Design Analysis Minor Revision Cover Sheet

Design Analysis (Minor Revision)		**Last Page No.** [6] 93	
Analysis No.: [1]	6S0-1882	**Revision:** [2]	1A
Title: [3]	Qualification of Safety-Related Buried Commodities for Tornado Missile and Seismic Evaluation		
DCP No(s)./ Revision: [4]	80101381 / 1	**AD No(s) / Revision:** [5]	S02 / 0
Station(s): [7]	Salem		
Unit No.: [8]	Units 1 & 2		
Safety/QA Class: [9]	Safety Related / Q-Listed		
System Code(s): [10]	N/A		

Is this Design Analysis Safeguards Information? [11] Yes ☐ No ☒ If yes, see SY-AA-101-106

Does this Design Analysis contain Unverified Assumptions? [12] Yes ☐ No ☒ If yes, ATI/AR#:

This Design Analysis SUPERCEDES: [13] N/A **in its entirety.**

Description of Changes (list affected pages): [14]

ECP 80101381 replaces in-kind sections of the 4" diameter No. 12 and 14 Auxiliary Feedwater (AF) system headers that are routed underground outside containment from the Salem Unit 1 Fuel Transfer Tube Area to the Unit 1 Main Steam Outer Penetration Area. The existing 5D bends are replaced by mitered pipe joints and cut elbows. Also, the excavated area is backfilled with flowable fill, a controllable low-strength material (CLSM).

Pages Revised: 88 – 91, 93
Pages Added: 90A

Disposition of Changes: [15]

Replacing the excavated soil with CLSM would increase the pipe stress due to soil overburden since the CLSM is denser than the soil. However, since DCP 80101382 reroutes the AF piping in the Fuel Transfer Tube Area above ground, the maximum buried depth of the Unit 1 AF piping is reduced to 5'-2 1/4" (6' is conservatively used in this calculation). This decreases the pipe stress on the Unit 1 buried AF piping due to soil overburden. The conclusion of this calculation that the pipe stress due to soil overburden is negligible remains valid. Also, the replacement of the 5D bends with mitered pipe joints and cut elbows does not impact this calculation since the stress intensification factor is not considered because the pipe is constrained by the CLSM, as stated on page 93.

Preparer: [16]	Kyle Spence (Sargent & Lundy)	Kyle Spence	4/25/10
	Print Name	Sign Name	Date
Method of Review: [17]	**Detailed Review** ☒ **Alternate Calculations** ☐ **Testing** ☐		
Reviewer: [18]	Justin Kriczky (Sargent & Lundy)	Kyle Spence for Justin Kriczky per telecon	4/25/10
	Print Name	Sign Name	Date
Review Notes: [19]	Independent review ☒ Peer review ☐		
(For External Analyses Only) **External Approver:** [20]	Sandy Jannetty (Sargent & Lundy)		4/25/10
	Print Name	Sign Name	Date
PSEG Reviewer [21]	GARY Leidy		4-25-10
	Print Name	Sign Name	Date
PSEG Approver: [22]	S B Davis		4/25/2010
	Print Name	Sign Name	Date

ATTACHMENT 2
Owners Acceptance Review Checklist for External Design Analysis

SAP Standard Text Key "NDAEXT"
Page 1 of 1

DESIGN ANALYSIS NO. 6S0-1882 **REV:** 1A

		Yes	No	N/A
1.	Do assumptions have sufficient rationale?	☑	☐	☐
2.	Are assumptions compatible with the way the plant is operated and with the licensing basis?	☑	☐	☐
3.	Do the design inputs have sufficient rationale?	☑	☐	☐
4.	Are design inputs correct and reasonable?	☑	☐	☐
5.	Are design inputs compatible with the way the plant is operated and with the licensing basis?	☑	☐	☐
6.	Are Engineering Judgments clearly documented and justified?	☐	☐	☑
7.	Are Engineering Judgments compatible with the way the plant is operated and with the licensing basis?	☐	☐	☑
8.	Do the results and conclusions satisfy the purpose and objective of the Design Analysis?	☑	☐	☐
9.	Are the results and conclusions compatible with the way the plant is operated and with the licensing basis?	☑	☐	☐
10.	Does the Design Analysis include the applicable design basis documentation?	☑	☐	☐
11.	Have any limitations on the use of the results been identified and transmitted to the appropriate organizations?	☐	☐	☑
12.	Are there any unverified assumptions?	☐	☐	☑
13.	Do all unverified assumptions have a tracking and closure mechanism in place?	☐	☐	☑
14.	Have all affected design analyses been documented on the Affected Documents List (ADL) for the associated Configuration Change?	☑	☐	☐
15.	Do the sources of inputs **and** analysis methodology used meet current technical requirements and regulatory commitments? (If the input sources **or** analysis methodology are based on an out-of-date methodology or code, additional reconciliation may be required if the site has since committed to a more recent code)	☑	☐	☐
16.	Have vendor supporting technical documents and references (including GE DRFs) been reviewed when necessary?	☐	☐	☑
17.	Has the Vendor supplied the native electronic file(s)?	☐	☐	☑

PSEG REVIEWER: GARY LUH — Print / Sign **DATE:** 4-25-10

FORM NC.DE-AP.ZZ-0002-2
CALCULATION CONTINUATION/REVISION HISTORY SHEET

PSEG	CALCULATION CONTINUATION/ REVISION HISTORY SHEET	SHEET : 88 CONT'D ON SHEET: 89

CALC. NO.: 6S0-1882			REFERENCE:				
ORIGINATOR, DATE	REV:	S. Singh 8/28/96	1				
REVIEWER/VERIFIER, DATE		AMA 8/29/96					

6. BURIED PORTION OF 4" AUX. FEEDWATER PIPING (#14 & #12)

Scope

Per DEF # DES-90-00084 and DEF# DES-90-00168, the stress calculation did not consider the soil buried effect. This calculation is made to address the buried effect.

80101381R1
S02R0
Page 3

References used

1. Salem Nuclear Generating Station No 1 Auxiliary Feed Water Plan & Section - ELEV 78'-0" & 100'-0" Drawing No 207483 A 8923 - 11.

2. Salem Nuclear Generating Station No 2 Auxiliary Feedwater Plan & Section El. 78'-0" & 100'-0" Drawing No 218233 A 8902 - 11

3. Auxiliary Feedwater Piping Fuel Handling Building to Containment Wall (Piping Underground) From Anchor 14-AFWA-21 @ EL 90'-0" to Anchor 14 AFWA-11 @ EL 96'-0" Drawing No. 267274F Sheets 1 to sheet 6.

1A Note: Calculation 267274F was Voided and Superseded by Calculation 6S0-1882 Rev. 1.

FORM NC.DE-AP.ZZ-0002-2
CALCULATION CONTINUATION/REVISION HISTORY SHEET

PSEG	CALCULATION CONTINUATION/ REVISION HISTORY SHEET	SHEET : 89 CONT'D ON SHEET: 90

CALC. NO.: 650-1882			REFERENCE:				
ORIGINATOR, DATE	REV:	S. Singh 8/28/96	1				
REVIEWER/VERIFIER, DATE		AMA 8/29/96					

4. Drawing No 226129 showing support details and drawing. 1A

5. DEF # DES-90-00084 & # DES-90-00168.

PIPE, SUPPORT & SOIL PARAMETERS

Pipes 4" sch 80 A-106 Grade B

OD = 4.5"
Wall thickness = 0.337" ✓
Moment of Inertia $I = 9.61\ in^4$ ✓
Section Modulus $= 4.27\ in^3$ ✓
Total Wt. per Unit length = 1.664 lb/inch ✓
Internal Pressure = 1950 psi ✓
Temp Cold = 70°F ✓
Temp Hot = 140°F ✓
$E_{cold} = 27.9 \times 10^6$ psi
$E_{hot} = 27.79 \times 10^6$ psi } Use 27.9×10^6 psi for both ✓
S_a = 22,500 psi ✓

80101381R1
S02R0
Page 4

FORM NC.DE-AP.ZZ-0002-2
CALCULATION CONTINUATION/REVISION HISTORY SHEET

PSEG | CALCULATION CONTINUATION/ REVISION HISTORY SHEET | SHEET : 90 | CONT'D ON SHEET: 90A 1A

CALC. NO. S50-1882			REFERENCE:				
ORIGINATOR, DATE	REV:	S.Singh 8/28/96	1				
REVIEWER/VERIFIER, DATE		~~AHA~~ 8/29/96					

Unit 1

Maximum buried depth = 99'-6" - 94'-3 3/4" = 5'-2 1/4", Use 6' for conservatism

Flowable Backfill, Controllable Low-Strength Material (CLSM)
Density = 120-135 lb/ft3 (see Material Master 1026607), Use 135 lb/ft3 for conservatism

Unit 2

1A

Maximum buried depth = 99.5 - 83 = 16.5 feet
(at the Fuel Handling wall anchor, vertical pipe)
Buried depth for horizontal portion of pipe ≈ 5.5', (use conservative 6'

Compacted back fill
soil unit wt. = 110 pcf assumed.

PIPE LOCATION

These pipe lines run between the Outer Penetration wall anchor @ 96'-0" and the Inner Penetration / Fuel Handling building wall anchor along outside and very close to the containment wall (at a distance of about 1 feet to 2 feet from the wall), The horizontal run of the pipes are also vertically supported at about 6' intervals by steel framing anchored to the containment wall,

80101381R1
S02R0
Page 5

Note: The Unit 1 #12 & #14 Aux Feed headers have been rerouted above ground in the Fuel Transfer Tube Area. See DCP 80101382R1 SUP05 & SUP06.

1A

Unit 1 Pipe Stresses due to Soil Overburden

Maximum overburden pressure, $p = k_o \times w \times h$

k_o = coefficient of pressure at rest (lower than k_p, passive pressure)
w = backfill density = 135 lb/ft^3
h = buried depth = 6 ft

Conservatively assume $k_o = k_p = \frac{1+\sin\phi}{1-\sin\phi}$

Assume $\phi = 40°$ for 90-95% relative density compaction

$k_p = \frac{1+\sin 40°}{1-\sin 40°} = 4.6$

$p = 4.6 \times 135$ lb/ft$^3 \times 6$ ft = 3726 psf = 25.9 psi

Hoop stress = $\frac{pd}{2t} = \frac{25.9\,\text{psi} \times 4.5\,\text{in}}{2 \times .337\,\text{in}} = 173$ psi

The pipe design internal pressure is 1950 psi. The soil overburden pressure is negligible compared to this pressure.

FORM NC.DE-AP.ZZ-0002-2
CALCULATION CONTINUATION/REVISION HISTORY SHEET

PSEG	CALCULATION CONTINUATION/ REVISION HISTORY SHEET	SHEET : 91 CONT'D ON SHEET: 92

CALC. NO.: 650-1880			REFERENCE:				
ORIGINATOR, DATE	REV:	S. Singh 8/28/96	1				
REVIEWER/VERIFIER, DATE		AMA 8/29/96					

1A Unit 2 Pipe stresses due to soil overburden

Maximum overburden pressure $p = k_o w h$

k_o = coeff. of pressure at rest (lower than k_p passive pressure)

w = soil weight density = 110 lb/cft

h = soil depth = 9.5 feet (at Fuel Hand Building)

Conservatively assume $k_o = k_p = \frac{1+\sin\phi}{1-\sin\phi}$

assume $\phi = 40°$ for 90-95% relative density Compaction

$$k_p = \frac{1+\sin 40}{1-\sin\phi} = \frac{1+.642}{1-.642} = 4.6$$

$$p = 4.6 \times 110 \times 16.5 = 8349 \text{ psf} = 58.0 \text{ psi}$$

hoop stress $\frac{pd}{2t} = \frac{58.0 \times 4.5}{2 \times .337} = 387$ psi

Very small i.e. negligible ✓

(The design internal pressure is 1950 psi. The soil over burden pressure is negligible as compared to this pressure).

80101381R1
S02R0
Page 7

Thermal Stresses

Due to soil overburden, the pipes are

PSEG	CALCULATION CONTINUATION/ REVISION HISTORY SHEET	SHEET : 93 CONT'D ON SHEET: 94

CALC. NO.: 650-1882			REFERENCE:				
ORIGINATOR, DATE	REV:	S.S.Singh 8/28/96	1				
REVIEWER/VERIFIER, DATE		AMA 8/29/96					

Effect of Seismic Anchor Movement

The horizontal run of the pipelines run very close to the containment wall (about 1-2 feet) and the vertical 6' drop at the Fuel Handlg end of the pipe is very close to the Fuel handlg wall (about 1 foot). The pipe segments are so close to the respective buildings that the soil surrounding the pipes will in general move about the same as the corresponding building during the seismic event. Hence there would not be a significant differential movement between the building anchor point and the soil with the particular pipe segment and the effect of seismic anchor movement will be insignificant.

80101381R1
S02R0
Page 8 of 8

Summary of Stresses

Stress due to soil overburden = negligible

* Stress intensification factor is not considered because the pipe is constrained by the CLSM at Unit 1 and constrained by the soil at Unit 2. 1A