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RECIP.NAME RECIPIENT AFFILIATION
VARGA,S.A. Operating Reactors Branch 1

SUBJECT: Forwards response to requests for addl info re structural review of expansion,Items addressed include steel column max compression load,analysis of floor & foundation slabs & load transfer. S66 Rpt

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Carolina Power & Light Company

APR 02 1982

Office of Nuclear Reactor Regulation
ATTN: Mr. Steven A. Varga, Chief
Operating Reactors Branch No. 1
United States Nuclear Regulatory Commission
Washington, D.C. 20555

H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2
DOCKET NO. 50-261
LICENSE NO. DPR-23
REQUEST FOR ADDITIONAL INFORMATION
CONCERNING SPENT FUEL POOL EXPANSION

Dear Mr. Varga:

SUMMARY

Over the past several weeks Carolina Power & Light Company (CP&L) has received several questions regarding the structural review of the H. B. Robinson Steam Electric Plant, Unit No. 2 (HBR2) spent fuel pool expansion submittals. This letter documents those questions and provides CP&L's responses (see enclosures).

Should you have further questions regarding this information, please contact a member of our staff.

Yours very truly,

S. R. Zimmerman
Manager
Licensing & Permits

DCS/lr (n-5)
Enclosures

cc: Mr. J. P. O'Reilly (NRC-RII)
Mr. W. J. Ross (NRC)

A001
s
1/1

ENCLOSURE A

H. B. ROBINSON STEAM ELECTRIC PLANT
RESPONSE TO NRC INFORMATION REQUEST

1. NRC Comment

For the steel column design, the 33 1/3% increase in allowable stresses is not permitted when loads are combined with the operating basis earthquake (OBE). See NRC position for "review and acceptance of spent fuel storage and handling applications".

CP&L Comment

Standard Review Plan, Section 3.8.4, II.5 states that the 33 1/3% increase is not permitted when combined with the OBE load. Calculations have been revised accordingly. There has been no impact on the design of the steel column.

See Attachment 1 for revised page 4-5b of the spent fuel pool submittal.

2. NRC Question

What is the maximum load in the column?

CP&L Response

The maximum compressive load is 293 kips for DBE load combination and 210 kips for OBE load combination.

3. NRC Question

Is the steel column always in compression?

CP&L Response

Yes

4. NRC Question

What is the ductility ratio (D.R.) for a fuel rack drop and a fuel assembly drop onto the spent fuel pool liner?

CP&L Response

For the fuel rack drop, D.R. = 6.2 where $D.R. = \frac{\text{plastic deformation}}{\text{elastic deformation}}$.

NRC acceptance criteria is for D.R. less than 10. This part of the analysis was performed by Ebasco.

For the fuel assembly drop, performed by Westinghouse, the term ductility ratio is not used. Instead of ductility ratio, Westinghouse makes a comparison of the compressive stress resulting from the impact force of a fuel assembly drop onto the pool liner and the allowable stress of the liner. From this comparison a margin of safety of six (6) was calculated.

5. NRC Question

Is SA-240 stainless steel material being used for the spent fuel storage racks?

CP&L Response

The following types of stainless steel materials are being used in the spent fuel racks:

SA 240	SA 312
SA 479	Type 304

6. NRC Question

How is the wrapper installed in the cells? Is it vented?

CP&L Response

As stated in Section 2 of CP&L's license amendment submittal dated December 1, 1980, the wrapper is attached to the outside of the cell by spot welding along the entire length of the wrapper. The wrapper covers the Boraflex material, and also provides for venting of the Boraflex to the pool environment.

7. NRC Question

The license amendment request states that the maximum seismic deflection at the top of the rack is 0.3".

a) What happens to adjacent racks - will they touch?
b) Was the 0.3" deflection calculated at the maximum coefficient of friction?

CP&L Response

The combination of sliding displacment at $\mu = 0.2$ with structural deflection at $\mu = 0.8$ was used to obtain the maximum deflection at the top of one rack. This is then combined by the square root sum of squares (SRSS) method with the structural deflection of a fixed, adjacent rack to

obtain the maximum rack-to-rack gap reduction (less than 0.3") for SSE seismic conditions. Conservatively adding the displacement due to a simultaneous thermal accident, the maximum gap reduction of 0.455" is less than the minimum as-installed gap of 1.00", therefore the rack will not touch.

8. NRC Comment

The NRC does not have structural drawings showing plans and elevations of the spent fuel pool slab and mat.

CP&L Response

One copy of the following Ebasco drawings was given to NRC on January 14, 1982:

G-190420 Fuel Handling Building Plan & Details, Ele. 226.0, Masonry
G-190423 Fuel Handling Building Sections & Elevations - Masonry, Sheet 1
G-190424 Fuel Handling Building Sections & Elevations - Masonry, Sheet 2
G-190426 Fuel Handling Building Spent Fuel Pit - Reinforcement, Sheet 1
G-190427 Fuel Handling Building Spent Fuel Pit - Reinforcement, Sheet 2

9. NRC Question

Have the floor and foundation slabs been analyzed for the new column loads? Provide computations.

CP&L Response

Yes, the floor and foundation slabs have been analyzed for the new column loads and the calculation sheets (Attachment 2, pages 132-148 and 180-188) are attached. Calculations are shown for the floor slab internal forces due to maximum column loads combined with additional concurrent loading on the floor slab. Reinforcement requirements are specified to adequately resist internal forces. Also shown are detailed calculations for foundation slab supporting piles.

10. NRC Question

How is the load transferred to the slab, pilings and soil?

CP&L Response

The column is secured to the foundation pile cap by means of a two (2) inch thick steel base plate and four (4)-1 inch diameter concrete anchor bolts. Column reaction loads are transferred primarily by compression under the base plate through the four (4) feet thick pile cap directly into the supporting piles beneath the column. An attached sheet, (Attachment 2, page 180) indicates that six (6) Type 5 compression piles are effective in transferring the column compression load to the surrounding soil. The attached sheet, (Attachment 2, page 186A)

calculates a maximum factored pile load of 207 kips in these piles leaving adequate reserve from the specified ultimate capability of 225 tons or 450 kips (FSAR Section 5.1.2.6, page 5.1.2-16) and the specified factored capacity of 169 tons or 338 kips (FSAR Section 5.1.2.4, page 5.1.2-13), utilizing 0.75 capacity reduction factor as specified.

11. NRC Comment

Provide more information on the details of the connection of the column to the slabs and itself.

CP&L Response

Details of column connections are shown on Drawing CAR 2762-B-410, Revision 1, dated December 4, 1981, (Attachment 3).

12. NRC Question

Why is the column needed?

CP&L Response

The assessment of the feasibility of increasing the spent fuel storage capacity from 276 fuel cells to 544 fuel cells included an evaluation of the load capacities of the existing supporting structure and foundation. This evaluation included a complete finite element analysis of the spent fuel pool structure with the latest Westinghouse arrangement of fuel cells (534 fuel cells + 10 spares). The evaluation indicated that with the addition of a single (1) column support for the fuel pool slab, acceptable safety margins were maintained for all portions of the structure including the foundation piles.

The detailed analysis revealed that a single (1) column support was preferable to a double (2) column support system for two reasons: 1) when two (2) column supports were incorporated into the finite element model (between Gas Decay Tanks 1 and 2, at the south end, and Gas Decay Tanks 3 and 4, at the north end), unacceptable moments developed in the pool slab in the area of the cask pit; 2) the reaction loads from the column located between Gas Decay Tanks 3 and 4, at the north end, would jeopardize foundation structural integrity as supporting piles do not extend below this area. The single (1) column support at the south end, between Gas Decay Tanks 1 and 2, results in acceptable moments and shears in all areas of the pool supporting structure, while at the same time preserving foundation integrity.

13. NRC Question

Where is the column located in relation to the piling?

CP&L Response

Attached are two sheets, (Attachment 2, pages 18 and 180), detailing the location of the column in relation to the foundation pile cap. Also, see Attachment 4, which is a drawing of the "Fuel Handling Building Piling - Plans and Details", Ebasco drawing G-190419.

14. NRC Question

Are the piles held by friction or founded on rock?

CP&L Response

The piles were designed to function by a combination of point bearing and friction in the hard silty-clay layer. No reliance is placed on the upper soils for vertical pile support.

15. NRC Comment

Provide more information on soil structure.

CP&L Response

At the ground surface approximate elevation 225, a 2 ft. layer of surficial sandy clay containing organics was encountered overlying 27 ft. of loose to medium dense fine to medium sand. Underlying the granular material, a 10 ft. layer of clayey silt occurs having an unconfined compressive strength of approximately 2000 psf. This deposit appears to be normally consolidated. Beneath the clayey silt a 15 ft. layer of dense fine to medium sand containing occasional lenses of non-plastic silty-sand and sandy silt ranging up to 3 ft. in thickness. Underlying this deposit, a 10 ft. depth of very hard silty clay was penetrated having an unconfined compressive strength of about 4000 psf and which has been subjected to a preconsolidation load of at least 6 tons per square foot as determined from three consolidation tests carried out on undisturbed samples. This material overlies a very dense fine to medium sand layer having a penetration resistance of about 100 blows/foot on a standard split spoon sampler. This layer is 10 ft. in thickness and overlies numerous very dense sandy silt and sand layers to a depth of about elevation 132. Various other high density deposits were logged extending on down to the bottom of the deepest hole at about elevation 77.

ATTACHMENT 1

H. B. ROBINSON UNIT NO. 2

SPENT FUEL STORAGE EXPANSION REPORT

REVISED PAGE 4-5b

39) $1.4(D_1+D_2)+1.4T_o$

40) $0.75(1.4(D_1+D_2)+1.7(L_1+L_2)+1.9(EO\text{-}NS+EO\text{-}NS_1+EO\text{-}VERT)1.04T_o)$

41) $0.75(1.4(D_1+D_2)+1.7(L_1+L_2)+1.9(EO\text{-}NS+EO\text{-}NS_2/EW_1+EO\text{-}VERT+1.04T_o)$

42) $0.75(1.4(D_1+D_2)+1.7(L_1+L_2)+1.9(EO\text{-}SN+EO\text{-}SN_1/WE_2+EO\text{-}VERT+1.4T_o)$

43) $0.75(1.4(D_1+D_2)=1.7(L_1+L_2)+1.9(EO\text{-}SN+EO\text{-}SN_2/EW_2+EO\text{-}VERT)1.4T_o)$

44) $0.75(1.4(D_1+D_2)=1.7(L_1+L_2)+1.9(EO\text{-}EW+EO\text{-}NS_2/EW_1+EO\text{-}VERT)1.4T_o)$

45) $0.75(1.4(D_1+D_2)=1.7(L_1+L_2)+1.9(EO\text{-}EW+EO\text{-}SN_2/EW_2+EO\text{-}VERT)1.4T_o)$

46) $0.75(1.4(D_1+D_2)=1.7(L_1+L_2)+1.9(EO\text{-}WE+EO\text{-}NS_1/WE_1+EO\text{-}VERT)1.4T_o)$

47) $0.75(1.4(D_1+D_2)=1.7(L_1+L_2)+1.9(EO\text{-}WE+EO\text{-}SN_1/WE_2+EO\text{-}VERT)1.4T_o)$

48) $1.0(D_1+D_2)+1.0(L_1+L_2)+1.0(ESS\text{-}NS+ESS\text{-}NS_1/WE_1+ESS\text{-}VERT)+1.0T_o)$

49) $1.0(D_1+D_2)+1.0(L_1+L_2)+1.0(ESS\text{-}NS+ESS\text{-}NS_2/EW_1+ESS\text{-}VERT)+1.0T_o)$

50) $1.0(D_1+D_2)+1.0(L_1+L_2)+1.0(ESS\text{-}SN+ESS\text{-}SN_2/WE_2+ESS\text{-}VERT)+1.0T_o)$

51) $1.0(D_1+D_2)+1.0(L_1+L_2)+1.0(ESS\text{-}SN+ESS\text{-}SN_2/WE_2+ESS\text{-}VERT)+1.0T_o)$

52) $1.0(D_1+D_2)+1.0(L_1+L_2)+1.0(ESS\text{-}EW+ESS\text{-}NS_2/EW_1+ESS\text{-}VERT)+1.0T_o)$

53) $1.0(D_1+D_2)+1.0(L_1+L_2)+1.0(ESS\text{-}EW+ESS\text{-}SN_2/WE_2+ESS\text{-}VERT)+1.0T_o)$

54) $1.0(D_1+D_2)+1.0(L_1+L_2)+1.0(ESS\text{-}WE+ESS\text{-}NS_1/WE_1+ESS\text{-}VERT)+1.0T_o)$

55) $1.0(D_1+D_2)+1.0(L_1+L_2)+1.0(ESS\text{-}WE+ESS\text{-}SN_1/WE_2+ESS\text{-}VERT)+1.0T_o)$

Load combinations for the steel column are as follows:

At normal AISC Working Stress

1) $U=1.0(D_2+L_o+L_3)+1.0FC$ ($L_o=0$ During Cask Impact)

2) $U=1.0(D_2+L_o+L_3)$

3) $U=1.0(D_2+L_o+L_3)+1.0W\text{-}NS$

4) $U=1.0(D_2+L_o+L_3)+1.0W\text{-}SN$

5) $U=1.0(D_2+L_o+L_3)+1.0W\text{-}EW$

6) $U=1.0(D_2+L_o+L_3)+1.0W\text{-}WE$

7) $U=1.0(D_2)+1.0(EO\text{-}NS\text{-}EO\text{-}NS_1/WE_1+EO\text{-}VERT)+1.0FC$

8) $U=1.0(D_2)+1.0(EO\text{-}NS+EO\text{-}NS_2+EW_1+EO\text{-}VERT)+1.0FC$

9) $U+1.0(D_2)+1.0(EO\text{-}SN+EO\text{-}SN_1/WE_2+EO\text{-}VERT)+1.0FC$

ATTACHMENT 2

H. B. ROBINSON UNIT NO. 2

SPENT FUEL STORAGE EXPANSION

NEW COLUMN UNDER FUEL POOL FLOOR

EXPLANATION OF ATTACHMENT 2

CALCULATION BOOK HB-102

Pages: 18, 132 - 148, 180 - 185

185A, 185B, 185C, 186A, 186B

187A, 187B, 188, 188A, and 188B

<u>EXPLANATION OF ATTACHMENT 2</u>

The following computation pages are excerpts from Calculation Book HB-102 and detail the analysis of the fuel pool floor slab and pile cap.

The column support, as indicated on page 18, was included in a finite element model of the spent fuel pool. Primary loadings (i.e.: dead load, live load, wind load, seismic load, etc.) were input into a computer run and then combined with appropriate load factors to determine the governing maximum internal element force envelopes. These resulting enveloped forces are shown on pages 132 through 148 for critical load combinations (LC1 through LC55, as applicable) for both mechanical only load combinations and mechanical plus thermal load combinations. As the support column was included in the finite element model, resulting forces in the fuel pool floor slab reflect the effects of the column reaction loads. From the critical force envelopes, the existing concrete slab and reinforcing is checked against that required in order to verify its adequacy. Inspection of pages 132 through 138 shows that both the concrete slab and its reinforcing are adequate to resist the effects of maximum factored loading combinations and the column reaction loads.

The effects of the column loads on the pile cap and piles are detailed on pages 180 through 188B. Maximum governing load combinations are determined from the computer output reaction forces and transferred to the pile group center of gravity so as to predict maximum and minimum pile loads. The loads in the six (6) piles beneath the column reflect the effects of both the maximum factored column loads and the maximum factored load combinations from the computer output. Inspection of pages 180 through 188B shows that pile loads do not exceed acceptable capacities for both axial and shear force effects.

EBASCO SERVICES INCORPORATED

NEW YORK

BY R. Schmidt DATE 5-23-81 SHEET 18 OF 206

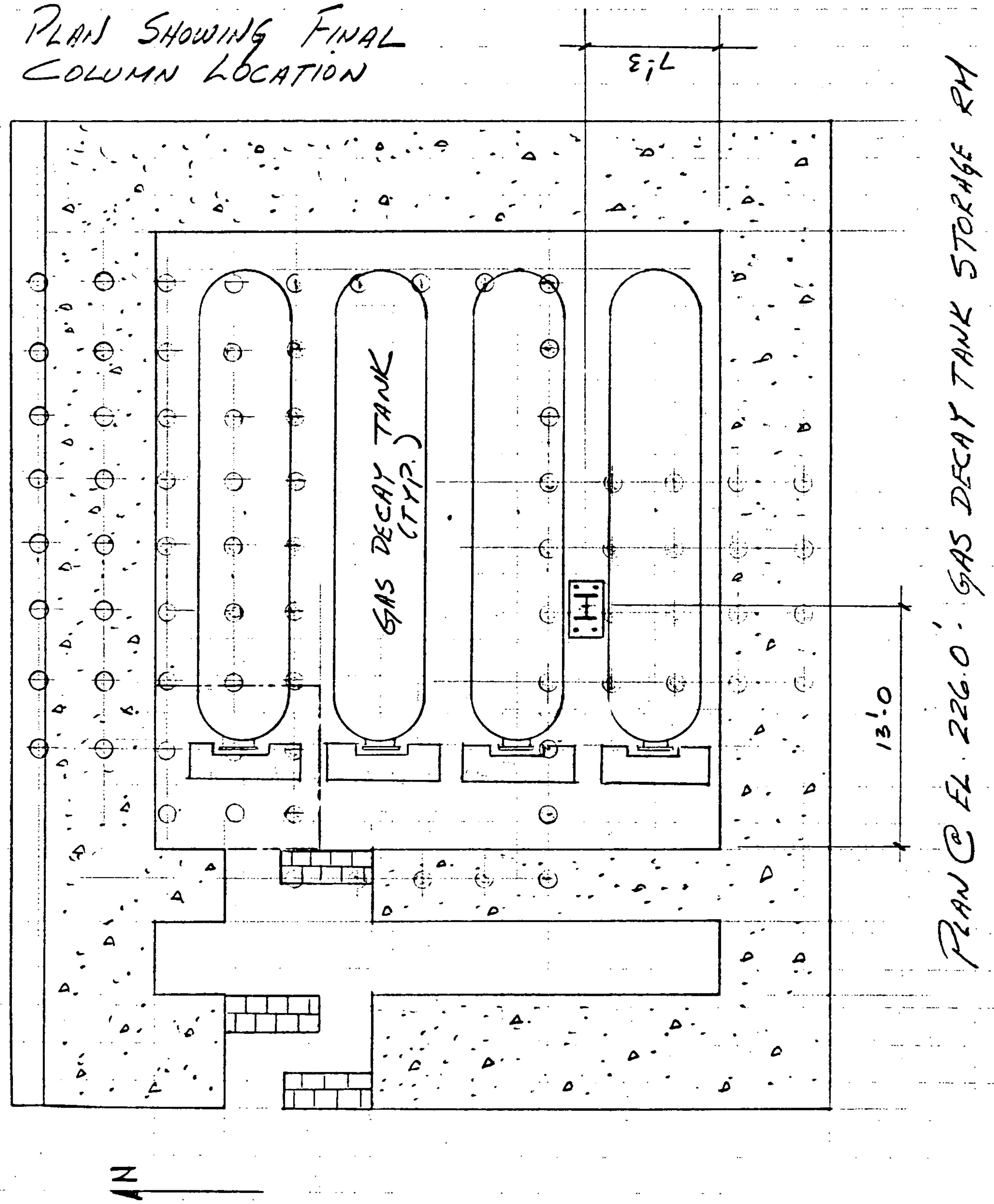
CHKD. BY S. Sun DATE 5-27-81 OFS NO. CAR 2762.018 DEPT. NO. 403

CLIENT CP&L

PROJECT HBR #2

SUBJECT FHB - RACK EXTENSION - FUEL POOL

PLAN SHOWING FINAL COLUMN LOCATION

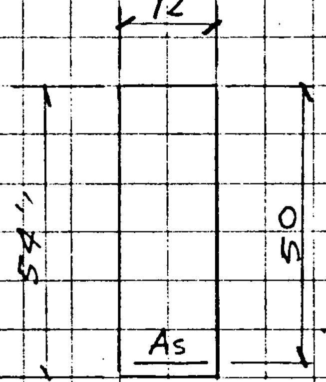


FORM 561 REV 7-71

SLAB 4'-6 ELEMENT 53 LC 1 MECH LOAD ONLY

$M_Y = -162\ ^{1k}/FT$ N-S TENSION @ BOT

$F_Y = 4.3^k$ TENSION



#10 @ 12

$M_{US} = M_u - N_u(d - \frac{h}{2})$

$= 162 - 4.3(50 - \frac{54}{2})(\frac{1}{12})$

$= 153.8^{1k}$

$F = \frac{bd^2}{12000} = \frac{12(50)^2}{12000} = 2.5$

$K_u = \frac{153.8}{2.5} = 61.5$

$a_u = 2.96$

$A_s = \frac{M_{US}}{a_u d} + \frac{P_u}{\phi F_Y} = \frac{153.8}{2.96(50)} + \frac{4.3}{.9(40)}$

$= 1.04 + 0.12 = 1.16\ ^{IN^2}/FT < 1.27\ ^{IN^2}/FT$

PROVIDE (#10 @ 12) BOT

SEE COMPUTER OUTPUT NO. 5 (JOB # 371F)

ELEMENT 61 LC 1

$M_Y = -160\ ^{1k}/FT$

$F_Y = 4.9\ ^k/FT$

$M_{US} = M_u - N_u(d - \frac{h}{2}) = 160 - 4.9(50 - \frac{54}{2})(\frac{1}{12}) = 150.6\ ^{1k}/FT$

$F = 2.5$ $K_u = \frac{150.6}{2.5} = 60.2$, $a_u = 2.96$

$A_s = \frac{150.6}{2.96(50)} + \frac{4.9}{0.9(40)} = 1.02 + 0.14 = 1.16 < 1.27\ ^{IN^2}/FT$

OK

EBASCO SERVICES INCORPORATED

NEW YORK

BY I. REITANO DATE 5-18-81 SHEET 133 OF [illegible]

CHKD. BY S. SUN DATE 5-20-81 OFS NO. 2762.018 DEPT. NO. 403

CLIENT CP&L

PROJECT H B ROBINSON #2

SUBJECT SPENT FUEL POOL STORAGE EXTENSION

ELEMENT 47 E-W TENSION @ BOT.

$M_x = -141.3 \ ^{'K}/FT \ (LC1)$

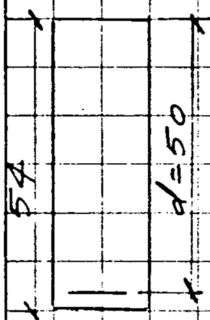
$F_x = 24.2 \ ^{K}/FT \ (LC1)$

$M_{us} = 141.3 - 24.2\left(50 - \frac{54}{2}\right)\left(\frac{1}{12}\right) = 94.9$; $F = \frac{12(50)^2}{12000} = 2.5$

$K_u = \frac{94.9}{2.5} = 38$

$K_u = 0.9 f_c' \omega(1 - 0.59\omega) = 0.9 f_c' \omega - 0.531 f_c' \omega^2$

$\omega^2 - 1.695\omega + \frac{K_u}{0.531 f_c'} = 0$



$\omega = .8475 - \left(\sqrt{2.873 - 7.533 \frac{K_u}{f_c'}} / 2\right)$

WHEN $\frac{K_u}{f_c'} = \frac{38}{3000} = 0.0127$

$\omega = .8475 - \left(\sqrt{2.873 - 7.533(0.0127)} / 2\right) = 0.0142$

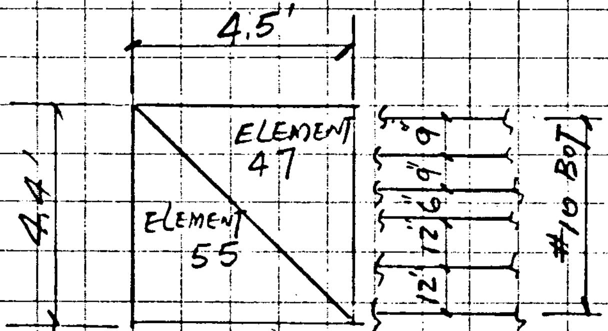
$a_u = \phi f_y (1 - 0.59\omega)/12000$

$= 0.9(40000)[1 - 0.59(0.0142)]/12000$

$= 2.975$

$A_s = \frac{94.9}{2.975(50)} + \frac{24.2}{0.9(40)} = 0.638 + 0.672$

$= 1.31 \ ^{IN^2}/FT$



FROM DWG G 190426

6 - #10 IN 4'-4 WIDTH

$A_{s \ PROVIDED} = \frac{6 \times 1.27}{4.4} = 1.73 \ ^{IN}/FT > 1.31$

OK

FORM 581 REV 7-71

EBASCO SERVICES INCORPORATED

NEW YORK

BY T. REITANO DATE 5-18-81 SHEET 134 OF

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CLIENT CP&L

PROJECT H B ROBINSON #2

SUBJECT SPENT FUEL POOL STORAGE EXTENSION

ELEMENT 62 E-W TENSION @ BOT

$M_x = -141.5$ IK/FT (LC1)

$F_x = 17.5$ K/FT (LC1)

$M_{us} = 141.5 - 17.5\left(50 - \frac{54}{2}\right)\left(\frac{1}{12}\right) = 108^{\text{IK}}$

$F = 2.5$, $K_u = \frac{108}{2.5} = 43.2$

$a_u \cong 2.95$

$A_s = \frac{108}{2.95(50)} + \frac{17.5}{.9(40)} = 0.73 + 0.49 = 1.22$

FROM DWG G-190426

#10 @ 12 BOT

A_s PROVIDED $= 1.27 > 1.22$ OK

CHECK BOND STRESS

@ T ℄ #6, 12, 110, 118 FROM DWG-G190426

#41, 49, 48, 56 #10 @ 6 TWO LAYERS

MAX $V_u = 89.3^K$ (LC1, ELEMENT #48)

$\mu_u = \frac{V_u}{\phi \Sigma o j d} = \frac{89300}{0.85(4)(3.99)(.9)(50)} = 146^{\text{PSI}} < 4.2\sqrt{f_c'} = 230^{\text{PSI}}$

@ T ℄ #5, 11, 109, 117

#57, 65, 64, 72 #11 @ 6 ONE LAYER

MAX $V_u = 77.23^K$ (LC1, ELEMENT 64)

$\mu_u = \frac{V_u}{\phi \Sigma o j d} = \frac{77230}{0.85(2)(4.43)(.9)(50)} = 228 < 230^{\text{PSI}}$ OK

SHEAR: MAX $V_u = 89.3$ (EL 48, LC1)

< 118.0 K/FT CAPACITY

FORM 581 REV 7-71

EBASCO SERVICES INCORPORATED

NEW YORK

BY T. REITANO DATE 5-19-81 SHEET 135 OF [illegible]

CHKD. BY S. SUN DATE 5-20-81 OFS NO. 2762.018 DEPT. NO. 403

CLIENT CP&L

PROJECT H B ROBINSON #2

SUBJECT SPENT FUEL POOL STORAGE EXTENSION

FIND PROJECTED M_x^t @ EDGE OF WALL (TENSION @ TOP E-W)

$b = \frac{a}{4} \times 3 = 0.75a$

LC1, EL 467 $M_x = 364^{1K}$

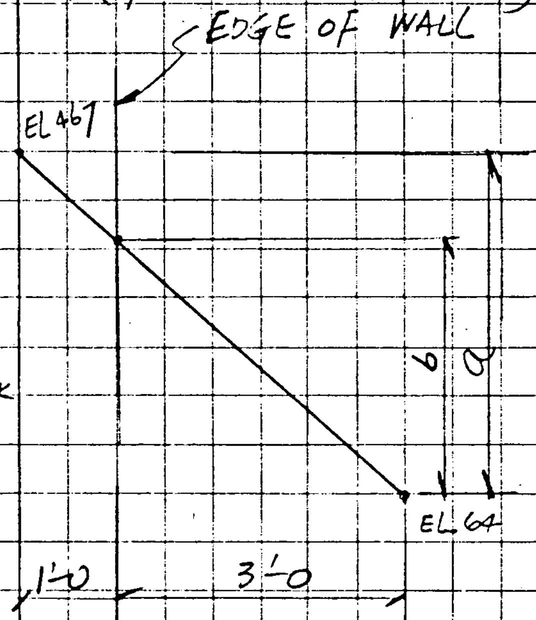
LC1, EL 64 $M_x = 137$

$a = 364 - 137 = 227$

$b = 0.75\,a = 170.3$

PROJECTED $M_x^t = 137 + 170.3 = \underline{\underline{307.3}}^{1K}$ GOVERN

$F_x = 24.1^K$ (LC1, EL 64)



$b = \frac{a}{2.5} \times 1.5 = 0.6\,a$

LC1 EL 465 $M_x = 383^{1K}$

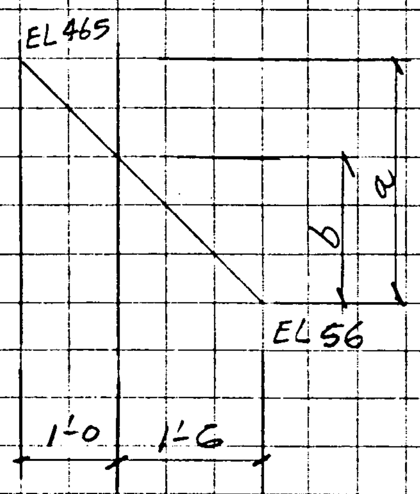
LC1 EL 56 $M_x = 141$

$a = 383 - 141 = 242$

$b = 242(0.6) = 145.2$

PROJECTED $M_x^t = 141 + 145.2 = 286.2^{1K}$

$F_x = 23.6^K$ (LC1, EL 56)



$M_{us} = 307.3 - 24.1(50 - \frac{54}{2})(\frac{1}{12}) = 261.1^{1K}$

$F = 2.5$ $K_u = \frac{261.1}{2.5} = 104.4$

$a_u = 2.93$

$A_s = \frac{261.1}{2.93(50)} + \frac{24.1}{.9(40)} = 1.78 + 0.67 = 2.45$ □"/FT < 3.12

#11 @ 6" TOP PROVIDED E-W

EBASCO SERVICES INCORPORATED

NEW YORK

BY T. REMANO DATE 5-19-81 SHEET 136 OF [illegible]

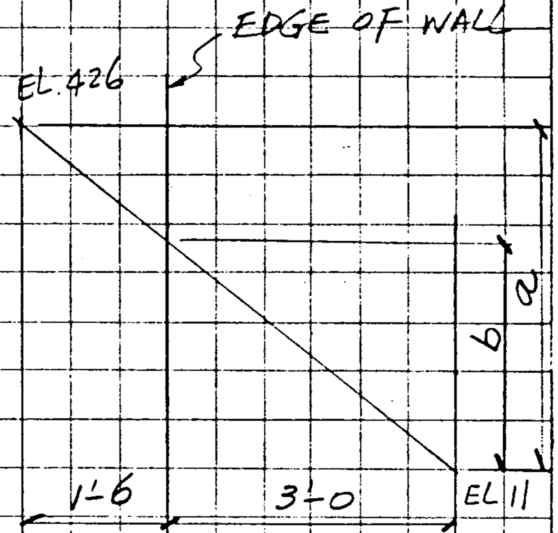
CHKD. BY S. SUN DATE 5-20-81 OFS NO. 2762.018 DEPT. NO. 403

CLIENT CP & L

PROJECT H B ROBINSON #2

SUBJECT SPENT FUEL POOL STORAGE EXTENSION

FIND PROJECTED M_Y^+ @ EDGE OF WALL
TENSION @ TOP N-S



LC 1 EL 426 $M_Y = 403.4$

LC 1 EL 11 $M_Y = 143.3$

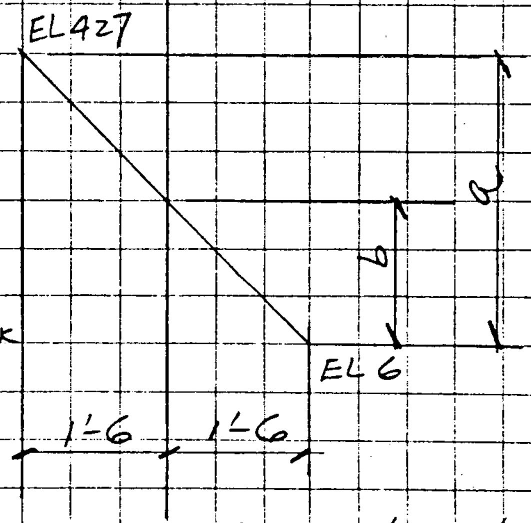
$b = \frac{a}{4.5} \times 3 = 0.67\, a$

$a = 403.4 - 143.3 = 260.1$

$b = 0.67(260.1) = 174.3$

PROJECTED $M_Y^+ = 143.3 + 174.3 = 317.6^{'k}$

$F_Y = 6.1^k$ (LC 1, EL 11)



LC 1, EL 427 $M_Y = 438^{'k}$

LC 1, EL 6 $M_Y = 146.9^{'k}$

$b = \frac{a}{3.0} \times 1.5 = 0.5\, a$

$a = 438 - 146.9 = 291.1$

$b = 0.5(291.1) = 145.6$

PROJECTED $M_Y^+ = 146.9 + 145.6 = 292.5^{'k}$

$F_Y = 5.8^k$ (LC 1, EL 6)

NOT GOVERN

$M_{us} = 317.6 - 6.1\left(50 - \frac{54}{2}\right)\left(\frac{1}{12}\right) = 305.9^{'k}$

INTERPOLATION BETWEEN TABLE VALUE FLEX 1.1

$F = 2.5 \quad K_u = \frac{305.9}{2.5} = 122.4, \quad a_u = 2.915$

$A_s = \frac{305.9}{2.915(50)} + \frac{6.1}{0.9(40)} = 2.10 + 0.17 = 2.27\ \square''/FT < 3.12$

#11 @ 6 TOP PROVIDED N-S

FORM 581 REV 7-71

EBASCO SERVICES INCORPORATED

NEW YORK

BY T. REITANO DATE 5-19-81 SHEET 137 OF ?

CHKD. BY S. SUN DATE 5-20-81 OFS NO. 2762.018 DEPT. NO. 403

CLIENT CP & L

PROJECT H B ROBINSON #2

SUBJECT SPENT FUEL POOL STORAGE EXTENSION

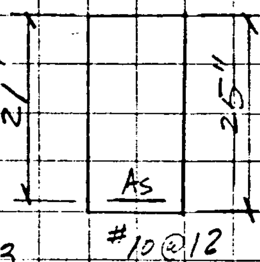
2'-1 SLAB MECH LOAD ONLY

MAX NEG MOMENT — TENSION @ BOT

E-W X-DIRECTION

$M_x^- = -18.8^{'k}$ EL 37, LC 27

$F_x = 12.2^k$ EL 37, LC 27



$M_{us} = 18.8 - \frac{12.2}{12}\left(21 - \frac{25}{2}\right) = 10.2^{'k}$

$F = \frac{12 \times 21^2}{12000} = 0.441$, $K_u = \frac{10.2}{.441} = 23.13$

$\frac{K_u}{f_c'} = \frac{23.13}{3000} = 0.00771$

$\omega = .8475 - \left(\sqrt{.2873 - .7533(0.00771)}/2\right) = 0.00861$

$a_u = 0.9(40000)[1 - 0.59(0.00861)]/12000 = 2.98$

$A_{s\,REQ'D} = \frac{10.2}{2.98(21)} + \frac{12.2}{.9(40)} = 0.16 + 0.34 = .50 < 1.27$

#10 @ 12 BOT PROVIDED

N-S Y-DIRECTION

$M_Y^- = -19^{'k}$ EL 31 LC 25

$F_Y = 4.8^k$ EL 31 LC 25

$M_{us} = 19 - \frac{4.8}{12}\left(21 - \frac{25}{2}\right) = 15.6^{'k}$

$F = 0.441$, $K_u = \frac{15.6}{.441} = 35.3$ $a_u \cong 2.97$

$A_{s\,REQ'D} = \frac{15.6}{2.97(21)} + \frac{4.8}{.9(40)} = 0.25 + 0.13 = .38 < 1.27$

#10 @ 12 BOT PROVIDED

EBASCO SERVICES INCORPORATED

NEW YORK

BY T. REMANO DATE 5-19-81 SHEET 138 OF [illegible]

CHKD. BY S. SUN DATE 5-20-81 OFS NO. 2762.018 DEPT. NO. 403

CLIENT CP&L

PROJECT H B ROBINSON #2

SUBJECT SPENT FUEL POOL STORAGE EXTENSION

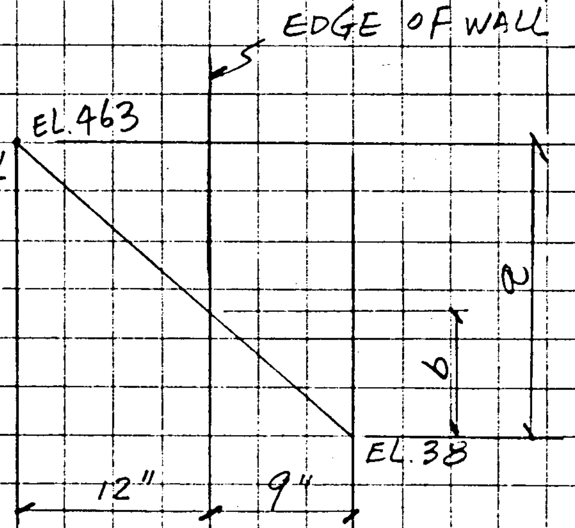
2'-1 SLAB

MAX POSTIVE MOMENT — TENSION @ TOP

E-W X-DIRECTION

LC1 EL 463, $M_x^+ = 112.4$

LC1 EL 38, $M_x^+ = 37.7^{1K}$



FIND PROJECTED M_x^+ @ EDGE OF WALL

$b = \frac{a}{21} \times 9 = 0.43\,a$

$a = 112.4 - 37.7 = 74.7$

$b = 0.43(74.7) = 32.1$

$M_{x\,PROJECTED}^+ = 37.7 + 32.1 = 69.8^{1K}$

$F_x = 12.6^K$ (LC1, EL.38)

$Mus = 69.8 - \frac{12.6}{12}(21 - \frac{25}{2}) = 60.9^{1K}$

$K_u = \frac{60.9}{.441} = 138$, $a_u = 2.905$

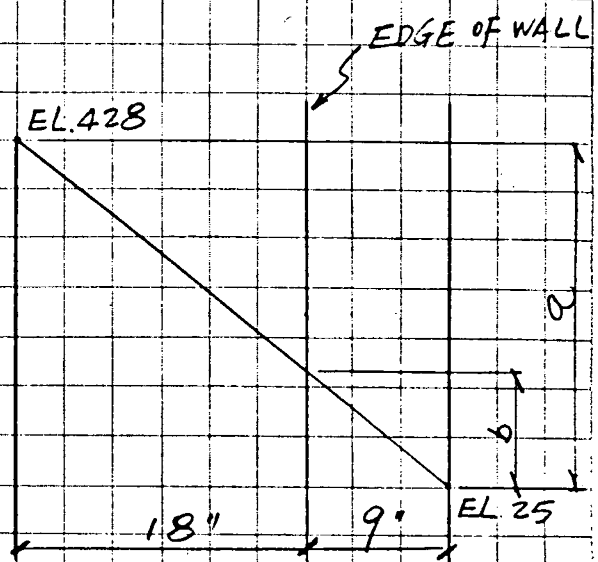
$A_s = \frac{60.9}{2.905(21)} + \frac{12.6}{.9(40)} = 1.00 + 0.35 = 1.35 < 2.54\,\square''$

#10 @ 6 TOP PROVIDED

N-S Y-DIRECTION

LC1 EL.428 $M_Y^+ = 131.8$

LC1 EL 25 $M_Y^+ = 38.8^{1K}$



FIND PROJECTED M_Y^+ @ EDGE OF WALL

$b = \frac{a}{27} \times 9 = 0.33\,a$

$a = 131.8 - 38.8 = 93$

$b = 0.33(93) = 31$

$M_{Y\,PROJECTED}^+ = 38.8 + 31 = 69.8^{1K}$

$F_Y = 3.8^K$ (LC1, EL 25)

$Mus = 69.8 - \frac{3.8}{12}(21 - \frac{25}{2}) = 67.1$

$K_u = 67.1/.0441 = 152$, $a_u = 2.89$

$A_s = \frac{67.1}{2.89(21)} + \frac{3.8}{.9(40)} = 1.11 + 0.11 = 1.22 < 2.54$ (#10 @ 6 TOP PROVIDED)

OK

FORM 381 REV 7-71

EBASCO SERVICES INCORPORATED

NEW YORK

BY T. REITANO DATE 5-19-81 SHEET 139 OF 2??

CHKD. BY S. SUN DATE 5-20-81 OFS NO. 2762.018 DEPT. NO. 403

CLIENT CP&L

PROJECT H B ROBINSON #2

SUBJECT SPENT FUEL POOL STORAGE EXTENSION

2'-1 SLAB

SHEAR:

$V_{MAX} = 29^{k}/FT$ (EL 29, LC 7)

$< 55.7^{k}/FT$ CAPACITY OK

BOND:

$$u_a = \frac{V_u}{\phi \Sigma o j d} = \frac{29000}{.85(2)(3.99)(.9)(21)} = 226 \text{ PSI}$$

$< 4.2\sqrt{f'_c} = 230^{PSI}$

WHERE #10 @ 6 PROVIDED

FORM 581 REV 7-71

MECH. LOAD PLUS THERM LOAD
(ADD THERM MOMENT ONLY)

SEE COMPUTER OUTPUT No. 6 JOB # 3719

4'-6 SLAB TENSION @ BOT.

E-W X DIRECTION - BY CASK STORAGE AREA $M_T = -47.9^{1K}$

$M_x^- = -123^{1K}$ @ ELEMET 47, LC 6

$F_x = 22.2^K$ @ " "

$(M_x^-)_{MAX}$ + THERMAL MOMENT (P. 130)

$= -123 - 1.4(0.75)(47.9) = -173.3^{1K}$

$F_x = 22.2^K$ TENSION

$M_{us} = 173.3 - \frac{22.2}{12}(50 - \frac{54}{2}) = 130.8^{1K}$

$F = \frac{12 \times 50^2}{12000} = 2.5$

$K_u = 130.8/2.5 = 52.3$, $a_u = 2.96$

A_s REQ'D $= \frac{130.8}{2.96(50)} + \frac{22.2}{0.9(40)} = 0.88 + 062$

$= 1.50 < 1.73$ IN²/FT OK

REINF. PROVIDED SEE MECH LOAD CALC.

E-W X-DIRECTION - IN AREA OTHER THEN ABOVE $M_T = -34.1^{1K}$

$M_x^- = 123.8^{1K}$ @ ELEMENT 62, LC 6

$F_x = 13.3^K$ @ " "

$(M_x^-)_{MAX}$ + THER. M $= -123.8 - 1.4(0.75)(34.4) = -159.6^{1K}$ (P. 130)

$F_x = 13.3^K$ TENSION

$M_{us} = 159.6 - \frac{13.3}{12}(50 - \frac{54}{2}) = 134.1^{1K}$

$K_u = \frac{134.1}{2.5} = 53.6$ $a_u = 2.96$

$A_s = \frac{134.1}{2.96(50)} + \frac{13.3}{0.9(40)} = 0.9 + 0.37 = 1.27 = 1.27$

OK REINF PROVIDED #10 @ 12

ADD THERMAL MOMENT
(ADD THER. MOMENT ONLY)

4.6 SLAB (CONT.) TENSION @ BOT

N-S Y-DIRECTION - BY CASK STORAGE AREA $M_T = -37.1^{1K}$

$M_Y^- = -139.7^{1K}$ @ EL 46, LC 5

$F_Y = 2.7^K$ @ " "

$(M_Y^-)_{MAX}$ + THER. MOMENT (P.130)

$= -139.7 - 1.4(0.75)(37.1) = 178.7$

$F_Y = 2.7^K$ TENSION

$M_{us} = 178.7 - \frac{2.7}{12}(50 - \frac{54}{2}) = 173.5^{1K}$

$K_u = \frac{173.5}{2.5} = 69.4$, $a_u = 2.95$

$A_s = \frac{173.5}{2.95(50)} + \frac{2.7}{0.9(40)} = 1.17 + 0.08 = 1.25 < 1.27 \square''$ REINF PROVIDED

OK

N-S Y-DIRECTION - AREA OTHER THEN ABOVE $M_T = -34.1$

$M_Y^- = -143.2^{1K}$ @ EL. 53, LC 5

$F_Y = 2.2^K$ @ " "

$(M_Y^-)_{MAX}$ + THER. MOMENT (P.130)

$= -143.2 - 1.4(0.75)(34.1) = 179^{1K}$

$F_Y = 2.2^K$ TENSION

$M_{us} = 179 - \frac{2.2}{12}(50 - \frac{54}{2}) = 174.8^{1K}$

$K_u = \frac{174.8}{2.5} = 70$ $a_u = 2.95$

$A_s = \frac{174.8}{2.95(50)} + \frac{1.9}{0.9(40)} = 1.19 + 0.05 = 1.24 < 1.27$

OK REINF PROVIDED

MECH. LOAD PLUS THERM LOAD
4'-6 SLAB TENSION @ TOP

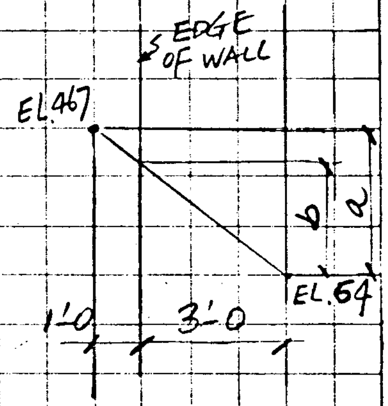
E-W X-DIRECTION

$M_x = 115.8^{1k}$ EL 64 LC 5

$M_x = 293.5^{1k}$ EL. 467 LC 5

$a = 293.5 - 115.8 = 177.7$

$b = 0.75\,a = 133.3$



PROJECTED $M = 115.8 + 133.3 = 249.1^{1k}$

$F_x = 21.9^k$
(EL 64 LC 5)

$M_{us} = 249.1 - 21.9\left(50 - \frac{54}{2}\right)\left(\frac{1}{12}\right) = 207.1^{1k}$

$F = 2.5 \quad K_u = \frac{207.1}{2.5} = 82.9 \quad , a_u = 2.95$

$A_s = \frac{207.1}{2.95(50)} + \frac{21.9}{0.9(40)} = 1.4 + 0.61 = 2.01 < 3.12$

#11 @ 6" TOP PROVIDED

* My @ EL #6 IS GREATER THAN My @ EL #11, BUT EL #6 IS NEARER CASK STORAGE AREA WHERE REINF IS GREATER

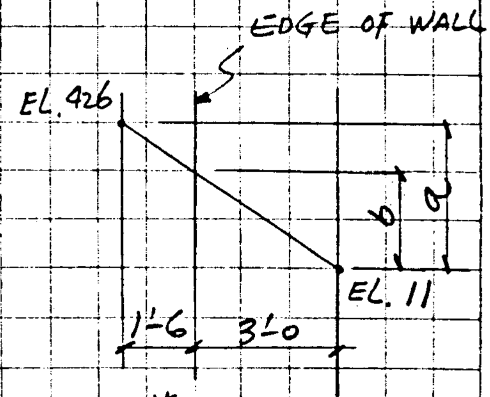
N-S Y-DIRECTION

* $M_Y = 137^{1k}$ EL 11 LC 11

$M_Y = 353^{1k}$ EL 426 LC 11

$a = 353 - 137 = 216$

$b = 0.67\,a = 144.7$



PROJECTED $M = 137 + 144.7 = 281.7^{1k}$

$F_Y = 12.5^k$
(EL. 11, LC 1)

$M_{us} = 281.7 - 12.5\left(50 - \frac{54}{2}\right)\left(\frac{1}{12}\right) = 257.7^{1k}$

$F = 2.5 \quad , \quad K_u = \frac{257.7}{2.5} = 103.1 \quad , \quad a_u = 2.93$

$A_s = \frac{257.7}{2.93(50)} + \frac{12.5}{0.9(40)} = 1.76 + 0.35 = 2.11 < 3.12$

#11 @ 6 TOP PROVIDED

EBASCO SERVICES INCORPORATED

NEW YORK

BY T. REITANO DATE 5-20-81 SHEET 143 OF 206

CHKD. BY S. SUN DATE 5-21-81 OFS NO. 2762.018 DEPT. NO. 403

CLIENT CP & L

PROJECT H B ROBINSON #2

SUBJECT SPENT FUEL POOL STORAGE EXTENSION

MECH LOAD PLUS THER LOAD

4'-6 SLAB (CONT.)

SHEAR:

$V_{MAX} = 74.2^{k}/_{FT}$ @ EL 48 LC 8.

$V_{CAPACITY} = 118.0^{k}/FT$

BOND: $\mu_u = \frac{V_u}{\phi \Sigma o j d} = \frac{74.2 \times 1000}{0.85(4)(3.99)(.9)(50)} = 121.5 < 4.2\sqrt{f'_c}$
$= 230$ PSI

WHERE #10 @ 6 TWO LAYERS PROVIDED OK

$V = 63.4^{k}/FT$ @ EL 11 LC 3

$\mu_u = \frac{63400}{0.85(2)(4.43)(.9)(50)} = 187 < 230$ PSI

OK

WHERE #11 @ 6 ONE LAYER PROVIDED

EBASCO SERVICES INCORPORATED

NEW YORK

BY T. REITANO DATE 5-20-81 SHEET 144 OF 306

CHKD. BY S. Sui DATE 5-21-81 OFS NO. 2762.018 DEPT. NO. 403

CLIENT C P & L

PROJECT H B ROBINSON #2

SUBJECT SPENT FUEL POOL STORAGE EXTENSION

MECH. LOAD PLUS THERM. LOAD
(ADD THERM. MOMENT ONLY)

2'-1 SLAB (CASK STORAGE AREA) TENSION @ BOT.

E-W X-DIRECTION: $M_T = -9.7^{1k}$

$M_x = -14.4^{1k}$ EL 37 LC 6

$F_x = 11.5^k$ " "

$(M_x^-)_{MAX}$ + THER. MOMENT (P.130)

$= -14.4 - 1.4(0.75)(9.7) = -24.6^{1k}$

$F_x = 11.5^k$ TENSION

$M_{us} = 24.6 - \frac{11.5}{12}(21 - \frac{25}{2}) = 16.5^{1k}$

$F = \frac{12(21)^2}{12000} = .441$, $K_u = \frac{16.5}{.441} = 37.4$

$a_u = 2.97$

$A_s = \frac{16.4}{2.97(21)} + \frac{11.5}{0.9(40)} = 0.26 + 0.32 = 0.58\ IN^2 < 1.27\ IN^2$

OK #10 @ 12 PROVIDED

N-S Y-DIRECTION: $M_T = -9.7^{1k}$

$M_y = -16.1^{1k}$ EL 39, LC 6 } AXIAL COMP.

$F_y = -1.6^k$ (COMP.) EL 39, LC 6 } NOT GOVERN.

$M_y = -14.1^{1k}$ EL 31, LC 4

$F_y = 4.3^k$ EL 31, LC 4

$(M_y^-)_{MAX}$ + THER. M (P 130) $= -14.1 - 1.4(0.75)(9.7) = -24.3^{1k}$

$F_x = 4.3^k$ TENSION

$M_{us} = 24.3 - \frac{4.3}{12}(21 - \frac{25}{2}) = 21.3^{1k}$

$K_u = \frac{21.3}{.441} = 48.2$ $a_u = 2.96$

$A_s = \frac{21.3}{2.96(21)} + \frac{4.3}{0.9(40)} = 0.34 + 0.12 = 0.46\ IN^2 < 1.27\ IN^2$

OK #10 @ 12 PROVIDED

MECH LOAD PLUS THER LOAD
2'-1 SLAB TENSION @ TOP

E-W X-DIRECTION

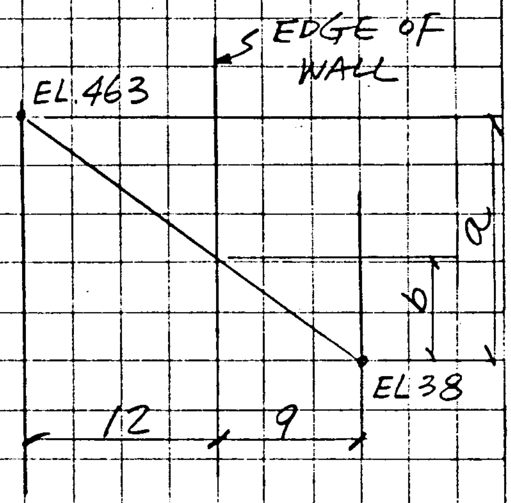
$M_x^+ = 30.6$, EL 38, LC8
$M_x^+ = 91$ EL 463, LC8

$a = 91 - 30.6 = 60.4$

$b = \frac{9}{21} \times a = 0.43(60.4) = 26$

PROJECTED $M = 30.6 + 26 = 56.6^{1K}$

$F_x = 12.7^K$ (EL 38, LC 15)



$M_{us} = 56.6 - \frac{12.7}{12}(21 - \frac{25}{2}) = 47.6^{1K}$

$F = \frac{12(21)^2}{12000} = 0.441$

$K_u = \frac{47.6}{.441} = 108$, $a_u = 2.93$

$A_s = \frac{47.6}{2.93(21)} + \frac{12.7}{(.9)(40)} = 0.77 + 0.35 = 1.12 < 2.54\ IN^2$
#10 @ 6 TOP PROVIDED

N-S Y-DIRECTION

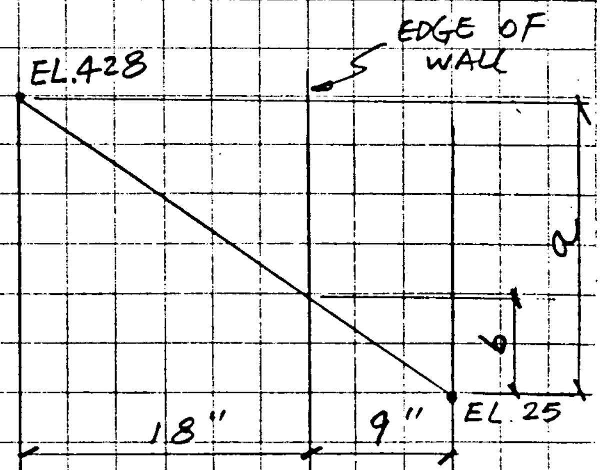
$M_Y^+ = 33.9$, EL 25, LC 3
$M_Y^+ = 114.6$ EL 428, LC 3

$a = 114.6 - 33.9 = 80.7$

$b = \frac{9}{27}(80.7) = 26.6$

M_Y^+ PROJECTED $= 33.9 + 26.6 = 60.5^{1K}$

$F_Y = 7.2^K$ (EL 25, LC 13)



$M_{us} = 60.5 - \frac{7.2}{12}(21 - \frac{25}{2}) = 55.4^{1K}$

$K_u = \frac{55.4}{0.441} = 125.6$, $a_u = 2.91$

$A_s = \frac{55.4}{2.91(21)} + \frac{7.2}{.9(40)} = 0.91 + 0.2 = 1.11 < 2.54\ IN^2$ (#10 @ 6 TOP PROVIDED)
OK

EBASCO SERVICES INCORPORATED

NEW YORK

BY T. REITANO DATE 5-21-81 SHEET 146 OF 216

CHKD. BY S. SUN DATE 5-22-81 OFS NO. 2762.018 DEPT. NO. 403

CLIENT CP&L

PROJECT H B ROBINSON #2

SUBJECT SPENT FUEL POOL STORAGE EXTENSION

MECH LOAD PLUS THER. LOAD
2'-1 SLAB (CONT.)

SHEAR:

$$V_{MAX} = 22.5\,^{K}/_{FT} \text{ (EL. 29, LC2)}$$

$$< 55.7\,^{K}/_{FT} \text{ (CAPACITY)}$$

OK

BOND:

$$\mu_u = \frac{V_u}{\phi \Sigma o\, j\, d} = \frac{22500}{.85(2)(3.99)(.9)(21)} = 175.5 \text{ PSI}$$

$$< 4.2\sqrt{f'_c} = 230 \text{ PSI}$$

WHERE #10 @ 6 PROVIDED

FORM 581 REV 7-71

EBASCO SERVICES INCORPORATED

NEW YORK

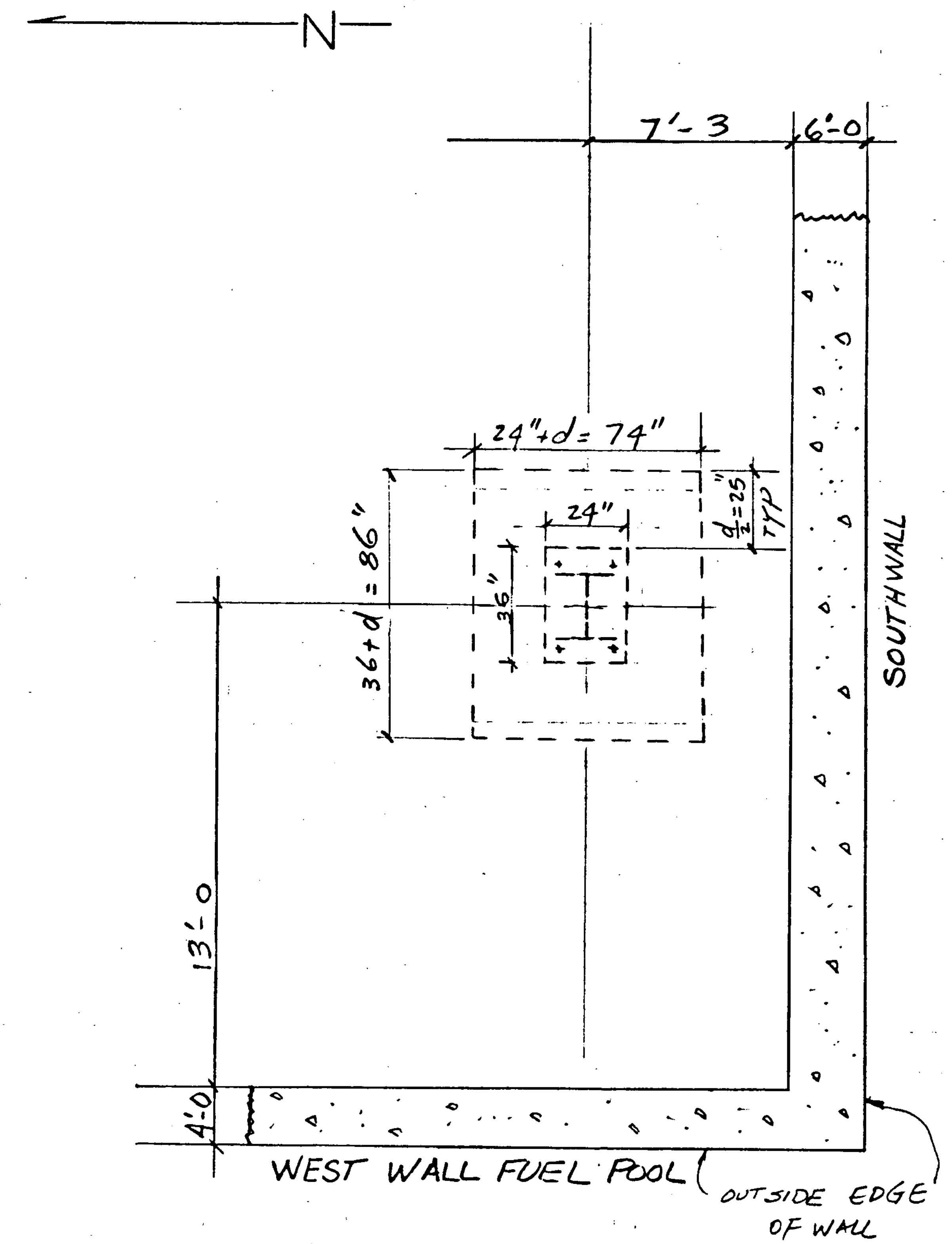
BY T REITANO DATE 5-23-81 SHEET 147 OF 206

CHKD. BY W LIU DATE 5-23-81 OFS NO. 2762.018 DEPT. NO. 403

CLIENT CP&L

PROJECT H. B. ROBINSON UNIT #2

SUBJECT FHB - SPENT FUEL POOL STORAGE RACKS



A. PUNCHING SHEAR ON THE SPENT FUEL POOL STORAGE SLAB

RUN No 10

1) FROM COMPUTER OUTPUT (JOB-374K, 5-20-81)
AXIAL FORCE IN THE COLMUN:

$$P = 195.5^K$$

SINCE THE AXIAL FORCE IN THE COLMUN IS BASED ON AISC CODE AND ACI CODE REQUIREMENT NEED TO BE ACCOUNTED FOR IN THE SLAB. THE AXIAL FORCE P IS MULTIPLIED BY A FACTOR OF 1.5.

$$P_U = 1.5P = 1.5 \times 195.5^K = 293.25^K \quad \text{USE } 295^K$$

$$d = 50''$$

PERIPHERY SHEAR @ $\frac{1}{2}d$ DISTANCE OUT

$$v_u = \frac{295000}{2(74+86)(50)} = 18.43 \text{ PSI} < 4\phi\sqrt{f_c'}$$

$$= 4(0.85)(54.8)$$

$$= 186 \text{ PSI}$$

OK

EBASCO SERVICES INCORPORATED

NEW YORK

BY TREITANO DATE 5-23-81 SHEET 160 OF 206

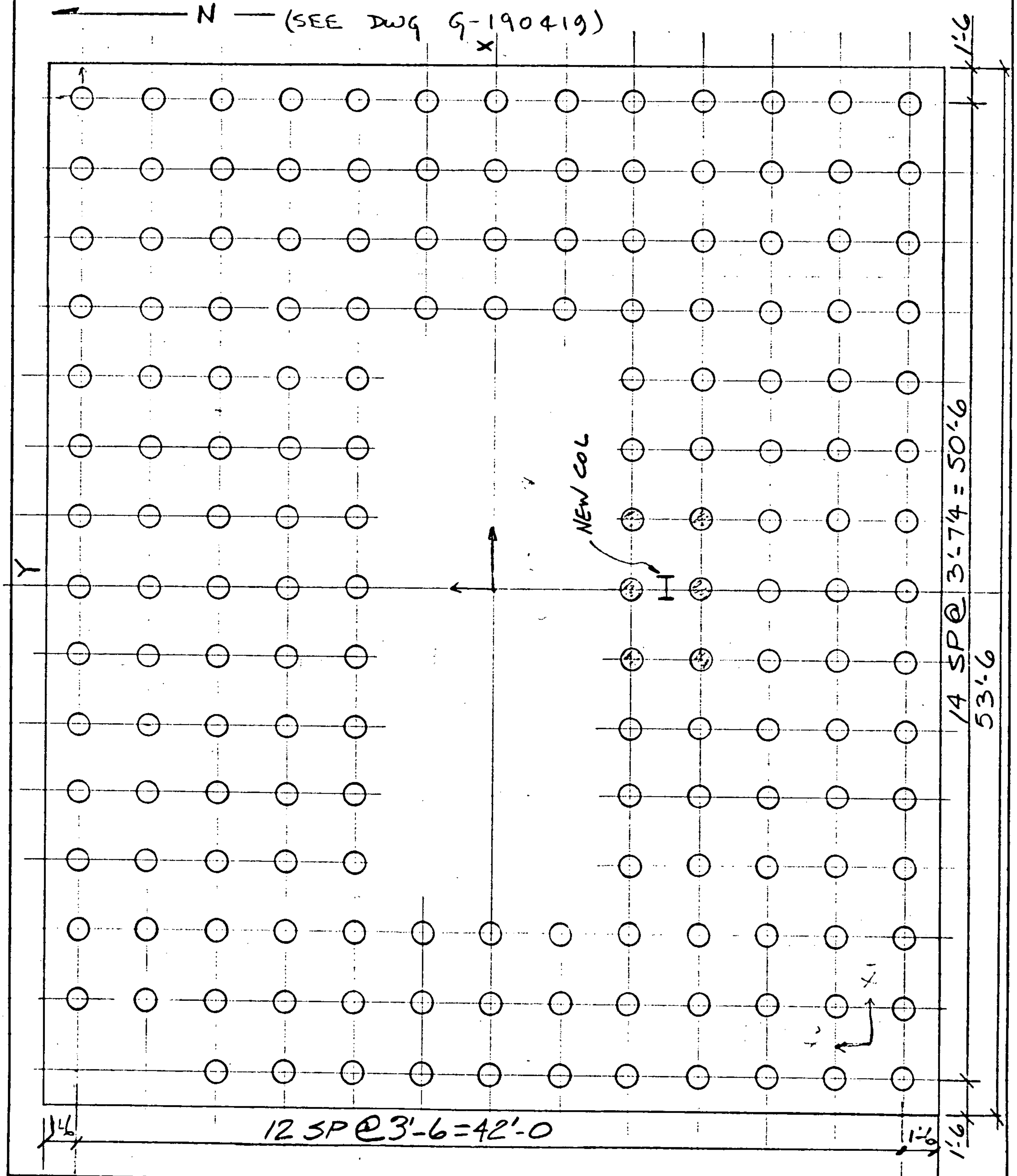
CHKD. BY S. SUN DATE 5-26-81 OFS NO. 2762.018 DEPT. NO. 403

CLIENT C P&L

PROJECT H. B. ROBINSON UNIT #2

SUBJECT FHB - SPENT FUEL POOL STORAGE RACKS

PILE ARRANGEMENT



FORM 581 REV 7-71

PROPERTY OF PILES

I_{Y-Y}

PILES	X	X^2	PILES x X	PILES x X^2
11	-25.25	637.56	-277.75	7013.16
26	-19.84	393.77	-515.84	10238.13
40	-9.03	81.56	-361.2	3262.4
10	0			0
30	+7.21	51.96	+216.3	1558.8
52	+19.82	392.95	+1030.64	20433.3
169			+ 92.15	42505.79*

*THERE WILL BE A SMALL BUILT-IN ERROR SINCE 14 X 3'-7¼ IS LESS THAN 50'-6

$\bar{X} = 92.15/169 = 0.545'$

$I_{Y-Y} = 42505.79 - 169(0.545)^2 = 42455.6$

PROPERTY OF PILES

I_{x-x}

PILES	Y	Y^2	PILE(Y)	PILE Y^2
28	19.25	370.56	539	10,375.75
45	10.5	110.25	472.5	4961.25
75	-14	196	-1050	14,700
3	3.5	12.25	+10.5	36.75
3	-3.5	12.25	-10.5	36.75
4	3.5	12.25	+14.0	49
4	-3.5	12.25	-14.0	49
7	0			0
169			-38.5	30,208.5

$\bar{Y} = -38.5/169 = -0.228'$

$I_{x-x} = 30,208.5 - 169(0.228)^2 = 30,200$

BY R. SCHMIDT DATE 5-23-81 SHEET 183 OF 206

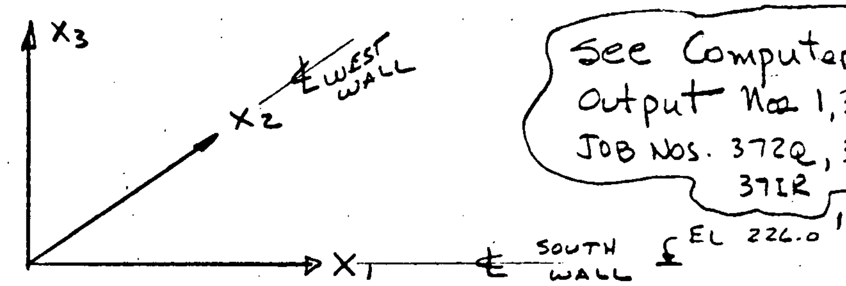
CHKD. BY S. SUN DATE 5-26-81 OFS NO. CAR 2762.018 DEPT. NO. 403

CLIENT CP&L

PROJECT HBR #2

SUBJECT FHB- PILE LOADS

TABULATION OF TOTAL LOADS ON FHB PILE GROUP @ ELEV 226.0'



See Computer Output Nos 1,3,4 JOB NOS. 372Q, 37H3, 37IR

LOAD CASE #	LOAD CASE TITLE	SYM.	FX1 (K)	FX2 (K)	FX3 (K)	MX1 (FT-K)	MX2 (FT-K)	MX3 (FT-K)
1	HYDRO + CRANE COL	D1	-899.	38.	-12,543.	-231,468.	263,922.	17,623.
2	EXIST RACKS	L1	0.	0.	-313.	-5,343.	10,995.	0.
3	CASK	L2	0.	0.	-176.	-5,192.	2,728.	0.
4	7.0FT HYDRO	D2	-462.	9.	-454.	-8,478.	-131.	8,774.
5	CASK COL LDS	L0	74.	-43.	-199.	-1,741.	9,527.	-2,396.
6	NEW RACKS	L3	0.	0.	-633.	-10,832.	11,993.	0.
7	WIND NS	WNS	-19.	-220.	0.	12,964.	-429.	-3,427.
8	WIND SN	WSN	-19.	167.	0.	-11,509.	-429.	2,612.
9	WIND EW	WEW	-171.	-19.	0.	163.	-10,573.	2,632.
10	WIND WE	WWE	181.	-19.	0.	163.*	11,191.*	-2,786.*
11	EXIST NS-OBE	EØ-NS	0.	1816.	0.	-44,890.	0.	41,465.
12	NEW RACKS NS-WE OBE	EØ NS1/WE1	-236.	236.	-682.	-14,547.	9,953.	8,374.
13	NEW RACKS NS-EW OBE	EØ NS2/EW1	236.	236.	-706.	-15,023.	16,406.	808.
14	NEW RACKS SN-WE OBE	EØ SN1/WE2	-236.	-236.	-683.	-9,039.	9,956.	-203.
15	NEW RAKES SN-EW OBE	EØ SN2/EW2	236.	-236.	-701.	-9,415.	16,294.	-9,437.
16	EXIST EW-OBE	EØ-EW	1,811.	0.	0.	0.	44,754.	-33,355.
17	EXIST-VERT OBE	EØ-VERT	0.	0.	-1,354.	-25,112.	30,833.	0.
18	NEW RACKS NS-WE SSE	SSE NS1/WE1	-390.	390.	-834.	-18,623.	11,032.	13,892.
19	NEW RACKS NS-EW SSE	SSE NS2/EW1	390.	390.	-867.	-19,294.	21,071.	1,338.
20	NEW RACKS SN-WE SSE	SSE SN1/WE2	-390.	-390.	-834.	-9,756.	11,030.	-333.
21	NEW RACKS SN-EW SSE	SSE SN2/EW2	390.	-390.	-859.	-10,256.	20,869.	-15,737.
22	CASK IMPACT	FC*	0.	0.	-365.	-10,779.	5,663.	0.

* L.C #3 × 2.076

FORM 581 REV 7-71

* ESTIMATED VALUES

*REV 4

EBASCO SERVICES INCORPORATED

NEW YORK

BY R. SCHMIDT DATE 5-23-81 SHEET 184 OF 206

CHKD. BY S. SUN DATE 5-26-81 OFS NO. CAR 2762.014 DEPT. NO. 403

CLIENT CP&L

PROJECT HBR #2

SUBJECT FHB - PILE LOADS

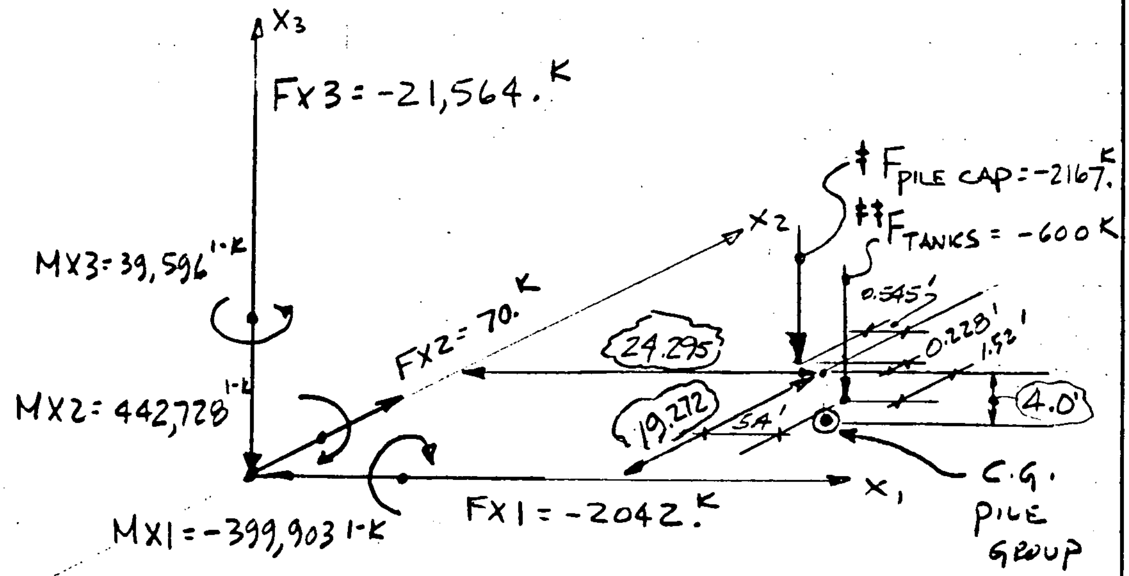
*REV 4
BY : R.S.
CHKD BY. S.S.
DTD. 3-1-82

LOAD TABULATION (CONT.)

USE L.C.1 - 1.5(D1+D2)+1.8(L1+L3)+1.0 FC

LOAD CASE #	SYM	1.5 FX1	1.5 FX2	1.5 FX3	1.5 MX1	1.5 MX2	1.5 MX3
1	D1	-1,349.	57.	-18,815.	-347202.	395893.	26,435.
4	D2	-693.	13.	-681.	-12,717.	-197.	13,161.
		1.8 FX1	1.8 FX2	1.8 FX3	1.8 MX1	1.8 MX2	1.8 MX3
2	L1	0.	0.	-563.	-9,617.	19,791.	0.
6	L3	0.	0.	-1140.	-19,588.	21,588.	0.
		1.0 FX1	1.0 FX2	1.0 FX3	1.0 MX1	1.0 MX2	1.0 MX3
22	FC	0.	0.	-365.	-10,779.	5,663.	0.
		FX1	FX2	FX3	MX1	MX2	MX3
	Σ	-2,042.	70.	-21,564.	-399,903	442,728.	39,596.

∴ For L.C.1 - 1.5(D1+D2)+1.8(L1+L3)+1.0 FC



† ADD 1.5 × D.L. OF PILE CAP, (1.5×45.0×53.5×4.0×0.15) = 2167.K (1445.K)

†† ADD 1.5× D.L. FOR GAS DECAY TANKS (1.5×4×100.0) = 600.K (400.K)
(CONSERVATIVELY - 100K/TANK)

FORM 581 REV 7-71

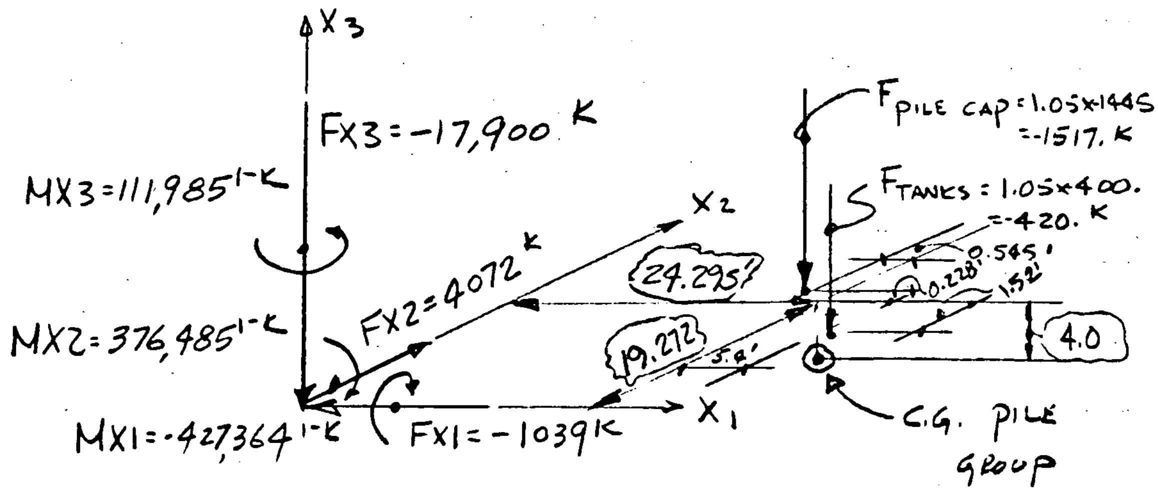
* REV 4
BY R.S.
CHKD BY: S.S.
DTD. 3-1-82

LOAD TABULATION (CONT.)

USE L.C. 24‡ - 1.05(D1+D2) + 1.0L1 + 1.0(ESS-NS + ESS NS2/EW1 + ESS-VERT) + 1.0FC

LOAD CASE	SYM	1.05 FX1	1.05 FX2	1.05 FX3	1.05 MX1	1.05 MX2	1.05 MX3
1	D1	-944.	40.	-13,170.	-243,042.	277,118.	18,504.
4	D2	-485.	10.	-477.	-8,902.	-138.	9,213.
		1.0 FX1	1.0 FX2	1.0 FX3	1.0 MX1	1.0 MX2	1.0 MX3
2	L1	0.	0.	-313.	-5343.	10,995.	0.
19	ESS-NS2/EW1	390.	390.	-867.	-19,294.	21,071.	1,338.
22	FC	0.	0.	-365.	-10,779.	5663.	0.
		2.0 FX1	2.0 FX2	2.0 FX3	2.0 MX1	2.0 MX2	2.0 MX3
11	ESS-NS‡‡	0.	3632	0.	-89780.	0.	82930.
17	ESS-VERT‡‡	0.	0.	-2,708.	-50,224.	61,776.	0.
		FX1	FX2	FX3	MX1	MX2	MX3
	Σ	-1039.	4072.	-17900.	-427364.	376485.	111985.

∴ For L.C. 24 - 1.05(D1+D2) + 1.0L1 + 1.0(ESS-NS) + 1.0 FC



‡ THIS LOAD COMB CAUSES LARGEST W14X283 AXIAL LOAD
‡‡ ESS = 2.0 Eθ

L.C. 24 - 1.05 (D1 + D2) + 1.0 L1 + 1.0 (ESS-NS) + 1.0 FC (CONT.)

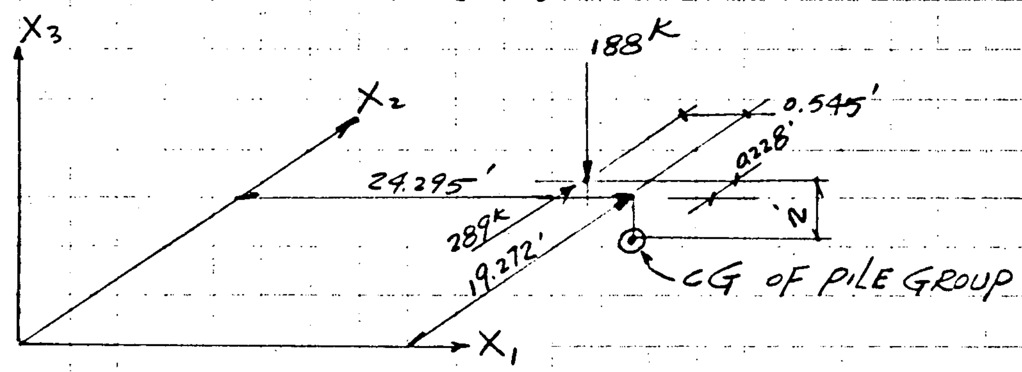
* ENTIRE PAGE NEW

ESS-NS FOR PILE CAP = 0.2 (1445) = 289^k

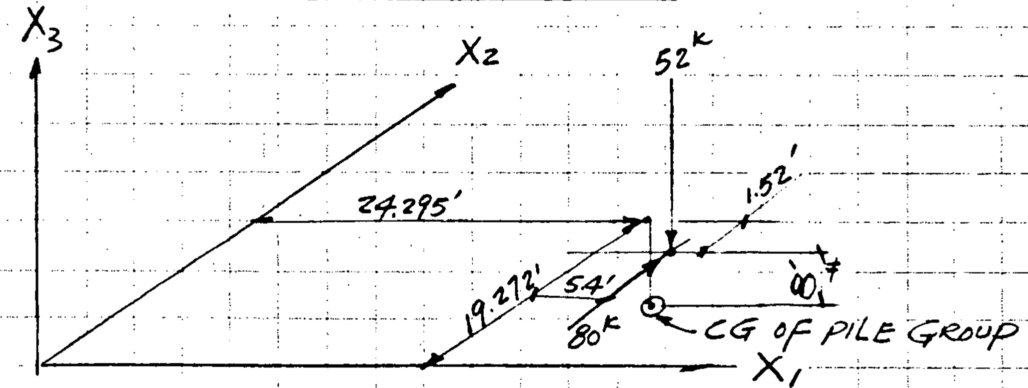
ESS-VERT " " = 0.13 (1445) = 188^k

ESS-NS FOR DECAY TANK = 0.2 (400) = 80^k

ESS-VERT " " " = 0.13 (400) = 52^k



ESS PILE CAP



ESS DECAY TANKS

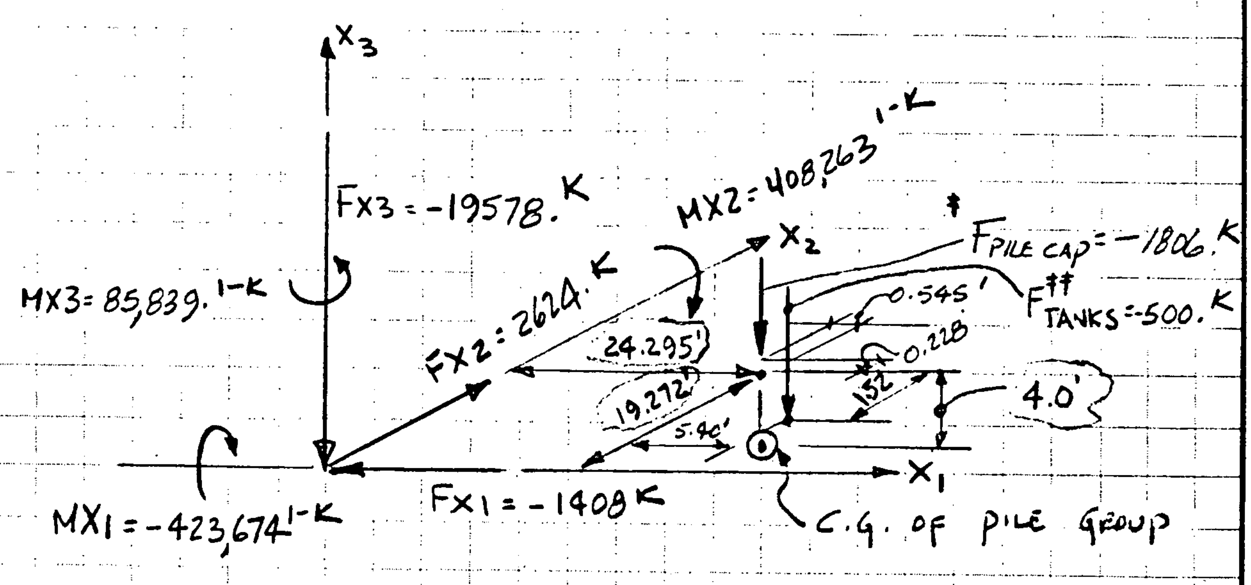
‡ FROM ℄ TANK TO BOT OF PIPE CAP

* ENTIRE PAGE NEW

LOAD TABULATION (CONT.)

USE L.C. 8 - $1.25(D_1 + D_2 + L_1 + EO\text{-}NS + EONS_2/EW_1 + EO\,VERT) + 1.0\,F_C$

LOAD CASE #	SYMBOL	1.25 FX1	1.25 FX2	1.25 FX3	1.25 MX1	1.25 MX2	1.25 MX3
1	D_1	-1124.	48.	-15679.	-289336.	329902.	22029.
4	D_2	-578.	12.	-568.	-10598.	-164.	10968.
2	L_1	0.	0.	-391.	-6679.	13744.	0.
11	EO-NS	0.	2270.	0.	-56113.	0.	51831.
13	$EONS_2/EW_1$	295.	294.	-882.	-18779.	20508.	1011.
17	EO-VERT	0.	0.	-1693.	-31390.	38610.	0.
		1.0 FX1	1.0 FX2	1.0 FX3	1.0 MX1	1.0 MX2	1.0 MX3
22	F_C	0.	0.	-365.	-10779.	5663.	0.
	Σ	-1408.	2624.	-19578.	-423674.	408263.	85839.



‡ ADD 1.25 × D.L. OF PILE CAP, (1.25 × 45.0 × 53.5 × 4.0 × 0.15) = 1806.K

‡‡ ADD 1.25 × D.L FOR GAS DECAY TANKS (1.25 × 4 × 100.0) = 500.K

*ENTIRE PAGE NEW

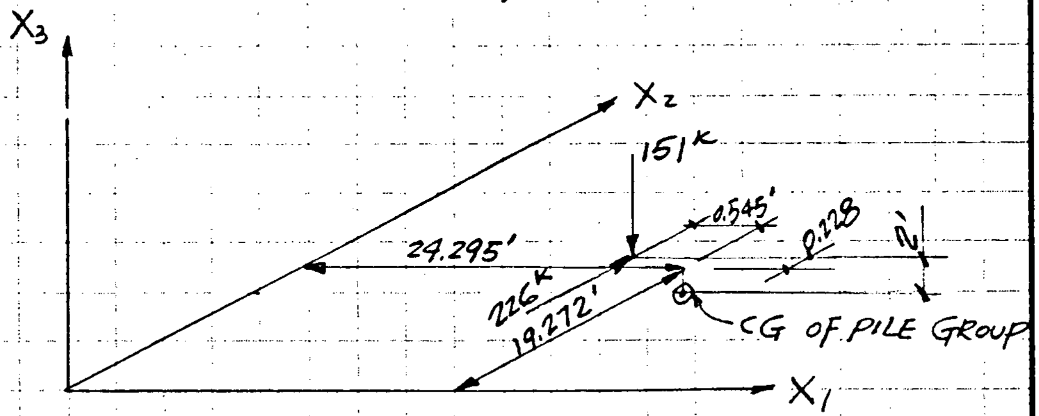
L.C. 8 (CONT.) $1.25(D_1+D_2+L_1+EO\text{-}NS+EONS_2/EW_1+EO\ VERT)+1.0FC$

EO-NS FOR PILE CAP $=1.25(0.1)(1806)=226^k$

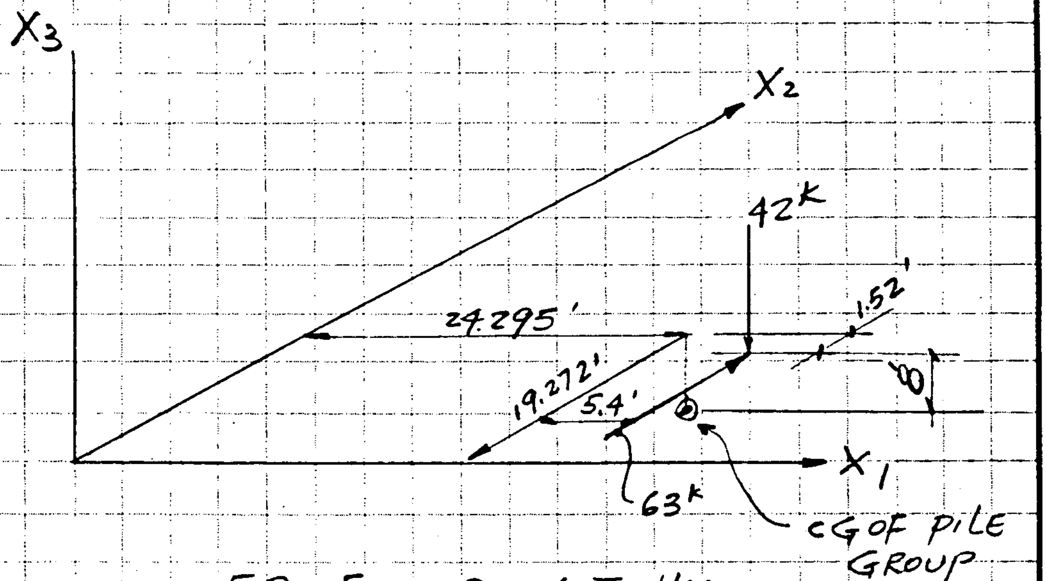
EO-VERT " " " $=1.25(0.067)(1806)=151^k$

EO-NS FOR DECAY TANKS $=1.25(0.1)(500)=63^k$

EO-VERT " " " $=1.25(0.067)(500)=42^k$



EO FOR PILE CAP



EO FOR DACAY TANKS

* REV 3

EBASCO SERVICES INCORPORATED

BY R. SCHMIDT DATE 1-18-82 SHEET 186A OF 206

CHKD. BY S. SUN DATE 1-19-82 OFS NO. CAR 2762.018 DEPT. NO. 403

CLIENT CP&L

PROJECT HB ROBINSON #2

SUBJECT FHB - PILE LOADS

1.5(D1+D2)+1.8(L1+L3)+1.0FC

* ENTIRE PAGE REVISED

TRANSFER LOADS & MOMENTS TO CG. OF PILE GROUP

$FX_1 = -2402^K$, $FX_2 = 70^K$, $FX_3 = -21564. - 2167. - 600. = -24331.^K$

$MX_1 = -399,903 + 21564(19.272) - 70(4) - 2167(0.228) + 600(1.52) = 15816.^{1-K}$

(415581) (494) (912)

$MX_2 = 442,728 - 21564(24.295) - 2402(4) - 2167(0.545) + 600(5.40) = -88718.^{1-K}$

$MX_3 = 39596 - 2402(19.272) - 70(24.295) = -8396^{1-K}$

$$MAX\ P = \frac{24331}{169} + \frac{15816(21-0.228)}{30200} + \frac{88718(25.25+0.545)}{42456}$$

$= 144.0 + 10.9 + 53.9 = {}^{\#}208.8\ ^K/PILE$ OK

$$MIN\ P = \frac{24331}{169} - \frac{15816(21+0.228)}{30200} - \frac{88718(25.25-0.545)}{42456}$$

$= 144.0 - 11.1 - 51.6 = 81.3\ ^K/PILE$ (NO UPLIFT)

PILE CAPACITY = 450 K/PILE (DWG G-190419)

CHECK 6 PILES BELOW NEW COL.

MAX COL LOAD ##

$$P = 144.0 + \frac{15816(10.5-0.228)}{30200} + \frac{88718(3.60+0.545)}{42456} + \frac{295}{6}$$

$= 144.0 + 5.4 + 8.7 + 49.2 = 207.3\ ^K/PILE$ OK

SEE PG 148

EBASCO SERVICES INCORPORATED

NEW YORK

BY S. SUN DATE 5-23-81 SHEET 186B OF 206

CHKD. BY K. SCHMIT DATE 5-27-81 OFS NO. 2762.018 DEPT. NO. 403

CLIENT CP&L

PROJECT H B ROBINSON #2

SUBJECT FHB — SPENT FUEL POOL STORAGE EXTENSION

FIND I_p

SINCE BOTH $\bar{X} = 0.545'$ & $\bar{Y} = -0.228'$ ARE SMALL.

$$I_p \simeq (11+13)(25.25)^2 + 2(13)(21.64)^2 + 2(13)(18.04)^2$$
$$+ (10+13)(14.4)^2 + 2(10)(10.8)^2 + 2(10)(7.2)^2 + 2(10)(3.6)^2$$
$$+ (14+15)(21)^2 + (14+15)(17.5)^2 + 2(15)(14)^2 + 2(15)(10.5)^2$$
$$+ 2(15)(7)^2 + 2(7)(3.5)^2$$
$$= 15302 + 12176 + 8461 + 4769 + 2333 + 1037 + 259$$
$$+ 12789 + 8881 + 5880 + 3308 + 1470 + 172$$
$$= 76837$$

MAX. SHEAR

$$S_1 = \frac{2402}{169} + \frac{8396(21)}{76837} = 14.2 + 2.3 = 16.5^K$$

$$S_2 = \frac{70}{169} + \frac{8396(25.25)}{76837} = 0.4 + 2.8 = 3.2^K$$

$$S = \sqrt{S_1^2 + S_2^2} = \sqrt{16.5^2 + 3.2^2} = 16.8^K/\text{PILE}$$

SHEAR CAPACITY $= 32^K/$PILE (DWG. G-190419)

* ENTIRE PAGE REVISED

1.05(D1+D2)+1.0L1+1.0(ESS-NS+ESSNS2/EW1+ESS-VERT)+1.0Fc

TRANSFER LOADS & MOMENTS TO C.G. OF PILE GROUP

$FX_1 = -1039.^K$, $FX_2 = 4072.+289.+80. = 4441.^K$, $FX_3 = -17900.-1517.-420.-188.-52. = -20077.^K$

$MX_1 = -427364.+17900.(19.272)-4072.(4)-1517(0.228)-289(2)-80(8)-188(0.228)+52(1.52)+420(1.52) = -99573.^{1-K}$

$MX_2 = 376485-17900.(24.295)-1039(4)-1517.(0.545)+420(5.40)-188(0.545)+52(5.4) = -60932.^{1-K}$

$MX_3 = 111985-1039.(19.272)-4072.(24.295)-289(0.545)+80(5.4) = -6693.^{1-K}$

$$MAX\ P = \frac{20077}{169} + \frac{99573(21.228)}{30200} + \frac{60932(25.25+0.545)}{42456}$$

$= 118.8 + 70.0 + 37.0 = 225.8^K/\text{PILE} < 450^K/\text{PILE}$ OK

$$MIN\ P = \frac{20077}{169} - \frac{99573(21-0.228)}{30200} - \frac{60932(25.25-0.545)}{42456}$$

$= 118.8 - 68.5 - 35.5 = 14.8^K/\text{PILE}$ (NO UPLIFT) OK

CHECK 6 PILES BELOW NEW COLUMN

$$P = 118.8 - \frac{99573(7-0.228)}{30200} + \frac{60932(3.604+0.545)}{42456} + \frac{295}{6}$$

$= 118.8 - 22.3 + 6.0 + 49.2 = 151.3^K/\text{PILE}$

MAX SHEAR

$$S_1 = \frac{1039}{169} + \frac{6693(21)}{76837} = 8.0^K$$

$$S_2 = \frac{4441}{169} + \frac{6693(25.25)}{76837} = 28.5^K$$

$$S_T = \sqrt{\overline{8.0}^2 + \overline{28.5}^2}$$

$S_T = 29.6^K/\text{PILE} < 32.^K/\text{PILE}$ OK

* REV 3

EBASCO SERVICES INCORPORATED

BY R. SCHMIDT DATE 1-15-82 SHEET 187B OF 206

CHKD. BY S. SUN DATE 1-20-82 CAR OFS NO. 2762.018 DEPT. NO. 403

CLIENT CP&L

PROJECT HBR #2

SUBJECT FHB-PILE LOADS

1.25 (D1 + D2) + 1.25 (L1) + 1.25 (EO-NS + EONS$_2$ / EW$_1$ + EOVERT) + 1.0 Fc

TRANSFER LOADS & MOMENTS TO C.G. OF PILE GROUP

(* ENTIRE PAGE NEW)

$Fx_1 = -1408.^K$, $Fx_2 = 2624 + 226 + 63 = 2913.^K$

$Fx_3 = -19578. - 1806. - 500. - 151. - 42. = -22077.^K$

$Mx_1 = -423674. - 2624.(4.0) + 19578.(19.272) + 42(1.52) - 151(0.228) - 1806.(0.228) + 500.(1.52) - 226(2) - 63(8) = -57441.^{1\text{-}K}$

$Mx_2 = 408{,}263 - 1408.(4.0) - 19578.(24.295) + 42(5.4) - 151(0.545) + 500.(5.4) - 1806.(0.545) = -71{,}156.^{1\text{-}K}$

$Mx_3 = 85839. - 1408.(19.272) - 2624.(24.295) - 226(0.545) + 63(5.4) = 4{,}829.^{1\text{-}K}$

$$\text{MAX } P = \underset{(130.6)}{\frac{22077.}{169}} + \underset{(40.4)}{\frac{57441.(21 + 0.228)}{30200}} + \underset{(43.2)}{\frac{71{,}156(25.25 - 0.545)}{42456}}$$

MAX P = 214.^{K} < CAPACITY (450^K/PILE) OK

$$\text{MIN } P = \underset{(130.6)}{\frac{22077}{169}} - \underset{(39.5)}{\frac{57441(21 - 0.228)}{30200}} - \underset{(41.4)}{\frac{71156(25.25 - 0.545)}{42456}}$$

MIN P = 50.^{K} NO UPLIFT OK

CHECK 6 PILES BELOW NEW COL.

$$P = 130.6 - \underset{(12.9)}{\frac{57441(7 - 0.228)}{30200}} + \underset{(7.0)}{\frac{71156(3.604 + 0.545)}{42456}} + \underset{(34.9)}{\frac{209.5}{6}} = 160.^K$$

MAX SHEAR PER PILE

$$S_1 = \frac{1408}{169} + \frac{4829(21)}{76837} = 9.7^K$$

$$S_2 = \frac{2913}{169} + \frac{4829(25.25)}{76837} = 18.8^K$$

$$\therefore S_T = \sqrt{9.7^2 + 18.8^2} = 21.2^K$$

S_T = 21.2^K/PILE < CAPACITY/PILE (32^K/PILE) OK

*ENTIRE PAGE NEW

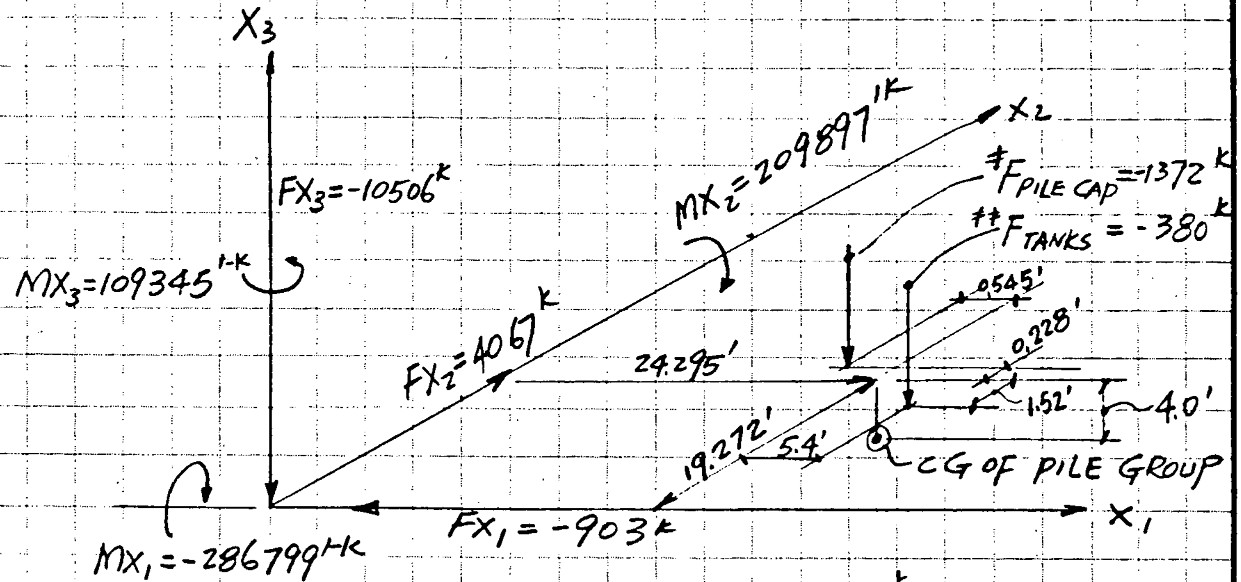
LOAD TABULATION OF MAX UPLIFT CASE.

AS PER REFERENCE #8,
COMBINATION LOAD CASE CAN BE WRITTEN AS:

$$0.95(D_1 + D2) - 1.0(E_{SSNS} + E_{SSNS_2/EW1} + E_{SSVERT})$$

(NO CASK DROP FOR UPLIFT INCLUDED)

LOAD CASE #	SYMBOL	0.95 FX_1	0.95 FX_2	0.95 FX_3	0.95 MX_1	0.95 MX_2	0.95 MX_3
1	D1	-854	36	-11916	-219895	250726	16742
4	D2	-439	9	-431	-8054	-124	8335
		2.0 FX_1	2.0 FX_2	2.0 FX_3	2.0 MX_1	2.0 MX_2	2.0 MX_3
11	Ess-NS	0	3632	0	-89780	0	82930
17	Ess-VERT	0	0	+2708	+50224	-61776	0
		1.0 FX_1	1.0 FX_2	1.0 FX_3	1.0 MX_1	1.0 MX_2	1.0 MX_3
19	EssNS2/EW1	390	390	-867	-19294	21,071	1338
	Σ	-903	4067	-10506	-286799	209897	109345



ADD 0.95 × D.L. OF PILE CAP. (0.95×45.0×53.5×4.0×0.15) = 1372 k (1445 k)

ADD 0.95 × D.L. OF GAS DECAY TANKS (0.95×4×100.0) = 380 k

* ENTIRE PAGE NEW

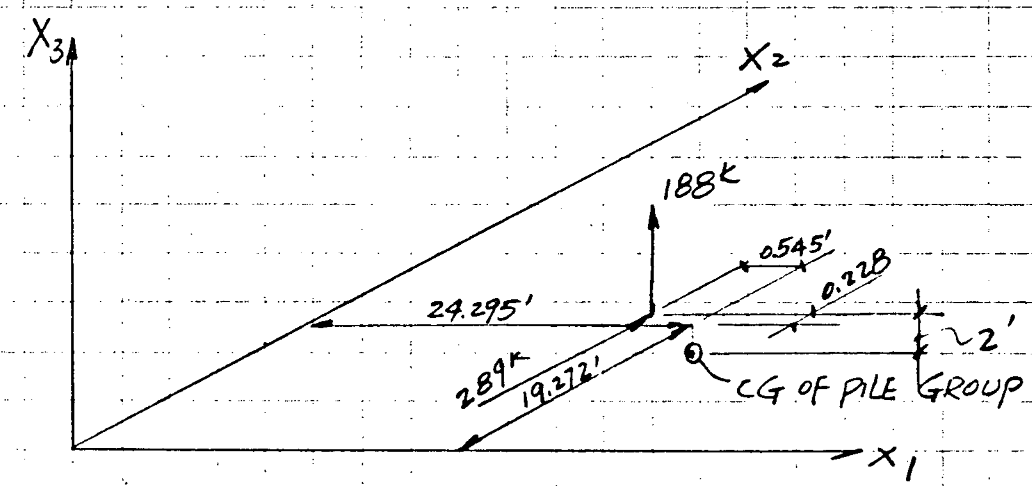
0.95(D1 + D2) - 1.0(Ess NS + Ess NS2/EW1 + Ess VERT) CONT.

Ess-NS FOR PIPE CAP = 1.0(0.2)(1445) = 289^K

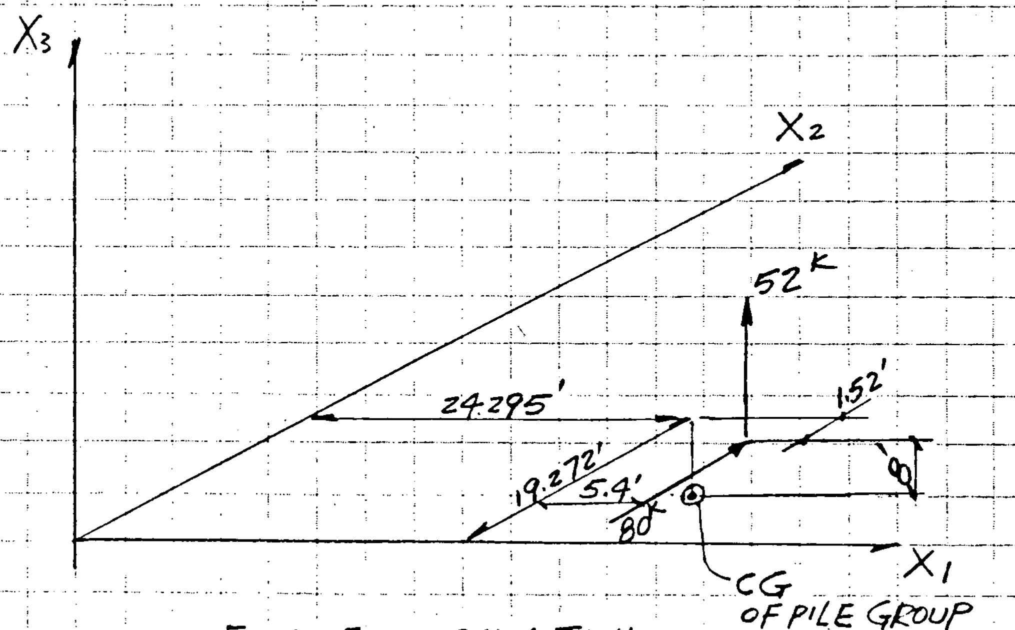
Ess-VERT " " " = 1.0(0.13)(1445) = 188^K

Ess-NS FOR DECAY TANKS = 1.0(0.2)(400) = 80^K

Ess-VERT " " " = 1.0(0.13)(400) = 52^K



ESS FOR PILE CAP



ESS FOR DECAY TANKS

* ENTIRE PAGE NEW

$0.95(D1+D2) - 1.0(Ess_{NS} + Ess_{NS2/EW1} + Ess_{VERT})$

TRANSFER LOADS & MOMENTS TO C.G. OF PILE GROUP

$FX_1 = -903^k \quad FX_2 = 4067 + 289 + 80 = 4436^k$

$FX_3 = -10506 + 188 + 52 = 10266^k$

$$MX_1 = -286799 - 4067(4.0) + 10506(19.272) - 1372(0.228) + 380(1.52) + 188(0.228) - 52(1.52) - 289(2.0) - 80(8.0) = -101584^{\prime\text{-}k}$$

$$MX_2 = 209897 - 903(4.0) - 10506(24.295') - 1372(0.545) + 380(5.4) + 188(0.545) - 52(5.4) = -47832^{\prime\text{-}k}$$

$$MX_3 = 109345 - 903(19.272) - 4067(24.295) - 289(0.545) + 80(5.4) = -6591^{\prime k}$$

MAX UPLIFT CASE:

$$\text{MIN } P = \frac{10266}{169} - \frac{101584(21-0.228)}{30200} - \frac{47832(25.25-0.545)}{42456}$$

$$= 60.7 - 69.9 - 27.8 = -37^k < \text{CAPACITY / PILE}$$

(260^k/PILE UPLIFT) FOR UPLIFT PILE

FOR COMPRESSION ONLY PILES (SEE DWG. G190419 FOR LOCATION)

$$\text{MIN. } P = 60.7 - \frac{101584(21-0.228-2\times3.5)}{30200} - \frac{47832(25.25-0.545-2\times3.604)}{42456}$$

$$= 60.7 - 46.3 - 19.7$$

$$= -5.3^k$$

OK, SINCE VERY LARGE RESERVE ARE LEFT IN UPLIFT PILES.

ATTACHMENT 3

H. B. ROBINSON UNIT NO. 2

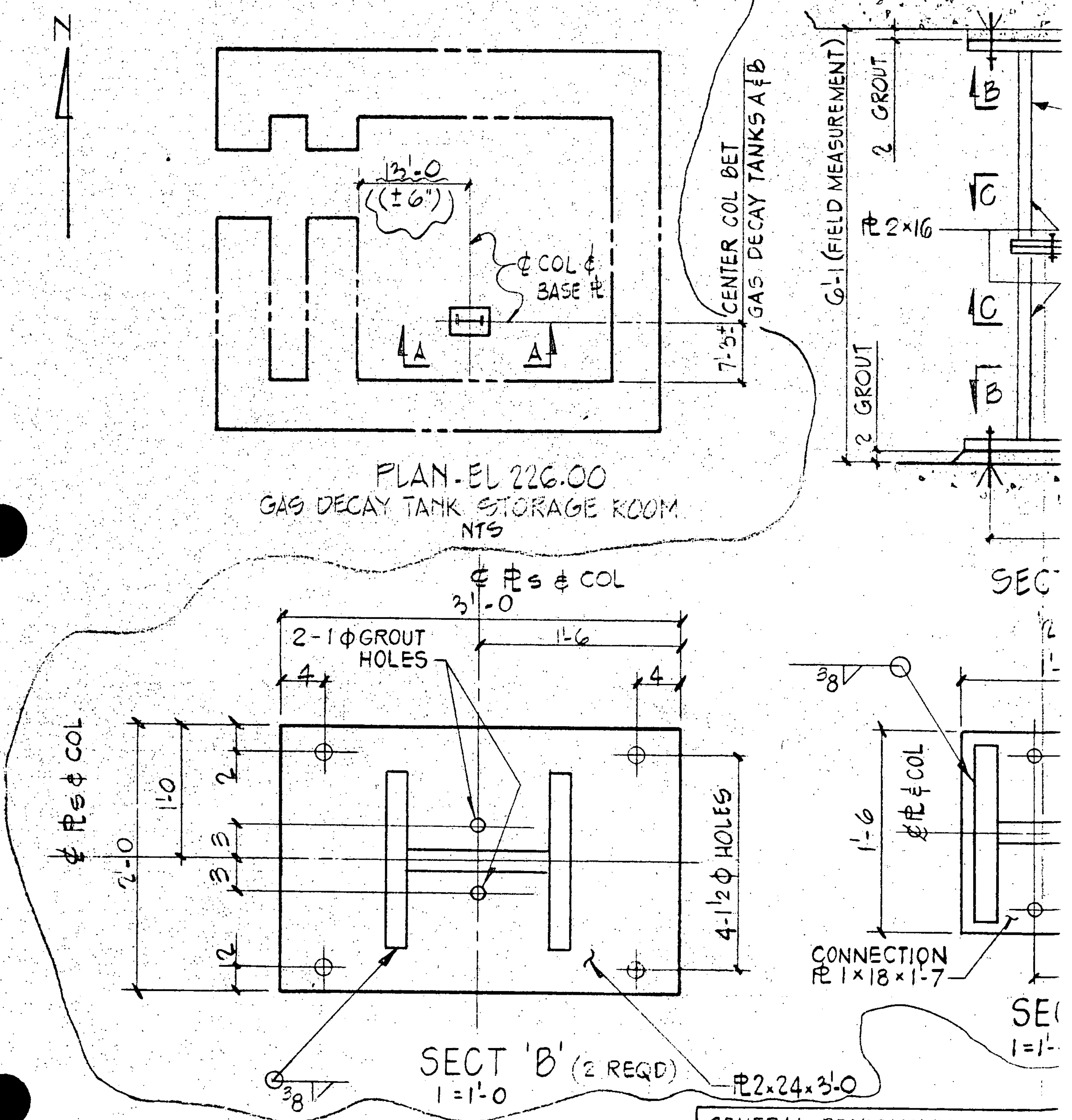
SPENT FUEL POOL AREA

STRUCTURAL MODIFICATION

DRAWING CAR 2762-B-410-R1

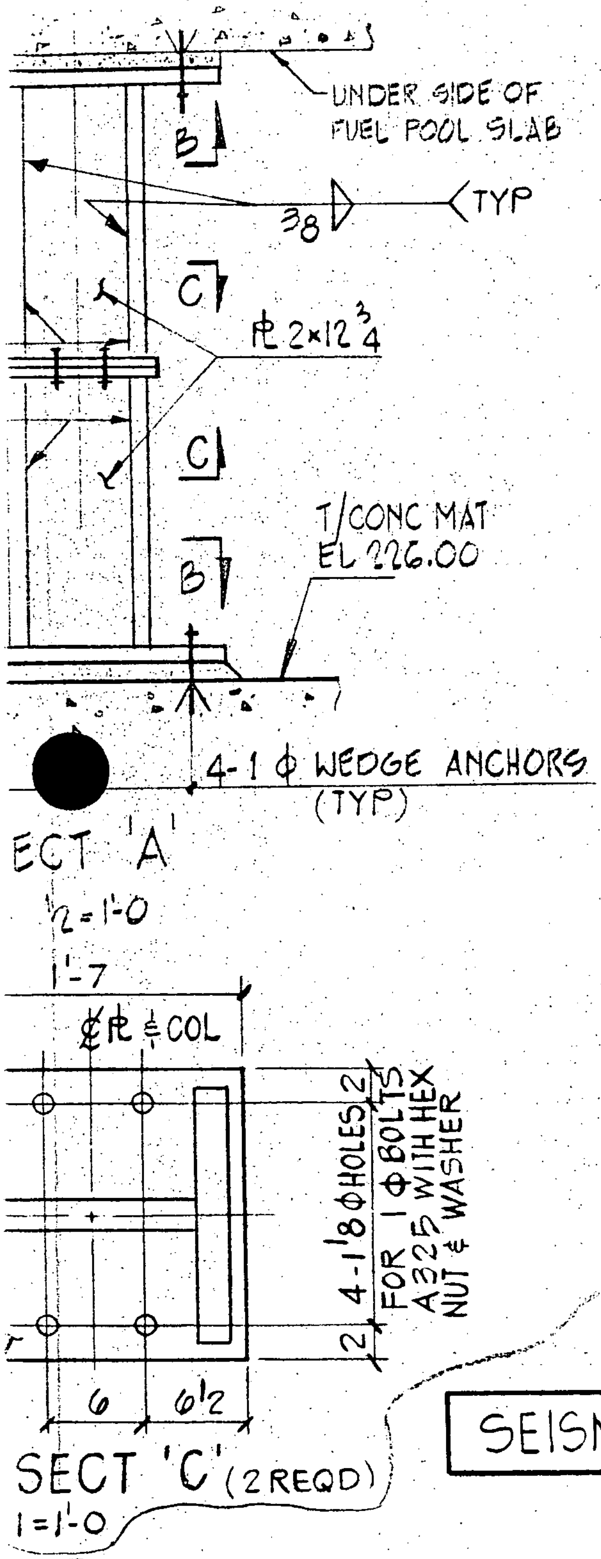
REFERENCE DRAWING:

PLAN-GEN ARRGT-FUEL HANDLING BLDG & MACHINE SHOP
G-190192



GENERAL REVISION "AS CIRCLE				
1	12-4-31	JR	SS	WL PC/GM
Nº	DATE	BY	CH	APPROVE

INCHES 0 1 2
CM. 0 1 2 3 4 5



NOTES:

1. ALL STEEL PLATE SHALL BE ASTM A-36.
2. CONCRETE WEDGE ANCHORS SHALL BE 1Ø X 12 WEDGE ANCHORS, NO. WS-100120 AS MANUFACTURED BY PHILLIPS DRILL CO. OR APPROVED ALTERNATE.
3. GROUT SHALL BE MASTER BUILDERS EMBECO 636 OR APPROVED ALTERNATE.
4. WELDERS, WELDING OPERATORS AND WELDING AND WELD PROCEDURES SHALL BE IN ACCORDANCE WITH AWS D1.1.81. STRUCTURAL WELDING CODE.
5. WELDING ELECTRODES SHALL BE AWS-A5.1 LOW HYDROGEN CLASS E70XX FOR MANUAL SHIELDED METAL ARC WELDING, OR AWS-A5.17 F7X FOR SUBMERGED ARC WELDING.
6. PREHEAT IS REQUIRED IN ACCORDANCE WITH AWS D1.1.81. TABLE 4.2 GROUP 1.
7. ALL WELDS SHALL BE INSPECTED BY THE LIQUID PENETRANT METHOD IN ACCORDANCE WITH ASTM E165.
8. ALL MATERIAL SHALL BE FURNISHED WITH A CERTIFICATE OF COMPLIANCE.
9. ALL COLUMN ENDS AND CONNECTION AND BEARING PLATES SHALL BE MILLED TO BEAR ON ALL METAL TO METAL CONTACT SURFACES.
10. FOR SURFACE PREPARATION AND PAINTING, SEE EBASCO SPECIFICATION CAR-HBR-C-4.
11. FOR BILL OF MATERIAL, SEE BM-410.
12. INSTALL UPPER COLUMN SECTION FIRST, UTILIZING WEDGE ANCHORS FOR LEVELING. AFTER GROUT HAS THOROUGHLY SET, TIGHTEN WEDGE ANCHORS ACCORDING TO MANUFACTURER'S INSTRUCTIONS (250-300 FT-LBS). THEN SLIDE LOWER COLUMN SECTION IN PLACE, BOLT CONNECTING PLATES TOGETHER USING A325 BOLTS WITH TURN-OF-NUT METHOD OR LOAD INDICATOR WASHERS. INSTALL WEDGE ANCHORS, GROUT, AND AFTER GROUT HAS THOROUGHLY SET, TIGHTEN LOWER WEDGE ANCHOR NUTS TO 75-100 FT-LBS TORQUE. UPPER WEDGE ANCHOR BOLTS ARE NOT TO BE USED TO HOLD ENTIRE COLUMN IN PLACE DURING GROUTING OF BOTTOM BASE PLATE. JACKS OR WEDGES MUST BE UTILIZED TO ENSURE NO TENSION IN COLUMN.
13. GROUT FOR UPPER AND BASE BEARING PLATES MUST BE INSTALLED IN STRICT ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS TO ENSURE FULL AND COMPLETE BEARING.

SEISMIC CLASS I

GEORGIA REGISTERED No 3372 PROFESSIONAL ENGINEER JOHN DOUGLAS SYKES, JR.

J. D. SYKES, JR. REGISTERED NO. 1883 PROFESSIONAL ENGINEER SOUTH CAROLINA

RCLED"
IDS
ROVED

EBASCO SERVICES INCORPORATED	APPROVED	CAROLINA POWER & LIGHT H.B. ROBINSON STEAM ELECTRIC PLANT-UNIT No2 FUEL HANDLING BUILDING SPENT FUEL POOL AREA STRUCTURAL MODIFICATION	CAR 2762 B-410
DIV. CIVIL DR. SOMERSZALL SUN			
SCALE AS NOTED CH. SCHMIDT			
DATE 7-24-81	WL/RGM GM		

ATTACHMENT 4

H. B. ROBINSON UNIT NO. 2

FUEL HANDLING BUILDING PILING

PLAN AND DETAILS

DRAWING NO. G-190419

Note: W. J. Ross received this attachment