COMANCHE PEAK STEAM ELECTRIC STATION
OMISSION OF SHEAR TIE REINFORCING STEEL
APPROXIMATE ELEVATION 993 to 997
UNIT No. 2 - REACTOR CONTAINMENT BUILDING
CONCRETE PLACEMENT NO. 201-5805-032

GENERAL OVERVIEW

On August 27,1979 following completion of the subject concrete placement, a construction reinforcing steel foreman observed that additional shear tie reinforcing steel specified by the design documents above the construction joint at Elevation 997'-6" were not in place. Further investigation by the foreman determined that the three rows of additional shear tie reinforcement specified for inclusion in the completed placement between Elevation 993'-1½" and 996'-9½" had inadvertently been omitted. The foreman immediately reported the matter to the Quality Control Inspector of record. The Inspector documented the matter on Nonconformance Report C-1653 and this report was submitted to responsible personnel for resolution and disposition. A Supervisory hold in accordance with established procedures was placed on further concrete placements pending Engineering review of the matter.

Project Management and Site Engineering personnel in consultation with Gibbs and Hill structural designers and management personnel in New York decided, following preliminary analysis of the discrepancy, that additional shear tie reinforcement in excess of the original specified requirements should be placed above the construction joint at Elevation 997'-6". This decision is documented on CPSES Design Change Authorization (DCA) No. 5536. A remote economic risk consisting of possible drilling and grouting of shear reinforcement into placement No. 201-5805-032 (in the unlikely event of an overstress condition at this level following completion of detailed engineering calculations) was pointed out by Gibbs & Hill to Project Management. This risk, considering the conservative nature of the original design, was determined to be acceptable to Project Management. DCA No. 5536 was released on August 30,1979 in accordance with established procedures thus removing the supervisory holds previously established. The next concrete lift (Placement No. 201-5805-033) was completed on August 31,1979.

1506 038

On September 4, 1979, the NRC Regional Resident Inspector (RRI) was informed of the details surrounding the matter by the TUGCO Construction QA Supervisor, following telephonic conversations that date with the TUGCO, Manager, Quality Assurance. Subsequent discussions between TUGCO/TUSI Executive management and NRC Region IV, Arlington, Texas resulted in the agreement to postpone further concrete placements on RCB No. 2 pending completion of the detailed Engineering calculations directed by Project Management on August 28, 1979 and September 5, 1979.

DETAILED ENGINEERING ANALYSIS (Safety Implications)

A detailed analysis of the shear tie reinforcement omission has been completed by Gibbs & Hill and is documented in their Letter No. GTN-39821 dated September 12, 1979, included as Attachment A to this report.

This analysis clearly indicates that the shear tie reinforcement omission results in a minor modification to the originally specified design requirements and, as such, does not constitute a "change" in the original design, i.e., form, fit and/or function have not been compromised. The structure is acceptable as constructed and no corrective action is required.

The engineering analysis is currently being expanded to include (for the record) additional calculations to further document the range of stress levels in the reinforcing steel and concrete at the elevations affected by the identified discrepancy. This expansion of the analysis will be submitted under separate cover by September 26, 1979, but will not alter the conclusions reached to date, as summarized above. The Final Safety Analysis Report will be modified to reflect the current design and analysis approach.

CORRECTIVE ACTION (For Apparent QA Program Breakdown)

The apparent breakdown in the QA/QC Program which allowed the omission of the reinforcing steel to occur has been analyzed independently by Construction and Quality Assurance Management. This review indicates that the shear tie omission was the direct result of human error on the part of both the craft and Quality Control personnel, i.e., Program and Procedural requirements were adequate but were not fully implemented.

Consequently, corrective action to minimize recurrence of this type QA/QC breakdown has or will consist of the following actions.

1. Construction management has formally directed through issuance of Construction Instruction 35-1195-CEI-24 on September 13,1979, a checkoff program to verify installation of reinforcing steel on RCB No. 2 in accordance with specified requirements. This program includes documented verification by craft supervision as well as an independent check by at least one individual to further verify the adequacy of the installation. This program will be in addition to the established independent inspections by Quality Control (QC) personnel.

2. The QC Inspector involved has been counselled by immediate supervision as well as the CPSES Quality Control Supervisor, resulting in a clarification of duties and responsibilities. Considering the experience and dedication of the inspector, this action together with normal daily supervision will result in adequate preventive action for future inspection errors in the structural discipline.

PREVENTIVE ACTIONS (Generic Issues-Inspection Efforts)

The results of our analysis of the shear tie reinforcing steel omission discrepancy coupled with previously initiated QA Management Review of QA/QC efforts at CPSES, and considering recent inspection efforts on the part of the NRC-RRI, the following actions have been or will be implemented.

1. The Construction QA/QC organizational structure has been under QA Management review for some time which has resulted in reassignment of key personnel. The details of these personnel changes have been discussed with the RRI and will be formally included in the next revision of Procedure CP-QP-3.0, "CPSES Site Quality Assurance/Quality Control Organization."

2. The organizational changes include the assignment of experienced and knowledgable supervisory personnel in lead positions. In addition, a Quality Engineering (QE) Organization was established in May,1979 and staffing was essentially completed in August. The QE group

has been assigned the authority for detailed inspection planning as well as to assure positive quality assurance indoctrination and technical training of inspection personnel.

3. Beginning the week of September 17, 1979, the QE Group will be aided by knowledgeable and experienced Senior QA/QC personnel with the objective of accelerating completion of the QC/QE Charter. It is anticipated that these efforts will include:

   a. Interviews with QC personnel for the purpose of analyzing background and experience and to establish additional training sessions that may be required.

   b. Implementation of documented training programs based on the results of the personnel interviews.

   c. Reassignment of personnel, as required.

4. Upon completion of these efforts, the TUGCO Manager, Quality Assurance, will conduct a comprehensive audit of the implementation of the Construction QA/QC Program, with identified corrective actions to be implemented as required. It is anticipated that this audit will be completed by November 15, 1979.

PREVENTIVE ACTIONS (Generic Issues-Construction Craft)

Construction supervision, Engineering personnel and the Quality Engineering group are in the process of reviewing established Quality Assurance systems and procedures to verify that they adequately address CPSES Quality Assurance Program requirements. The principal objective of this review effort is to assure that specified design and construction requirements are presented in a straightforward manner thus minimizing the possibility of craft errors. Additionally, maximum use is currently being made of an established Construction Operation Traveler System which sequentially outlines construction and inspection efforts thereby reflecting specified design, construction and inspection requirements in a highly visible manner. Site QA and QE Staff personnel initiated a detailed surveillance of the Traveler System in early September and this effort will be ongoing as required to maintain the system's objectives.

COMANCHE PEAK STEAM ELECTRIC STATION
OMMISSION OF SHEAR TIE REINFORCING STEEL
APPROXIMATE ELEVATION 993 TO 997
UNITE NO. 2 - REACTOR CONTAINMENT BUILDING
CONCRETE PLACEMENT NO. 201-5805-032

ATTACHMENT A

DETAILED ENGINEERING ANALYSIS

Gibbs & Hill, Inc.
ENGINEERS DESIGNERS CONSTRUCTORS

DIRECT DIAL EXTENSION
(212) 760- 4450

September 12, 1979

GTN- 39821

CPSES-OPGM		
JBG	RGT	HOK
MH	MEH	RTW
[illegible]	RGW	UDD
MRM	TPM	LAA
GBC	KHB	
LFF		
EGG		
BJM		
JCK		
REC		FILE

Texas Utilities Generating Company
Post Office Box 1002
Glen Rose, Texas 76043

Attention: Mr. J. B. George
Project General Manager

Gentlemen:

TEXAS UTILITIES GENERATING COMPANY
COMANCHE PEAK STEAM ELECTRIC STATION
1981-83 - 2300 MW INSTALLATION
G&H PROJECT NO. 2323
ENGINEERING EVALUATION OF AS-BUILT
UNIT 2 CONTAINMENT
ELEVATIONS 993'-1 1/2" AND 996'-9 1/2"
REF 1: TWX-11,384, DATED 8/28/79
REF 2: DCA 5536, REV. 1, DATED 9/10/79
REF 3: GTT-4188, DATED 9/6/79

CPSES Engineering (New York) was requested to review the Unit 2 containment exterior wall reinforcement as-built condition as described in references 1 and 2. Reference 3 recommended that subsequent concrete lifts could be placed with the understanding that further analysis was necessary to determine if additional remedial action would be necessary. This letter presents a summary of this engineering evaluation.

Details of this study are contained in Gibbs & Hill calculation book SRB-122C between pages 3/2 and 3/15. A summary of these calculations are attached as well as two sketches showing containment wall shear ties per the construction drawings and the as-built condition.

1506 043

The Problem

Some of the shear reinforcement indicated on the construction drawings for the Unit 2 containment wall between elevations 993'-1 1/2" and 996'-9 1/2" below the dome spring line, were inadvertently omitted. When this omission was discovered, after the concrete had been poured, the field provided additional shear reinforcement in addition to that called for on the construction drawings between the construction joint at elevation 997'-6" and the dome spring line above, reference 2.

Original Design

Below the spring line, radial shear forces occur in the containment wall as a result of the design loadings, due to the discontinuity between the wall and the dome.

In the analysis, three different mathematical models were conservatively considered to evaluate possible response patterns of the concrete containment, see FSAR Subsection 3.8.1.4.1., subparagraph 2. In Model No. 1, the properties of the concrete and reinforcement were considered in the stiffness calculations in both vertical and horizontal directions.

In MOdel No. 2, the properties of the concrete in the horizontal direction were discounted in the stiffness calculation and only the stiffness of the resteel in this direction was used.

In Model No. 3, the stiffness of the concrete was ignored in the stiffness calculations and the stiffness of the reinforcing steel only was used in both horizontal and vertical directions.

In the original design, reinforcement was provided in the area in question to conservatively resist maximum envelope shear forces, for the most critical loading combinations using the model, which gave the maximum forces. It should be noted that no attempt was made to reduce the reinforcement by investigating the applicability of the model to the critical loading condition.

Present Approach to Evaluate the As-Built Condition

The critical shear forces for which the reinforcement was originally designed were established as enveloping those resulting from the LOCA accident pressure loading associated with Model

No. 1, Model No. 2 and Model No. 3. It has been determined through analysis that of the three models, Model No. 3 response is the most appropriate model to be used due to the effects of the high vertical and circumferential tensile membrane forces in the wall resulting from the critical LOCA loading combination.

Therefore, the shear forces determined using Model No. 3 were used to verify the as-built shear reinforcement and the as-built condition was found to be more than adequate. It should be noted that with Model No. 3 computed loads all the shear load in the subject area is assumed to be resisted by the shear tie reinforcing only and no reliance is placed on the shear capacity of the concrete. If, in fact, Model No. 1 or Model No. 2 were applied, then there would be shear capability in the concrete which was ignored in Model No. 3. In this event, the concrete would resist some of the shear load. The total shear load would be resisted by the concrete together with the as-built reinforcing steel shear ties. Accordingly, the Engineer concludes that the as-constructed condition is acceptable. The remedial action as described in DCA-5536, Rev. 1 is adequate to assure the integrity of the Unit 2 containment in the design bases condition.

Very truly yours,

GIBBS & HILL, Inc.

R. E. Ballard

Harvey R. Rock
Manager of Projects

HRR-ELB-IG:lc
1 Letter + Attachments

CC: ARMS (B&R Site) OL + 1A
J. T. Merritt (TUSI Site) 1L + 1A
H. C. Schmidt (TUSI Dallas) 2L + 2A
J. C. Kuykendall (TUGCo Site) 1L 1A
R. E. Holloway (G&H Dallas) 2L 2A
R. E. Heim (G&H Site) 1L 1A

Date SEPT. 1979 | Gibbs & Hill, Inc. | 3/1 | Filing Code SRB-12?C.

ENGINEERS, DESIGNERS, CONSTRUCTORS
NEW YORK

Calc By P. K. Banga | Sheet No. 1 of 18

Chk'd/Appr'd. By C.J. 9/11/79 UNIT-2 | G & H Job No. 2323-001.

Subject TUSI: CONTAINMENT WALL

Checkers Comments Accepted By ..... Safety Related: YES ☑ NO ☐

Materials: CONC.: f'_c = 4 Ksi REBAR: f_y = 60 Ksi

Ref. Codes: ASME-ACI 359

Rel. FSAR: SEC. 3.8

Other Ref.: FIELD D.C.A. # 5536 REV. 1 DATED SEPT. 10, 1979 (COPY ENCLOSED).

Assumptions: FIELD TWX-11384 DATED AUG. 28, 1979 (COPY ENCLOSED);

RESULTS

OBJECT:

3 Rows of Addl. # 6 shear bars as shown in drg. # 2323-S2-0505 REV. 5 bet. EL. 993'-1½" and 996'-9½" were omitted in the field.

This became known after concrete was poured upto EL. 997'-6" (Refer TWX-11384). Add'l. # 6 shear bars at closer spacings were added above EL. 997'-6". This is shown in detail on enclosed Field DCA # 5536 REV. 1 dated Sept. 10, 1979.

The object is to determine if this as-built condition <u>without</u> additional shear ties between EL. 993'-1½" and 996'-9½" is acceptable.

CONCLUSION:

As-built condition is acceptable without additional shear ties between EL. 993'-1½" and EL. 996'-9½". See detail calculations on pages 3/2 to 3/16 ✓

1506 046

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Calc By P.K.B. — Sheet No. 2 Of .....

Chk'd/Apprd. By C.Z. 9/11/79 — G & H Job No. 2323-001

Subject TUSI: CONT. WALL - UNIT 2

Checkers Comments Accepted By ..... Safety Related: YES ☑ NO ☐

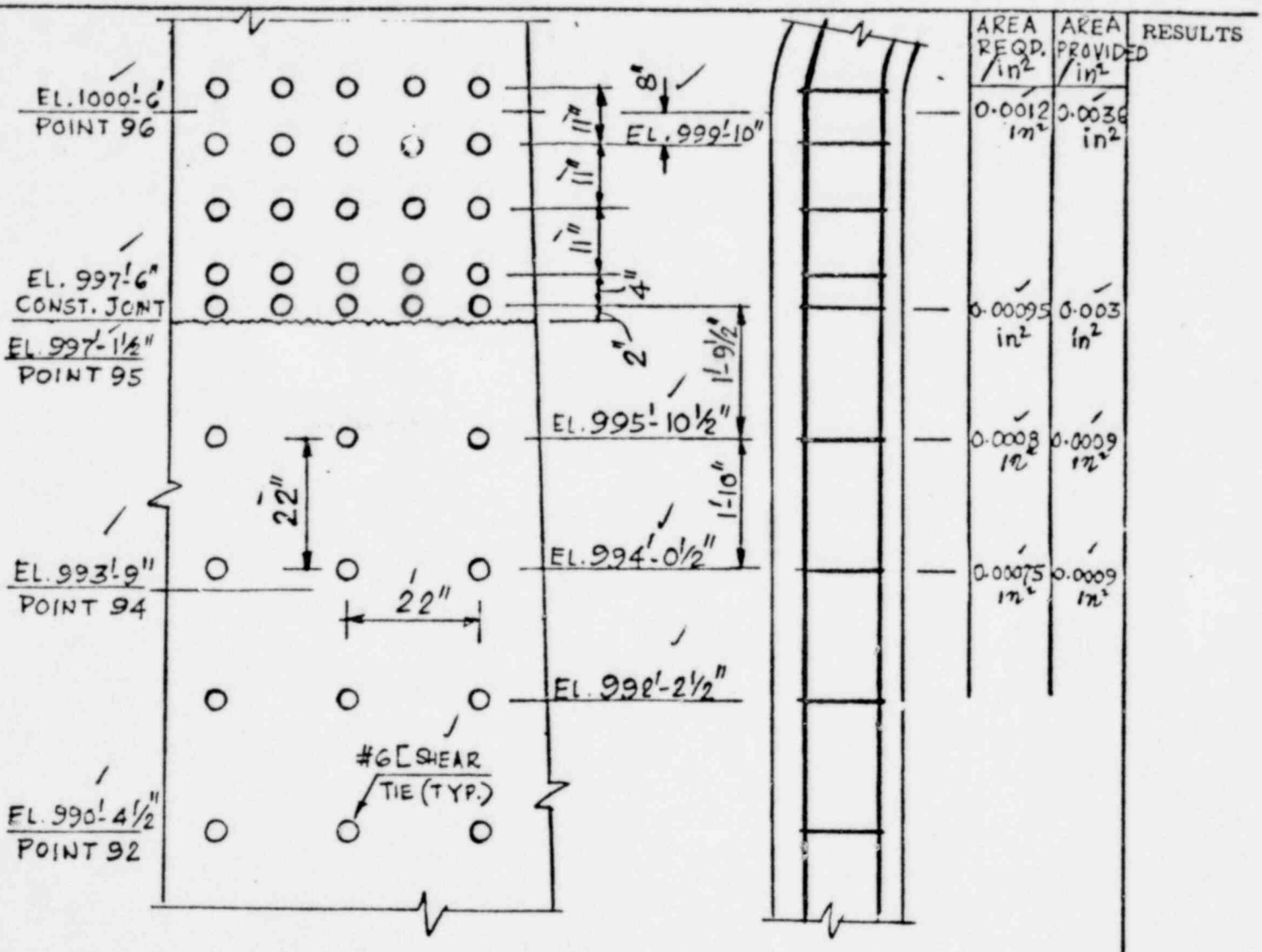
Materials: .....

Ref. Codes: SEE PAGE 3/1

Ref. FSAR: .....

Other Ref.: .....

Assumptions: SEE BELOW



PART ELEVATION OF WALL SHOWING AS-BUILT SHEAR REINFORCEMENT

(REFER DC/DDA # 5536 & TWX - 11384

WALL SECTION

1506 047

Date SEPT. 1979. Gibbs & Hill, Inc. 3/3 Filing Code SRB-122C..
ENGINEERS, DESIGNERS, CONSTRUCTORS
NEW YORK
Calc By P.K.B. Sheet No. 3 Of
Chk'd/Apprd. By C.Z. 9/14/79 G & H Job No. 2323-001.
Subject T.U.S.I. CONTAINMENT WALL UNIT-2
Checkers Comments Accepted By Safety Related: YES ☑ NO ☐
Materials:
Ref. Codes: SEE PAGE-3/1
Ref. FSAR:
Other Ref.:
Assumptions: SEE BELOW

RESULTS

Three different models are investigated in the analysis of the containment shell. Each model assumes a different degree of concrete cracking. Model 1 assumes a completely uncracked section. Model 2 assumes only vertical cracks throughout structure, so that the stiffness in the direction perpendicular to cracks ~~Cracked direction~~ is represented by the properties of rebar only, neglecting stiffness of concrete. Model 3 assumes both vertical and horizontal cracks throughout structure; the stiffness of concrete is ignored in both directions, with only properties of rebar considered.

REV. 1 PKB 9-12-79 C.Z 9/14/79

OUT REV. 1 PKB 9-12-79 C.Z 9/11/79

In the original design, the requirement for worst condition occuring in any model was conservatively considered for disign of shear reinforcement. However, the requirements for Models 1 and 2 are not relevant for design of shear reinforcement at the location in question. This is explained in the following page.

RESULTS

Maximum radial shear acts during accident pressure and temperature condition. In this case, the magnitudes of axial tensions $N\phi$ and $N\theta$ associated moments $M\phi$ and $M\theta$ are such that concrete will crack in both vertical and horizontal directions in all Models (Model 1, Model 2 and Model 3). ✓

Therefore, for design purposes, it will be inappropiate to consider maximum values of radial shear for Models 1 and 2. As such, Containment wall section between El. 993'-1½" and 996'-9½" will be checked for maximum values of radial shear occuring in Model 3 only. ✓ This will be further confirmed in the following pages by performing calculations to ascertain the validity of completely cracked section in both vertical and horizontal directions. ✓

RESULTS

RADIA SHEAR Q

The following tables# 1A, 1B & 1C show max^m values of radial shear acting on the cont. between EL. 990'-4½" and 1000'-6". The max^m radial shear Q along with associated axial tensions and moments in meridional and circumferential directions (N_ϕ, M_ϕ, N_θ and M_θ) are obtained from Computer output Book # SRB-97P and SRB-99P.

Furthermore, the tables # 2A, 2B & 2C show the corresponding maximum values of radial shear occuring during condition when there is NO accident pressure and temperature inside containment. Shear reinf. requirements in Models 1 & 2 under this condition is less than that which is required for Model 3 under accident pressure and temperature condition as is evident in the following Tables.

1506 050

Date SEPT. 1979 — Gibbs & Hill, Inc. — ENGINEERS, DESIGNERS, CONSTRUCTORS — NEW YORK — 3/6 — Filing Code SRB-122C

Calc By PKB — Sheet No. 6 Of .....

Chk'd/Apprd. By C.Z. 9/11/79 — G & H Job No 2323-001

Subject T.U.S.I. CONT. WALL : UNIT 2

Checkers Comments Accepted By ..... Safety Related: YES ☑ NO ☐

Materials: .....

RSI Codes: ..... SEE PAGE 3/1

Ref. FSAR: .....

Other Ref.: .....

Assumptions: SEE BELOW

MAXM. RADIAL SHEAR WITH ACC. PRESS. & TEMP. (Q)

RESULTS

LOADING COMBINATION: CL 410 : U = D + T_{S_1} + 1.5 Pa + Ta
CL 430 : U = D + TW + 1.5 Pa + Ta

F.S.A.R. SEC. 3.8.1-32.2a

TABLE 1A

MODEL - 1							
MERIDIAN	POINT	Q (K/in)	Nφ (K/in)	Mφ (K-in/in)	Nθ (K/in)	Mθ (K-in/in)	LOADING COMB.
8	92	-1.7	44.4	270	67.6	348	CL 430
8	94	-2.29	44.5	190	66.6	334	CL 430
8	95	-2.9	44.7	86	66.9	316	CL 430
8	96	-3.45	44.8	-42	69.4	294	CL 430

TABLE 1B

MODEL - 2							
MERIDIAN	POINT	Q	Nφ	Mφ	Nθ	Mθ	LOADING COMB.
8	92	-2.09	36.9	190	57.0	63	CL 430
8	94	-2.56	36.7	97	56.8	63	CL 430
8	95	-3.02	36.4	-15	57.0	63	CL 430
8	96	-3.47	36.2	-146	57.8	63	CL 430

TABLE 1C POOR ORIGINAL

MODEL - 3								
MERIDIAN	POINT	Q	Nφ	Mφ	Nθ	Mθ	LOADING COMB.	
8	92	-1.04	32.6	110	55.0	124	CL 430	EL. 990'-4½"
6	94	-1.5	36.7	-109	57.6	-51	CL 410	EL. 993'-9"
6	95	-2.05	363	-181	56.6	-51	CL 410	EL. 997'-1½"
6	96	-2.61	35.9	-275	56.8	-51	CL 410	EL. 1000'-6"
8	94	1.49	32.4	60	53.3	124	CL 430	EL. 993'-9"

Date: SEPT. 1979 — Gibbs & Hill, Inc. — 3/7 — Filing Code SRB-122.C

ENGINEERS, DESIGNERS, CONSTRUCTORS
NEW YORK

Calc By PKB — Sheet No. 7 Of

Chk'd/Apprd. By G.J. 9/4/79 — G & H Job No. 2323-001

Subject TUSI: CONT. WALL: UNIT 2

Checkers Comments Accepted By — Safety Related: YES ☑ NO ☐

Materials:
Ref. Codes: SEE PAGE 3/1
Ref. FSAR:
Other Ref.:
Assumptions: SEE BELOW

MAXM. RADIAL SHEAR WITHOUT ACC. PRESS. & TEMP. (Q)

RESULTS

LOADING COMB. CL 713: $U = D + T_{S_1} + (E'_c - E'_v)$
CL 731: $U = D + T_w + (E'_t + E'_v)$
REFER F.S.A.R SEC. 3.8.1.3.2.2.b2

TABLE 2A

MODEL-1							
MERIDIAN	POINT	Q (K/in)	Nφ (K/in)	Mφ (Kin/in)	Nθ (K/in)	Mθ (Kin/in)	LOADING COMB.
8	92	-0.53	+1.8	327	-5.3	355	CL 731
8	94	-0.68	+1.6	304	-5.4	351	CL 731
8	95	-0.83	1.5	276	-5.2	346	CL 731
5	96	-0.95	1.5	241	-4.5	339	CL 731

TABLE 2B

MODEL-2							
MERIDIAN	POINT	Q	Nφ	Mφ	Nθ	Mθ	LOADING COMB
8	92	-0.63	1.8	217	-4.0	62	CL 731
8	94	-0.71	1.7	192	-3.9	62	CL 731
8	95	-0.78	1.5	163	-3.6	62	CL 731
8	96	-0.83	1.4	132	-3.0	61	CL 731

TABLE 2C

MODEL-3							
MERIDIAN	POINT	Q	Nφ	Mφ	Nθ	Mθ	LOADING COMB.
8	92	0.17	-7.0	-51	4.0	-51	CL 713
8	94	0.27	-6.5	-43	4.6	-51	CL 713
8	95	0.4	-6.0	-31	5.1	-51	CL 713
8	96	0.54	-5.6	-13	5.5	-51	CL 713

RESULTS

I) RADIAL SHEAR: (FACTORED LOADING: ULTIMATE STRENGTH)

(A) POINT 9G: (EL. 1000'-6")

$Q = -2.61$ K/in
$N\phi = 35.9$ K/in
$M\phi = -275$ Kin/in
$N\theta = 56.8$ K/in
$M\theta = -51$ Kin/in

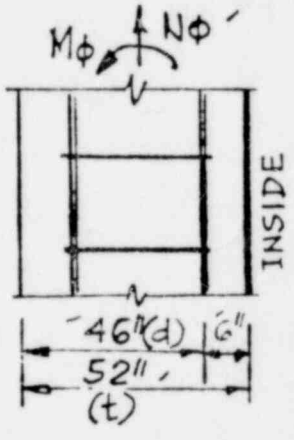
MODEL 3 CL410
SEE TABLE 1C on Page 3/6

$Q = \pm 0.098$ K/in $\approx \pm 0.1$ K/in } ROT. PLAT. LOAD COMP. BOOK# SRB-116 P1 LOADING PL2, MOD. 3 MERI. 1, POINT 73

$\therefore \sum Q = -2.61 - 0.1 = (-)\ 2.71$ K/in

CHECK WHETHER ENTIRE SECTION IN TENSION:

$N\phi = 35.9$ and $M\phi = (-)275$
$\therefore$ Tension acting on Inside face



O/A Min^m depth of Section = $4'-3\frac{5}{8}" + \frac{3}{8}"$ (Liner)
$= 4'-4" = 52"$
(Refer Field Transmittal # CPPA 2793 dated 9-10-79)

$\therefore$ Eff. depth $= d = 52 - 6 = 46$ in

$\therefore d - t/2 = 46 - \frac{52}{2} = 46 - 26 = 20$ in.

$\therefore M_{US} = M_\phi - N_\phi (d - t/2) = 275 - 35.9 \times 20 = (-)\ 443$ Kin/in.

Since M_{US} becomes negative, entire section is in tension in vert. direction.

RESULTS

Similarly, $N\theta = 56.8$ $M\theta = -51$ ✓

Tension is large compared to moment.

∴ Entire section in tension in horz. direction.

concrete has cracked in both directions.

∴ Model 3 applies. ✓

CHECK ALLOWABLE CONCRETE SHEAR STRESS:

Allow. conc. shear stress = v_c

$$v_c = 2\sqrt{f_c'}\left(1 + \frac{0.002\,N\phi}{A_g}\right)$$ ✓

ASME-ACI: 359
SEC. C.C. 3411.4.1.C

$$\therefore v_c = 2\sqrt{4000}\left[1 + 0.002\,\frac{(-)\,35900}{52\times 1'}\right]$$ ✓

$\therefore v_c = 2 \times 63.2\,(1 - 1.38)$ Result is negative

$\therefore v_c = 0$ ✓

Similarly, in the other direction, $N\theta = 56.8$ ✓

$\therefore v_c = 0$ ✓

∴ Concrete has cracked in both directions.

∴ Model 3 applies. ✓

Date SEPT. 1979 | Gibbs & Hill, Inc. ENGINEERS, DESIGNERS, CONSTRUCTORS NEW YORK | 3/10 | Filing Code SRB-122C

Calc By ... P.K.B. | Sheet No. 10 Of .....

Chk'd/Appd. By C.Z. 9/11/79 | G & H Job No. 2323-00

Subject T.U.S.I.: CONT. WALL: UNIT 2 [redacted]

Checkers Comments Accepted By ..... Safety Related: YES ☑ NO ☐

Materials: .....

Ref. Codes: SEE PAGE 3/1

Ref. FSAR: .....

Other Ref.: .....

Assumptions: SEE BELOW

RESULTS

$\therefore$ Shear Stress $v_u = \dfrac{Q}{0.85\,bd} = \dfrac{2.71 \times 1000}{0.85 \times 1 \times 46} = 69.31$ psi

As per Field DC/DDA # 5536,

#6 [shear bars provided @ 11" V.C. #.

$\therefore$ $A_{v\,Reqd.} = \dfrac{v_u \times s \times h}{f_y} = \dfrac{69.31 \times 11 \times 11}{60000} = 0.14$ in^2

Area provided : 1 - #6 bar (Area = 0.44 in^2) O.K.

ALTERNATE CALCULATION (SEE SKETCH ON PAGE 3/2):

$A_{v\,Reqd.} = \dfrac{69.31 \times 1 \times 1}{60000} = 0.0012$ in^2/inch in both direc.

$A_{v\,provided} = \dfrac{0.44}{11 \times 11} = 0.0036$

O.K.

1506 055

Date: SEPT. 1979 | 3/11

Calc. By: PKB

Chk'd/Appd. By: C.Z 9/11/79

Gilbbo & Hill, Inc.
ENGINEERS, DESIGNERS, CONSTRUCTORS
NEW YORK

Book No. SRB-122C
Sheet No. 3/11
G & H Job No. 2323-00

Subject: TUSI: CONT WALL @ UNIT 2

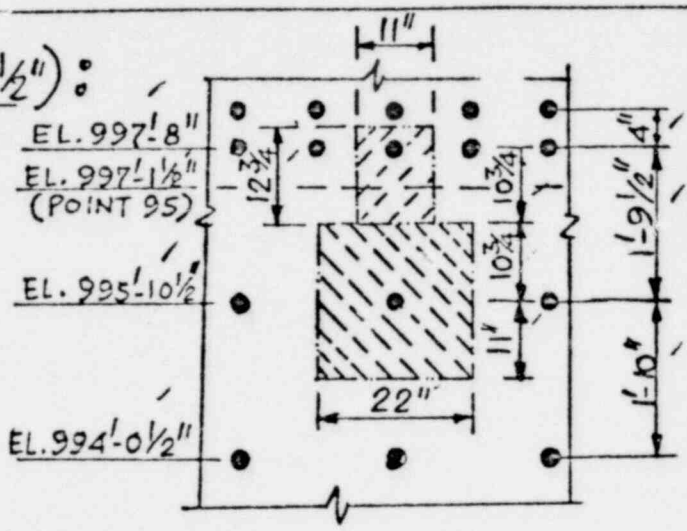
Checkers Comments Accepted By: ..... Nuclear Safety Related: YES ☑ NO ☐

Materials: }
Ref. Codes: } SEE PAGE 3/1
Ref. FSAR: }
Other Ref.: }

Assumptions: SEE BELOW

RESULTS

(B) POINT 95 (EL. 997'-1½"):



$Q = -2.05$	MODEL 3
$N\phi = 36.3$	CL 410
$M\phi = -181$	TABLE 1C
$N\theta = 56.6$	ON
$M\theta = -51$	PAGE 3/6

$Q = \pm 0.1$ K/in ROT. PLAT. LOAD
COMP. OUTPUT BOOK SRB-116 P1
LOADING PL2, MOD. 3, MERI. 1, POINT 71

$\therefore \Sigma Q = -2.05 - 0.1 = -2.15$ K/in

O/A Minm depth of section = 4'-4" = 52"
(obtained by interpolation bet. approx. EL 992' and 999'
from Field Transmittal # CPPA 2793 dated 9-10-79)

Total Radial Shear at EL. 997'-8" (obtained by interpolation bet. points 95 & 96)

$$Q = 2.15 + \frac{(2.71 - 2.15) \times 6.5}{40.5} = 2.24 \text{ K/in}$$

Total Radial Shear at EL. 995'-10½" (obtained by interpolation between points 95 & 94)

[Note: ΣQ at point 94 = -1.58 K/in (see Page 3/14)]

$$Q = 1.58 + \frac{(2.15 - 1.58) \times 25.5}{40.5} = 1.95 \text{ K/in}$$

Date: SEPT 1979
Calc. By: PKB
Chk'd/Apprd. By: C.Z 9/11/79

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ENGINEERS, DESIGNERS, CONSTRUCTORS
NEW YORK

Book No. SRB-122C
Sheet No. 3/12
G & H Job No. 2323-001

Subject: TUSI : CONT. WALL : UNIT 2

Checkers Comments Accepted By: Nuclear Safety Related: YES ☑ NO ☐

Materials:
Ref. Codes: SEE PAGE 3/1
Ref. FSAR:
Other Ref.:

Assumptions: SEE BELOW

RESULTS

CHECK WHETHER ENTIRE AREA IN TENSION :

$N\phi = 36.3$, $M\phi = -181$ ∴ Tension on Inside face

$d = 52' - 6 = 46''$ $t = 52''$

Since Tension is Large compared to moment, Entire section in tension in Virt. direction

Similarly $N\theta = 56.6$, $M\theta = -51$

∴ Entire section in tension in horz. dir.

∴ Concrete has cracked in both directions

∴ Model 3 applies.

CHECK ALLOWABLE CONCRETE SHEAR STRESSES:

$N\phi = 36.3$

Refer calculations done on page 3/9, ∴ $v_c = 0$

$N\theta = 56.6$ ∴ $v_c = 0$

∴ Concrete has cracked in both dir.

∴ Model 3 applies.

Rad Shear Q at EL. 997'-8" (See Page 3/11) = 2.24 K/in

∴ Shear Stress = $v_u = \frac{2.24 \times 1000}{0.85 \times 1 \times 46.} = 57.29$ psi

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Calc. By: PKB | Book No. SRB-122C

Chk'd/Apprd. By: C.2 9/11/79 | Sheet No. 3/13

Subject: TUST: CONT. WALL: UNIT 2 | G & H Job No. 2323-001

Checkers Comments Accepted By: ..... Nuclear Safety Related: YES ☑ NO ☐

Materials: }
Ref. Codes: } SEE PAGE 3/1
Ref. FSAR: }
Other Ref.: }

Assumptions: SEE BELOW

RESULTS

Refer Sketch on Page 3/11, $S = 11''$ and $h = 12\frac{3}{4}''$

$$\therefore A_{v_{Reqd.}} = \frac{57.29 \times 11 \times 12.75}{60000} = 0.134 \text{ in}^2$$

Area provided = 1-#6 bar (0.44 in^2) O.K.

ALTERNATE CALCULATION (SEE SKETCH ON PAGE 3/2):

$$A_{v_{reqd.}} = \frac{57.29 \times 1 \times 1}{60000} = 0.000095 \text{ in}^2/\text{inch in both dir.}$$

$$A_{v_{provided}} = \frac{0.44}{11 \times 12.75} = 0.003$$

Radial Shear Q at EL. 995'-10½" (See Page 3/11) = 1.95 K/in

$$\therefore v_u = \frac{1.95 \times 1000}{0.85 \times 1 \times 46} = 49.87 \text{ psi}$$

Refer Sketch on Page 3/11, $S = 22''$ and $h = 21.75''$

$$\therefore A_{v_{Reqd.}} = \frac{49.87 \times 22 \times 21.75}{60000} = 0.40 \text{ in}^2$$

Area provided: 1-#6 bar (0.44 in^2) O.K.

ALTERNATE CALCULATION: (SEE SKETCH ON PAGE 3/2)

$$A_{v_{Reqd.}} = \frac{49.87 \times 1 \times 1}{60000} = 0.00008 \text{ in}^2/\text{inch in both dir.}$$

$$A_{v_{Provided}} = \frac{0.44}{22 \times 21.75} = 0.0009$$

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Book No. SRB-122C
Sheet No. 3/14
G & H Job No. 2323-001

Subject: TUSI: CONT. WALL: UNIT 2

Checkers Comments Accepted By: Nuclear Safety Related: YES ☑ NO ☐

Materials, Ref. Codes, Ref. FSAR, Other Ref.: SEE PAGE 3/1

Assumptions: SEE BELOW

RESULTS

(C) POINT 94 (EL. 993'-9"):

$Q = -1.5$
$N\phi = 36.7$
$M\phi = -109$
$N\theta = 57.6$
$M\theta = -51$

Mod. 3, CL 410, TABLE 1C ON PAGE 3/6

$Q = \pm 0.08$ K/in

ROT. FLAT. LOAD MOD. 3, MERI. 1, POINT 68 BOOK # SRB-116 P1 LOADING PL2

$\therefore \Sigma Q = -1.5 - 0.08 = -1.58$ K/in

O/A depth of Section $t = 4'-4" = 52"$ (Refer

Total Radial Shear at EL. 994'-0½" (obtained by interpolation bet. points 95 & 94)

$$Q = 1.58 + \frac{(2.15 - 1.58) \times 3.5}{40.5} = 1.63 \text{ K/in}$$

NOTE: Since $N\phi$ and $N\theta$ are approx. same as for point 95, therefore the following conclusions can be drawn:

Concrete has cracked in both dir.

$\therefore$ Model 3 applies.

Shear stress $= v_u = \frac{1.63 \times 1000}{0.85 \times 1 \times 46} = 41.69$ psi
($d = 52 - 6 - .46'$)

Refer sketch on Page 3/2,

$S = 22"$, $h = 22"$

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Calc. By PKB

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Subject TUSI : CONT. WALL : UNIT-2

Checkers Comments Accepted By ..... Nuclear Safety Related: YES ☑ NO ☐

Materials ... Ref. Codes ... SEE PAGE 3/1 ... Ref. FSAR ... Other Ref. ...

Assumptions SEE BELOW

RESULTS

$\therefore A_{v_{Reqd}} = \frac{41.69 \times 22 \times 22}{60000} = 0.336 \text{ in}^2$

Area provided: 1 - #6 bar (Area = 0.44 in²) O.K.

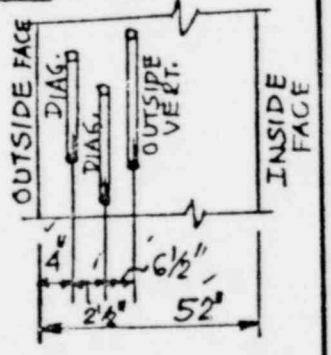
ALTERNATE CALCULATION: (SEE SKETCH ON PAGE 3/2)

$A_{v_{Reqd.}} = \frac{41.69 \times 1 \times 1}{60000} = 0.00069$ in²/inch in both dir.

$A_{v_{Provided}} = \frac{0.44}{22 \times 22} = 0.0009$

CHECK POINT 94 FOR MERIDIAN 8:

Q = 1.49	MOD. 3	Since M_ϕ is positive, torsion acts on outside face of concrete.
N_ϕ = 32.4	CL 430	
M_ϕ = 60	TABLE 1C ON PAGE 3/6	Rebars on outside face:
N_θ = 53		2 #18 Diag. @ 12" = 0.333 in²/in
M_θ = 124		#18 vert. @ 11" = 0.364 in²/in



$\therefore$ C.G of rebars from outside face:

$\frac{\frac{1}{2} \times 0.333 (4 + 6.5) + 0.364 \times 13}{2 \times \frac{1}{2} \times 0.333 + 0.364} = \frac{1.75 + 4.73}{0.697} = 9.3$ in.

$\sum Q$ at EL. 994'-0½" (See Page 3/14) = 1.63 K/in

$\therefore$ Eff depth = d = 52 - 9.3 = 42.7 in

$\therefore$ Shear stress $v_u = \frac{Q}{0.85 bd} = \frac{1.63 \times 1000}{0.85 \times 1 \times 42.7} = 44.90$ psi

$\therefore A_{v_{Reqd.}} = \frac{44.9 \times 1 \times 1}{60000} = 0.00075$ in²/in. in both dir.

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Sheet No. 3/16
G & H Job No. 2323-001

Calc. By: PKB
Chk'd/Apprd. By: C.Z. 9/11/79

Subject: TVSI: CONT. WALL @ UNIT-2

Checkers Comments Accepted By: Nuclear Safety Related: YES ☑ NO ☐

Materials:
Ref. Codes: SEE PAGE 3/1
Ref. FSAR: --
Other Ref.:

Assumptions: SEE BELOW

RESULTS

NOTE:

If Concrete does not crack, Model 1 Shear forces are to be used. As the Concrete has not cracked, concrete has the full shear capacity of $2\sqrt{f_c'}$ = 126 psi ✓

Maxm Radial Shear in Model 1 at point 96 (See Table 1A on Page 3/6) = 3.45 K/in

Effective depth = d = 46 in. (See Page 3/8) ✓

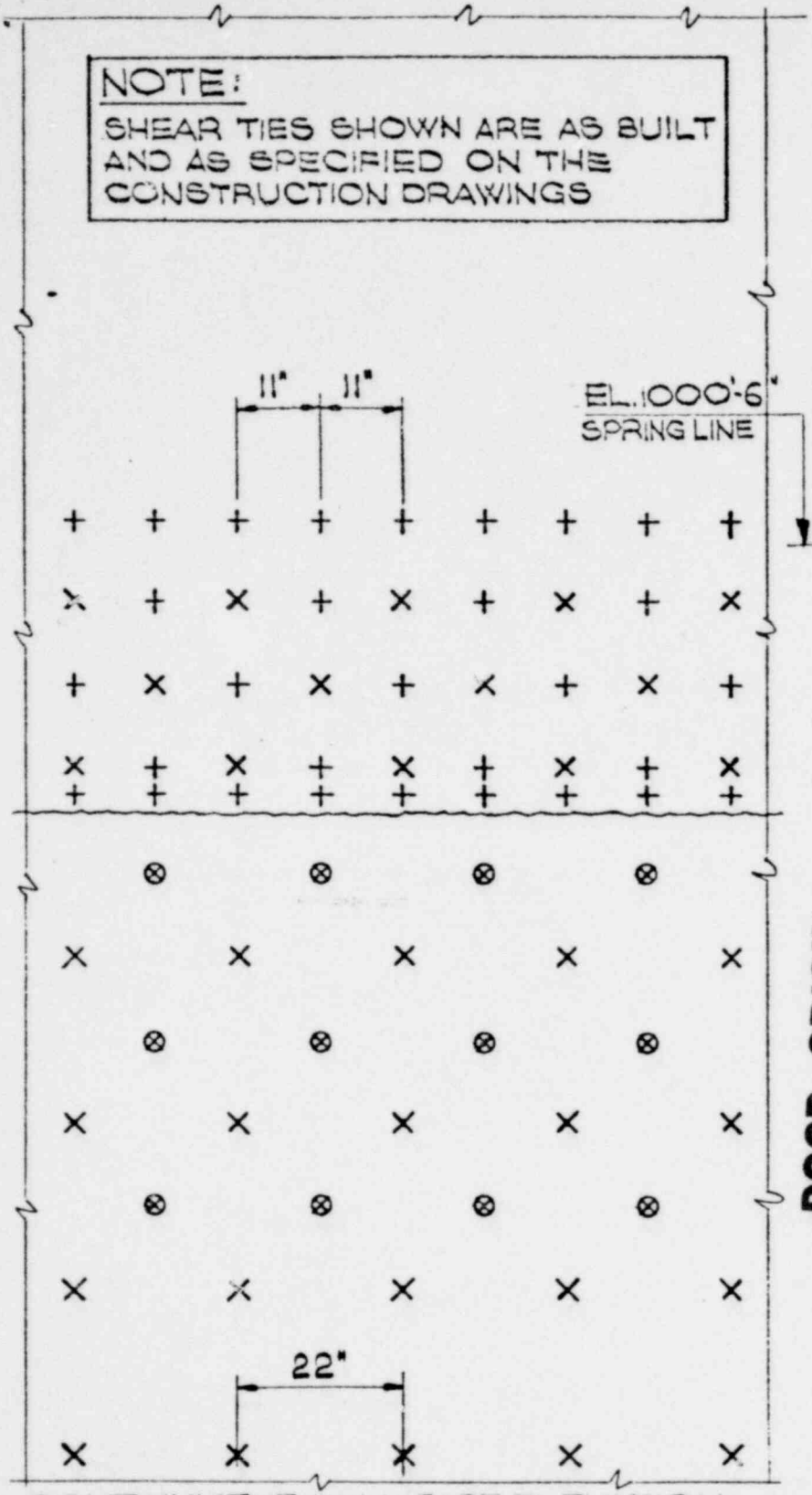
∴ Concrete Shear Stress

$$v_u = \frac{Q}{0.85\,bd} = \frac{3.45 \times 1000}{0.85 \times 1 \times 46} = 88.2 \text{ psi}$$

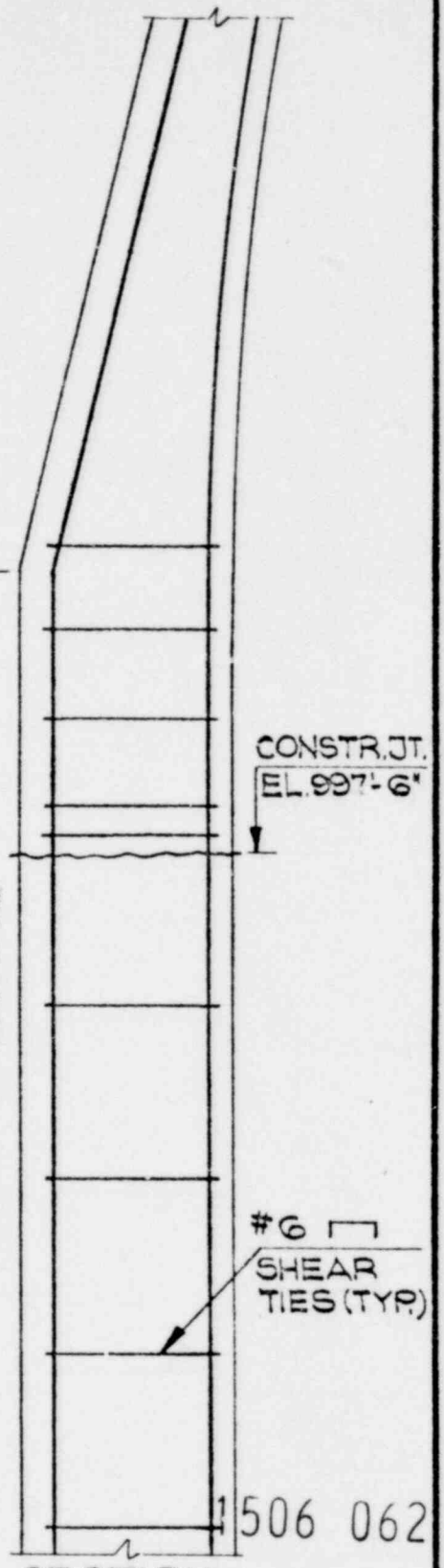
< 126 ✓

O.K.

NOTE:
SHEAR TIES SHOWN ARE AS BUILT AND AS SPECIFIED ON THE CONSTRUCTION DRAWINGS



CONTAINMENT WALL PART ELEVATION (SEE NOTE)



SECTION

X - DENOTES SHEAR TIES SHOWN ON CONSTRUCTION DWG. # 2323-S2-0505

+ - DENOTES ADDITIONAL SHEAR TIES OVER AND ABOVE THAT SHOWN ON CONSTR. DWG. # 2323-S2-0505

⊗ - DENOTES SHEAR TIES SHOWN ON CONSTRUCTION DRAWING # 2323-S2-0505 WHICH WERE OMITTED.

TUSI
COMANCHE PEAK

CONTAINMENT WALL SHEAR TIES NEAR SPRING LINE EL. 1000'-6"

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SCALE - N.T.S.

JOB NO 2323

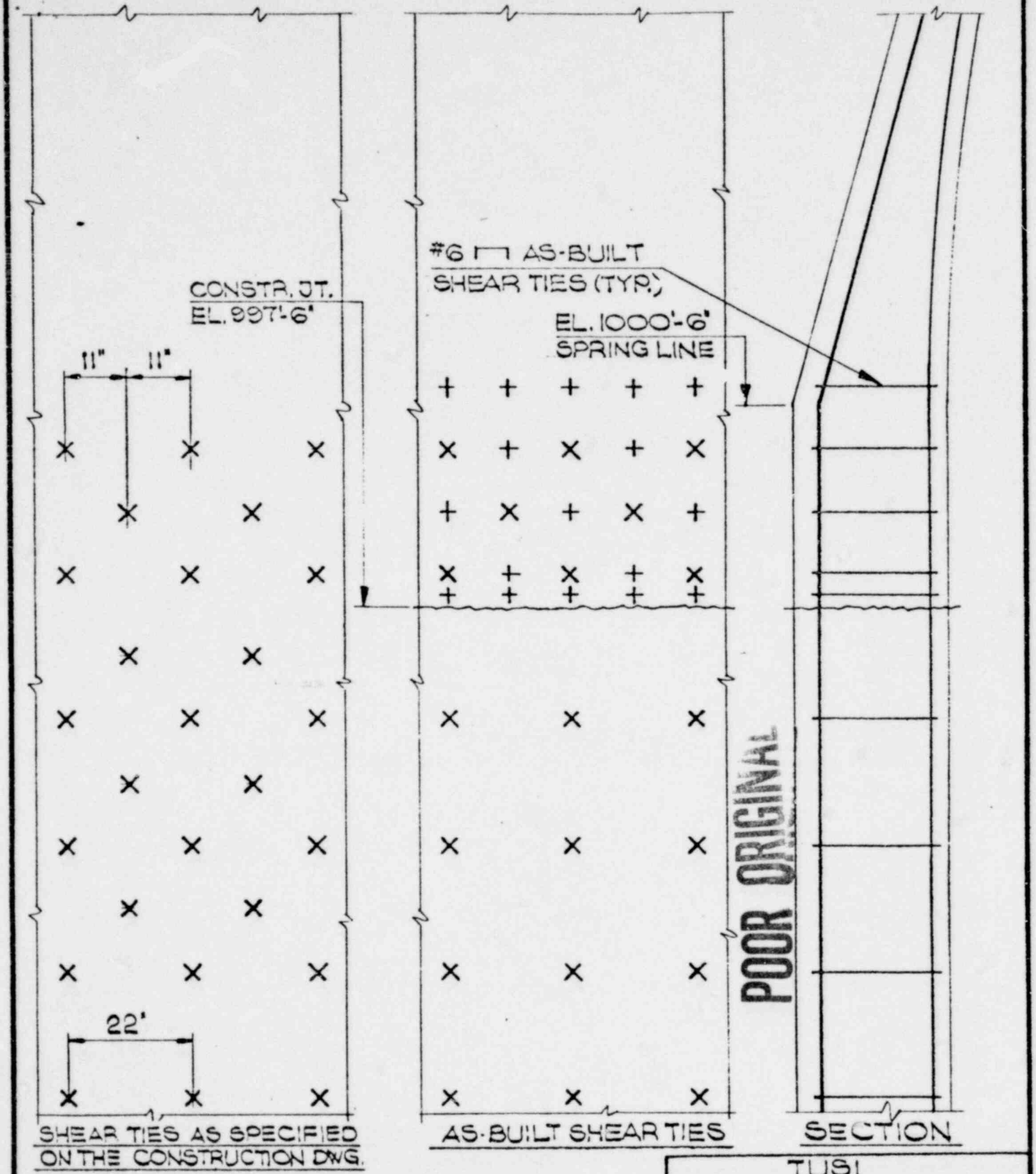
FIG. 2

MICRO FILM	ISSUE NO	DATE	DWN	CHKD

APPROVALS: ARCH | STR | MECH | ELEC | CHEM ENGR | I & C | BALD | CONSTR | P.M.

ISSUED FOR

S/76



CONTAINMENT WALL PART ELEVATION

X - DENOTES SHEAR TIES SHOWN ON CONSTRUCTION DWG. # 2323-S2-0503

+ - DENOTES ADDITIONAL SHEAR TIES OVER AND ABOVE THAT SHOWN ON CONSTR. DWG. # 2323-S2-0505

TUSI
COMANCHE PEAK

CONTAINMENT WALL SHEAR TIES NEAR SPRING LINE EL. 1000'-6"

Gibbs & Hill, Inc.
ENGINEERS DESIGNERS CONSTRUCTORS
NEW YORK

SCALE - N.T.S.

JOB NO 2323

FIG. 1

MICRO FILM	ISSUE NO	DATE	DWN	CHKD

APPROVALS

ISSUED FOR

1506 063

PAGES 3/17 BOOK SRB-122C

ED BEZKOR/VON G&H-NY STRUCTURAL

BKB 9/11/79 Page 1 of 1
Verified c.z. 9/11/79

COMANCHE PEAK STEAM ELECTRIC STATION
DESIGN CHANGE AUTHORIZATION

(WILL) ~~(WAS/WERE)~~ BE INCORPORATED IN DESIGN DOCUMENTS

AUTHORIZATION NO. 5536-REV.1

SAFETY RELATED DOCUMENT X YES ___ NO

1. DESCRIPTION:

A. APPLICABLE SPEC/DWG/~~DOCUMENT~~ 2323-S2-0505 REV. 5
NOTE: THIS DOCUMENT SUPERSEDES AND VOIDS DCA-5536-Rev.0.

B. DETAILS In lieu of shear reinforcement above elevation 997'-6" as shown on the design drawing, additional shear reinforcement has been placed as follows:

Four rows of #6 [at approximate elevation 997'-8", elevation 998'-0", elevation 998'-11" and elevation 999'-10" spaced at 0'-11" horizontally.

SOLUTION: Shear reinforcement as placed above exceeds the design requirements and is therefore acceptable.

2. SUPPORTING DOCUMENTATION

RECEIVED BY TELECOPIER
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DATE 9/11/79 TIME 9:20

3. SIGNATURES: CRH/ss 9-10-79

A. APPROVED BY: [signature] G&H Representative — 9-10-79 Date

B. APPROVED BY: CR Hooston Originating Engineer — 9-10-79 Date

4. STANDARD DISTRIBUTION:

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BOOK # SRB-122C
PAGE: 3/18

TO CZ

PKB 9/11/79
Verified CZ 9/11/79 8-29-79

8/28/79

CI ENG NY

TUGCO-GRSE

AUGUST 28, 1979
TWX: 11,334
ATTN: H.R. ROCK/M.L. BERGMAN
PPE: REACTOR BUILDING UNIT #2,
EXTERIOR GALL REINFORCEMENT
REF: 2323-S2-0505

ADDITIONAL #6 SHEAR TIES AT 1'-10" VERTICAL AND 1'-10" APPROXIMATE HORIZONTAL ALTERNATE WITH MAIN SHEAR BARS BEGINNING AT EL. 993'-1&1/2" AND ENDING AT EL. 997'-7&1/2" HAVE NOT BEEN PLACED. MAIN SHEAR REINFORCEMENT HAS BEEN PLACED IN ACCORDANCE WITH THE DESIGN DRAWING. CONCRETE HAS BEEN PLACED IN ACCORDANCE WITH THE DESIGN DRAWING. CONCRETE AS BEEN PLACED TO APPROXIMATE EL. 997'-6".

REQUEST ENGINEERING EVALUATION OF THE THREE OMITTED ROW OF SHEAR TIES AT EL. 993'-1&1/2", 994'-11&1/2" AND 996'-9&1/2" FOR ACCEPTANCE TO USE-AS-IS.

ADDITIONAL SHEAR REINFORCEMENT CAN BE PLACED BETWEEN MAIN REINFORCEMENT STARTING AT AND CONTINUING TO WHATEVER ELEVATION IS REQUIRED.

CONCRETE PLACEMENT TO EL. 1000'-6" IS TENATIVELY SCHEDULED FOR 8-29-79. PLACEMENT WILL BE HELD UNTIL RESOLUTION OF THIS DEFICIENCY.

R.E. HEIM/C.R. HOOTON
CPSES JOBSITE
REH/CRH/JG

CI ENG NY

1506 065