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OFFICE OF NUCLEAR REACTOR REGULATION

TVA PROJECTS DIVISION

Report No.: 50-260/89-32

Docket No.: 50-260

Licensee: Tennessee Valley Authority
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1101 Market Street
Chattanooga, Tennessee 37402-2801

Facility Name: Browns Ferry Nuclear Plant, Unit 2

Inspection At:

1. Tennessee Valley Authority Office
Knoxville, Tennessee
2. EQE Incorporated
San Francisco, California
3. Bechtel Power Corporation
San Francisco, California

Inspection Conducted: June 5 - August 18, 1989

Inspector: D. Terao for 11-7-89
Thomas H. Cheng, Team Leader Date

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Engineering Branch
TVA Projects Division
Office of Nuclear Reactor Regulation

Special Inspection

Relating to Civil Calculation Program

1 INTRODUCTION AND BACKGROUND

As documented in NRC Inspection Report (IR) 50-260/89-30 dated September 20, 1989 (Reference 6.1) the staff conducted an inspection of the Browns Ferry Nuclear Plant, Unit 2 (BFN-2) civil calculation review program. The purposes of that inspection were: (1) to understand and become familiar with the approach and procedures that TVA used for completing the civil calculation review program, (2) to review the justification for not completing its evaluation of four design areas before the restart of Browns Ferry Nuclear Plant, Unit 2 (BFN-2), and (3) to conduct an inspection of the results of TVA's review of the remaining design areas, which must be resolved before restart of BFN-2. A total of 14 concerns were identified as summarized in Enclosure 3 of IR 50-260/89-30 and ten of them remained open. TVA is required to resolve these open items before restart of BFN-2.

2 PURPOSE AND SCOPE

The purpose of this inspection was to review TVA's responses to the ten open items identified in IR 50-260/89-30. In addition, the staff also intended to review TVA's review results of design calculations related to primary containment and four issues covered under the BFN-2 seismic design program. These four issues are: CSG-9 (Impact Assessment of New Amplified Response Spectra), CSG-10 (Horizontal Rigidity of Drywell Steel Platforms), CSG-11 (Equivalent Static Vertical Analysis of Drywell Steel Platforms), and CSG-24 (Buckling Evaluation of HVAC Ductwork).

3 REVIEW FINDINGS

On June 5-9, 1989, the staff and its consultants conducted the second inspection of the BFN-2 civil calculation review program at TVA's office in Knoxville, Tennessee. The attendees of the meeting are listed in Enclosures 1 and 2. Because of the complexity of the issues, discussions continued after June 9, 1989 between the staff and TVA, and the exit meeting was not held until August 18, 1989. The list of attendees at the exit meeting is contained in Enclosure 3. The following subsections document the inspection findings, the staff's conclusions, and TVA's verbal commitments made during the inspection. The updated status summaries of all the open items identified in IR 50-260/89-30 and IR 50-260/88-38 are provided in Enclosures 4 and 5, respectively.

3.1 (3.2)* Justification for Post Restart Design Areas

During the first civil calculation review program inspection, TVA proposed to postpone its review of four design areas (heavy loads, flooding, tornado and tornado missiles, and settlement and slope stability) until after the restart

* The number in the parenthesis of the subsections under Section 3 denotes the section number in IR 50-260/89-30

of BFN-2. As a result of that inspection, the staff accepted TVA's justification for postponing the review of heavy loads after restart of BFN-2. However, TVA was required to provide additional justification for the other three design areas.

During this inspection, TVA provided its bases for postponing the completion of the remaining three design areas (tornado and tornado missiles, settlement and slope stability, and flooding) until after the restart of BFN-2. The staff's review findings and conclusions are discussed in the following subsections:

3.1.1 Tornado and Tornado Missiles

In response to the staff's concern about this issue, TVA provided the following documents for review:

(1) CAQR BF P890327 (R76890606 899)
(2) QIR CEB BFN 89029 (B22 890321 005)
(3) QIR CEB BFN 89049 (B22 890601 001)
(4) QIR CEB BFN 89050 (B22 890606 010)
(5) Design Memorandum from McCall to Smith dated May 1, 1989 (B41 890501 001)
(6) Meeting handouts

Because the three QIRs and one CAQR were written against the tornado evaluation, TVA committed to reconsider the review of the tornado (including tornado missiles) design calculations as a pre-restart item. In resolving this issue, TVA will create a detailed list of all systems and components required for the safe shutdown of the plant, resolve related concerns raised by the staff, and complete the calculations before the next inspection.

In addition, in TVA document B41 890501 001 (design memorandum from McCall to Smith), the potential missile velocity for the diesel generator building access door was revised to 100 miles per hour. This appeared to be in conflict with FSAR Section 12.2.2.9.2 which states:

"As an upper limit, each missile is assumed to be traveling 300 miles per hour at impact. No credit is taken for the crushing effect of missiles."

TVA agreed to resolve this concern prior to restart of BFN-2.

3.1.2 <u>Settlement and Slope Stability</u>

<u>Settlement</u>

The staff consultant reviewed the following documents provided by TVA.

(1) Diesel generator building (DGB) settlement evaluation CDQ0303 884347 sheet 120 of 121, dated June 3, 1989.

(2) Results of settlement and detection monitoring.

(3) Memorandum from S. Stone to C.D. Simms, "Settlement Monitoring Program," dated November 19, 1987

(4) Meeting handouts

The review found that:

(1) All Class I structures with the exception of the DGB, standby gas treatment building (SGTB) and vacuum pipe building (VPB) are supported directly on rock or H-piles driven into rock. Therefore, foundation settlement is not a concern for these buildings.

(2) The VPB is not required for the operation of BFN-2. The settlement of this building can be evaluated after restart of BFN-2.

(3) The Unit 2 DGB is founded on three feet of compacted soil which in turn is supported by 38 feet of compacted crushed stone placed directly on rock. The settlement monitoring program for the BFN Unit 3 DGB indicates a maximum settlement of 0.3 inches.

(4) The SGTB is founded on ten feet of compacted fill overlying 38 feet of compacted crushed stone supported on rock. The settlement of this building is similar to the BFN Unit 3 DGB. Because the settlement of these soil-supported structures is insignificant for the near term, the staff concluded that the evaluation of soil settlement can be completed after the restart of BFN-2.

Slope Stability

The staff consultant reviewed the following TVA documents:

(1) B04 890530 200, "Intake Channel Slope Stability."

(2) Drawing 10 N 214 - R2, dated March 4, 1968

(3) Drawing 10 N 214 - R3, dated March 26, 1971

(4) Meeting handouts

The review found that the original intake channel was excavated in the in-situ earth materials. The slope ratio was 3 (horizontal) to 1 (vertical). In April 1970, approximately one and one half years after the intake channel was excavated, a portion of the eastern slope between stations 1+60 ± and 3+00 ± failed. The cause of the failure was a layer of soft basal clay immediately above the rock. As shown on drawings 10 N 214 and 10 N 215, 52 feet of in-situ material on both the east and west slopes was removed and replaced with compacted crushed stone between station 1+50 ± and station 3+50 ±. The remaining intake channel slopes were flattened to a slope of 6 (horizontal) to 1 (vertical). The slopes were analyzed for the following load condition:

(1) Normal load case - dead load plus active soil load assuming the pool water level at El.556'-0".

(2) Sudden draw-down case - dead load plus active soil load and hydrostatic load assuming pool water level drops from EL. 556'-0" to El. 519'-0".

(3) Earthquake load case - dead load plus active soil load and design basis earthquake (DBE) load.

The analysis indicated that the calculated factor of safety (FOS) against sliding is 1.48 for the normal load case, 1.08 for the sudden draw-down case, and less than 1.0 for the DBE load case. To resolve the concern of FOS less than 1.0, TVA performed an analysis for the DBE load case based on Newmark's theory and showed that the maximum horizontal slope movement would be 16 to 17 inches. Because this movement will not affect the total flow needed for the plant operation, it was considered acceptable to the staff.

TVA also reviewed the safety significance of other earth embarkments and slopes. TVA found that the following slopes will have to be evaluated prior to restart:

(1) North slope of the cooling water discharge channel from Gate No. 2 to the intake pumping station.

(2) Berm on the south side of the reactor building.

(3) Cooling water discharge channel dike in the area where the RHR service water discharge pipes pass beneath it.

TVA agreed to complete its evaluation of these slopes before the next staff inspection.

3.1.3 Flood

The staff consultant reviewed the following TVA documents:

(1) Meeting handouts prepared by N. Perry and R. Hernandez, dated June [illegible], 1989,

(2) SSA-Flood, Appendix 32A dated January 30, 1987,

(3) QIR - Class I Building - Flood Protection dated May 18, 1989 (RIM B22 890522 000),

(4) BFNP Appendix 2.4A to the FSAR, "Maximum Possible Flood," dated February 1972,

(5) TVA Responses to NRC Question 2.6 dated March 25, 1971 and Amendment No. 40 dated August 24, 1972,

(6) BFNP Design and Analysis Report, Volume 1, Section 4.1, dated November 1966, and

(7) Procedure 0-AOI-100-3, "Flood Above Elevation 565'-0"-Abnormal Operation Instruction," dated June 23, 1988.

The review found that three floods were discussed in the FSAR.

(1) The probable maximum floor or PMF (flood level of 572.5' plus 5.5' wave run-up) is produced by a three-day storm with an average precipitation of 13.6 inches preceded by a three-day storm of 5.5 inches with a 3 day dry period between storms,

(2) The maximum possible flood is the same as the PMF, and

(3) The maximum probable flood (MPF) (flood level of El. 561'-0" plus additional three feet caused by dam failures and wave run-up) is produced by a three-day storm with an average precipitation of 9.5 inches over the water shed preceded by a three-day storm of 3.9 inches with a 3 day dry period between storms.

TVA has designed or reviewed the design of all Class I structures for a probable maximum flood level at El. 578'-0".

In response to NRC Question 2.6 in the FSAR, TVA stated that the flood protection provides for the combined effects of the operating basis earthquake coincident with the maximum probable flood. TVA also stated that the intent of this statement was to determine maximum flood level and was not to provide criteria for structural design. This is consistent with the staff position and is, thus, acceptable.

A TVA internal memorandum from H.B. Bounds to G.C. Campbell requested that Operating Instruction 0-AOI-100-3 be revised to include the discharge valves from the stack to the radwaste building. TVA committed to revise this instruction to include these valves prior to restart of BFN-2.

In an associated issue, TVA is relying on a depression in the Tennessee River adjacent to the BFNP site as the source of emergency cooling water in the event that Wheeler Dam should fail. This depression is approximately 1000 feet wide and seven miles long. The water is trapped by the 529 feet contour and represents approximately 100 x 10^6 cubic feet of water.

In Section 2.4.2.2.2 of the FSAR, TVA committed to verify the silt levels in this pool every ten years starting in 1971. The silt levels were last verified in August 1977 at only one cross section corresponding to SR 26 (approximately 2 miles south east of the site). TVA staff concluded that the silt levels should be rechecked at several stations prior to plant restart including SR 24 which is closest to the plant site. TVA has committed to resurvey this area prior to restart.

In summary, for the design areas of tornado (including tornado missiles), settlement and slope stability, and flooding, TVA agreed either to provide justification for not completing its evaluation prior to restart or to complete its calculations before the next staff inspection. This item remains open. (CC-1)

3.2 (3.3.1) Equipment Access Lock Pile Foundation

In response to the staff's concern documented in IR 50-260/89-30, TVA completed its calculations B04 890602 200 (equipment access lock pile foundation), B30 880811 202 (soil amplification for equipment access lock), and B04 890608 207 (reactor building equipment access lock-foundation check) and submitted them to the staff for review.

The review of these calculations found that the equipment access lock is essentially a buried structure. Accordingly, it is appropriate to assume in the analysis that the structure will move together with the surrounding soil during an earthquake event. Therefore, the maximum axial load on the piles is due to dead load, live load and vertical seismic load. The vertical pile load due to horizontal earthquake was not calculated because the structure is expected to move together with the surrounding soil and the vertical load caused by the foundation overturning moment was determined to be negligible.

The staff consultant also found that the maximum pile stresses were calculated using the maximum axial load and the seismic movements of the pile head in the two horizontal directions. The highest stress was calculated to be 22.6 ksi which is below the allowable stress (32.4 ksi) for the design basis earthquake load case. In addition, TVA calculated that the structure has a factor of safety of 1.6 against flotation during the probable maximum flood. From the discussion above, the staff considers this item closed. (CC-2)

3.3 (3.3.3) Buried Structures

As a result of the last inspection, four of the issues identified in this design area still remained open:

(1) the use of more recent codes (e.g., ACI 318-71 and 318-77 codes) instead of the design codes specified in the FSAR (e.g., ACI 318-63 code) for the standby gas treatment building (SGTB) evaluation,

(2) the adequacy of the methods used for the seismic analysis of buried conduit banks and the design adequacy of the connection at the interface between the conduit banks and buildings,

(3) the determination of the differential seismic anchor movement (SAM) of the piping systems inside the residual heat removal (RHR) pipe tunnel and the movement at the tunnel-reactor building (RB) interface, and the transferring procedure of the SAM results to the Engineering Mechanics Group (EMG) for the piping analysis, and

(4) evaluation of the Class I buried piping.

The staff and its consultants reviewed TVA's response to the above concerns and concluded the following.

For the issue concerning the use of later codes, TVA calculation B41 890609 001 confirmed that only the ACI 318-63 code was used in the design calculations. The use of ACI 318-63 code for design is consistent with FSAR requirements. Therefore, this issue closed.

For the the issue concerning the seismic design of conduit banks, the review of TVA documents B41 890428 001, B22 890526 003, and B04 890608 208 found that the seismic analysis of the electrical conduit banks was performed in accordance with the methods specified in Design Criteria BFN-50-C-7103 which are consistent with the current industry practice. The analysis results were found to satisfy the code allowable stress values. Regarding the design adequacy of the couplers for accommodating the relative seismic movements at the interface between the banks and the buildings, such as diesel generator building, the staff found that the couplers have a capacity of 3/4" against relative movement. The calculated maximum relative movement was found to be significantly less than 3/4" for the design basis earthquake condition. Based on these findings, the staff considers this issue closed.

For the issue concerning the seismic anchor movements at the tunnel-reactor building interface, TVA calculation B04 890608 200 computed the ground displacement at grade level relative to the bedrock assuming that the seismic wave propagates vertically through the soil layer. This displacement was then associated with a horizontally propagating wave along the axis of the pipe tunnel with a wave length equal to the product of the fundamental period of the soil layer and the shear wave velocity of the soil. From this approach, the seismic anchor movement between two consecutive pipe supports was calculated. In order to demonstrate its adequacy, TVA also compared this movement with a calculated seismic anchor movement based on the current industry practice (e.g. the approach documented in NRC NUREG/CR-1161). This movement was then transmitted to TVA's Engineering Mechanics Group (EMG) for piping evaluation. The staff consultant reviewed TVA's calculation and information transmitting procedures, and found that the seismic anchor movement was reasonably calculated and the information transmitting procedures were adequate.

For the issue concerning Class I buried piping, TVA used the same method applied to the electrical conduit banks evaluation for analyzing the buried piping. The staff consultant reviewed the analytical method and the results contained in TVA Calculation ND-Q0023-88009, and found them technically adequately and reasonable.

In summary, the staff considers this item closed. (CC-4)

3.4 (3.3.5) <u>Foundation Design Calculation - Reactor Building Base Slab</u>

During the previous inspection (IR 50-260/89-30), the staff consultant questioned an assumption in TVA's original reactor building base slab design calculations, that the distribution of the reactor building super-structure loads to the exterior walls and the center core would be 40% and 60%, respectively. TVA was requested to verify the reasonableness of this assumption.

For this inspection, TVA prepared Calculation B04 890512 200 to address the question. This calculation indicated that the distribution of the super-structure loads would be 48.5% to the exterior walls and 51.5% to the center core. The final calculation for the foundation evaluation is based on this load distribution. TVA noted that the differential settlement between the exterior and interior of the reactor building slab and the shear forces and bending moments would be reduced because of a more uniform load distribution. Furthermore, TVA performed a review of the design adequacy of the exterior walls, columns, control bay, and P-line wall using the final load distribution.

The staff consultant reviewed TVA's calculations and found that the calculation of the foundation load distribution was appropriate and technically sound and the stresses in those sample structural elements were within design allowable values. Therefore, this item is considered closed. (CC-6)

3.5 (3.3.7) <u>Embedments and Anchorages</u>

During this inspection, the staff consultant reviewed samples of embedded plate qualification calculations relating to HVAC duct supports (B22 890515 114, B22 890515 115, B22 890515 117 and the related drawings). The review found that TVA used computer program BASEPLATE II to evaluate the embedded plates and the attached stud anchors. For this purpose, a finite element model of each embedded plate was prepared and input to this computer program with maximum loads on the plate. Another computer program, CONAN, was used to account for the concrete pull-out capacities of the stud anchors.

The results of the analyses and the additional calculations performed showed that the embedded plates, as analyzed in the above listed calculations, met the requirements of TVA Design Standard DS-C1.7.1. Therefore, the staff considered the qualification of these embedded plates acceptable. Although, the analysis of other embedded plates relating to HVAC duct supports are still ongoing, the staff considers this concern closed based on the audit performed on the above mentioned sample calculations. (CC-8)

3.6 (3.3.9) <u>Reactor Building Corner Room Floor Framing</u>

During the previous inspection, the staff had identified concerns in the applied loads, load combination, and design evaluation related to the structural design of the corner room steel platforms. In order to resolve the staff's concerns, TVA performed new calculations for all four corner room platforms at elevation 541'-6" and presented them to the staff for review during this inspection. The following subsections document the staff review findings and conclusions:

(1) Applied Loads

For dead loads, the calculations comply with the requirements specified in the Design Criteria BFN-50-C-7100, Attachment G. Design Criteria BFN-50-C-7100, Attachment G is acceptable to the staff, because these criteria are more stringent than the operability criteria which were accepted by the staff for BFN-2 restart (Reference 6.3). For the equipment weights, the only equipment in the area was a pump supported on the north-west corner room platform and its weight was properly included in the calculation. This resolved the staff's concern on the unverified assumption for the equipment weight.

Initially, the staff expressed a concern on the 10 psf live load specified in the design criteria during plant operations. A review of the TVA procedure SDSP14.6 indicated that all live loads will be removed from the platform during plant operation and hence the concern was resolved.

For seismic loads, TVA performed both horizontal and vertical seismic analysis of the platforms using the STRUDL computer code with the floor response spectrum previously accepted by the staff (IR 50-260/89-39) as input motion. Therefore, the staff considers the concern about the structural seismic loads resolved.

The attachment load due to dead weight was adequately included in the calculation. The attachment load due to seismic excitation has not been completed yet because of the incomplete status of the IEB 79-14 piping program from which the pipe loads for the platform evaluation are to be generated. Therefore, the concern about attachment loads will be resolved when the piping loads become available.

Thermal load was not included in the analysis. For normal operation condition, the effect from thermal loads was judged to be negligible in accordance with the harsh environment data at BFN. For accident condition, the effect of accident temperature was addressed by the thermal growth issue under the BFN Seismic Design Program. TVA agreed to complete its calculations before the next staff's inspection. Therefore, the exclusion of thermal load from the calculations is considered acceptable under this inspection. The issue of the thermal growth of steel structural members will be resolved as a part of seismic design program review.

(2) Load Combinations

The load combinations considered in the calculations are consistent with the design criteria BFN-50-C-7100 and the FSAR and therefore, acceptable.

(3) Design Evaluation

The loads and stresses in the framing members, member connections, and concrete anchors were checked against the allowables specified in Design Criteria BFN-50-C-7100, Attachment G. The review found that these stresses are all within the allowable stress value. However, due to the incomplete status of the seismic attachment load calculations, the staff was not able to complete its review of the reactor building corner room floor framing design at this time.

In summary, TVA's calculations adequately addressed the staff's previous concerns except for the seismic attachment loads. TVA agreed to incorporate the final piping loads to be generated under the IEB 79-14 piping program and finalize its calculations of the reactor building corner room platforms before the staff's next inspection.

In addition to the calculations of the corner room platforms, the staff consultant also reviewed TVA's calculation for the steel platforms supporting heat exchangers located in the reactor building. The purpose of this review was to determine whether the platforms met the design requirements as stated in the Design Criteria BFN-50-C-7100, Attachment G. The review included design loads, load combinations, and stress analysis of structural steel elements including anchorages to concrete. As a result, the staff found that the loads and load combinations applied were consistent with the design criteria and the calculated stresses are within the allowable stress values as specified in the design criteria.

However, the staff had a concern relating to the qualification of the support attachments to concrete. The upper and lower heat exchanger supports were attached to the concrete by embedded plates with ductile stud anchors. The anchorage design considered only the ductile capacity of the stud anchors, but failed to consider the anchor concrete pull-out capacity. During the inspection, TVA performed additional calculations and showed that both the upper and lower embedded plate assemblies had enough capacities to resist the tension loads and still satisfy the safety factors as stated in TVA Design Standard DS-C1.7.1.

As discussed above, TVA adequately addressed the staff's concerns about the steel platforms inside the reactor building except for the seismic attachment loads. This item remains open. (CC-10)

3.7 (3.3.10) <u>Base Plate Prying</u>

TVA's previous response to this item indicated that prying action do not exist. TVA based this conclusion on the scoping calculations using the BASEPLATE II computer code. These calculations assumed a relatively low stiffness for the SSD expansion anchors and a relatively high stiffness for the base plate. The low stiffness of the SSD expansion anchors and high base plate stiffness resulted in separation between the base plate and concrete interface, and therefore, very small prying forces.

During this inspection, the staff consultant reviewed TVA documents B41 890602 001, "Tensile Stiffnesses for Expansion Anchor for BASEPLATE II Analysis," and B41 890602 002, "Design Standard Change Notice on General Anchorage and Concrete, DS-C1.7.1, R4," and found that TVA revised its Design Standard DS-C1.7.1 to increase the expansion anchor bolt stiffnesses from 100 kips/in. to 400 kips/in. From the review of the existing load-deflection curves, the staff agreed with TVA that a stiffness of 400 kips/in. stiffness would approximate the test results. The staff finds the use of 400 kips/in. stiffness for evaluating the prying force acceptable because the higher the anchor bolt stiffness results in a larger prying force. The staff consultant also reviewed the scoping analyses and calculations performed by TVA and found that the effect of prying increases bolt load by approximately 12% for bolts spaced 6 times the thickness of the plate from the edge of the support to the centerline of the bolt. For a bolt spacing of 8 times the plate thickness, the increase in the bolt load due to prying is approximately 22%. The staff finds the 12% increase in bolt load due to prying is judged to be acceptable because of the high factor of safety applied for the expansion anchors. However, the 22% increase is considered a significant increase and may affect the accuracy of the calculated bolt load. TVA agreed to analyze all base plates using expansion anchors where the distance from the edge of the support to the centerline of any bolt exceeds 6 times the thickness of the base plate. All supports using SSD expansion anchors which fail to meet the restart criteria will be redesigned to meet the revised Design Standard DS-C1.7.1 (Revision 4) prior to restart. Based on these commitments, the staff considers this item closed. (CC-11)

3.8 (3.3.11) Reactor Building Concrete

The outstanding issues identified from the previous inspection include:

(1) Discrepancy in the bending moment due to jet load at the base of the reactor pressure vessel (RPV) pedestal between the 6000 kip-ft used in the Stone & Webster Engineering Corporation (SWEC) calculation and the 9250 kip-ft previously specified in TVA calculation RIM B22-881123 120.

(2) Verification of the adequacy of the OBE seismic moment at the top of the pedestal as shown in Fig. 12.2-38 of the FSAR.

(3) Adequacy of the jet and seismic loads for the design of the concrete anchor bolts for the RPV support skirt.

(4) Use of ACI 318-71 and 318-77 Code in SWEC supplemental calculations in addition to ACI 318-63 Code, which represents the licensing basis for the reactor building (RB) concrete, and the generic implication of using the later version of design code for other Class I concrete structures.

(5) Clarification of the seismic design method for the reactor building walls.

(6) The thermal restraint load "RESTR" was not included in SWEC's supplemental calculation for the biological shield wall.

In response to these concerns, TVA, during this inspection, provided its updated calculations and justifications for review. The following paragraphs summarize the staff's review findings and conclusions.

For the issue concerning a discrepancy in the jet load bending moment, TVA re-evaluated the RPV pedestal design by considering the originally specified jet moment of 9250 kip-ft in lieu of the 6000 kip-ft moment used in the SWEC calculation. The staff consultant reviewed the re-evaluation which used the 9250 kip-ft moment as contained in TVA's calculation B41 890609 001 and found that the stresses are within the design allowable. Therefore, this issue is considered closed.

For the issue concerning the adequacy of the OBE moment, the staff's concern was that the response of the RPV might not be properly included in calculating the OBE moment on the pedestal as shown in Figure 12.2-38 of the FSAR. During this inspection, TVA provided a comparison of the OBE moment profile shown in Figure 12.2-38 of the FSAR with a corresponding profile generated by Bechtel Power Corporation (BPC) (Calculation B22 890425 108). The review found that the dynamic model used by BPC did include the RPV and the two corresponding moments at the top of the pedestal are consistent with each other. Therefore, the staff considers this issue closed.

For the issue concerning the adequacy of loads in the RPV support skirt anchor bolts, the staff consultant reviewed TVA Calculation B22 880829 191. The staff consultant found that the anchor bolts used for the RPV skirt were designed for the shear force and moment equal to 1150 kips and 25300 kip-ft, respectively, for the combined load of OBE and jet impingement. These design loads are much higher than the combined loads (680 kip shear and 12800 k-ft moment) as specified in the FSAR. This closed out the staff concern of this issue.

For the issue concerning the use of later codes, the staff consultant reviewed TVA calculations and handouts provided during this inspection and found that the ACI 318-71 and 318-77 codes were not used in the design of the reactor building (RB), chimney, standby gas treatment building and the pumping station slab. Instead, these codes were provided as references in the Stone & Webster Engineering Corporation's (SWEC) supplemental calculations. This resolved the staff's concern.

For the issue concerning the seismic design method for reactor building walls, the staff's concern was that it was not clear from reviewing TVA's calculations how the seismic loads were considered in the design of reactor building walls. During this inspection, TVA clarified its methods for the seismic design of the reactor building walls. The staff consultant reviewed TVA's calculation B22 880921 121 for P-line wall and U-line wall, and found that the seismic loads was adequately considered in the design of these walls. Therefore, this issue is considered resolved.

For the issue concerning the thermal load for the biological shield wall, TVA revised the SWEC's supplemental calculation for the reevaluation of the biological shield wall to include the thermal restraint load (RESTR) due to the restraint from the suppression pool. The staff consultant reviewed the revised calculation and found that the final calculated stresses were still within design allowable values. This issue is considered resolved.

In summary, all six issues were adequately resolved, and the staff considers this item closed. (CC-12)

3.9 (3.3.13) <u>Diesel Generator Building Base Slab</u>

During the previous inspection, the staff had identified various concerns related to the design of the diesel generator building (DGB) base slab. These concerns as stated in the Inspection Report (IR) 50-260/89-30 and are summarized below:

1) Factors of safety against overturning and sliding were not calculated. Maximum bearing soil pressures were not compared to allowables. Possible differential settlement of the DGB foundation due to the presence of the high pressure coolant injection (HPCI) room was not considered.

2) The original design of the DGB did not appear to include an analysis of the base slab. Only the minimum flexural reinforcing was provided and shear stresses were not checked against design allowable stress. Effects of openings in the base slab due to embedded diesel day tanks were not considered.

3) The effects of the displacements of the base slab on the buried tanks were not considered.

In order to resolve these concerns, TVA performed a new analysis of the base slab which is contained in TVA calculation B04 890609 209. The review of this calculation showed that TVA performed a rigid base analysis to calculate the factors of safety against uplift, overturning and sliding of the DGB. In addition to this analysis, a finite element analysis of a portion of the base slab was performed to determine the effects of the openings due to buried tanks. The staff review of this reanalysis finds the following.

(1) The rigid analysis showed that the bearing soil pressures calculated for the combined load conditions which include the design basis earthquake (DBE) exceeded the allowable soil bearing pressure of 3.0 ksf, as specified in FSAR Section 12.2.8.1. However, TVA believed that a higher allowable bearing pressure could be justified for the load combinations with DBE. Based on the test results obtained for the BFN site TVA performed additional calculation B04 890608 208, to show that an ultimate bearing capacity of 10.5 ksf would be appropriate for dynamic loading conditions. This would yield to a safety factor of 2.8 for the maximum bearing pressure calculated for the same dynamic loading conditions. The staff is continuing its review of the proposed ultimate bearing capacity.

For the concern of differential settlement of the DGB base slab, TVA reviewed the settlement records recorded for the DGB slab of Browns Ferry Unit 3. The Unit 3 DGB slab rests on the soil foundation similar to that of the Unit 2 DGB slab. Settlement records of the four corners of the Unit 3 DGB show that there is no appreciable differential settlement of the building. These records were documented in TVA Calculation B04 890609 209. Therefore, the staff's concerns on the load combinations as well as the differential settlement of the DGB base slab for BFN Unit 2 is considered resolved.

(2) The dynamic stability analysis performed by TVA showed that a safety factor of approximately 0.74 exists against sliding of the DGB in the north direction due to the load combination including the DBE. TVA has calculated the sliding displacement of the DGB in this direction to be 0.1 inches. The method used for calculating the sliding displacement is documented in Bechtel Topical Report BCTOP-4, Revision 4. This displacement will be used to calculate stresses in piping attached to the DGB. As a result of its review, the staff found the problem of dynamic sliding is highly nonlinear and the method used by Bechtel has not been reviewed and approved by the NRC staff. TVA plans to revise its dynamic stability analysis and to show that the safety factor against sliding is higher than 1.0. This issue remained open.

(3) TVA performed a finite element analysis to determine the forces and moments in the base slab. This analysis was performed on a section of the base slab, which was judged by TVA to be the worst loaded section. Although this finite element analysis would predict the local behavior of the base slab, the staff found it does not predict the overall response of the base slab. To resolve this concern, TVA performed a beam-on-elastic-foundation analysis to a complete section of the base slab using the worst case loading combination as input. The results of this analysis showed that the base slab is capable of withstanding the moments and shears resulting from the worst case loading. TVA agreed to finalize its Calculation B04 890609 209 to include the beam-on-elastic-foundation analysis before the next inspection.

(4) The effect of openings in the base slab due to the buried tanks were considered in the finite element analysis performed using the STRUDL computer program. TVA checked the critical sections from this analysis to show that the base slab was capable of resisting the moments and shears obtained from the worst case loading of the slab. The finite element analysis also showed that the relative displacements of the edge of the tank were insignificant and hence, such displacements would not affect the overall integrity of the tanks. Therefore, the staff's concern on local stresses due to openings and the integrity of the tanks due to the base slab displacements is resolved.

In conclusion, TVA's reanalysis of the DGB (including the evaluation of the base slab) was found to be reasonable and acceptable with the exception of (1) soil bearing capacity, (2) safety factor against sliding, and (3) finalization of calculation B04 890609 209. This item remains open. (CC-14)

3.10 Primary Containment (Drywell)

The staff consultant reviewed the design specification (B30 870305 212) and the original design report prepared by Pittsburgh-Des Moines (PDM) Steel Company, and found that the design of the drywell did not consider the seismic load due to the design basis earthquake (DBE). However, Table C.0-8 of the FSAR specified that DBE should be included in the emergency condition for the design of the primary containment. The staff raised a concern that this finding might not be consistent with the FSAR commitments. A further review of the FSAR Table C.0-8 indicated that the allowable stress specified for the emergency condition is the same as those for the normal and upset conditions. From this finding, TVA judged and the staff agreed that the inclusion of the DBE in the emergency condition as contained in Table C.0-8 was a typographical error. TVA agreed to correct this error during the next FSAR revision and the staff considers this issue resolved.

During TVA's in-house technical adequacy review for the primary containment design, SWEC identified three concerns as documented in its supplemental calculation; namely, design adequacy of the drywell shell adjacent to the personnel lock, equipment hatch, and penetration X-45. To address these three concerns, TVA performed reevaluations based on the load conditions specified in the FSAR. The staff consultant reviewed SWEC supplemental calculation and TVA's calculation B22 890602 106, B22 890602 107, and B22 890602 105 and found that the resulting stresses are within the design allowable values.

For the other minor concerns identified in the SWEC supplemental calculation, as shown in its punch lists B74 890606 001 and B74 890608 001, TVA committed to address these items prior to the restart of BFN-2. This resolved staff's concern.

The staff concludes, based on its sample review, that TVA adequately demonstrated the design adequacy of the primary containment. Therefore, this item is considered closed. (CC-15)

4 REVIEW OF OPEN ITEMS IDENTIFIED IN IR 50-260/88-38

During this inspection, the staff and its consultant also reviewed TVA's response to the remaining open items (CSG-9, CSG-10, CSG-11 and CSG-24) identified in Inspection Report (IR) 50-260/88-38. The staff's review findings are discussed below.

4.1 (3.5.6)* Impact Assessment of New Amplified Response Spectra (ARS)

As discussed in IR 50-260/88-38 (Reference 6.2), from the review of the comparison of the original amplified response spectra (ARS) (without peak broadening) obtained from the El Centro earthquake ground-motion time-history, and the new ARS (with peak broadening) based on the artificial ground-motion time-history, significant differences were identified in which the new ARS exceeded the original ARS. TVA committed to assess the impact of these differences on the already completed evaluation of (1) miscellaneous steel, (2) drywell steel platforms, (3) electrical conduit and supports, (4) heat, ventilation and air conditioning (HVAC), (5) other civil/structural items, and to use the new ARS for the remaining evaluation.

During this inspection, the staff consultant reviewed TVA's responses to this item and the staff's review findings and conclusions are as follows:

(1) Miscellaneous Steel

Because of the incomplete status of the IEB 79-14 piping program (using the new ARS as the input motion) from which the pipe loads based on the new ARS for the evaluation of miscellaneous steel support frames (MSSF) are to be generated, the calculations were not available for the staff review at this inspection. TVA agreed to complete at least 90% of its evaluation before the next staff inspection.

(2) Drywell Steel Platforms

According to TVA document B22 890802 010, the final drywell platform design calculations will include the updated pipe support loads generated from the IEB 79-14 piping program based on the new ARS. TVA agreed to complete its calculations by the next inspection.

(3) Electrical Conduit and Supports

TVA presented its basis and impact assessment results during this inspection. This information is being reviewed by the staff.

(4) Heating, Ventilation and Air Conditioning (HVAC)

According to TVA calculation B22 890421 104 and QIR LMEBFN 89051 R4 (B22 890616 012), there is no Class I HVAC ductwork in the off gas treatment building, reactor building inside the drywell, service water tunnel, yard, reactor building superstructure, and pumping station. Therefore, the

* The number in the parenthesis shown in the subsections under Section 4 denotes the section number in IR 50-260/88-38.

impact assessment for the HVAC was limited to the Class I ductworks in the reactor building (outside the drywell), diesel generator building, chimney, and standby gas treatment building.

For the Class I ductworks in the reactor building (outside the drywell), TVA selected three samples for the new ARS impact evaluation: two rectangular duct problems and one circular duct problem. The two rectangular duct problems are System 3-SWHVAC-83 in the control room / control bay and System 2-SWHVAC-07 for the residual heat removal and core spray cooling. The circular duct problem is the standby gas treatment system 3-SWHVAC-39C&E and 2-SWHVAC-39C&D. The analysis method and approach, used by TVA for the impact evaluation, include: (1) re-calculation of the seismic duct stresses and support loads based on the new ARS, (2) combining the new seismic loads (duct stresses and support loads) with the duct stresses and support loads due to the dead load, and (3) comparison of the new combined loads with the corresponding original loads. The original dynamic models and the computer code TPIPE were used for the generation of the new seismic loads. The staff consultant reviewed the impact evaluation results and found that the new combined loads and stresses are generally smaller than the original loads and stresses, except at a few locations of System 3-SWHVAC-83, in which the new support loads exceed the previous loads by 5% or less. Based on this finding, the staff concludes that the impact of the new ARS on the HVAC System evaluation and design is negligible. The final calculations for the impact assessment of the Class I HVAC ductworks located in the chimney, diesel generator building, and standby gas treatment building were not available for review at this inspection. TVA agreed to present its final evaluation results of these systems to the staff during the next inspection.

(F) Cable Tray and Supports

In order to verify that the cable trays and supports are adequate for restart and interim operation of BFN-2, TVA performed an interim seismic qualification of the BFN-2 cable tray systems. A formal report which contains the qualification calculation and modifications required for the cable tray supports prior to BFN-2 restart was submitted to NRC for review. As a result of review, the NRC staff accepted this program and issued a safety evaluation on February 5, 1987.

In response to the staff's concern about the impact of the new ARS on the cable tray system evaluation, TVA, believes that an impact assessment is not needed for the cable tray system before restart of BFN-2. As with conduit, the reductions in peak horizontal accelerations is expected to offset increases in seismic response due to higher vertical accelerations and broadened spectral peaks. The final qualification of cable tray and supports will be completed as TVA implements its program for the resolution of Unresolved Safety Issue (USI) A-46.

Because only the horizontal earthquake motion and dead weight were considered in the original design of BFN-2 cable tray system, and the peak spectral accelerations of the 5% damped and 7% damped new vertical ARS are as high as 0.8g and 0.6g, respectively at higher elevation in the reactor building for the SSE case, the staff requested that TVA assess the impact of these high seismic loads on the cable tray systems. Although the peak spectral accelerations of the original horizontal ARS are higher than those for the new ARS and the original cable tray seismic qualification was previously accepted by the NRC staff, the applied vertical seismic loads to the cable tray system are independent from the horizontal seismic loads. The staff requested that a sample impact evaluation of the new ARS on the worst-case cable tray systems should be done prior to BFN-2 restart. TVA agreed to perform a worst-case sample impact evaluation of cable tray systems before restart of BFN-2.

(6) Equipment Qualification

Because TVA has adopted for BFN-2 the resolution to Unresolved Safety Issue A-46, "Seismic Qualification of Equipment in Operating Plants", the seismic equipment qualification will be conducted during the implementation of NRC USI A-46. The review of the ARS impact evaluation on safety related equipment was excluded from the scope of this issue.

(7) Reactor Pressure Vessel (RPV) and Internals

For the seismic reevaluation of the RPV and internals, TVA used the new ARS as input motion. Therefore, the impact has been addressed directly. The staff's review of the RPV and internals seismic re-evaluation is documented in NRC Inspection Reports (IR) 50-260/89-31 dated July 13, 1989 and 50-260/89-39 dated October 13, 1989.

(8) Torus and Torus Attached Piping

The staff's review of this item will be conducted under the IE Bulletin 79-14 piping program inspection.

(9) Masonry Wall

The staff consultant reviewed TVA calculation B22 890329 101 which evaluated the impact of the new ARS on the masonry walls in the reactor building, intake structure, chimney and diesel generator building. The evaluation was done by comparing the new ARS acceleration at the frequency of the wall to the corresponding design acceleration. The design acceleration represents the seismic load that was used in TVA's qualification/modification program for the masonry walls in 1988. However, the design acceleration was never reviewed by the staff. In addition, the review found that the calculation B22 890329 101 was not completed. TVA agreed to provide the basis of the design acceleration and the final calculations for review during the next inspection.

(10) Small Bore Piping

The staff's review results of this item are documented in NRC Inspection Report 50-260/89-36 dated September 21, 1989.

(11) 79-14/02 Class I Piping and Supports

The staff review of this item will be conducted during the IE Bulletin 79-14 piping program inspection.

(12) CRDH Insert and Withdrawal Piping

Same as Item (11) above.

(13) Instrumentation and Tubing

Same as Item (10) above.

In summary, from reviewing TVA's impact evaluation for a total 13 design areas, 6 areas need either additional information or need to be finalized by TVA. This item remains open. (CSG-9)

4.2 (3.1.1) <u>Percent of Work Completed</u>

As documented in IR 50-260/89-29, because of the incomplete status of the IEB 79-14 piping program from which the pipe support loads based on the new ARS for the miscellaneous steel support frame (MSSF) evaluation are to be generated, the final calculations were not available at that time. During this inspection, TVA proposed and the staff agreed that because the final pipe support will be calculated based on the new ARS under the IEB 79-14 piping program and the final evaluation of the MSSF's will be performed for the new ARS loads also, this item can be combined as part of the new ARS impact evaluation. Therefore, this item is considered closed for the purpose of this inspection and it will be resolved under CSG-9, New ARS Impact Evaluation. (CSG-7a)

4.3 (3.2.1) <u>Assumption of Rigid Lower Platforms in the Horizontal Direction</u>

During the previous inspection (IR 50-260/89-29), TVA agreed to calculate the fundamental modal frequency of the lower platforms in the horizontal direction to justify the assumption of rigid platforms. The results of the horizontal platform analysis based on the computer code GTSTRUDL were documented in TVA calculation B22 890720 102. The staff consultant reviewed this calculation and found that the analysis was simplified by considering a 150-degree sector of platform. Two uniform attachment loads (i.e., 40 pounds per square foot and 80 pounds per square foot) were assumed. The mass of the grating was included in the analysis of the 150-degree sector global model. However, this mass was not considered in the refined local analysis of the tangential beams. As a result, the staff raised the following concerns:

(a) The boundary conditions at where the 150-degree sector model is cutoff from the overall platform were not adequately specified.

(b) Justification is required regarding the assumption of the 40 psf and/or 80 psf uniform attachment loads.

(c) The grating mess was not consistently considered in both the global model and local tangential beam analyses.

(d) Justification is needed for using the 150-degree sector to represent the whole platform.

TVA agreed to address the above concerns in its final calculation and make it available for review before the next inspection. This item remains open. (CSG-10)

4.4 (3.2.2) Equivalent Static Analysis of Drywell Platforms

The previous staff's concern of this item was that a proper dynamic factor to account for the effect of multi-mode response was not used when TVA performed an equivalent static analysis of the lower drywell platforms in the vertical direction (IR 50-260/89-29). In response to the staff concerns, TVA completed its calculations B22 890807 101 and B22 890810 102 for the platforms at elevations 584'-0" and 563'-0", respectively. The review of these calculations found that TVA/BPC developed a 90-degree sector vertical platform model based on BPC computer code BSAP and performed three analyses: (1) an equivalent static analysis, (2) a response spectrum analysis using a constant spectral acceleration equal to the peak spectral acceleration of the new vertical ARS as input motion, and (3) a response spectrum analysis using the new vertical ARS as input. From these analysis, TVA/BPC derived the following multi-mode dynamic factors for the equivalent static analysis of these platforms with the peak spectral acceleration of the ARS as input:

Multimode Factor

Elevation	Radial Beams	Tangential Beams
584'	1.2	1.5
563'	1.0	1.5

Using the assumptions, theory, modeling techniques, and computer code previously accepted by NRC staff, the staff concludes that the dynamic load factors used by TVA in the equivalent static analysis of the platforms are acceptable. This item is closed. (CSG-11)

5 Conclusion

As discussed in Sections 3 and 4 of this report, three out of ten civil calculation items and two out of four seismic design items reviewed during this inspection remain open. In order for the staff to finalize its review of the civil calculation review program and seismic design program, TVA is requested to complete the remaining open items. The staff is planning to conduct its final inspection on the seismic design program and civil calculation program during the week of November 6, 1989.

6 References

6.1 NRC Inspection Report 50-260/89-30, "Special Inspection Relating to Civil Calculation Program," dated September 30, 1989

6.2 NRC Inspection Report 50-260/88-38, "Special Inspection Relating to Seismic Design Program," dated April 19, 1989

6.3 Letter from S. Black (NRC) to S.A. White (TVA), "Interim Operability Criteria for the Seismic Design Program for the Browns Ferry Nuclear Plant, Unit 2," dated July 26, 1988

Enclosure 1

BFN Civil Calculation Inspection

06/05/89

Entrance Meeting

Wayne A. Massie	BFN Site Licensing
J. Valente	BFN Site
Tom N.C. Tsai	NRC Consultant
Owen Mallon	NRC Consultant
Thomas M. Cheng	NRC
Ahmet I. Unsal	NRC Consultant
R. D. Cutsinger	TVA
J. A. Ellis	TVA
Newton Perry	TVA

Enclosure 2

Civil Calculation Inspection

06/09/89

Wayne A. Massie	BFN Site Licensing
Newton Perry	TVA
Jon R. Rupert	BFN-Civil
Owen Mallon	NRC Consultant
Thomas M. Cheng	NRC
Ahmet Unsal	NRC Consultant
Tom N. C. Tsai	NRC Consultant
Rick Cutsinger	TVA
John A. Ellis	TVA
Ruben O. Hernandez	TVA-CE

Enclosure 3

Civil Calculation and Seismic Design Inspection

Exit Meeting

08/18/89

T. Cheng	NRC
D. Terao	NRC
Tom Tsai	NRC Consultant
R. Cutsinger	TVA
Wayne A. Massie	TVA
J. Valante	TVA

Enclosure 4

Status Civil Calculation Review Program

Open Items

Concerns Identified	Status	Subject	Section Number 50-260/89-30	50-260/89-32
CC-1	Open	Justification for Post-Restart	3.2	3.1
CC-2	Closed	Pile and Foundations	3.3.1	3.2
CC-3	Closed	Soil and Rock Analysis	3.3.2	
CC-4	Closed	Buried Structures	3.3.3	3.3
CC-5	Closed	Tanks & Heat Exchangers	3.3.4	
CC-6	Closed	Foundation Design Calculations	3.3.5	3.4
CC-7	Closed	Soil Amplification	3.3.6	
CC-8	Closed	Embedments/Anchorages	3.3.7	3.5
CC-9	Closed	Foundation Design Calculations Intake Structure	3.3.8	
CC-10	Open	Reactor Building Corner Room	3.3.9	3.6
CC-11	Closed	Baseplate Prying	3.3.10	3.7
CC-12	Closed	Concrete Structures	3.3.11	3.8
CC-13	Closed	Control Bay Floor Steel	3.3.12	
CC-14	Open	Diesel Generator Base Slab	3.3.13	3.9
CC-15	Closed	Primary Containment - Drywell		3.10

Enclosure 5

STATUS OF SEISMIC DESIGN PROGRAM OPEN ITEMS

CSG No.	Status	Subject	IR 50-260/88-38	IR 50-260/88-39	IR 50-260/89-21	IR 50-260/89-29	IR 50-260/89-32
CSG-1	Closed	Review of IEB 79-14 Program	3.6				
CSG-2	Closed	Comparison of New ARS and Original Design ARS	3.5.1	3.1			
CSG-3	Closed	Damping Values for Steel Members Inside Drywell	3.5.2	3.2			
CSG-4	Closed	Soil Amplification Factors for Soil-Supported Structures	3.5.3	3.3			
CSG-5	Closed	Soil Spring Constants for Soil-Supported Structures	3.5.4	3.4			
CSG-6	Closed	Coupling of Horizontal and Vertical Response of Soil-Supported Structures	3.5.5	3.5			
CSG-7	Closed	Design Criteria and Percent of Work Completed	3.1.1			3.1	
CSG-7a	Closed	Percent of Work Completed	3.1.1			3.1	4.2
CSG-8	Closed	Clarification of Design Criteria Used	3.1.2			3.2	
CSG-9	Open	Impact of New ARS	3.5.6	3.6		3.3	4.1

CSG No.	Status	Subject	IR 50-260/88-38	IR 50-260/88-39	IR 50-260/89-21	IR 50-260/89-29	IR 50-260/89-32
CSG-10	Open	Assumption of Rigid Lower Platforms in the Horizontal Direction	3.2.1			3.4	4.3
CSG-11	Closed	Equivalent Static analysis of Drywell Platforms	3.2.2			3.5	4.4
CSG-12	Closed	Damping Values for Drywell Platform Evaluation	3.2.3			3.6	
CSG-14	Closed	Thermal Effects Drywell Platforms	3.2 4		3.1		
CSG-15	Closed	Load Interface	3.1.3			3.7	
CSG-16	Closed	Percentage of Mass Participation in the Vertical Seismic Analysis	3.5.7	3.7			
CSG-17	Closed	End Moments on Platform Radial Beams	3.25				
CSG-18	Closed	Evaluation of Embedment Plate Anchors of Radial Beams	3.2.6			3.8	
CSG-19	Open	Platform Clip Angle Criteria	3.2.7			3.9	
CSG-20	Closed	List of Beam Modifications	3.2.8			3.10	
CSG-21	Closed	Superseded Pages of Platform Design Calculation	3.2.9			3.11	
CSG-22	Closed	Design Criteria BFN-50-C-7100 through 7300	3.7			3.12	

CSG No.	Status	Subject	IR 50-260/88-38	IR 50-260/88-39	IR 50-260/89-21	IR 50-260/89-29	IR 50-260/89-32
CSG-23	Closed	Definition of Zero Period Acceleration (ZPA) of New ARS	3.5.8	3.8	3.2		
CSG-24	Open	Buckling of HVAC Ductwork	3.3.1			3.15	
CSG-25	Closed	Buckling of Aluminum Conduit	3.4.1			3.13	
CSG-26	Closed	Allowable Stress for Aluminum Conduit	3.4.2		3.3	3.14	
CSG-27	Open	Flexible Conduit Program	3.8				
CSG-28	Open	Use of Factor "1.33" to Increase Stress Allowable	3.2.10				
CSG-29	Closed	Modeling of HVAC Supports	3.3.2			3.16	
CSG-30	Closed	Welding Allowables for HVAC Supports	3.3.3				
CSG-31	Closed	Buckling of Rod Supports	3.4.3			3.17	
CSG-32	Open	Evaluation of Support Rod Hangers	3 4.4			3.18	
CSG-33	Closed	Evaluation of Conduit Supports	3.4.5			3.19	
CSG-34	Open	Thermal Expansion of Steel Structures Outside the Drywell				3.20	
CSG-35	Ope	Evaluation of Conduit with Unistrut Supports				3.21	