QA Record

TVA 10697 (ONE 6-86)

DNE CALCULATIONS

TITLE MODERATE ENERGY LINE BREAK FLOODING STUDY REFINED STRUCTURAL FLOOD LOAD ASSESSMENT	PLANT/UNIT WATTS BAR / 1 & 2
PREPARING ORGANIZATION SARGENT & LUNDY	KEY NOUNS (Consult RIMS DESCRIPTORS LIST) CIVIL CALCULATIONS, FLOOD CONT, FLOODING, CONCRETE, STEEL
BRANCH/PROJECT IDENTIFIERS WCG-1-270	Each time these calculations are issued, preparer must ensure that the original (RO) RIMS accession number is filled in.

Rev (for RIMS' use)	RIMS accession number
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APPLICABLE DESIGN DOCUMENT(S): 1ON320-1; 41N306-1; 41N318-1,2,4; 41N319 series; 41N330-1; 41N372-1,2; 16W418-2; 16W419-1,2; 46W401-4,6; AND 46W405-4.

SAR SECTION(S) | UNID SYSTEM(S)

Safety-related? Yes ☒ No ☐

Revision 0	R1	R2	R3
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Prepared J Smi			
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List all pages changed by this revision.			

Use form TVA 10534 if more space required.

Statement of Problem

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REFINED STRUCTURAL ASSESSMENT FOR MODERATE ENERGY LINE BREAK FLOODING.

Abstract

These calculations contain an unverified assumption(s) that must be verified later. Yes ☐ No ☒

THESE CALCULATIONS CONSTITUTE THE REFINED ASSESSMENT OF THE WATTS BAR SAFETY-RELATED STRUCTURAL ELEMENTS FOR THE EFFECTS OF FLOOD LOADS DUE TO MODERATE ENERGY LINE BREAKS IN AUXILIARY AND DIESEL GENERATOR BLDGS. A TOTAL OF 8 FLOOD ZONES (676.0-A2, A3, 737.0-A6, A7', A8', A10, A16 AND 742.0-D8) WERE ASSESSED.

ATTACHED TO THIS SHEET IS SARGENT & LUNDY CALCULATION NUMBER. SF-OP-02, REV. 1 AND CONSTITUTES THE REV. 0 ISSUE OF THIS CALCULATION FOR TVA.

☐ Microfilm and store calculations in RIMS Service Center.

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Microfilm and destroy. ☐

Address: 55FB, Watts Bar

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I. Purpose and Scope

The purpose of the structural flood load assessment is to ensure that the Watts Bar Plant safety related structures are adequate to support internal flood loads caused by moderate energy line breaks (M.E.L.B.) within the plant. The analysis of these structures shall conform to the appropriate Watts Bar Design Criteria and F.S.A.R. commitments.

The safety related structures to be included in this assessment are the:

1) Auxiliary Building,
2) Control Building,
3) Reactor Building,
4) Diesel Generator Building, and
5) Intake Pumping Station.

Each building is made up of internal compartments or areas at each elevation which can form a physical boundary where internal flood water can accumulate and be isolated from other areas of the plant. Each bounded area where internal floods can accumulate is designated as a flood zone. These zones shall be identified and furnished by Sargent & Lundy's Nuclear Safeguards and Licensing Division (NSLD). Also, NSLD shall provide the postulated M.E.L.B. flood levels in each zone.

The initial assessment of the structural elements was performed using conservative methods to facilitate the analysis of a large number of flood zones. Concrete slabs were assessed by calculating an allowable flood level, using the posted live load as an allowable flood load and comparing this allowable flood level with the postulated M.E.L.B. flood levels from NSLD. Concrete and masonry walls were assessed by using conservative boundary conditions and minimum steel requirements to calculate allowable flood levels.

The scope of this work is to perform a refined analysis for those flood zones which had postulated flood levels greater than the conservative allowable flood levels calculated in the initial assessment. These flood zones include:

Flood Zones	Components
676-A2	Base Mat
676-A3	Base Mat
737-A6	Concrete Wall
	Slab
737-A7'	Slab
737-A8'	Slabs
737-A10	Concrete Wall
	Slab
737-A16	Slab
742-D8	Slab

II. Organization of Calculations

The structural flood load refined analysis calculation (S&L No. SF-OP-02) is divided into five sections. The following paragraphs briefly describe the contents of each of these sections.

Section 1 contains the Design Control Summary (D.C.S.). This section includes the signatures of design and verification, calculation index, design assumptions and procedures, construction materials, loading combinations, and design input information. In short, this section summarizes the design basis of this calculation.

Section 2, Design Input Documents, includes key reference documents utilized in the structural flood load assessment. The documents include design information transmittals (D.I.T.'s) from N.S.L.D. and any other reference document which is directly related to the structural flood load assessment. The documents used in the original flood load assessment are filed in Branch/Project Identifier WCG-1-277 (S&L Calculation No. SF-OP-01 Rev. 0) Section 3, and are referenced in this section. Subsequent transmittals which directly relate to the refined analysis are filed here.

Section 3 contains a summary of the results of the initial assessment for the eight flood zones listed in Section 1. The summary includes the allowable and postulated flood level for each zone, and the live loads used to develop the allowable flood levels for slabs.

Section 4 contains the detailed calculations for the revised allowable flood levels based on the refined analysis.

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Section 5 provides the summary and conclusion of the refined structural analysis. This section includes the tabulated comparison of the allowable flood height per flood zone to the postulated flood height computed by NSLD.

III. The applicable abnormal load combination for the structural flood load refined analysis is

1.0 D.L. + 1.0 F

for reinforced concrete and masonry applications. Where "D.L." = design dead load from the original Watts bar calculations (per QIR-CEB-87-088) "F" = hydrostatic M.E.L.B. flood load. Additional permanent loads, such as equipment, have been included in the individual calculations.

A M.E.L.B. flood event is considered not to be concurrent with an operating or safe-shutdown earthquake; however, it is still considered an abnormal loading condition. The definition of loads and load combinations conform to T.V.A. Design Criteria WB-DC-20.1.1, Rev. 7, (see DIM-WB-DC-20.1.1-6).

IV. Materials and Allowables

The materials and allowables for reinforced concrete, used in the structural flood load assessment shall be per the appropriate T.V.A. Design Criteria WB-DC-20.1.1, Rev. 7 and WB-DC-20.1, Rev. 4.

V. Refined Analysis for Revised Allowable Flood Levels

When the postulated flood levels, provided by NSLD, exceed the allowable flood levels, a refined analysis shall be performed. The following describes the assumptions and procedures which will be used to perform the refined analysis calculations. The procedures are listed in the order which may be followed when performing the refined analysis.

A. Replication of Sequoyah's Refined Flood Analysis Procedures

Based on the initial flooding assessment at the Sequoyah plant, a refined analysis was performed similar to that being performed for Watts Bar. When the areas are similar in Watts Bar and Sequoyah, the refined analysis performed for Sequoyah may be replicated as follows:

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1. A review of the Sequoyah calculations will be made to determine the governing check (shear or bending) for the structural element.

2. Based on the governing check and the applicable loads from the Sequoyah calculations, the revised allowable flood level will be calculated for the Watts Bar flood zone.

When replicating the Sequoyah calculations, the engineer shall check and document that the design drawings and calculations from the two plants are similar. This would include a comparison of the design loads, slab or wall span and thickness, reinforcing, and boundary conditions.

For areas which are not similar or where a refined analysis was not required for Sequoyah, the method of analysis in Section B may be used.

B. Revised Allowable Flood Levels Based on Watts Bar Calculations.

The simplified criteria used to establish the allowable floor levels for slabs in the Watts Bar plant, was formulated by equating the live load portion of the normal load combination and the abnormal flood load combination:

$$1.7\ L.L. = 1.0F$$

where: L.L. = The posted live loads from the T.V.A. drawings

F = The hydrostatic M.E.L.B. Flood Load

Since the live load is known for each flood zone, the allowable flood load and flood level can be calculated: Reference T.V.A. calculation Branch/Project Identifier WCG-1-277 (S&L Calculation SF-OP-01 Rev. 0 pages 1.6 to 1.8). This criteria was used to facilitate the assessment of a large number of flood zones.

For the refined analysis, the same comparison will be made between the normal and abnormal load combinations, however, the allowable flood level will be calculated using both the dead load and the design live load:

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1.4 D.L. + 1.7 L.L. = 1.0 D.L. + 1.0F

where: D.L. = The design dead load from the Watts Bar calculations.

L.L. = The design live load from the Watts Bar calculations.

F = The hydrostatic M.E.L.B. flood load

The revised allowable flood level can be calculated as follows:

1. Concrete Slabs

   a. Review the Watts Bar original design calculations for the slab to determine the design dead loads and live loads.

   b. Calculate the allowable flood level "H" (in inches) using the dead load and live loads from the Watts Bar design calculations:

      $H = (0.4\ D.L)\ (12)/62.4 + (1.7\ L.L)\ (12)/62.4$

   c. Compare the flood level provided by NSLD with the revised allowable level calculated.

   d. If the flood level is greater than the refined allowable, the senior structural engineer shall be informed and the more detailed analysis methods outlined in Section C will be used.

2. Reinforced Concrete Walls

   a. Review the original Watts Bar design calculations to obtain the uniform out of plane design loads and the original boundary conditions.

   b. Review the T.V.A. drawings for the wall reinforcing and boundary conditions.

   c. Recalculate the allowable flood heights for a 1' strip utilizing the ultimate strength design method per ACI-318-71 in conjunction with the actual boundary conditions, reinforcement, and out-of-plane design loads.

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d. Compare the actual flood level with the revised allowable level. If the revised allowable level is less than the actual flood level, consider possible two way action of the wall. The shears and moments can then be calculated using the publication "Moments and Reactions for Rectangular Plates" (Engineering Monograph No. 27 - United States Department of the Internal Bureau of Reclamation). These shears and moments would then be used to calculate a revised allowable flood level.

C. Refined Analysis for the Actual Structural Element

The procedures outlined in this section will be used to calculate the allowable flood levels considering the actual loads and construction of the structural element. The analysis method for concrete walls and concrete slabs are outlined below.

1. Review the original design calculations for the analysis method and the design loads.

2. Review the design drawing for the reinforcement sizes and placement.

3. Calculate the allowable moment and shear capacities based on the ACI 318-71 ultimate strength method.

4. Using the original design loads, the original design methodology, and the ultimate strength allowable moments and shears, calculate the revised allowable flood height.

D. Columns

Columns are designed to support several different elevations of the structure. Each elevation will consist of individual slabs and beams that contribute to the column loads. The refined analysis consists of only eight zones in the plant compared with a total of 248 analyzed in the initial assessment. These eight flood zones are located such that only one of these flood zones would add flood loads in excess of the live load to any single column. As

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such, the combined dead load plus live load combination for all the column tributary area will govern over the dead load plus flood load. No further analysis of columns is required for the refined flood load analysis.

VI. Qualification of Structural Components

The revised allowable flood levels calculated in Section V will be compared to the flood levels provided by NSLD. When the actual flood levels are less than the revised allowables, the structural elements are qualified for the M.E.L.B. flood.

When the actual flood level is greater than the revised allowable, the engineer shall inform the senior structural engineer and discuss other possible analysis refinements, such as redistribution of moments, revised boundary conditions or other unique structural or analysis considerations which will yield greater strength.

If an element cannot be feasibly qualified and is found not to be structurally adequate to resist the postulated flood loads, then corrective actions shall be formulated and suggested to T.V.A. for the purpose of flood level reduction and or member strength enhancement, i.e., actual in place concrete strength.