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November 18, 1987

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

Gentlemen:

Subject: Docket No. 50-206
Tornado Loadings
San Onofre Nuclear Generating Station
Unit 1

On September 25, 1987, representatives of SCE and their consultant met with the NRC staff and their consultant in Bethesda, Maryland. The purpose of the meeting was to resolve the remaining items on the Systematic Evaluation Program Topics III-2, Wind and Tornado Loadings, and III-4.A, Tornado Missiles. The remaining items are identified in Enclosure 1 to this letter. The purpose of this letter is to document the agreements made at the meeting and to provide completed responses to the remaining items in Enclosure 2.

If you have any questions regarding this matter, please call me.

Very truly yours,

M. O. Medford

Enclosures

cc: J. O. Bradfute, NRR Project Manager, San Onofre Unit 1
J. B. Martin, Regional Administrator, NRC Region V
F. R. Huey, NRC Senior Resident Inspector, San Onofre Units 1, 2 and 3

AE01
~~A001~~
1/1

Enclosure 1

Meeting Agenda

25 September 1987

WIND AND TORNADO LOADINGS

SAN ONOFRE 1

1. The possibility of the vent stack collapsing and impacting equipment or structures needed for safe shutdown.

2. The way in which the condensate storage tank, if required for safe shutdown, is protected against tornado and wind missiles.

3. Design criteria for proposed modification concepts including applicable codes and minimum horizontal windspeed capacity. (Note: the NRC's 10^{-5} windspeed is 135 mph. Modifications should be designed according to this criterion). Also indicate a time frame for completion of modifications.

4. The RWS tank does not meet the NRC's 10^{-5} windspeed criterion and the Licensee does not propose to modify it. (The RWS tank has a capability of withstanding 123 mph winds whereas the NRC's 10^{-5} criterion is 135 mph.) The Licensee should either commit to modify this tank to meet the 135 mph limit or identify conservatisms in the analysis that would suggest an actual performance capacity higher than 123 mph.

ITEM 1

The possibility of the vent stack collapsing and impacting equipment or structures needed for safe shutdown.

RESPONSE

A calculation which demonstrates the capability of the vent stack is provided. The calculation shows the vent stack can withstand winds up to 135 mph without failure. The calculation also includes the impact of a tornado missile on the vent stack. The calculation reviewed during the September 25, 1987 meeting by the NRC staff and their consultant, Franklin Research Center, did not include the tornado missile. Therefore, based on this calculation, the vent stack will not collapse during a tornado event and consequently will not affect safety related equipment or structures required for safe shutdown.

CYGNA

Calculation Cover Sheet

Project SONGS I TORNADO RESISTANCE

Job No. 87086

File No. 2F

Client SCE

Calc. Set No. VS

No. of Sheets 16 INCLUDING VS-1a, 11a, 11b

Subject VENT STACK

Statement of Problem INVESTIGATE THE EFFECTS OF TORNADO MISSILE IMPACT ON THE VENT STACK. CONSIDER THE PROJECT D.C. MISSILE SPECTRUM & THE 10^{-5} PROBABILITY NRC TORNADO WINDSPEED. IF THE RESPONSE BEHAVIOR OF THE STACK UNDER MISSILE IMPACT IS FOUND TO BE INADEQUATE, INVESTIGATE THE EFFECT OF THE VENT STACK COLLAPSE ON NEIGHBORING PLANT STRUCTURES

Sources of Data PLANT DRAWINGS 567941-3 REV.3 & 567942-1, REV.1

Sources of Formulae & References SEE pp VS-1 & VS-1a

Remarks THE VENT STACK WILL NOT COLLAPSE ON THE NEIGHBORING PLANT STRUCTURES. SEE pp. VS-12 & 13 FOR SUMMARY & CONCLUSIONS.

REVISIONS: ADDED pp. VS-1a, 11a, 11b

REVISED pp. VS-7, 8, 12

Originators	Checkers	Distribution	Revision No. 1
B. ATALAY	T.Y. WANG	PROJECT FILE	Supersedes Calculation Set No. 87086/2F, CALC. SET VS REV. 0
			Approved By: Jim Raspe Date: 11/4/87

CYGNA

Calculation Sheet

Project SONGS 1 TORNADO RESISTANCE
Prepared By: B. ATALAY Date 10/20/87
Subject MISSILE IMPACT
Checked By: TY Wang Date 10/21/87
System VENT STACK
Job No. 87086 File No. 2F
Analysis No.
Rev. No. 0
Sheet No. VS-1

REFERENCES

1. PROJECT 85028 DESIGN CRITERIA, DC-85028-01, REV.0, CYGNA
2. SRP SECTION 3.5.1.4
3. "INTRODUCTION TO STRUCTURAL DYNAMICS", JOHN M. BIGGS
4. PROCEEDINGS OF THE 2ND ASCE CONF. ON CIVIL ENG'G & NUCLEAR POWER, VOL. V, REPORT OF THE ASCE COMMITTEE ON IMPACTIVE & IMPULSIVE LOADS
5. EPRI REPORT NO. NP-440, "FULL SCALE TORNADO MISSILE IMPACT TESTS"
6. 85028 CALC. BINDER 1F, CALC. SET V, SONGS 1 VENT STACK
7. "TUBULAR STEEL STRUCTURES, THEORY & DESIGN", M.S. TROITSKY
8 "LOCAL BOND-STRESS TO SLIP RELATIONSHIPS FOR HOT ROLLED DEFORMED BARS AND MILD STEEL PLAIN BARS", A.D. EDWARDS AND P.J. YANNOPOULOS, ACI JOURNAL, PROCEEDINGS V.76, NO.3, pp 405-42

CYGNA

Calculation Sheet

Project SONGS I TORNADO RESISTANCE
Prepared By: B. ATALAY
Date 11/3/87
Subject MISSILE IMPACT
Checked By: TY Wang
Date 11/4/87
System VENT STACK
Job No. 87086
File No. 2F
Analysis No.
Rev. No. 0
Sheet No. VS-1a

REFERENCES (CONT'D)

9. "SOIL DYNAMICS", S. PRAKASH, MCGRAW-HILL BOOK CO.

10. COMMUNICATION REPORT BETWEEN B. ATALAY (CYGNA) & T. YEE (SCE), DATED 11/3/87, 2:45PM

CYGNA

Calculation Sheet

Project SONGS 1 TORNADO RESISTANCE	Prepared By: B. ATALAY	Date 10/12/87	
Subject MISSILE IMPACT	Checked By: T Y Wang	Date 10/21/87	
System VENT STACK	Job No. 87086	File No. 2F	
Analysis No.	Rev. No. 0	Sheet No. VS-2	

IT IS REQUIRED TO EVALUATE THE POTENTIAL EFFECT OF THE VENT STACK COLLAPSE ON NEIGHBORING PLANT STRUCTURES DUE TO THE IMPACT OF THE VENT STACK BY TORNADO MISSILES. THE MISSILES ARE ASSUMED TO BE:

i. 1"ϕ REBAR WEIGHING 8 LBS
ii. 13½"ϕ UTILITY POLE WEIGHING 1490 LBS

THE ABOVE MISSILE SPECTRUM IS PER THE PROJECT (JOB NO. 85028) DESIGN CRITERIA. THE TORNADO WINDSPEED TO BE CONSIDERED IS THE 10^{-5} NRC TORNADO WINDSPEED OF 135 MPH. THE FOLLOWING SCENARIOS WILL BE CONSIDERED:

i. PERFORATION OF THE VENT STACK
ii. OVERALL RESPONSE EVALUATION OF THE VENT STACK

CYGNA

Calculation Sheet

Project SONGS 1 TORNADO RESISTANCE

Prepared By: B. ATALAY Date 10/12/87

Subject MISSILE IMPACT

Checked By: TY Wang Date 10/21/87

System VENT STACK

Job No. 87086 File No. 2F

Analysis No.

Rev. No. 0

Sheet No. VS-3

1. PERFORATION

UNDER TORNADO $V = 135$ MPH $= 198$ FPS

MISSILE VELOCITIES $= V_s = \begin{cases} 0.6V = 118 \text{ FPS FOR REBAR} \\ 0.4V = 79.2 \text{ FPS FOR UTIL. POLE} \\ \quad = 950 \text{ IN/SEC.} \end{cases}$

USING THE BRL FORMULA, $T_{REQ'D} = \dfrac{M_m^{2/3} \, V_s^{4/3}}{203.36 \, D}$ (*)

REBAR: $D = 1''$, $m_m = \dfrac{8}{386.4} \dfrac{\text{LB-SEC}^2}{\text{IN}}$, $V_s = 118$ FPS

THEN (*) WILL GIVE $T_{REQ'D} = 0.217''$ ✓

UTIL. POLE: $D = 13.5''$, $m_m = \dfrac{1490}{386.4} \dfrac{\text{LB-SEC}^2}{\text{IN}}$, $V_s = 79.2$ FPS

THEN $T_{REQ'D} = 0.305''$

NOTE: $T_{AVAIL} = \begin{cases} 0.25'' \text{ BETWEEN } 50' \,\&\, 100' \text{ ABOVE GRADE} \\ 0.375'' \text{ UP TO A HEIGHT OF } 50' \text{ ABOVE GRAD} \end{cases}$

NOTE ALSO THAT UTIL. POLE WILL NOT BE AIRBORNE HIGHER THAN 30' ABOVE GRADE PER SRP 3.5.1.4, p. 4.

THEREFORE, BASED ON THE ABOVE, ALL REQUIRED T IS LESS THAN T_{AVAIL} & THERE WON'T BE ANY PERFORATION

Calculation Sheet

Project SONGS 1 TORNADO RESISTANCE Prepared By: B. ATALAY Date 10/20/87
Subject MISSILE IMPACT Checked By: TY Wang Date 10/21/87
System VENT STACK Job No. 87086 File No. 2F
Analysis No. Rev. No. 0 Sheet No. VS-4

ii. OVERALL RESPONSE EVALUATION

a. CALCULATE FORCE, F GENERATED BY UTILITY POLE IMPACT:

NOTE THAT $F_{UTIL.\ POLE} >> F_{REBAR}$; ∴ ONLY UTILITY POLE IMPACT WILL BE INVESTIGATED HEREAFTER.

UTILITY POLE TO VENT STACK IMPACT IS A SO-CALLED SOFT IMPACT SINCE THE MISSILE WILL CRUSH. SEE SECTION 4.2.1.1.1 OF REF 4. ACCORDING TO REF. 4

$$F = P + uV_s^2$$

WHERE P = MISSILE CRUSHING STRENGTH

u = MASS/LENGTH OF UTIL. POLE

$$= \frac{1.49\ K}{32.2\frac{FT}{SEC^2}\cdot 35'} = 0.00132\ \frac{K\text{-}SEC^2}{FT^2}$$ ✓

$V_s = 79.2$ FPS.

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Calculation Sheet

Project SONGS I TORNADO RESISTANCE Prepared By: B. ATALAY Date 10/20/87

Subject MISSILE IMPACT Checked By: TY Wang Date 10/21/87

System VENT STACK Job No. 87086 File No. 2F

Analysis No. Rev. No. 0 Sheet No. VS-5

ii. OVERALL RESPONSE EVALUATION (CONT'D)

a. CALCULATION OF F (CONT'D)

TO CALCULATE P, UTILIZE EPRI RESULTS (REF 5) FOR TEST NO. 7. IN THAT TEST F WAS MEASURED AS 170 K FOR A 1470 LB UTILITY POLE WITH A STRIKE VELOCITY OF 204 FPS

THEN

$$P = F - uv^2$$

$$= 170^k - \frac{1.47^k}{32.2\frac{FT}{SEC^2}\cdot 35'}(204\ FPS)^2$$

$$= 115.7\ k$$

(NOTE: THIS CORRESPONDS TO A CRUSHING STRESS OF $\frac{115700\ LBS}{\pi(13.5'')^2/4} = 808$ PSI WHICH IS REASONABLE)

THEN, FOR THE 1.49^k POLE WITH A STRIKE VELOCITY OF $V_s = 79.2$ FPS:

$$F = P + uV_s^2$$

$$= 115.7 + (0.00132)(79.2)^2$$

$$\underline{F = 123.8\ K}$$

1006.00

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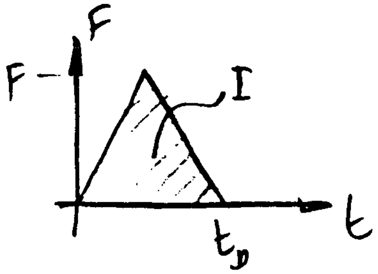
Calculation Sheet

Project SONGS 1 TORNADO RESISTANCE
Prepared By: B. ATALAY
Date 10/20/87
Subject MISSILE IMPACT
Checked By: TY Wang
Date 10/21/87
System VENT STACK
Job No. 87086
File No. 2F
Analysis No.
Rev. No. 0
Sheet No. VS-6

ii. OVERALL RESPONSE EVALUATION (CONT'D)

b. CALCULATION OF THE MISSILE IMPACT LOAD TIME HISTORY, AND THE DYNAMIC LOAD FACTOR

THE IMPACT LOAD TIME HISTORY IS TRIANGULAR AS SHOWN IN REF. 4 (p. 2-109) & 5.



FROM THE IMPULSE-MOMENTUM RELATIONSHIP

$$m_m V_s = I = \int_0^{t_D} F(t)\,dt = \frac{1}{2} F t_D$$

$$t_D = \frac{2 m_n V_s}{F} = \frac{2(1.49/32.2)(79.2)}{123.8} = 0.059 \text{ SEC}$$

FOR THE VENT STACK $f = 3.4$ Hz (SEE REF. 6, p. V6),

$$t_D/T = t_D f = 0.059(3.4) = 0.20$$

USING FIG. 2.8a OF REF. 3, WITH THE ABOVE CALCULATE t_D/T, A DLF = 1.00 CAN BE USED

THEN THE STACK CAN BE EVALUATED UNDER AN IMPACT FORCE OF 123.8 K APPLIED STATICALLY

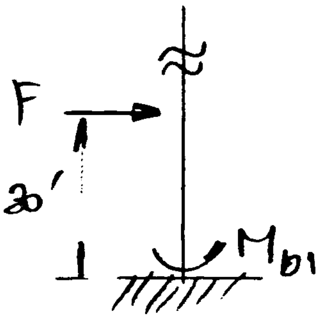
CYGNA

Calculation Sheet

Project SONGS 1 TORNADO RESISTANCE | Prepared By: B. ATALAY | Date 10/20/87
Subject MISSILE IMPACT | Checked By: TY Wang | Date 10/21/87
System VENT STACK | Job No. 87086 | File No. 2F
Analysis No. | Rev. No. ~~0~~ 1 | Sheet No. VS-7

ii. OVERALL RESPONSE EVALUATION (CONT'D)

C. CROSS-SECTION AT BASE OF STACK



IMPACT WILL BE ASSUMED AT THE UTILITY POLE'S HIGHEST AIRBORNE ELEV. (30' ABOVE GRADE PER REF. 2, p. 3.5.1.4-4).

$$M_{b1} = 123.8^k (30') = 3714 \text{ K-FT}$$

DUE TO 135 MPH WIND PRESSURE LOADING:

$$M_{b2} = 0.04346 V^2 \text{ K-FT (SEE p. VII OF REF. 6)}$$

$$= 0.04346 (135)^2 = 792 \text{ K-FT}$$

TOTAL $M_b = M_{b1} + M_{b2} = 4506$ K-FT $\cong$ 54,000 K-IN

SECTION MODULUS, $S = \frac{\pi(d_o^4 - d_i^4)}{32 d_o}$, $d_i = 96$ IN
$d_o = 96 + 0.75$ IN

THEN $S = 2725$ IN^3

~~& $\sigma = \frac{54,000}{2725} \cong$ 20 KSI < 36 KSI, O.K.~~

~~CHECK COMPRESSIVE CAPACITY OF STACK SHELL~~

~~$\sigma_{CR} = \frac{8,000}{d_o/t}$ (SEE EQ. 2.14 OF REF. 7)~~

~~$\cong \frac{8000}{96/0.375} = 31.25$ KSI > 20 KSI O.K.~~

REV. △1
PREP. BY:
B. ATALAY 11/3/87
TYWang 11/4/87

CYGNA

Calculation Sheet

Project SONGS 1 TORNADO RESISTANCE
Prepared By: B. ATALAY
Date 11/3/87
Subject MISSILE IMPACT
Checked By: TY Wang
Date 11/4/87
System VENT STACK
Job No. 87086
File No. 2F
Analysis No.
Rev. No. 1
Sheet No. VS-8

ii. OVERALL RESPONSE EVALUATION (CONT'D)

C. CROSS-SECTION AT BASE OF STACK

$$\sigma_{BENDING} = \frac{54{,}000}{2725} \cong 20 \text{ KSI}$$

$$\sigma_{ALLOW.} = 1.6\left(0.6\sigma_y\right) = 1.6(0.6)(36) = 34.56^{KSI}.$$

$$\underset{\sim\sim\sim\sim\sim\sim\sim\sim\sim\sim\sim\sim\sim\sim\sim\sim\sim\sim}{\sigma_{BENDING} < \sigma_{ALLOW}\ ;\ \text{O.K}}$$

CHECK COMPRESSION:

NOTE THE ABOVE CONSERVATIVELY HAS THE MOMENT ARM AS 30'. THE ACTUAL MOMENT ARM HOWEVER IS (30'-1'4")=28.67' WHERE 1'4" IS THE HEIGHT OF THE STIFFENED BOTTOM PORTION OF THE VENT STACK (SEE SECTION M OF DRAWING 567941-3)

THEN $M_{b1} = 123.8^{K}(28.67') = 3550$ K-FT

$$M_{b2} = 0.317(135)^2(75'-1'4") + 0.82(135^2)(24'-1'4")$$

$$= 764{,}400 \text{ LB-FT} = 764 \text{ KFT} \quad (\text{SEE p.V-11 OF REF.6})$$

$$\sigma_{COMPR} = \frac{M_{b1}+M_{b2}}{S} = \frac{(3550+764)\text{K-FT}\cdot 12^{\text{IN}}/\text{FT}}{2725 \text{ IN}^3} = 19.0 \text{ KSI}$$

$$\sigma_{COMPR.\ ALLOW} = 1.6\ (12.2) = 19.52 \text{ KSI} > \sigma_{COMPR.}\ ;\ \text{O.K}$$

INCREASE ALLOWED OVER CODE ALLOWABLES FOR TORNADO LOADING

ASME CODE ALLOW; SEE p.V-15 OF REF.6

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Calculation Sheet

Project SONGS 1 TORNADO RESISTANCE | Prepared By: B ATALAY | Date 10/20/87

Subject MISSILE IMPACT | Checked By: TY Wang | Date 10/21/87

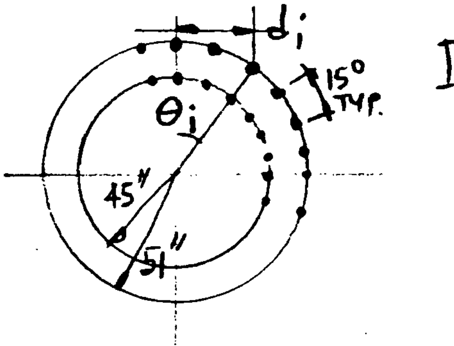
System VENT STACK | Job No. 87086 | File No. 2F

Analysis No. | Rev. No. 0 | Sheet No. VS-9

ii. OVERALL RESPONSE EVALUATION (CONT'D)

d. CHECK ANCHOR BOLTS. THE ANCHOR BOLTS WILL BE SUBJECTED TO

$$M_b = 54{,}000 \text{ K-IN} \quad (\text{SEE p. VS-7})$$



BOLT PATTERN
(24- 1"φ A193 GR.B7 HIGH STRENGTH BOLTS ON EACH CIRCLE)

$$I_{\text{BOLT PATTERN}} = \sum_{i=1}^{48} A_b d_i^2 , \quad d_i = r \sin\theta ;$$

$$= A_b \left[4(45'' \sin 15)^2 + 4(45 \sin 30)^2 + \dots + 4(45 \sin 75)^2 + 2\cdot 45^2 \right.$$

$$\left. 4(51'' \sin 15)^2 + 4(51 \sin 30)^2 + \dots + 4(51 \sin 75)^2 + 2\cdot 51^2 \right]$$

$$= A_b (51^2 + 45^2)\left[4(\sin^2 15 + \sin^2 30 + \sin^2 45 + \sin^2 60 + \sin^2 75) + 2 \right]$$

$$= 55512 \; A_b \; \text{IN}^4$$

$$\text{EXTREME BOLT TENSION} = \frac{(54{,}000 \text{ K-IN})(51'')}{55512 A_b} \cdot A_b = 49.6 \text{ K} = T$$

$$\text{BOLT STRESS} = \frac{49.6}{A_b} = \frac{49.6}{\pi \cdot (\frac{1}{2})^2} = 63.2 \text{ KSI} < \underline{105 \text{ KSI}} \; ; \text{ O.K.}$$

BOLT YIELD CAPA. PER DRWG. 567942-1 Rev. 1.

CYGNA

Calculation Sheet

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Subject MISSILE IMPACT | Checked By: TY Wang | Date 10/21/87

System VENT STACK | Job No. 87086 | File No. 2F

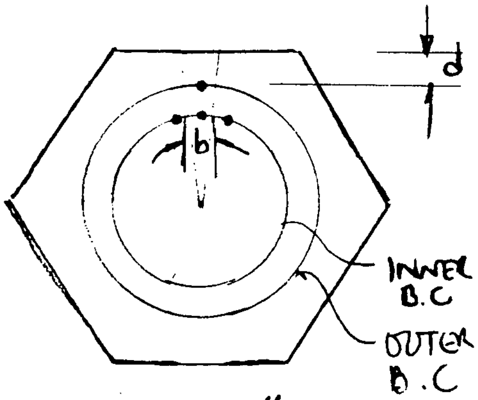
Analysis No. | Rev. No. 0 | Sheet No. VS - 10

ii. OVERALL RESPONSE EVALUATION (CONT'D)

e. SHEAR CAPACITY OF PEDESTAL CONCRETE

$f_c' = 1.25\ (2500\ PSI)$; 1.25 INCREASE DUE TO DYNAMIC LOADING PER p. 2.121 OF REF. 4.

$= 3125\ PSI$



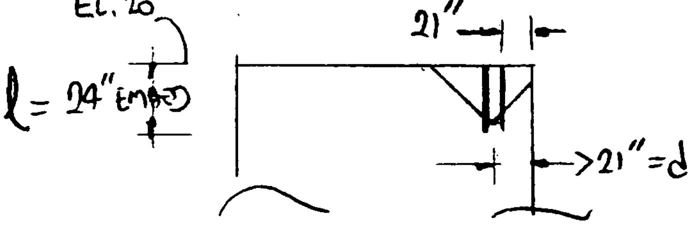
$d = \dfrac{12'0'' - 8'6''}{2} = 21''$ (SEE DWG 567942

$b = \dfrac{\pi(7'6'')}{24} = 0.99' \cong 12''$

SINCE EMBED = 24" > d = 21"

SHEAR CONE AREA :

$\cong 2bd\sqrt{2} = 713\ in^2 = A$

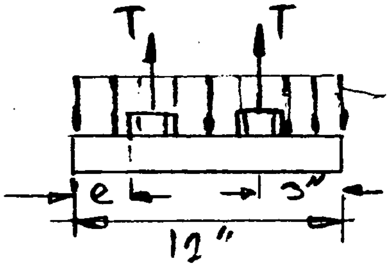


SHEAR CONE CAPA.

$= 0.85\,4 A\sqrt{f_c'} = 135{,}500\ \#$

$= 135.5K > 2T = 2(49.6^K)$

f. BEARING PLATE ; PL 5x12x3/4" $\Rightarrow S = \frac{1}{6}(5)(3/4)^2 = 0.47\,in$



$P = \dfrac{2(T-U)}{12''}$; U = FORCE RESISTED BY BOND PER BOLT

e = DISTANCE BETWEEN EDGE OF NUT TO EDGE OF PLATE

$= 3'' - \frac{1}{2}(\text{NUT SIZE}) = 2.25''$

$U = \pi \cdot d \cdot l\, u_0$, u_0 = BOND STRESS

Project SONGS 1 TORNADO RESISTANCE

Prepared By: B. ATALAY Date 10/30/87

Subject MISSILE IMPACT

Checked By: TY Wang Date 10/21/87

System VENT STACK

Job No. 87086 File No. 2F

Analysis No.

Rev. No. 0

Sheet No. VS - 11

ii. OVERALL RESPONSE EVALUATION (CONT'D)

f. BEARING PL. (CONT'D)

$U_0 \cong 500$ PSI FROM TESTS OF PLAIN BARS AS REPORTED ON TABLE 2 OF REF. 8

THEN $U = \pi \cdot 1 \cdot 500 \cdot 24'' = 37{,}700^{\#} = 37.7^{K}$

$P = \dfrac{2(49.6-37.7)}{12} \cong 2^{K}/IN$; $M = Pe \cdot \dfrac{\ell}{2} = 2(2.25)(1.125) = 5^{K-IN}$

$\sigma = M/S = 5/0.47 = \underline{10.7\ KSI < 36\ KSI\ ;\ O.K.}$

g. CONCRETE BEARING STRENGTH AT BEARING PLATE

$= \phi\ (0.85\ f_c' A_1)$

$= 0.70(0.85)(3.125)(12 \times 5)$

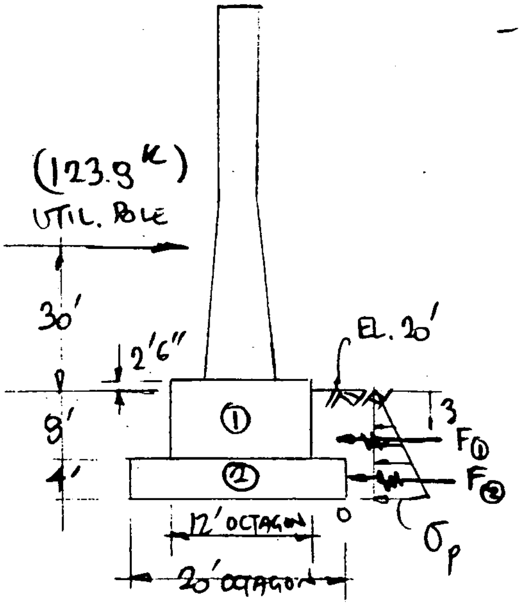
$= 111.6\ K >$ BEARING LOAD

$= 2(T-U) = 24\ K.$

Project SONGS 1 TORNADO RESISTANCE Prepared By: B. ATALAY Date 11/3/87
Subject MISSILE IMPACT Checked By: TY Wang Date 11/4/87
System VENT STACK Job No. 87086 File No. 2F
Analysis No. Rev. No. 0 Sheet No. VS-11a

ii. OVERALL RESPONSE EVALUATION (CONT'D)

h. OVERALL STABILITY



- SOIL PROPERTIES (SEE REFERENCE 10)

ANGLE OF INTERNAL FRICTION $= 41° = \phi$
GROUND WATER ELEV. = 5 FT.

THEN $\sigma_p = K_p \gamma_s z$, $K_p = \tan^2\left(45° + \frac{\phi}{2}\right)$
$= 4.81$

$\sigma_p = (4.81)(0.120\ ^{k}/_{ft^3})z = 0.578z$ KSF.

WT. OF ① $= 3.314\,(6^2)^{*}(10.5')(0.150\ k/ft^3)$
$= 188$ K

WT. OF ② $= 3.314(10^2)(4')(0.150\ k/ft^3) = 199$ K

WT. OF SOIL $= 3.314(10^2 - 6^2)(8')(0.120\ k/ft^3) = 204^{K}$

WT. OF STACK $= 25^{K}$ (SEE p. V-10 OF REF. 6)

SOIL LATERAL RESISTANCE: $F_{①} = \frac{1}{2}(0.578)(8)(8)(12') = 222$ K

$F_{②} = \frac{1}{2}(0.578)(8' + 12')(4')(20') = 462^{K}$

WIND LATERAL PRESSURE @ TOP HALF $= 0.317(135\text{ MPH})^2$ (SEE p. VII OF REF. 6)
$= 5777\ \# = 5.8k$

WIND LATERAL PRESSURE @ BOTTOM HALF $= 0.82(135\text{ MPH}^2) = 14945\# = 14.9$ K

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* AREA OF OCTAGON W/ INSCRIBED CIRCLE OF RAD. $R = 8R^2 \tan 22.5° = 3.314R^2$

Project SONGS I TORNADO RESISTANCE | Prepared By: B. ATALAY | Date 11/3/87

Subject MISSILE IMPACT | Checked By: TY Wang | Date 11/4/87

System VENT STACK | Job No. 87036 | File No. 2F

Analysis No. | Rev. No. 0 | Sheet No. VS-11b

ii. OVERALL RESPONSE EVALUATION (CONT'D)

h. OVERALL STABILITY (CONT'D)

1. SLIDING $F.S. = \frac{\text{SOIL RESISTANCE}}{\text{APPLIED FORCES}}$ (FRICTION BETWEEN CONCRETE & SOIL IS CONSERVATIVELY IGNORED)

$$= \frac{(222 + 462)^k}{(123.8 + 5.8 + 14.9)^k} = 4.73 > 1.5 \therefore O.K$$

2. OVERTURNING $F.S = \frac{\text{RIGHTING MO.}}{\text{OVERTURNING MO.}}$ ABOUT "O".

$$M_{①} = (222^k)(4' + \tfrac{8'}{3}) = 1480 \text{ K-FT}$$

$$M_{②} = \underbrace{(0.578)(8)(4)(20)}_{F_{②}'}(2') + \underbrace{\tfrac{1}{2}(0.578)(4)(4)(20)}_{F_{②}''}(\tfrac{4}{3})$$

$$= 863 \text{ K-FT}$$

THEN RIGHTING MO. $= 1480 + 863 + (188 + 199 + 204 + 25)^k(10')$

$$= 8503 \text{ K-FT.}$$

OVERTURNING MO $= (123.8^k)(30' + 8' + 4') + 14.9^k(24'^{*} + 8' + 4')$

$$+ 5.8^k(75'^{*} + 8' + 4') = 6241 \text{ K-FT}$$

THEN OVERTURNING $F.S = \frac{8503}{6241} = 1.36$

ALTHOUGH THIS F.S. IS LESS THAN 1.5, IT IS ACCEPTABLE FOR THIS EXTREME LOADING CONDITION

* SEE p. VII OF REF. 6

Project SONGS I TORNADO RESISTANCE
Prepared By: B. ATALAY
Date 10/20/97
Subject MISSILE IMPACT
Checked By: TY Wang
Date 10/21/87
System VENT STACK
Job No. 87086
File No. 2F
Analysis No.
Rev. No. ~~0~~ 1
Sheet No. VS-12

SUMMARY

i. THE VENT STACK WILL NOT BE PERFORATED BY EITHER THE REBAR OR THE UTILITY POLE INJECTED BY THE 135 MPH WINDSPEED 10^{-5} NRC TORNADO. SEE p. VS-2 FOR THICKNESSES NECESSARY TO PREVENT PERFORATION. THOSE THICKNESSES ARE AVAILABLE. THE NON OCCURANCE OF PERFORATION ENSURES THAT FULL SECTION PROPERTIES (RATHER THAN "PERFORATED" SECTION PROPERTIES) OF THE STACK CAN BE RELIED ON IN THE OVERALL STRUCTURAL RESPONSE EVALUATION

ii. THE FOLLOWING ELEMENTS OF THE VENT STACK WERE CHECKED AND FOUND ADEQUATE UNDER COMBINED ACTION OF UTILITY POLE IMPACT & 135 MPH TORNADO WINDPRESSURE

a. BASE SECTION OF THE VENT STACK; BENDING TENSION & COMPRESSION

b. ANCHOR BOLTS

c. PEDESTAL CONCRETE SHEAR CONE & CONCRETE BEARING

d. THE BEARING PLATE DISTRIBUTING THE ANCHOR BOLT TENSION

e. OVERALL STABILITY (OVERTURNING & SLIDING)

REV. △
PREP. BY: B. ATALAY 11/3/87
TYWang 11/4/87

CYGNA

Calculation Sheet

Project SONGS I TORNADO RESISTANCE	Prepared By: B. Ataay	Date 10/20/87	
Subject MISSILE IMPACT	Checked By: T Y Wang	Date 10/21/87	
System VENT STACK	Job No. 87086	File No. 2f	
Analysis No.	Rev. No. 0	Sheet No. VS-13	

__CONCLUSION__ - THE VENT STACK WILL NOT COLLAPSE ON NEIGHBORING PLANT STRUCTURES.

ITEM 2

The way in which the condensate storage tank, if required for safe shutdown, is protected against tornado and wind missiles.

RESPONSE

The condensate storage tank is not required for safe shutdown. Therefore, it will not be protected against tornado and wind missiles. The auxiliary feedwater storage tank, which is being protected, is required for safe shutdown. The condensate storage tank is identified as a possible source of water if it is available.

ITEM 3

Design criteria for proposed modification concepts including applicable codes and minimum horizontal windspeed capacity. (Note: The NRC's 10^{-5} windspeed is 135 mph. Modifications should be designed according to this criterion.) Also indicate a time frame for completion of modifications.

RESPONSE

The NRC tornado windspeed of 135 mph will be included in the Retrofit Design Criteria Manual for San Onofre Unit 1. This document provides the criteria by which modifications to the plant are designed. The document was reviewed by the NRC staff during the September 25, 1987 meeting. The tornado total windspeed velocity of 135 mph will be broken down into its rotational and translational speed in accordance with the Fujita model. The total windspeed of 135 mph will be used to determine tornado missile velocities. In the event that significant unanticipated design problems result from the above criterion, a case-by-case reevaluation with the NRC will be requested.

The schedule for implementation of modifications associated with tornado protection is determined in accordance with the Integrated Implementation Schedule (IIS). The IIS ranks all plant modifications in accordance with their safety importance. A preliminary ranking of the tornado modifications indicates they would be implemented during the Cycle XII refueling outage (approximately the third quarter of 1992). The final schedule will be included in the April 1988 IIS submittal.

ITEM 4

The RWS tank does not meet the NRC's 10^{-5} windspeed criterion and the Licensee does not propose to modify it. (The RWS tank has a capability of withstanding 123 mph winds whereas the NRC's 10^{-5} criterion is 135 mph.) The Licensee should either commit to modify this tank to meet the 135 mph limit or identify conservatisms in the analysis that would suggest an actual performance capacity higher than 123 mph.

RESPONSE

An analysis of the missile impact on the RWST using the 135 mph tornado was performed. The lower course of the tank is .329 inches thick and the upper four courses are .25 inches. The results indicated that the lower course of the RWST can withstand a tornado missile, the rebar or utility pole, in a 135 mph tornado windspeed. The calculation was provided to the NRC staff for their review during the September 25, 1987 meeting and is provided as an attachment. The lower course of the RWST contains one-fifth of the tank volume. Since the tank holds over 241,000 gallons of borated water and it is required by Technical Specifications to maintain a minimum of 240,000 gallons of borated water, the lower course will retain approximately 48,000 gallons of borated water. Assuming the RWST is penetrated just above the lower course, 48,000 gallons of borated water would be available for plant shutdown.

As part of the Fire Protection Program Review, minimum water requirements for the safe shutdown of San Onofre Unit 1 following a fire were addressed. The scenario for these water requirements included very conservative assumptions such as loss of offsite power, no reactor coolant pumps and other sources of boration such as the Chemical and Volume Control System are not available. As a result of not having the reactor coolant pumps available a 20 hour soak times is required to maintain coolant equilibrium. Details such as system leakages, shrinkage, reactor coolant pump leakage and boration requirements are provided in the SCE Fire Protection submittal dated May 21, 1986. Based on this information, the following is required:

1. 6,200 gallons of RWST water for boration.
2. 12,480 gallons of water needed during the first 8 hours. (This includes the 6,200 gallons for boration.)
3. 14,400 gallons of water needed during the next 20 hours for a system soak time.
4. 9,360 gallons of water is needed for the final 6 hours to bring the plant to cold shutdown.

A total of 36,240 gallons of water is required to bring the plant to cold shutdown within 34 hours. During a normal shutdown approximately 20,000 gallons of water including boration is needed to shutdown in about 14 hours.

The lower course of the RWST retains 48,000 gallons of borated water. Based on the pump requirements and the location of the discharge pipe on the RWST, it is estimated that under 18,000 gallons of the RWST is not useful. Such that the lower course contains 30,000 gallons of useful water. This is sufficient to get through the initial shutdown and the soak period which is 28 hours. Within that time period, additional water sources can be made available from Unit 1, Units 2 and 3, onsite or from offsite. This additional water would be used to bring the plant to cold shutdown and to continue to cool the plant.

ACL:9012F

CYGNA

Calculation Cover Sheet

Project SONGS 1

Job No. 87086

File No. 1F

Client SCE

Calc. Set No. C

No. of Sheets 3 INCL COVER SHT

Subject
REFUELING WATER STORAGE TANK (RWST)

Statement of Problem
USE BRL EQUATION TO DETERMINE THE ADEQUACY OF THE BOTTOM COURSE OF THE RWST UNDER REBAR & UTILITY POLE IMPACT. THE TORNADO WINDSPEED IS THE 10^{-5} PROBABILITY NRC WINDSPEED OF 135 MPH.

Sources of Data
CITED WITHIN THE BODY OF THIS CALC SET

Sources of Formulae & References
CITED WITHIN THE BODY OF THIS CALC. SET

Remarks
NEITHER THE REBAR NOR THE UTILITY POLE WILL PERFORATE THE BOTTOM COURSE OF THE RWST UNDER THE 10^{-5} PROBABILITY NRC TORNADO EVENT. REV 1 DELETED UNNEEDED REFERENCES PGS C-1 & C-2

Originators	Checkers	Distribution
J. RASP	RAVI BALIGA	PROJECT FILE

Revision No. 1

Supersedes Calculation Set No. 87086/1F REV 0

Approved By: N H Williams

Date: 9/16/87

CYGNA

Calculation Sheet

Project SONGS 1

Prepared By: Jim Russo Date 9/16/87

Subject RWST BOTTOM COURSE PERFORATION

Checked By: R. BALIGA Date 9/16/87

System —

Job No. 87086 File No. 1F

Analysis No. — Rev. No. 1

Sheet No. C-1

STATEMENT OF PROBLEM: SEE THE COVER SHT.

DATA AND FORMULAE:

10^{-5} PROBABILITY NRC WINDSPEED, $V_{TH} = 135 \text{ MPH} = 135 \cdot \frac{88 \text{ FPS}}{60 \text{ MPH}}$

$= 198 \text{ FPS} = V_T$

(SEE PAGE 2 OF THE ENCLOSURE OF NRC LETTER DATED 3/2/87, DOCKET NO. 50-206)

BRL FORMULA: (REARRANGE FORMULA, USE K=1)

$$T = \frac{m^{2/3} \, V^{4/3}}{203.36 \, D} \longleftarrow$$

PG. 2-88 "ANALYSIS OF NUCLEAR POWER PLANT STRUCTURES FOR THE EFFECTS OF IMPULSE AND IMPACT LOADS" CIVIL ENGINEERING AND NUCLEAR POWER, VOLUME V, ASCE, SEPT. 15-17, 1980

WHERE T = REQUIRED TARGET THICKNESS IN INCHES

(NOTE $T_{AVAIL.} = 0.329$ IN. FOR RWST BOTTOM COURSE)

V = MISSILE VELO. IN FT/SEC.; SEE S.R.P. 3.5.1.4, P.3

$$= \begin{cases} 0.6 \, V_{TH} = 0.6(198) = 118 \text{ FPS FOR THE REBAR} \\ 0.4 \, V_{TH} = 0.4(198) = 79.2 \text{ FPS FOR THE UTILITY POLE} \end{cases}$$

CONSERVATIVELY USING $V_{TH} = V_T$; SEE CONCLUSIONS ON NEXT PG.

CYGNA

Calculation Sheet

Project SONGS 1

Prepared By:

Date 9/16/87

Subject RWST BOTTOM COURSE PERFORATION

Checked By: R. BALIGA

Date 9/16/87

System –

Job No. 87086

File No. 1F

Analysis No. –

Rev. No. 1

Sheet No. C-2

D = MISSLE DIAMETER IN INCHES

$$= \begin{cases} 1 \text{ IN. FOR THE REBAR} \\ 13.5 \text{ IN. FOR THE UTILITY POLE} \end{cases}$$

M = MISSILE MASS IN $lb\text{-}SEC.^2/IN.$

$$= \begin{cases} 0.0207 \ lb\text{-}SEC^2/IN \text{ FOR REBAR} \\ 3.8561 \ lb\text{-}SEC^2/IN \text{ FOR UTILITY POLE} \end{cases}$$

CALCULATIONS:

FOR THE REBAR:

$$T_{REQD.} = \frac{0.0207^{2/3} \cdot 118.8^{4/3}}{203.36 \cdot 1} = 0.217''$$

$$T_{AVAIL.} = 0.329'' > T_{REQ'D} = 0.217'' \ ; \ O.K.$$

FOR THE UTILITY POLE:

$$T_{REQ'D} = \frac{3.8561^{2/3} \cdot 79.2^{4/3}}{203.36 \cdot 13.5} = 0.305''$$

$$T_{AVAIL.} = 0.329'' > T_{REQ'D} = 0.305'' \ ; \ O.K.$$

CONCLUSION:

BASED ON THE ABOVE CALCULATIONS, THE RWST BOTTOM COURSE IS THICK ENOUGH TO PREVENT PERFORATION BY THE REBAR AND THE UTILITY POLE UNDER THE TORNADO WINDSPEED OF 135 MPH. (10^{-5} PROBABILITY NRC TORNADO EVENT). NOTE THAT THE CALCULATION CONSERVATIVELY HAS V_{TH} = TORNADO HORIZONTAL WINDSPEED EQUAL TO V_T, TOTAL TORNADO WINDSPEED.