8 SGAS-STRUDL II PLANE FRAME S&W LIB. REF ST-019 RUN DT. 5-9-77 VER/LEV 09/0. PROGRAM BENCHMARKING CONFIRMED BY SDM-(SMIC) - 84/8 CASE 3A2. REF #26)

SOURCE OF DATA:

1. STRUCTURAL DESIGN CRITERIA FOR RIVER BEND NUCLEAR STATION UNIT #1 & #2
2. SEISMIC ANALYSIS OF DIESEL GENERATOR BLDG FROM ENGG MECHANICS CAL. BOOK #030
3. MACHINE LOCATION STANDBY DIESEL GEN. BLDG DWG. 12210-EM-13A

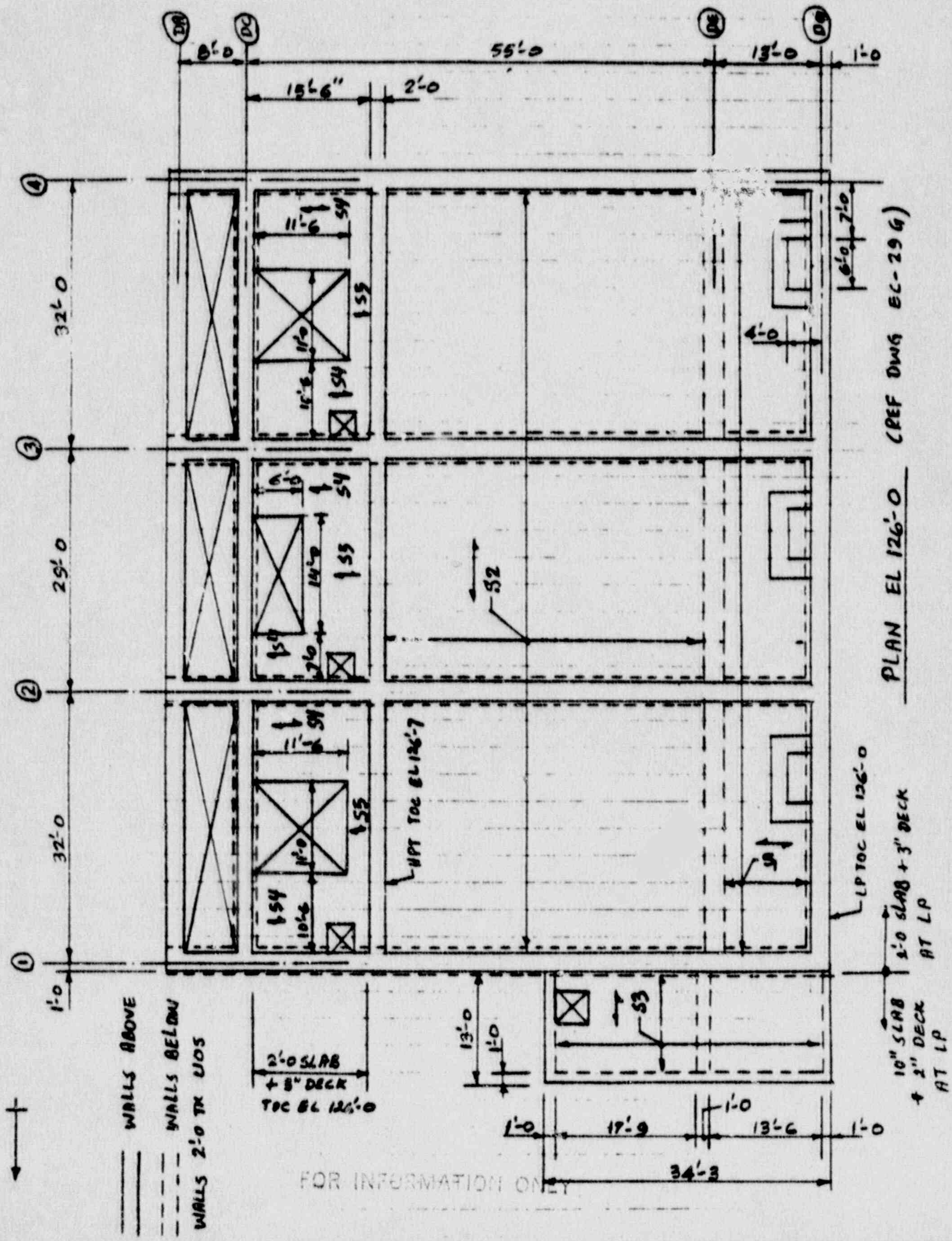
CALCULATION SHEET

A5010.61

J.O./W.O./CALCULATION NO.	REVISION	PAGE
12210	3	CE9.9

PREPARER/DATE	REVIEWER/CHECKER/DATE	INDEPENDENT REVIEWER/DATE
K. B. Shah / 1-18-85	M. Ahmed / 1-21-85	M. Ahmed / 1-21-85

SUBJECT/TITLE	QA CATEGORY/CODE CLASS
DIESEL GENERATOR BLDG FLOOR SLAB DESIGN EL 126'-0	I



SLAB S1

SPAN c/c = 13'-0

LOADS: DL : 2'-3" THICKNESS WILL BE CONSIDERED FOR DESIGN
= 338 PSF

ROOFING = 8 " (STRUCT DES. CRITERIA REV 8, 2.10
346 "

ROOF LL = 30 PSF (" " " , 5.6.2)
NO EQUIPMENTS IN THIS AREA

SEISMIC VERT OBE 'g' = 0.164 (Pg C29.2.1 REV 2)

WALL LOADS: FROM ROOF SLAB EL 137'-1½ (REF DWG EC-29G&J)

$= \left(\frac{6'}{2} + 2' + \frac{5.25'}{2}\right)$ 350 PSF = 2669 PLF ON WALL

SELF WT FROM EL 126'-0 TO EL 135'-0 = 9'x2'x150 = 2700 PLF

TOTAL = 2669 + 2700 = 5369 PLF

SEE PG C29.11 REV 3

U = 1.4D + 1.7L + 1.9 OBE + 1.3 To

VERT 'g' REF #11

= 1.4 x 346 + 1.7 x 30 + (1.9 x .164)(346+30) = 653 PSF

WALL LOAD U = 1.4 x 5369 + 1.9 x .164 x 5369 = 9190 PLF FOR 2'-0 SLAB WIDTH

= 4595 PLF USE 5000 PLF/FT WIDTH

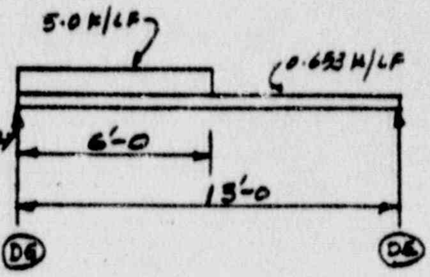
$R_L = 0.653 \times \frac{13'}{2} + (5.0 \times 5.0')\ 10'/13' = 27.3^k$

$R_R = 0.653 \times \frac{13'}{2} + (5.0 \times 6')\ 3/13 = 11.2^k$

ZERO SHEAR FROM LEFT = $\frac{27.3}{(5.0 + .653)}$ = 4.8'

$Mu = 27.3 \times 4.8 - 5.653\ (4.8)^2/2 = 66.0$ KFT

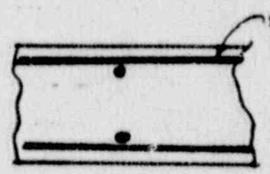
CONSERVATIVELY ASSUMED SIMPLY SUPPORTED



FOR INFORMATION ONLY

f'_c = 3 ksi   d = 24" - 2" COVER - 1.41 (#11) - $\frac{1.41}{2}$

= 24 - 4.1 = 19.9"



$F = \frac{bd^2}{12000} = \frac{12 \times 19.9^2}{12000} = 0.395$

3 SLAB S1 (cont)

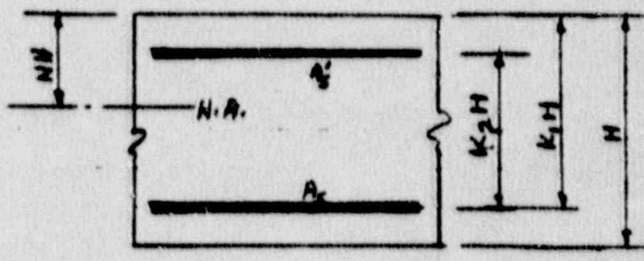
$K_U = \frac{M_U}{F} = \frac{66}{.395} = 167 \qquad a_u = 2.88$

$A_S = \frac{M_U}{a_u d} = \frac{66}{2.88 \times 19.9} = 1.15 \ in^2/LF$

TEMP EFFECT (REF: PARA 3.5 STR DESIGN CRITERIA REV 3)

$A_s = A_s' = \#11 @ 10'' = 1.87 \ in^2$

$\rho = \rho' = \frac{A_s}{bH} = \frac{1.87}{12 \times 24} = 0.0065$



$H = 24''$

$K_1H = 19.9 \qquad K_1 = 0.83$

$K_2H = 19.9 - 4.1 = 15.8'' \qquad K_2 = 0.66$

$\alpha = 5.5 \times 10^{-6} \qquad \Delta_T = 50° \ \text{FOR ROOF}$

$E_S = 29,000,000 \ psi \qquad E_c = 57000\sqrt{f_c} = 57000\sqrt{3,000} = 3,122,000 \ psi \qquad n = \frac{E_s}{E_c} = 9.29$

$\gamma = \text{POISSON'S RATIO} = 0.15 \qquad \rho + 2\rho' = .0195$

$N = -n(\rho + 2\rho') \pm \sqrt{n^2(\rho + 2\rho')^2 + 2n[2\rho'(K_1 - K_2) + K_1\rho]}$

$= -9.29(.0195) \pm \sqrt{(9.29)^2(.0195)^2 + (2 \times 9.29)[\{2 \times .0065(.83 - .66)\} + .83 \times .0065]}$

$= -.1812 \pm \sqrt{.0328 + .1418}$

$= -.1812 \pm .4173 = 0.2361$

$M_t' = \frac{\alpha N^2 H^2 \Delta_T E_c}{2}\left[\left(K_1 - \frac{N}{3}\right) + \frac{4n(N - K_1 + K_2)\rho' K_2}{N^2}\right]$

$= \frac{5.5 \times 10^{-6}(.2361)^2(24)^2 \ 50 \times (3.122 \times 10^6)}{2}\left[\left(.83 - \frac{.2361}{3}\right) + \frac{(4 \times 9.29)(.2361 - .83 + .66) .0065 \times .66}{(.2361)^2}\right]$

$= 13,783 [.7513 + .1890] = 12,960 \ Lbin/in = 12,960 \ LbFt/Ft$

$M_t = \frac{M_t'}{1 - \gamma} = \frac{12.96}{1 - .15} = 15.25 \ KFt/Ft$

$Mu_t = 1.3 M_t = 1.3 \times 15.25 = 19.8 \ KFt/Ft$

4 SLAB S1 (cont)

TEMP EFFECT (cont)

$$A_s = \frac{M_u}{a_u d} = \frac{19.8}{2.88 \times 19.9} = 0.35 \ in^2/LF$$

TOTAL A_s REQ'D = 1.15 + 0.35 = 1.50 in^2/LF < A_s PROVIDED #11 @10" = 1.87 in^2/LF

1.85 in^2/LF REQ'D FOR MISSILE PROTECTION = 1.85 in^2/LF EW, EF
(PARA 2.10 STRUCT DESIGN CRIT. REV 3)

SLAB S2

LOADS: DL SLAB THICKNESS AT LOW POINT = 2'-2" + 3" DECKING
LOAD = 345 PSF

(DL AT HPT WILL BE GREATER, SO WOULD THICKNESS WHICH TEND TO REDUCE REINF)

ROOFING = 8 PSF (PARA 2.10, STR CRITERIA REV 3)

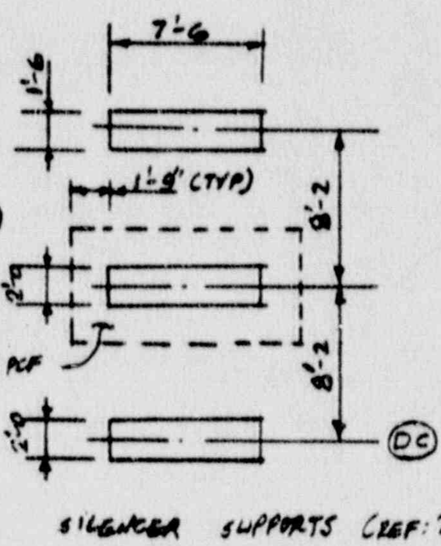
TOTAL DL = 345 + 8 + 7 (DECK) + 12 (STEEL FRMG) = 372 PSF

LL : ROOF LL = 30 PSF HOWEVER THIS AREA HAS EXHAUST SILENCER
(EQUIP I.D. S&W NO. 244.700-041-033E)
1HVP-SIL1A

EQUIPMENT LOAD WT = 15,635#

FOR MIDDLE SUPPORT
ASSUME 50% WT
DISTRIBUTED ON (7'-6 + 3'-6) × (2'-0 + 3'-6)

$$= \frac{0.5 \times 15635}{11.0 \times 5.5} = 130 \ PSF$$



FOR SIMPLICITY OF DESIGN
USE LL = 100 PSF ON ENTIRE
AREA WHICH IS CONSERVATIVE.

SILENCER SUPPORTS (REF: DWG EC-27G

CALCULATION SHEET

STONE & WEBSTER ENGINEERING CORPORATION

J.O./W.O./CALCULATION NO.	REVISION	PAGE
12210	3	C29.13

PREPARER/DATE	REVIEWER/CHECKER/DATE	INDEPENDENT REVIEWER/DATE
K. B. Shah / 1-21-85	M. Ahmed / 1-21-85	M. Ahmed / 1-21-85

SUBJECT/TITLE	QA CATEGORY/CODE CLASS
DIESEL GENERATOR BLDG FLOOR SLAB DESIGN EL 126'-0	I

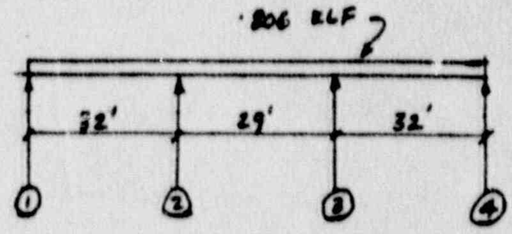
5 SLAB S2 (cont)

$U = 1.4D + 1.7L + 1.9\,OBE + 1.3\,T_o$ (← T_o TO BE ADDED SEPARATELY)

$= 1.4 \times 372 + 1.7 \times 100 + 1.9 \times .164\,(372 + 100)$ VERT g VALUE = 0.164 (Pg C29.2.1 REV 2)

= 838 PLF

$M_u = \frac{w_u l^2}{10} = \frac{.838 \times 32^2}{10} = 86$ kFt



A_s REQ'D $= \frac{M_u}{a_u d}$ $d = 26'' - 4.1 = 21.9''$ (SEE S1), $a_u = 2.85$

$= \frac{86}{2.85 \times 21.9''}$

$= 1.38\ in^2/LF$

DUE T_o = 0.35 (Pg C29.13 REV 3)

$1.73\ in^2 <$ A_s PROVIDED #11 @ 10" = 1.87 in² (DWG EC-29H)

MINIMUM REQ'D FOR MISSILE PROTECTION = 1.85 in² EW, EF (PARA 3.10 STR CRITERIA REV 3)

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The live load used for design shall be shown on each 4.7
concrete and steel floor plan.

All grating and checkered plate platforms shall be designed 4.9
for live loads of 100 psf unless otherwise specified. 4.10
Stairs, stair landings, and elevator machine rooms shall be 4.11
designed for 100 psf live loads unless otherwise specified. 4.12

The roof live load shall be 30 psf applied normal to the 4.14
roof surface and shall not be combined with wind uplift to 4.15
reduce net uplift.

3.5 Thermal Loads 4.18

Operating Condition: To 4.20

Unless otherwise stated, all structural components shall be 4.22
designed to withstand the following differential 4.24
temperatures between the two faces (except for structural 4.25
steel).

Structural Steel	-	20°F	4.28
Exterior Concrete Walls and Roof	-	50°F	4.29
Interior Concrete Walls, Foundation			4.30
and Floor Slab, and Exterior Con-			4.31
crete Walls Below Grade	-	20°F	4.32

Where compressible material is used in shake space, design 4.36
differential temperature can be reduced to 20°F.

Simplified cracked section analysis, as shown in 4.39
Attachment 3.5.1, can be used to determine the effect of 4.40
temperature stresses in designing the structures. This 4.41
method of analysis shall not be used while designing water-
retaining structures under constant hydrostatic pressure 4.42
head.

Some specific areas with high temperatures are listed in 4.46
Section 5 under each individual structure. For details of 4.48
design ambient temperatures for all areas of various
buildings, see Document No. 215.150, Environmental Design 4.49
Criteria for RB Station.

High Energy Pipe Break Accident Condition: Ta 4.52

Loads due to the temperature gradient through the concrete 4.54
or steel element associated with the corresponding high 4.57
energy pipe break shall be listed for each individual 4.58
element (or structure) in Section 5, as they become
available.

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Normal Operating Conditions

1. $U = 1.4D + 1.7(L + F + H + Pv + SRV_1) + 1.3(To + Ro)$

Severe Environmental Condition

2. $U = 1.4D + 1.7(L + F + H + Pv + W + SRV_1) + 1.3(To + Ro)$

2.1 $U = 1.2D + 1.7W$

3 $U = 1.4D + 1.7(L + F + H + Pv + SRV_1) + 1.3(To + Ro) + 1.9Feqs/2$

3.1 $U = 1.2D + 1.9\ Feqs/2$

4. $U = 0.9D + 1.4F + 1.7H + 1.3W$

5. $U = 0.9D + 1.4F + 1.7H + 1.45\ Feqs/2$

NOTE: Equations 4 and 5 are primarily to check against overturning.

Extreme Environmental Condition:

6. $U = 1.0(D + L + To + F + Pv + H + Ro + Wt + SRV_1)$

7. $U = 1.0(D + L + To + F + Pv + H + Ro + Feqs + SRV_1)$

8. $U = 1.0(D + L + To + Pv + H + Ro + F^1 + SRV_1)$

Abnormal/Severe Environmental Condition:

9. $U = 1.0(D + L + F + H + Ta1 + Ra + Rm + Rj + Rr + SRV_2 + LOCA) + 1.25\ (Pa_1 + Feqs/2)$

9.1 $U = 1.0(D + L + F + H + Ta_2 + Ra + Rm + Rj + Rr + SRV_3 + LOCA) + 1.25\ (Pa_2 + Feqs/2)$

Abnormal/Extreme Environmental Condition:

10. $U = 1.0(D + L + F + H + Pa_1 + Ta_1 + Ra + Rm + Rj + Rr + Feqs + LOCA + SRV_2)$

10.1 $U = 1.0(D + L + F + H + Pa_2 + Ta_2 + Ra + Rm + Rj + Rr + Feqs + LOCA + SRV_3)$

Abnormal Loading Condition

11. $U = 1.0(D + L + F + H + Ta_1 + Ra) + 1.25\ SRV_2 + 1.5\ (Pa_1 + LOCA)$

11.1 $U = 1.0(D + L + F + H + Ta_2 + Ra) + 1.25\ SRV_3 + 1.5\ (Pa_2 + LOCA)$

NOTES: 1. Loads resulting from thermal stratifi-

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2. MATERIALS 1.8

2.1 Concrete 1.12

Structural concrete shall have 28-day specified compressive 1.15
strength of 3,000 psi, unless otherwise specified in
Section 5. If higher strength concrete is required for a 1.17
particular design requirement, discuss the situation with
the Lead Structural Engineer. 1.18

Working mat concrete shall have a 28-day specified 1.20
compressive strength of 2,000 psi. 1.21

Lightweight concrete shall not be used on this project. 1.23

2.2 Reinforcing Steel 1.26

Reinforcing steel bars No. 3 through No. 11 shall be 1.28
Grade 40 conforming to the Specifications for Deformed 1.30
Billet Steel Bars for Concrete Reinforcement, ASTM A615,
Supplement S-1. All reinforcing steel bars 1.31
No. 14 and No. 18 shall be special chemistry steel with a
minimum yield stress of 50,000 psi and 60,000 psi (for 1.32
reactor building only) conforming to the specifications for
Deformed Billet Steel Bars for Concrete Reinforcement 1.34
ASTM A615, Supplement S-1.

Reinforcing steel bars No. 14 and No. 18 shall be spliced 1.36
using Cadweld T-Series full-tension reinforcing steel splice 1.37
sleeves. Rebar to plate splices shall be made using Cadweld 1.38
B-Series splice sleeves.

2.3 Structural Steel 1.41

Structural steel shall be ASTM A36 unless otherwise 1.43
specifically specified in Section 5 of the criteria. If a 1.46
higher strength steel is required for a specific design
requirement, discuss the situation with the Lead Structural 1.47
Engineer. Structural steel outside the containment is 1.48
galvanized while reactor building steel within the
containment is shop primed. 1.49

2.4 Structural Connections 1.52

The structural members shall be field bolted with ASTM A325 1.54
high strength bolts with friction type connections. 1.55
Bearing-type connections may be used when the connection is 1.57
not subject to stress reversal. If higher strength bolts 1.58
are required for a specific design requirement, ASTM A490
could be used after discussion with the Lead Structural 2.1
Engineer.

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