SUBJECT CODE	SOUTH CAROLINA & ELECTRIC AND GAS COMPANY CALCULATION RECORD	PAGE
3,3,8		1 OF 7

CALC TITLE	CALC NO.	REV	STAT
ADEQUACY OF CONTROL ROOM AIR INTAKE MISSILE SHIELDS TO PROTECT CHILLED WATER EXPANSION TANKS.	DC03380-001	1	A

PARENT DOCUMENT	SYSTEM	SAFETY CLASS	CALC. CLASS
MRF 22114	VU	NN QR (SR)	I (II) ~~III~~ IV V VI OG 4/29/93

ORIGINATOR	DISC	ORGANIZATION	DATE	XREF NO
DAN GATLIN	CS	SCE&G-DE	4/29/93	ES-1028

A. CALCULATION INFORMATION

CONTENT DESCRIPTION: ☐ SEE REVISION DETERMINE ADEQUACY OF EXISTING CONTROL ROOM AIR INTAKE MISSILE SHIELDS FOR SHIELDING CHILLED WATER SYSTEM EXPANSION TANKS XTK-174A,B-VU.

AFFECTED COMPONENTS/ANALYSIS: XTK-174A,B-VU

CONTAINS PRELIMINARY DATA/ASSUMPTIONS:
✓ NO ____ YES, PAGES ____

COMPUTER PROGRAM USED: ✓ NO
____ YES, VALIDATION NOT REQ'D (REF. 3.5) ____ YES, VALIDATED (OTHERS)
____ YES, VALIDATED (ES-412) ____ PROGRAM VALIDATION CALCULATION

B. VERIFICATION

☐ CONTINUED, ATTACHMENT

VERIFICATION SCOPE: VERIFY DESIGN INPUTS ARE CORRECT; METHOD IS ACCEPTABLE; RESULTS ARE REASONABLE; CALCULATION CONTENT IS IN ACCORDANCE WITH ES-412, REV 1.

VERIFIER: CHUCK RICE
ASSIGN BY: G.V. MEYER

Dan Gatlin 4/29/93
LEAD ENGINEER (DESIGNEE)/DATE

VERIFIER/DATE	APPROVAL/DATE
[signature] 4-30-93	B.X. Estes 4/30/93

C. RECORDS

TO PRS: ____ INIT/DATE

REEL	FRAME

ORIGINAL MAINTAINED BY:
___ SCE&G DE ___ VENDOR ____
___ SCE&G ____

DISTRIBUTION: CALC FILE (ORIGINAL)
DSE GVM /SYSTEM ENG R. WORD/DE FILE 20.6602 (ATTACH 1 ONLY, COPY)

SOUTH CAROLINA ELECTRIC & GAS COMPANY REVISION SUMMARY	PAGE 2 OF 7

CALCULATION NO.
DC 03380-001

REV NO. | SUMMARY DESCRIPTION

① REVISE CALCULATION FOR INSTALLED CONFIGURATION PER MRF 22114. UPDATE FORMAT AS REQUIRED BY ES-412, REV 1.
See attached TWR pages, 3-7

[ ] CONTINUED ON PAGE _____

PURPOSE:

Demonstrate that the VU expansion tank placed within the outer boundary of the existing Control Room Air Intake Housing, as shown on Ref. 3, will not exceed the acceptance criteria as stated in the FSAR for a tornado impact. The VU expansion tank is being installed per Ref. 1.

DESIGN INPUTS/REFERENCES:

1) MRF-22114
2) FSAR SECTION 3.5.1.4
3) DWG# E-414-401{Rev 8} & E-414-403{Rev 3} "CONTROL BLDG STRUCTURE" See attached sketch, page 7 of 7.
4) NUREG/CR-3485(9/85) "PRA REVIEW MANUAL"

ASSUMPTIONS:

1) The missile barrier in which the VU expansion tank is installed has two missile inlet areas each having an opening of 49.2 ft^2(9'10" x 5'0") for a total inlet area of 98.4 ft^2. See attached sketch, page 7 of 7.

2) The specific missile impact probability parameters P_5, P_6, P_7, and P_8 are all set to one to ensure conservative results.

EVALUATION:

Method-By setting the impact probabilities in assumption 2) to one and using the tornado impact probability equation in Ref. 3, a maximum target area can be determined for any missile. The following equation from Ref. 2 will be used:

$$P_T = \sum_{i=1}^{i=n} P_1 \times P_2 \times P_3 \times P_4 \times P_5 \times P_6 \times P_7 \times P_8 \leq 1.0 \times 10^{-7}$$

Where:

n = Total number of openings on the exposed surfaces of Seismic Category I structures.

P_1 = Probability of the design basis tornado striking the reactor site = 1.0×10^{-3}

P_2 = Probability of a missile being acted upon by a maximum wind over a sufficiently long distance, conservatively assumed to be 1.0.

P_3 = Probability of an object maintaining an orientation inside the tornado which exposes its maximum cross-sectional area to the full force of the wind. Since missiles tend to tumble, this probability will be quite low; a conservative estimate is 1.0×10^{-1}

P_4 = Probability of a missile being hurled to the exact location of the specific target. Missiles of the type being considered could land anywhere within the area confined by the width of tornado damage path. This area is about

$$\frac{\pi (500)^2}{4} = 196{,}350 \text{ ft}^2$$

compared to the area of the opening, A_T. Therefore, the probability of the geometric center of the object being hurled to the target (i.e., the opening) is:

$$P_4 = A_T/196{,}350$$

P_5 = Probability of the missile impacting the target on its ends. Since the missiles would have no preferred angle of impact on the target, the probability of impacting within the critical angle required to cause damage is dependent upon the length of the missile and the general dimensions of the opening. Therefore the probability can be expressed as:

$$P_5 = \frac{(2\theta_1)}{(180)} \frac{(2\theta_1)}{(180)}$$

Where:

θ_1 = Arcsin x/lm.

θ_2 = Arcsin y/lm.

x = One dimension of the opening

y = Other dimension of the opening

lm = Length of the missile

P_6 = Probability of a missile impacting a target of specific dimension and the ability of the missile to pass through the target opening by nature of the frontal area of the missile.

$$P_6 = \frac{A_T - A_M}{A_T}$$

Where:

A_T = Area of target

A_M = Frontal area of missile

If A_T is greater than A_M, $P_6 = 1.0$. If A_T is less than A_M, $P_6 = 0.0$.

P_7 = Probability that a missile will pass through structures or barriers exterior to openings on the exposed surfaces or walls of Seismic Category I structures. The directional probability density per unit solid angle can be expressed as:

$$P_7 = \frac{1}{2}\left(\frac{\Theta_H}{180} \times \frac{\Theta_V}{180}\right) \leq 0.5$$

Where Θ_H and Θ_V are the angles in the horizontal and vertical planes, respectively, through which the missile must pass to strike the opening.

P_8 = Probability of a missile striking the exact location of components required to ensure the integrity of the reactor coolant pressure boundary and to maintain safe shutdown conditions or to provide the capability to prevent accidents which could result in exceeding offsite radiation exposure limits after the missile has passed through the opening on the exposed surface or wall of a Seismic Category I structure. The directional probability density per unit solid angle per component can be determined using the following expression:

$$P_8 = \frac{\Theta_H}{B_H} \times \frac{\Theta_V}{B_V}$$

Where Θ_H and Θ_V are the angles in the horizontal and vertical planes, respectively, through which the missile must pass to strike the critical component and B_H and B_V are the preferred angles of impact through which the missile must pass to penetrate through the opening in the horizontal and vertical planes, respectively. The angles B_H and B_V are defined by the wall or roof thickness and the physical dimensions of the opening.

P_8 is evaluated for all critical components located behind the subject opening.

Let: $P_{5,6,7,8}=1.0$ $n=1$ (Setting number of openings to one will yield the maximum total target area)

Given: $P_1=1.0x10^{-3}$ $P_2=1.0$ $P_3=0.1$ $P_4=A_T/196,350ft^2$

Solve for target area that causes $P_T=1.0x10^{-7}$

$1.0x10^{-7}=1*(1.0x10^{-3}*1.0*0.1*(A_T/196,350))$

$A_T=196.35ft^2$= "Maximum Allowable Target Area, Total"

RESULTS:

Since the total missile inlet area of $98.4ft^2$ is less than the total allowable inlet area of $196.35ft^2$, the probability of the new VU expansion tank being impacted by a tornado missile is much less than the FSAR criteria of $1.0x10^{-7}$. The design is therefore acceptable.

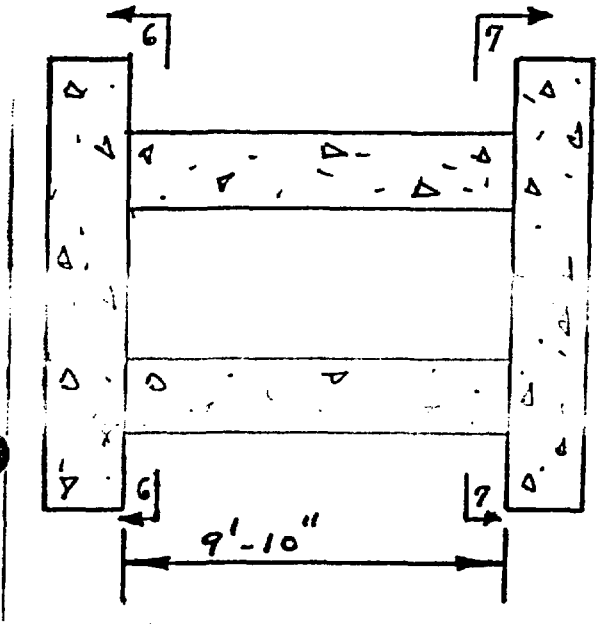
Dan Gatlin

ENGINEERS

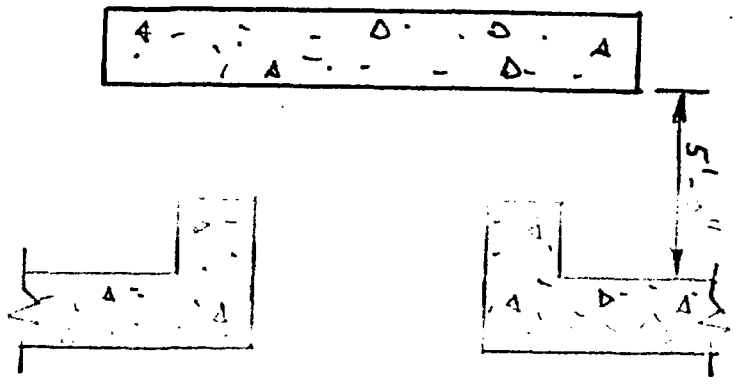
TECHNICAL WORK RECORD

Serial 10894
Engineer DAN GATLIN
Date 4-29-93
Tab V-1 Page 7 of 7

Project Title CALC # DC 03380-001



PLAN VIEW
(REF E-414-401 Rev 8)



ELEVATION VIEW 6-6; 7-7
(REF E-414-403 REV 3)

ENGINEERS
TECHNICAL WORK RECORD

Serial 14992
Engineer C. H. Rice
Date 4/30/93

Project Title DC03380-001,REV 1 VERIFICATION Tab 4.27 Page 1 of 1

This verification is performed in accordance with the scope defined on page 1 of the subject calculation.

DESIGN INPUTS

The design inputs (location of XTK0174A,B-VU and dimensions of the affected air intake missile shield) are correctly taken from MRF 22114 and E-414-401, Rev 8 and E-414-403, Rev 3.

CALCULATION METHOD

The calculation method is taken from FSAR section 3.5.1; and is used correctly. Those probabilities that are specified in the FSAR have been used, other probabilities have conservatively assumed to be 1.0. This is acceptable.

RESULTS

The results show that an acceptable target area is 196.35 ft^2. This appears to be a reasonable area in that it is a small area when compared to the total area of the immediate plant site. Therefore, if a tornado were to strike the plant site, the probability of a missile being thrown into this target area would be small.

CALCULATION CONTENT

The content of the calculation is in accordance with ES-412, Rev. 1.

All comments have been resolved with the preparer. This calculation (including results) is reasonable and acceptable.