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Inspector: George B. Georgiev — 6-14-89
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NRC TEAM INSPECTION DESIGN BASELINE AND VERIFICATION PROGRAM

BROWNS FERRY NUCLEAR PLANT

I BACKGROUND INFORMATION

The Tennessee Valley Authority's (TVA) Browns Ferry Nuclear Plant (BFN) Design Baseline and Verification Program (DBVP) was established to resolve several problems related to design control that had occurred at BFN. These problems were (1) the original design control program allowed an as-built set of drawings to be maintained by plant operations and an as-designed set of drawings to be maintained by engineering, (2) the plant configuration was not reconciled with the design basis because the plant design basis was scattered among many documents, thus making them not readily usable, and (3) external reviews and studies indicated weaknesses in plant modifications that were implemented after the plant became operational.

The objectives of the DBVP are to re-establish the plant design basis and ensure that the plant configuration meets it.

TVA is implementing the BFN DBVP in two phases: Phase 1 will be completed before startup and will include the evaluation of systems and portions of systems required for safe shutdown. These systems will be identified by evaluating the abnormal operational transients, design basis accident and special events addressed in the BFN Chapter 14 of the Final Safety Analysis Report (FSAR), and by determining the safety functions necessary to mitigate these events. Phase 2 will be completed after startup and will include implementation of the remaining modifications of systems not required for startup, completion and revision of the design criteria documentation, completion of system evaluations, and implementation of corrective actions to other systems as required.

TVA first submitted the BFN DBVP to NRC on August 28, 1986. On March 13 and July 10, 1987, TVA submitted a more detailed version of the DBVP, which upgraded the program to (1) reconcile design control issues, (2) re-establish the design basis, and (3) evaluate the plant configuration.

From October 26 through 30, 1987, an NRC inspection team reviewed and assessed the adequacy of the information contained in the BFN DBVP, including Revision 2. The NRC team found that TVA's DBVP contained the essential elements needed to achieve its goals and objectives; however, several weaknesses were identified, and the team requested that TVA address them. The extent, scope, and findings of this NRC team inspection are documented in NRC Inspection Reports 50-259/87-36, 50-260/87-36, and 50-296/87-36 dated January 21, 1988.

On March 25, 1988, TVA submitted to the NRC Revision 4 of the BFN DBVP, which incorporated the DBVP calculation effort.

On April 18 through April 22, 1988, an NRC inspection team reviewed and assessed the adequacy of Revision 4 of the BFN DBVP, TVA's responses to open items from the first NRC team inspection, and the associated DBVP calculation effort. The NRC team found that Revision 4 of the BFN DBVP incorporates the required DBVP calculation effort and in general does not contain other significant technical changes. The NRC team was also able to close 11 of the 16 items left open after the first NRC team inspection. The NRC team also concluded that TVA has adequately addressed the previously identified issue in Inspection Reports 50-259/87-36, 50-260/87-36, and 50-296/87-36 on communication and interaction between the DBVP and the other ongoing programs at Browns Ferry. However, the NRC team identified weaknesses relating to the implementation aspects of the DBVP calculation effort, and the team requested that TVA address them. The extent, scope, and findings of this NRC team inspection are documented in NRC Inspection Reports 50-259/88-07, 50-260/88-07, and 50-296/88-07 dated September 8, 1988.

On November 3, 1988, TVA submitted its response to NRC Inspection Reports 50-259/88-07, 50-260/88-07, and 50-296/88-07.

From February 27 through March 10, 1989, an NRC inspection team reviewed and assessed the adequacy of the implementation aspects of the BFN DBVP.

2 SCOPE

During the inspection on February 27 through March 10, 1989, the NRC team reviewed the status of open items from the first and second NRC team inspection of the DBVP, a sample of engineering calculations, design change control documents, and configuration control drawings. The NRC team also interviewed cognizant TVA personnel about TVA's implementation effort of the BFN DBVP.

3 SUMMARY

The NRC team noted no significant deviations from the requirements of the BFN DBVP. Most of the deficiencies noted during this inspection were previously identified by TVA and the associated corrective actions were tracked by the DBVP punchlist report. Therefore, the NRC team concludes that, in general, TVA is adequately implementing the BFN DBVP for those essential systems required to safely shutdown the plant. Upon successful completion of the DBVP, the NRC team concludes that the plant configuration will be in conformance with the design basis. However, the NRC team identified several weaknesses, related to the implementation aspects of the DBVP, which are listed below:

(1) The voltage profile calculations for the 4160V Shutdown Board A battery did not consider the maximum value of the surge currents present in the first minute of the duty cycle. The NRC team noted that the battery calculations did not use the maximum transient current value for a minimum of one minute, as recommended in IEEE standard 485-1983, when performing voltage profile calculations. All other battery calculations except this one used the maximum transient current value recommended by the IEEE Standard. The calculation used a lower value of current based on the estimated duration of the current surge. If the maximum estimated current is used, the battery capacity is insufficient to support the duty cycle while maintaining a minimum required voltage of 210VDC. TVA needs to find out why the battery calculation did not consider the maximum value of the surge currents.

(2) Automatic Depressurization System (ADS) elementary diagram 2-730E929 indicated that the Alternating Current (AC) interlock, used to ensure low-pressure core cooling availability before ADS is initiated, would not work properly. Pressure switches connected to RHR B and D pumps were incorrectly connected to RHR relays K102B and K103B. Loss of one battery or one diesel could disable both redundant trains of ADS. TVA needs to establish the correct plant configuration and revise the ADS elementary diagram.

(3) The Calculation Cross Reference Information Systems (CCRIS) is seen by the NRC team as one of TVA's primary means of tracking and managing information generated and used in the calculations. However, many errors were found within the CCRIS database involving references that were used in the calculation but were not in CCRIS; some calculations were also miscategorized. The NRC team attributed most of these errors to the improper inputting of data into CCRIS. TVA needs to provide some additional training to the users of CCRIS with particular emphasis on the purpose and goals of CCRIS and the proper inputting of data into CCRIS.

4 INSPECTION DETAILS

The general scope of this inspection included a review of the status of open items determined by the first and second NRC team inspection; a review of engineering calculations as related to DBVP; a review of design change control documents, such as Engineering Change Notices (ECN's) and Design Change Notices (DCN's); and a review of configuration control drawings (CCD's), such as flow and control diagrams and single line and schematic drawings. The NRC team also interviewed cognizant TVA personnel to obtain pertinent information about the implementation aspects of the DBVP. The team divided its review into four areas: civil/structural area, mechanical and nuclear systems, electrical systems, and instrumentation and control systems. The specific documents reviewed, findings, and conclusions for each of the areas are discussed in the following sections.

4.1 Civil/Structural Area

4.1.1 Documents Reviewed

The NRC team reviewed the following documents during the third inspection:

Engineering Calculations

(1) Calculation No. CD-Q2074-88750, "Pipe Stress Analysis of RHR Pump 2A Drain (PX-074001)," Revision No. 1, dated July 22, 1988 (TVA RIMS No. B22 88 1109 159).

(2) Calculation No. CD-Q2074-88747, "Qualification of Pipe Support No. GCN1-2-074013-01-001," Revision No. 1, dated July 14, 1988 (TVA RIMS No. B22 88 1115 136).

(3) Calculation No. CD-Q2074-88748, "Qualification of Pipe Support No. GCN1-2-074013-01-002," Revision No. 1, dated July 15, 1988 (TVA RIMS No. B22 88 1111 118).

(4) Calculation No. CD-Q2074-88749, "Qualification of Pipe Support No. GCN1-2-074013-01-003," Revision No. 1, dated July 15, 1988 (TVA RIMS No. B22 88 1111 117).

(5) Calculation No. CD-Q2074-88991, "Pipe Stress Analysis of Stress Problem No. N1-274-1R," Revision No. 0, dated February 1, 1989 (TVA RIMS No. B22 89 0303 105).

(6) Calculation No. CD-Q2074-88679, "Qualification of Pipe Support No. 247B452S0152," Revision No. 0, dated September 17, 1988 (TVA RIMS No. B22 88 1010 131).

(7) "Engineering Assurance Oversight Review Report / Browns Ferry Nuclear Plant - Unit 2 / Design Baseline and Verification Program EA-OR-002," dated December 14, 1988.

(8) TVA Civil Final Report RIMS B90 890207 002.

(9) Civil Program Integration Review Report prepared by SWEC.

(10) Detailed Technical Evaluation Finding Sheets for 12 concrete structure items, Primary Containment Design Stress Report, Drywell Floor Framing Steel (CEB-8714-18), and Drywell Miscellaneous Steel Platforms (CEB 8714-16).

(11) SWEC Supplemental Calculation for Chimney Foundation Review (6/29/88).

(12) TVA Calculation E-10-3.1 (CD-Q0303-884720, RIMS B22 880923 102) for Chimney.

Engineering Change Notices (ECNs)

(13) ECN P0625-P1 (HPCI)

(14) ECN P0651 (HPCI)

(15) ECN P3184 (HPCI)

(16) ECN P5246 (HPCI)

(17) ECN P0083 (RHR)

(18) ECN P0666 (RHR)

(19) ECN P0962 (RHR)

(20) ECN P0795 (CS)

(21) ECN P3069 (CS)

(22) DCN W5026A

(23) ECN P0238 (CS)

(24) ECN P0370 (CS)

(25) ECN P7166

(26) DCN W2712B (CS)

Engineering Assurance Oversight Program Documents

(27) o TVA Nuclear QA Joint Audit Report No. BFK88901, "System Preoperability Checklist and System Plant Acceptance Evaluations Programs," 11/18/89.

(28) o TVA EA Oversight Review Report, BFN-Unit 2, DB&VP EA-OR-00, 12/14/89

(29) o BFEP EA Audit BFT88991 - Essential Calculations (RIM No. B05 890224 007) with the following CAQRS:

(30) - PRD BFT890154901P.

(31) - PRD BFT890156901P.

(32) - PRD BFT890155901P.

(33) - PRD BFT890164901P.

(34) o TVA Resolutions for EA Identified Action Items T-009; C-047; C-079, -080, -081, -090, -091.

4.1.2 Findings

4.1.2.1 Review of Open Items from the Second NRC Team Inspection

TVA responded to each of the civil/structural concerns that were raised during the second NRC team inspection and that are identified in Inspection Reports 50-259/88-07, 50-260/88-07, and 50-296/88-07. The concerns and the NRC team's evaluations of TVA's responses to the concerns follow:

(1) Concern

TVA does not review the technical content of contractor-generated civil/structural calculations. TVA should review a sample of contractor-generated civil/structural calculations to ensure that the calculations are adequate and correct.

TVA Response

TVA has taken steps to ensure an adequate level of review of contractor-generated calculations. The civil group has performed reviews of contractor design output to ensure adequacy and compliance with general civil design criteria.

NRC Team Assessment

TVA has reviewed about 60 of approximately 2600 calculations that contractors (primarily Stone & Webster) have issued to date. TVA selected most of these calculations from the following BFN civil issue programs:

CEB 8714-1, Tubing and Tubing Support Qualification Program

CEB 8714-6, NRC OIE Bulletin 79-14
CEB 8714-7, Seismic Qualification of Existing Electrical Conduit and Conduit Support
CEB 8714-11, Class I HVAC (in Class I Structures) Qualification Program
CEB 8714-15, Miscellaneous Steel Support Framing Qualification Program

TVA has indicated that contractors will issue or revise approximately 1,800 remaining pre-restart calculations by mid-1989. The NRC team found this response acceptable. This item is considered closed.

(2) Concern

Two pipe stress calculations (N1-3677T and N1-2701R) deviate from the requirement stated in the applicable design criteria and FSAR commitments. TVA should revise those calculations to meet the applicable design criteria and FSAR commitments.

TVA Response

Pipe stress problem N1-367-7T

The calculation for the EECW piping in the RHR-EECW tunnels was revised to incorporate the appropriate soil properties and site conditions. A soil shear wave velocity (Vs) of 1,000 ft/sec was used in the analysis, which is consistent with Section C.2.1 of Appendix C to the FSAR. This velocity was considered more appropriate for the firm clay soil conditions around the RHR-EECW tunnels. The minimum Vs (250 ft/sec) represents an anomaly for the site. This anomaly is very soft soil that was encountered only in the area of the intake channel and subsequently excavated. Therefore, this minimum Vs was not considered in establishing a reasonable average Vs for analysis of the piping. A normalized site specific value of 17 in/sec (OBE) was used for the peak ground velocity.

Pipe stress program N1-270-1R

The evaluation of the impact of flexible valves on seismic qualification of piping (including piping analyzed in N-270-1R) is being tracked by CAQR BFP880121 R1. Based on similar evaluations for Sequoyah Nuclear Plant, it is expected that there will be few flexible valves identified on Browns Ferry and, where flexible valves are identified, the impact on piping seismic qualification will be minimal. The identification of non-rigid valves and the consideration of the impact of these valves on piping seismic qualification will be completed after Unit 2 restart.

NRC Team Assessment

The first part of TVA's response addresses the deficiencies documented in the Stone & Webster Pipe Stress Problem No. N1-3677T, Revision No. 0. The calculation, which qualified a portion of an 18-inch diameter emergency equipment cooling water line, used values of dynamic soil constants for BFN site that did not completely agree with the values specified in Section C.2.1 of BFN FSAR Appendix C, "Structural Design Criteria." TVA's

response also documents Stone & Webster's revision of Pipe Stress Problem No. N1-3677T to incorporate appropriate BFN soil properties and site conditions.

The second part of TVA's response addresses the identified deficiency involving Stone & Webster Pipe Stress Problem No. N1-2701R, Revision 0. The calculation contained an assumption that valves 2-FCV-70-313 and -47 had fundamental frequencies greater than 20 Hz. However, the calculation did not verify this assumption as required by Design Criteria Document BFN-50-C-7103. TVA issued Revision No. 1 to Condition Adverse to Quality Report (CAQR) No. BFP880121 on April 22, 1988, to resolve the generic issue of the flexibility of valves and other in-line components post-restart. The corrective actions detailed in the CAQR include revisions to Design Criteria BFN-50-C-7103 and the Rigorous Analysis Handbook, identification of flexible in-line components, and appropriate revision of existing piping analyses for such equipment.

The NRC team found this response acceptable. This item is considered closed.

(3) <u>Concern</u>

Attachment F to Design Criteria Document BFN-50-C-7100 provides only the criteria for the lower drywell access platforms, and it is not clear which attachment provides the criteria for the upper drywell access platforms. TVA clarification is required.

<u>TVA Response</u>

The upper drywell access platform criteria is Attachment G of BFN-50-C-7100 R1. This is the general criteria for miscellaneous steel for Class I and Class II structures at BFN. The last sentence in Section 1.1 of Attachment F to BFN-50-C-7100 specifies that "For remainder of drywell platforms, see BFN-50-C-7100, Attachment G."

<u>NRC Team Assessment</u>

The open item requested TVA clarification on which design criteria covers upper drywell platforms. TVA response is that Design Criteria BFN-50-C-7100. Attachment G, specifies design criteria for upper platform while Attachment F specifies the design criteria for lower access platforms. FSAR has specific criteria for the design of lower platforms but is unclear for upper platforms. Attachment F is consistent with the FSAR criteria for lower platforms. Attachment G provides criteria for all miscellaneous steel, including upper platforms, for which FSAR has no specific criteria. TVA also provided a comparison of design allowables between Attachments F and G. The team considered the TVA response acceptable, and, hence, the item is closed.

(4) <u>Concern</u>

For the design of drywell access platforms, the jet force was explicitly included in Section 12.2.2.7.2 of the FSAR as a concentrated load, but is

now exlcuded from Revision 1 of Design Criteria Document BFN-50-C-7100. TVA should determine if this exclusion violated the project licensing commitment.

Additional details related to this concern from Section 4.1.2.2 of report

TVA must also evaluate the effect of jet loads on the electrical cable and instrumentation to ensure that only one train would be affected by the postulated jet loads.

TVA Response

FSAR Section 12.2.2.7.1 identifies loading conditions that were applied to the drywell platforms. The term "jet" refers to the reaction force of mitigating devices (which could be attached to the platforms) subjected to pipe break loadings. Attachment F to Design Criteria BFN-50-C-7100 established the criteria for the lower drywell access platforms consistent with the above. The equivalent static load (Yr) on the structure is generated by the pipe whip reaction from pipe rupture restraints attached to the drywell steel. The main steam and feedwater pipe whip restraints at the drywell penetrations at 180 degrees azimuth are designed to transfer rupture loads from the process piping to the reactor pedestal and to the concrete at elevation 549.92 feet without significantly loading the drywell steel.

Primary emphasis for jet impingement protection inside the drywell was directed toward protecting primary containment. In addition to the recirculation, main steam, and reactor feedwater system restraints, further consideration to containment protection was provided by installation of honeycomb panels on the inside surface of the drywell shell and jet deflectors over the main vent openings to the wetwell. Protection of other equipment in the drywell is inherent in the plant arrangement of equipment. Redundant systems and devices are located on opposite sides of the drywell to minimize the concerns of dynamic forces associated with a pipe break.

In support of this position, the following was submitted to the previous Atomic Energy Commission in response to their questions of March 25, 1971, on the effects of pipe rupture.

Response to Question 4.1.4

". . . special care is also taken in component arrangements to see that equipment associated with engineered safety systems such as the core spray and the LPCI are segregated in such a manner that the failure of one cannot cause the failure of the other." Additionally, "The redundant channels of reactor level and pressure sensing lines are located in the cylindrical section of the drywell 180° apart for maximum physical separation."

Response to Question 5.16

"The core standby cooling systems are physically separated, both inside

and outside the containment, minimizing the probability of simultaneous damage to more than one system from a missile source." In this case the missile source was jet impingement.

NRC Team Assessment

For the design of drywell access platforms, the jet force was explicitly included in Section 12.2.2.7.2 of the FSAR as a concentrated load but is now excluded from Revision 1 of Design Criteria Document BFN-50-C-7100. TVA should determine if this exclusion violated the project licensing commitment.

TVA must also evaluate the effect of jet loads on the electrical cables and instrumentation to ensure that only one train would be affected by the postulated jet loads.

TVA noted that the FSAR Section 12.2.2.7.1 identified loading conditions that were applied to the drywell platforms. The term "jet" refers to the reaction force of mitigating devices (which could be attached to the platforms) subjected to pipe break loadings.

Attachment F to Design Criteria BFN-50-C-7100 established the criteria for the lower drywell access platforms. The equivalent static load (Yr) on the structure as generated by the pipe whip reaction from pipe rupture restraints that may be attached to the drywell platform steel.

The main steam and feedwater pipe whip restraints at the drywell penetrations at 180 degrees azimuth are designed to transfer rupture loads from the process piping to the reactor pedestal and to the concrete at elevation 549.92 without significantly loading the drywell steel.

Primary emphasis for jet impingement protection inside the drywell was directed toward protecting the primary containment. In addition to the recirculation, main steam and reactor feedwater system restraints, further consideration to containment protection was provided by installation of honeycomb panels on the inside surface of the drywell shell and jet deflectors over the main vent openings to the wetwell. Protection of other equipment in the drywell is inherent in the plant arrangement of equipment. Redundant systems and devices are located on opposite sides of the drywell to minimize the concerns of dynamic forces associated with a pipe break.

TVA also stated that they had reviewed the configuration of the essential instrumentation and, electrical and control cable routing to ensure that a jet load could not cause the failure of both trains in any essential system.

TVA's response to this item is acceptable and this item is closed.

(5) Concern

Section 4.3 of the essential calculation cover sheet, RIMS B30 880329 001,

states that calculations for major building structures will not be reviewed for technical adequacy until after restart. TVA must review those calculations before plant startup.

TVA Response

A memorandum was issued by the lead civil engineer to clarify the intent of Section 4.3 to indicate that the calculation effort will review the Phase II calculation types before restart. New issues and revisions have incorporated this information.

NRC Team Assessment

The team's previous concern was that Section 4.3 of the essential calculation cover sheet, RIMS B30 880329 001, states that calculations for major structures will not be reviewed for technical adequacy until after restart. TVA was requested to review these calculations before restart. TVA's response is that they are committed to review these Phase II calculation types before restart. The lead civil engineer issued a memorandum to clarify this commitment. The team found TVA's commitment to be acceptable. The adequacy of TVA's implementation of the commitment, from both programmatic and technical points of view, is separately discussed in the team's evaluation of the civil calculation effort. This item is closed.

(6) Concern

The NRC team reviewed two heating, ventilation, and air-conditioning (HVAC) ductwork support calculations, but was not able to verify that the proper seismic load was used in the analysis to determine if prying action had been considered in the analysis of the bolts. TVA should verify that the calculations include proper seismic loads and that prying action is considered in the analysis of the bolts.

TVA Response

The HVAC Calculation, CD-Q1031-88311, Revision 0, utilized the seismic input contained in BFN-50-C-7104-7, Attachment B. Calculation CD-Q1031-88313, Revision 0, is a support calculation which utilized the load generated from CD-Q1031-88311, Revision 0.

In the anchor bolt calculation contained in CD-Q1031-88313, Revision 0, prying action was not explicitly considered. This is because the baseplate was judged to be relatively rigid and there existed ample safety margin in the anchor bolt design. In July 1988, because of other design changes, this calculation was revised to account for a 30 percent increase in design loads. During this revision, the baseplate and anchor bolts were reanalyzed with the Baseplate II computer program, which considered prying action. The anchor bolts were still found acceptable with the increased loads. This later analysis validates the judgment used in not considering prying action in Revision 0 of the calculation.

NRC Team Assessment

The NRC team reviewed two heating, ventilation, and air-conditioning (HVAC) ductwork support calculations, but was not able to verify that the proper seismic load was used in the analysis nor to determine if prying action had been considered in the analysis of the bolts. TVA should verify that the calculations include proper seismic loads and that prying action is considered in the analysis of the bolts.

TVA advised that the HVAC Calculation, CD-Q1031-88311, Revision 0, utilized the seismic input contained in BFN-50-C-71040-7, Attachment B. Calculation CD-Q1031-88313, Revision 0, is a support calculation that utilized the load generated from CD-Q1031-88311, Revision 0.

In the anchor bolt calculation contained in CD-Q1031-88313, Revision 0, pyring action was not explicitly considered. The action was not considered because the baseplate was judged to be relatively rigid and ample safety margin existed in the anchor bolt design. In July 1988, because of other design changes, this calculation was revised to account for a 30 percent increase in design loads. During this revision, the baseplate and anchor bolts were analyzed with the Baseplate II computer program, which considered prying action. The anchor bolts were still found acceptable with the increased loads.

This item will be reviewed as part of the NRC calculation inspection and is considered closed for this inspection.

(7) Concern

Calculations 481004-MS2-75-R5 and -12 indicate that certain steel members are overstressed. The overstressing was alleviated by a reanalysis of the STRUDL computer model in which the anchor at Node 23 was deleted. TVA should review this practice to ascertain the adequacy of the affected steel members.

TVA Response

Calculation 48N1004-MS2-75-R12 identifies the overstressing of certain components of the miscellaneous steel support framing for Core Spray supports R-12, H-27, and H-28. A modification was developed in the calculation to resolve the overstessed conditions and is analyzed in the calculation by incorporating changes to the STRUDL model. The modification is shown on drawing 48W1004-2, Revision 0, and field implementation is complete.

Calculation 48N1004-MS2-75-R5 identifies the overstressing of certain components of the miscellaneous steel support framing for Core Spray supports R-5, H-7, and H-8. The overstressed condition is the result of the loading from a 10-inch diameter pipe anchor for the Containment Inerting System, which is attached to the miscellaneous steel frame. The overstessed condition was resolved by assuming that the pipe anchor would be removed. This unverified assumption is documented in the calculation. Engineering review determined that removal of this pipe anchor was a better solution to the overstessed condition as compared to implementing major modifications to the miscellaneous steel frame. Work is currently under way to replace or modify the pipe anchor to allow removal of this unverified assumption from the calculation.

NRC Team Assessment

The team's previous concern was that the overstressing of certain miscellaneous steel members for core spray supports, as shown in TVA calculation 481004-MS2-75-R5 and -R12, was alleviated by using unverified assumptions. TVA was requested to confirm such unverified assumptions. For calculation 481004-MS2-75-R-12, TVA implemented a modification as shown on Drawing 48W1004-2, RWO 0, to resolve the overstressing condition. For calculation 481004-MS2-75-R5, TVA also developed a modification in order to remove the unverified assumption, and they initiated a DCN W5026A to implement the modification. TVA's actions are acceptable and the team considers the item closed.

Additional concerns in the Civil Structural area from Section 4.1.2.2 of report

(8) Concern

The team noted that TVA has committed to requalifying the safety-related buried pipe at Browns Ferry as part of the DBVP. Buried Class I piping is designated as essential calculation type D.14 in the civil engineering master calculation list (Reference 4 in Section 4.1.1 of this report). TVA should revise Section 4.4 of Design Criteria Document BFN-50-C-7103 to incorporate more explicit design criteria before implementing this commitment.

TVA Response

A Design Input Memorandum (DIM) to design criteria BFN-50-C-7103 will be developed to provide more explicit requirements for the design and evaluation of buried structures and features. The DIM will be issued by November 30, 1988.

NRC Team Assessment

The NRC team reviewed Revision 2 of design criteria document BFN 50-C-7103, which TVA issued on January 20, 1989. The team confirmed that TVA revised Section 4.4, Buried Piping, to provide more explicit design requirements for buried Class I piping. The team found this response acceptable. This item is considered closed.

4.1.2.2 Review of Engineering Calculations

TVA and contractors, such as Stone & Webster, are preparing pre-restart civil/structural calculations for BFN under twenty-six different TVA BFN civil issue programs.

The NRC team selected a sample of calculations from various ongoing BFN civil/structural programs.

The following Stone & Webster calculations prepared under the scope of TVA's civil issue program, CEB 8714-10, "Small Bore Piping Qualification Program," were reviewed by the team.

(1) Calculation No. CD-Q2074-88750, "Pipe Stress Analysis of RHR Pump 2A Drain (PX-074001)," Revision No. 1, dated July 22, 1988 (TVA RIMS No. B22 88 1109 159).

(2) Calculation No. CD-Q2074-88747, "Qualification of Pipe Support No. GCN1-2-074013-01-001," Revision No. 1, dated July 14, 1988 (TVA RIMS No. B22 88 1115 136).

(3) Calculation No. CD-Q2074-88748, "Qualification of Pipe Support No. GCN1-2-074013-01-002," Revision No. 1, dated July 15, 1988 (TVA RIMS No. B22 88 1111 118).

(4) Calculation No. CD-Q2074-88749, "Qualification of Pipe Support No. GCN1-2-074013-01-003," Revision No. 1, dated July 15, 1988 (TVA RIMS No. B22 88 1111 117).

The calculation referenced under Item (1) is one of forty small-bore pipe stress problems that Stone & Webster rigorously analyzed to compile a list of generic attributes for use in screening the remaining small-bore problems within the scope of civil issue program CEB8714-10. The three supports listed under Items (2) through (4) are the only supports in the pipe stress package.

During the course of this review, the team documented several concerns that were not judged technically significant for the specific small-bore pipe stress package referenced under Item (1), but which are programmatic in nature. TVA has punchlisted these concerns for tracking and resolution. The team has accepted TVA's proposed corrective actions for each of these concerns. The concerns identified by the NRC team are as follows:

(1) Stone & Webster did not explicitly address the nozzle thermal displacements for RHR Pump 2A in the referenced pipe stress package. Team review of related material which Stone & Webster provided TVA indicates that Stone & Webster is using 1/16-inch as an informal threshold to code equipment nozzle thermal displacements. Design Criteria BFN-50-C-7103, "Structural Analysis and Qualification of Mechanical and Electrical Systems (Piping and Instrument Tubing)," requires consideration of equipment thermal growth. To address this concern, TVA has prepared Punchlist Item No. 2-2230. TVA's proposed corrective actions are to revise the BFN Rigorous Analysis Handbook to require that equipment nozzle thermal displacements 1/16-inch or greater be considered, and to review a sample (5 or 6) of the 40 small-bore stress packages which Stone & Webster has already prepared to confirm that this requirement has been met.

(2) Revision No. 0 of the pipe stress calculation required a check of the magnitude of the branch line anchor point movements used in the calculation with respect to the branch line anchor point movements to be computed for the large-bore lines. However, this requirement was dropped in Revision No. 1 of the calculation. To address this concern, TVA

prepared Punchlist Item No. 2-2231, which requires that the branch line anchor point movements for a sample of the 40 small-bore pipe stress packages that Stone & Webster has already prepared be checked against the computed branch line anchor point movements in the large-bore pipe stress packages.

(3) The pipe stress calculation contains an incorrect support load transmittal. The team confirmed that the referenced pipe support calculations contained the correct support load transmittals. To address this concern, TVA has prepared Punchlist Item No. 2-2234 to require that the correct pipe support load transmittal be added to the pipe stress calculation when the calculation is revised.

As an outgrowth of the NRC team's review of the System Evaluation Report (SYSTER) for the containment spray (CS) portion of the residual heat removal (RHR) system for BFN, the team also reviewed the following large-bore pipe stress calculation and associated pipe support calculation. Stone & Webster prepared these calculations for TVA as part of TVA's 79-14 program (TVA's civil issue program CEB8714-6, NRC OIE Bulletin 79-14) as follows:

(1) Calculation No. CD-Q2074-88991, "Pipe Stress Analysis of Stress Problem No. N1-274-1R," Revision No. 0, dated February 1, 1989 (TVA RIMS No. B22 89 0303 105).

(2) Calculation No. CD-Q2074-88679, "Qualification of Pipe Support No. 247B452S0152," Revision No. 0, dated September 17, 1988 (TVA RIMS No. B22 88 1010 131).

The Item (1) large-bore pipe stress calculation which addresses a portion of the CS system was the only calculation that Stone & Webster had formally issued for the CS system at the time of the team's inspection. TVA configuration control drawing (CCD) No. 2-47E811-1, "Flow Diagram/Residual Heat Removal System," Revision No. 10, dated January 11, 1989, depicts the CS portion of the RHR system. The "as-built" configuration which Stone & Webster prepared for the portion of the CS system which the pipe stress calculation addresses is detailed on TVA Drawing No. 47W452-281, "N1-274-1R, Isometric Static, Thermal, Dynamic Analysis of RHR System." The piping isometric drawing is notated "For 79-14 Verification Inspection Only," and is dated January 28, 1987. The Stone & Webster piping stress isometric drawing which incorporates this walkdown information is shown on page 12 of the pipe stress calculation. The team reviewed the piping which runs between anchor points R66 and the discharge side of RHR heat exchanger 2C to the tee-intersection at node point 34. The Item (2) pipe support calculation is the only pipe support calculation which Stone & Webster had formally issued at the time of the inspection for this portion of the CS system.

During the course of this review, the team documented the following concerns:

(1) The pipe stress calculation uses a reactor building ambient temperature of 125°F instead of 70°F to perform an operating modes thermal analysis. The NRC identified this concern in another Stone & Webster calculation during an inspection of TVA's 79-14 program conducted during the period

January 23 through February 3, 1989, at Stone & Webster's offices in Cherry Hill, New Jersey.

To address this concern, TVA has prepared Punchlist Item No. 2-2233, which requires that the BFN Rigorous Analysis Handbook be revised to specify 70°F as the datum ambient temperature, and that all calculations be revised in accord with this requirement. The team accepted TVA's proposed corrective actions to address this concern.

(2) The pipe stress calculation does not evaluate the hydrostatic test condition. Section 2.0 of the calculation, "Assumptions" notes, in part, that:

> "Evaluation of hydrostatic/pneumatic pressure test is excluded from this calculation since this plant has been operated before. It can be safely assumed that any concern due to pressure has been resolved."

In discussion with TVA, the NRC team learned that this exemption is generic for all large-bore pipe stress calculations which Stone & Webster is preparing for TVA as part of TVA's 79-14 program, including steam-filled large-bore lines which may have been hydrostatically tested. TVA's decision not to require this evaluation is consistent with the corrective action detailed in Program Identification Report (PIR) BFNCEB8633, which TVA prepared on October 2, 1986. The PIR "Description of Condition" notes that:

> "The documented rigorous piping analyses of BFN piping systems which do not contain water during system operation have not considered the effect of water weight which would be present during hydrostatic testing. The systems affected include Main Steam, Torus and Drywell Purge, Reactor Core Isolation Cooling and High Pressure Coolant Injection."

The PIR additionally notes that consideration of the hydrostatic test condition is a requirement of USAS B31.1.0-1967, "Power Piping Code," the piping code of record for BFN.

The corrective action originally detailed in the PIR required revision of all piping analyses which had not considered water weight in piping subject to hydrotesting. TVA subsequently modified this corrective action to require an evaluation of the hydrostatic test condition prior to any subsequent hydrostatic testing.

The NRC team also determined that Design Criteria BFN-50-C-7103, "Structural Analysis and Qualification of Mechanical and Electrical Systems (Piping and Instrument Tubing)," does not explicitly address the hydrostatic test condition. However, the hydrotest condition is addressed in Design Criteria BFN-50-C-7104, "Design of Supports."

TVA does not agree with the team's contention that calculations for the hydrostatic test condition are required. However, TVA has agreed to review this concern and to provide the NRC with a response to this concern

at a later date. TVA is tracking this item as Engineering Assurance Action Item C-092.

(3) The Stone & Webster pipe sleeve clearance evaluation sheets in the pipe stress package have transposed global X and Z plan coordinates. TVA has prepared Punchlist Item No. 2-2232 to require that Stone & Webster revise the check sheet, and revise the pipe stress calculations which contain these check sheets. The team accepted TVA's proposed corrective actions to address this concern.

(4) For the primary containment stress report, (Reference 10) Stone & Webster did not specifically identify three of their review concerns on the findings summary sheet and it appears that TVA may have overlooked them, specifically:

   (a) Stone & Webster recommendation to TVA to revise Attachment D of Design Criteria BFN 50-C-7100 to include the use of a 4.5 psig negative design pressure and ASME Section III Code Case N-284, for the primary containment,

   (b) Stone & Webster concern that no design verification has been performed for the beam seat based on final loads from drywell floor analyses under the accident condition.

   (c) Stone & Webster recommendation of a design modification for local backing reinforcement of the shell at the lug locations.

TVA committed to implement Stone & Webster recommendation (a) and has already resolved concern (b) per reevaluation in calculation CD-Q2303-882953. TVA is reviewing their position on (c).

4.1.2.3 Review of System Evaluation Report (SYSTER) for the Residual Heat Removal System (Containment Spray Mode)

The function of the containment spray (CS) mode of the residual heat removal (RHR) system is documented in TVA's system evaluation report (SYSTER) entitled, "Browns Ferry Nuclear Plant Unit 2 Design Baseline and Verification Program System Evaluation Report / System 74: Residual Heat Removal," Revision No. 0, dated May 20, 1988 (TVA RIMS No. B30 88 0520 505).

As noted in Section 3.1.1 of the SYSTER, "Mechanical," the RHR system is designed for the following primary modes of operation:

(1) Low pressure coolant injection.
(2) Containment (torus) cooling.
(3) Containment (spray) cooling.
(4) Shutdown cooling.

Section 3.1.1.3, "Containment Spray Cooling Mode," notes that the RHR system is capable of injecting spray water into the primary containment (drywell and torus atmospheres) at the discretion of the operator as an augmented means of removing energy from the containment following a LOCA. The SYSTER incorporates the specific mechanical, electrical instrumentation, and control requirements of the RHR system by reference to Restart Design Criteria No. BFN-50-7074, "Browns Ferry Plan Residual Heat Removal System - Unit 2." The schematic configuration of the RHR system is depicted on Configuration Control Drawing (CCD) 2-47E811-1, "Flow Diagram/Residual Heat Removal System," Revision No. 10, dated January 11, 1989.

TVA has indicated that the following large-bore pipe stress calculations address the CS mode of the RHR system:

(1) N1-273-5R
(2) N1-274-3R
(3) N1-274-1R
(4) N1-274-5R
(5) N1-274-7R
(6) N1-274-14R
(7) N1-274-25R
(8) N1-274-26R

TVA has issued calculations Nos. N1-273-5R and N2-274-3R as part of TVA's civil issue program CEB8714-2, Torus Integrity Long-Term Program. TVA is preparing the remaining calculations as part of TVA's 79-14 program (TVA's civil issue program CEB8714-6, NRC OIE Bulletin 79-14). TVA will issue calculations Nos. N1-274-5R, N1-274-7R, and N1-274-14R post-restart, and calculations Nos. N1-274-1R, N1-274-25R, and N1-274-26R pre-restart. At the time of the inspection, calculation No. N1-274-1R was the only 79-14 calculation that TVA had formally issued. The team notes that calculations Nos. N1-274-25R and N1-274-26R contain stress analyses of the drywell ring headers. The drywell ring headers were originally qualified solely for jet impingement by Pittsburgh-Des Moines (PDM) in 1968.

4.1.2.4 Review of TVA's Engineering Assurance Oversight Review

TVA's Engineering Assurance (EA) overview of the BFN Unit 2 DBVP and related calculation programs are documented in the EA report entitled, "Engineering Assurance Oversight Review Report / Browns Ferry Nuclear Plant - Unit 2/Design Baseline and Verification Program EA-OR-002," dated December 14, 1988. EA performed this review in order to confirm that TVA and contractors such as Stone & Webster were effectively performing BFN DBVP activities in accordance with the DBVP plan and implementing procedures.

The EA report documents the status of 91 action items which EA prepared in the civil/structural discipline. By December 1988, EA had closed 55 action items, 34 action items remained open pending completion of agreed-upon resolution, and two action items remained unresolved.

The NRC team review of EA's report in the engineering mechanics discipline focused on EA's overview of Stone & Webster's calculation program in the civil/structural discipline. TVA contracted with Bechtel to perform the dynamic analysis of the major BFN structures. Stone & Webster is preparing all of the remaining civil/structural calculations.

The team also reviewed EA's overview of TVA's responses to the deficiencies which the team identified during the NRC inspection conducted at TVA's office in Knoxville, Tennessee from April 18 through 22, 1988.

EA prepared action items C-072 through C-082 during a review of 15 Stone & Webster calculation packages which EA conducted at Stone & Webster's office in Cherry Hill, New Jersey from June 13 through 17, 1988. EA prepared action items C-083 through C-091 during a followup audit of 14 Stone & Webster calculation packages at Stone & Webster's office in Decatur, Alabama from July 19 through 21, 1988.

Section 6.10.5 of the EA Report, Civil, summarizes the status of action items C-072 through C-091, as well as the status of action items C-012, C-047, C-060, C-062, C-065, C-066, and C-067, that resulted from the EA review in TVA's office in Knoxville, Tennessee, and the NRC inspection conducted in April 1988.

EA prepared action item C-066 to document the team's concern that Volume III of TVA's BFN Nuclear Performance Plan and Revision 4 of the BFN DBVP Program Plan did not address the seismic qualification of equipment. TVA has indicated that the Seismic Qualification Utility Group (SQUG) is addressing the seismic qualification of BFN equipment through the resolution of Unresolved Safety Issue (USI) A-46. Action item C-066 is, therefore, closed with respect to the NRC's inspection of BFN's DBVP program.

The team notes that EA's overview of Stone & Webster's calculation program appears to be effective. The team also concurs with EA's disposition of the action items which EA prepared to track the deficiencies which the NRC identified in the engineering mechanics discipline in April 1988.

The team finally notes that EA performed a subsequent audit of Stone & Webster's calculation program at Cherry Hill, New Jersey from December 6 through February 10, 1989. EA documented the results of that audit in a report entitled, "Browns Ferry Engineering Project (BFEP) Engineering Assurance (EA) Audit BFT88901 - Essential Calculations," dated February 24, 1989. However, EA did not require Stone & Webster to respond to the deficiencies identified in the audit report until after the period of the inspection.

4.1.2.5 Design Document Control

The NRC team reviewed the following sample of Engineering Change Notices (ECNs) from the system evaluation reports (SYSTERs) for the high pressure coolant injection (HPCI), residual heat removal (RHR), and core spray (CS) systems in order to assess TVA's implementation of engineering change notices (ECNs) to perform modifications to BFN Unit 2.

(1) ECN P0625-P1 (HPCI)
(2) ECN P0651 (HPCI)
(3) ECN P3184 (HPCI)
(4) ECN P5246 (HPCI)
(5) ECN P0083 (RHR)
(6) ECN P0666 (RHR)
(7) ECN P0962 (RHR)

(8) ECN P0795 (CS)
(9) ECN P3069 (CS)

The NRC team performed a programmatic review of samples of the following types of design documents which were required to document each ECN:

(1) Seismic qualification reports for valves and other equipment.
(2) Seismic calculations for piping and supports.
(3) Piping drawings.

ECN P0625-P1 required, in part, the seismic qualification of eight vent, drain, and test connections in the HPCI system as part of TVA's 79-14 program. TVA added tiebacks where necessary to seismically qualify these branch lines. The NRC team asked TVA to provide the seismic qualification documents for each of the eight piping configurations. TVA provided piping detail drawings, typified by TVA drawing 47B2455-218, "Mechanical/HPCI System/Pipe Supports," Revision No. 1, dated April 27, 1988; CEB Report CEB-75-18, "Small Line Attachment Details to Class 2 and 3 Piping Equal to or Larger than 2-1/2-Inch Diameter" (originally prepared for Sequoyah and Watts Bar Plants), Revision No. 3, dated May 22, 1984; and eight seismic calculations typified by TVA Calculation No. CD-Q2073-871703, "HPCI System Tie-Back Support," Revision No. 0, dated January 5, 1988.

ECN P0651 replaced containment isolation valve FCV-73-45. The team asked TVA to provide the vendor seismic qualification report for the replacement valve. TVA provided the team with Atwood & Morrill Report No. 311-15184-01, "Seismic Report for 14," ANSI B16.34 Std 900# ASME Class 1 Testable Check Valve," Revision No. 0, dated August 8, 1984.

ECN P3184 addressed the replacement/relocation of HPCI turbine control electrical components which were to be environmentally qualified. The unreviewed safety question determination (USQD) attached to the ECN specifies that a seismic evaluation be performed for the replacement components. The team asked TVA to provide the vendor seismic qualification report. TVA provided the team with GE Report No. NEDC-31597P, "Seismic Qualification Report for Selected Components on the HPCI Turbine Assembly for Browns Ferry Nuclear Plant Unit 2," dated June 15, 1988.

ECN P5246 replaced HPCI booster pump suction relief valve 73-506 with an equivalent valve. The team asked TVA to provide the vendor seismic qualification report for the replacement valve. TVA provided the team with Crosby Seismic Stress Report No. EC-641, "Crosby 3/4 X 1 JMP-WR Relief Valve, Drawing Number DS-C-62906 for TVA STRIDE Project Hartsville Nuclear Plants A & B / Phipps Bend Nuclear Plant," Revision No. 2, dated January 22, 1982.

ECN P0083 replaces the RHR pump seal heat exchanger. The team asked TVA to provide the seismic qualification report for the replacement heat exchanger. TVA provided the team with Borg-Warner Report No. 1792, "Seismic Analysis of Heat Exchanger Model No. NXW-0750-ER," Revision No. A, dated July 18, 1980.

ECN P0666 installs a 1-inch bypass line with two 3/4-inch check valves and a 3/4-inch manual valve around valves 74-674 and 74-675. The team asked TVA to provide the seismic calculation for the bypass line. TVA provided the team

with TVA Design Criteria No. BFN-50-712, "Seismically Qualifying Field Run Piping (Sizes 1/2 through 2 Inches)," Revision No. 1, dated July 21, 1981.

ECN P0962 removes a section of piping and installs pipe caps at primary containment penetration X-216 to obviate the need for implementing 10 CFR 50, Appendix J requirements for valves FCV-74-102, -103, -119, and -120 by isolating the RHR vent system from primary containment. The NRC team asked TVA to provide the seismic calculation for the abandoned piping. TVA provided the team with TVA Calculation No. N1-274-2R, "Browns Ferry Nuclear Plant, Summary of Piping Analysis, N1-274-2R," Revision No. 1, dated January 22, 1987.

ECN P0795 installs block, vent, and drain valves to allow leak testing of CS valves 75-606, -607, -609, and -610 in accordance with 10 CFR 50, Appendix J requirements. The team asked TVA to provide the seismic calculation for the new piping. TVA provided the team with TVA Calculation No. CD-Q2075-871733, "Browns Ferry Nuclear Power Plant, Summary of Piping Analysis:

CD-Q2075-871733," Revision No. 4, dated November 8, 1988.

ECN P3069 replaces valves 2-FSV-75-57 and -58 with equivalent valves which are environmentally qualified. The team asked TVA to provide the vendor environmental qualification report for the replacement valves. TVA provided the team with Automatic Switch Company Test Report No. AQS21678/TR, "Qualification Tests of Solenoid Valves by Environmental Exposure to Elevated Temperature, Radiation, Wear Aging, Seismic Simulation, Vibration Endurance, Accident Radiation and Loss-of-Coolant Accident (LOCA) Simulation," Revision No. A, dated August 3, 1981.

The NRC team concluded that TVA has satisfactorily documented the design modifications detailed in the sample of ECNs which the team selected for review.

4.1.2.6 Review of TVA's Calculation Cross Reference Information System (CCRIS)

TVA is implementing the Calculation Cross Reference Information System (CCRIS) document retrieval system in order to enable systematic retrieval of lifetime quality assurance records for BFN.

As noted in TVA EA review report, "Engineering Assurance Oversight Review Report / Browns Ferry Nuclear Plant - Unit 2 / Design Baseline and Verification Program / EA-OR-002," dated December 14, 1988, the CCRIS program is used by each TVA discipline as the data base for identifying, tracking, and cross-referencing project-related calculations. CCRIS has the capability to track essential information and cross references for different plants, disciplines, and document types. CCRIS enables calculation predecessors and successors to be maintained.

The EA report summarizes a limited review that EA conducted of the existing calculations which Ebasco coded into CCRIS. No calculations in the civil/structural discipline were available at the time of EA's review. EA prepared two action items to document the results of this review. Action Item E-038 addressed items such as "key nouns" not being properly identified,

missing predecessor and successor documentation, and incorrect identification of successor rather than predecessor documents. Action Item E-039 addressed deficiencies such as the incorrect identification of the "type" document into the CCRIS data sheets, the lack of a revision number for drawings, and missing data in several fields. EA accepted project's corrective actions to address the deficiencies identified in action items E-038 and E-039.

In the civil/structural area, the NRC team asked TVA to provide the CCRIS data sheets for 27 different calculations and documents. TVA was able to provide all of these data sheets.

4.1.3 Conclusions

The NRC team concluded that implementation of the DBVP is adequate in the civil/structural area. However, several discrepancies were identified. TVA has proposed resolutions for each discrepancy and added a new punchlist item to ensure their successful completion. The NRC team found the proposed resolution acceptable.

4.2 Mechanical and Nuclear Systems

4.2.1 Mechanical Systems

4.2.1.1 Documents Reviewed

The NRC team reviewed the following documents during the third inspection:

(1) TVA letter (R. Gridley) to NRC dated November 3, 1988, containing TVA response to NRC Inspection Reports 50-259/88-07, 50-260/88-07, and 50-296/88-07.

(2) Calculation MD-Q2003-87178, Revision 1, "Check Valve Low Flow Conditions."

(3) Calculation MD-Q2018-87163, Revision 0, "Minimum Pipe Wall Thickness."

(4) Calculation MD-Q2023-88125, Revision 0, "RHRSW Pump Minimum Flow Rate Analysis."

(5) Calculation MD-Q2064-87382, Revision 1, "Minimum Pipe Wall Thickness and Corrosion Allowance."

(6) Calculation MD-Q2065-87581, Revision 1, "Process Design Condition for SGTS Equipment."

(7) Calculation MD-Q2073-87194, Revision 0, "Size of HPCI System Orifices/Venturis."

(8) Calculation MD-Q2074-87155, Revision 0, "Total RHR System Head versus Flow Rate for Priority 1 Mode Support."

(9) Calculation MD-Q2074-87156, Revision 1, "Orifice/Venturi Sizing for RHR System."

(10) Calculation MD-Q2074-88225, Revision 0, "Total RHR System Head versus Flow Rate for Priority 1 Mode Support."

(11) Calculation MD-Q2074-88225, Revision 1, "Total RHR System Head versus Flow Rate for Priority 1 Mode Support."

(12) Calculation MD-Q2075-87214, Revision 0, "Orifice Sizing for Minimum Flow Line."

(13) Calculation MD-Q2075-87216, Revision 1, "Core Spray System Relief Valve Sizing."

(14) Calculation MD-Q2075-87221, Revision 0, "Orifice Sizing in 10 inch Pump Test Line."

(15) Calculation MD-Q2075-87232, Revision 0, "Core Spray Pump Suction Relief Valve Sizing."

(16) Conditions Adverse to Quality Report (CAQR) No. BFE880936.

(17) Calculation Cross Reference Information System (CCRIS) printouts for the following calculations:

(a) MEB MD-Q2001-88133, Revision 0.
(b) MEB MD-Q2018-87164, Revision 1.
(c) MEB MD-Q2031-87140, Revision 0.
(d) MEB MD-Q2032-87286, Revision 0.
(e) MEB MD-Q2064-88100, Revision 0.
(f) NTB ND-Q2000-87004, Revision 1.

(18) Engineering Change Notice P0157, Removal of Core Spray Pump Lube Oil Coolers, Closure Package.

(19) Engineering Change Notice P0795, Installation of Drain, Vent, and Block Valves in Core Spray System to Permit Appendix J Testing, Closure Package.

(20) Engineering Change Notice P3098, Core Spray System Flow Switch, Closure Package.

(21) Engineering Change Notice P7151, Core Spray System Flow Switch, In Process Package.

(22) Configuration Control Drawings 2-47E814-1, Revision 0 to Revision 6, Core Spray System.

(23) BFEP PI 87-48, "Revising and Controlling As-Constructed/Configuration Control Drawings (CCD)."

(24) SDSP 2.12, "Documentation Distribution Control."

(25) Engineering Assurance Oversite Review Report, EA-OR-002.

(26) Memorandum from A. P. Capozzi to H. B. Bounds dated February 24, 1989, Reporting on the BFEP Engineering Assurance Audit BFT 88901 - Essential Calculations.

4.2.1.2 Findings

4.2.1.2.1 Review of Open Items From First and Second NRC Team Inspections

TVA responded to each of the concerns raised by the second NRC team inspection and listed in Inspection Reports 50-259/88-07, 50-260/88-07, and 50-296/88-07. During the third inspection, the NRC team reviewed three open items with TVA's mechanical engineers. The proposed resolutions for all three items are acceptable. The NRC team review of the TVA responses follow.

(1) Concern: (Item B from first NRC team inspection)

Some design requirements contained in the FSAR Appendix C have not been included in the commitments/requirements (C/R) data base listing.

TVA Response

The commitments/requirements (C/R) data base has been updated to include design requirements contained in FSAR Appendix C. A total of 15 new C/Rs were generated from the review and were added to the data base.

NRC Team Review

The NRC team reviewed the TVA response and found it acceptable. The NRC team verified that the new entries are in the C/R data base. This item is considered closed.

(2) Concern: (Item 8 from second NRC team inspection)

Some of the mechanical calculations prepared by Ebasco and reviewed by TVA did not list specific criteria, did not draw any conclusions and, in the case of check valve flow, did not utilize conservative values. In addition, the calculations were not prepared in accordance with the governing design procedures.

TVA Response

The calculations (MD-Q2023-87123 and MD-Q2023-87298) that were reviewed have been revised in accordance with the governing procedures to list specific criteria, provide conclusions, and incorporate conservative values. A calculation improvement program has been implemented for contractor-generated calculations, the details of which are further discussed in our response to concern number 11 (from second NRC team inspection).

NRC Team Review

The NRC team reviewed the TVA response and found it acceptable. The NRC team reviewed in detail 14 mechanical calculations of various types. The

review included evaluation of format, identification of specific criteria, use of acceptable technical approaches, and identification of specific conclusions. The reviewed calculations were found to be satisfactory and greatly improved over those reviewed during the second inspection. This item is considered closed.

(3) Concern: (Item 9 from second NRC team inspection)

TVA's contract with Ebasco requires that TVA review the first calculation of each type and provide its comments to Ebasco so that Ebasco can incorporate the comments in the calculation packages. The NRC team found that TVA is not following up to ensure that Ebasco is incorporating the comments after the comments are transmitted to Ebasco, thus the comments may or may not be incorporated in the calculations.

TVA Response

Each of the specific types of calculations generated by Ebasco undergoes a detailed technical adequacy review by a TVA reviewer. The comments of the TVA reviewer become a QA record. The DBVP systems engineers have been instructed to perform an acceptance review of all calculations in accordance with the memorandum, Acceptance Criteria for Browns Ferry Nuclear Plant Calculations. As indicated in this memorandum, the DBVP systems engineers are instructed to obtain the original reviewer's comments from the detailed technical adequacy review and verify that the comments have been incorporated in the calculation. This acceptance review process will ensure that the comments are adequately resolved prior to the issuance of these calculations.

NRC Team Review

The NRC team reviewed the TVA response and found it acceptable. The NRC team reviewed over 200 calculation acceptance review sheets to ascertain whether the comments from the "First of a Type" technical adequacy review were used in the subsequent calculation reviews, and no problems were found. Several calculations were reviewed in detail and compared to the original "First of a Type" comments, and no problems were found. This item is considered closed.

4.2.1.2.2 Review of Engineering Calculations

Under the BFN DBVP, 367 essential mechanical calculations have been identified. Of these, 319 (about 87%) are completed. Of the 48 calculations not completed, 7 are in the ventilation system (system No. 30) and 26 are in the air conditioning system (system No. 31). Ebasco did not complete those calculations and they are currently being performed by TVA. TVA's Mechanical Engineering Branch (MEB) has a punchlist that identifies the calculations that are not completed.

The NRC team selected 14 various completed calculations for review. As discussed above in Section 4.2.1.2.1, the reviewed calculations were found to be satisfactory with regard to format, identification of specific criteria, use of acceptable technical approaches, and identification of specific conclusions.

TVA appeared to be using the "First of a Type" reviewer comments in reviewing subsequent calculations.

During the review of calculation MD-Q2075-87214, Revision 0, "Orifice Sizing for Minimum Flow Line," an error was found. The error involved a round off, in an unconservative manner, of the calculation result. The unconservative round off permitted the calculation result to meet the stated acceptance criteria; whereas, proper round off of the result would have resulted in not meeting the acceptance criteria. This error was identified to TVA, and TVA revised the calculation before the third inspection was completed. The revised calculation removed some conservatism in the original calculation so that the result met the acceptance criteria. The revised calculation was considered satisfactory. The error was not considered to be generic in nature; thus, no further action by TVA was considered necessary.

Another aspect of the calculation program reviewed by the NRC inspection team was the Calculation Cross Reference Information System (CCRIS). CCRIS calculation logs for six calculations were reviewed. The logs reviewed were for calculations: MEB MD-Q2001-88133, Revision 0; MEB MD-Q2018-87164, Revision 1; MEB MD-Q2031-87140, Revision 0; MEB MD-Q2032-87286, Revision 0; MEB MD-Q2064-88100, Revision 0; and NTB ND-Q2000-87004, Revision 1. Three generic problems were identified in this review. TVA developed resolutions of each of these problems and placed each problem resolution on the DBVP punchlist. Each problem and its resolution is discussed below. TVA should improve their review of the CCRIS input data sheets to identify input errors before they are entered into CCRIS.

(a) Incorrect CCRIS Input

A review of the "successor" calculations for NTB calculation NTB ND-Q2000-87004, Revision 1, showed that 15 of 36 MEB successor calculations were not listed on the CCRIS log. Review of the CCRIS input sheets for the 15 missing calculations showed that the "NTB" calculation was listed as an "MEB" calculation. Accordingly, the missing calculations cannot be listed as a "successor" to the NTB calculation since they will not be a part of its data base. During the inspection TVA DBVP personnel found that the problem existed with calculations from other TVA branches that were referenced in MEB calculations.

TVA DBVP has agreed to correct the CCRIS input errors. MEB has punchlisted this problem, P/L No. 2-2217, to ensure that it is corrected before plant startup. DBVP will address this problem on a generic basis in response to CAQR BFE 880646. The NRC inspection team considers this resolution to be satisfactory.

(b) Predecessor Documents Listed as Successors

The Browns Ferry environmental drawings were listed as successors for an HVAC calculation in the CCRIS data sheet. This is an error, since the environmental drawings provided design input for the calculation and will not be directly affected by the result of the calculation.

TVA DBVP has agreed to correct the problem. MEB has punchlisted this problem, P/L No. 2-2220, to ensure that it is corrected before plant startup. The NRC inspection team considers this resolution to be satisfactory.

(c) Incorrect Design Input References

In two cases, components' technical information was given in the flow diagrams. The calculation preparer used the information as design input because of convenience. This type of information is normally provided in vendor drawings or data sheets, and should be available in the vendor contract files.

TVA DBVP has agreed to correct the use of flow diagrams as input for component technical data. Vendor information will be used as input to the calculation and will be identified as such in the CCRIS sheets. MEB has punchlisted this problem, P/L No. 2-2219, to ensure that it is corrected before plant startup. The NRC inspection team considers this resolution to be satisfactory.

4.2.1.2.3 Review of Conditions Adverse to Quality Report

Conditions Adverse to Quality Report (CAQR) No. BFE880936 was reviewed by the NRC inspection team. This CAQR involved orifice sizing in the Core Spray System and resulted from differences between the required orifice sizes in calculations and those verified during system walkdown. The CAQR was reviewed in detail to ensure that the corrective actions were properly implemented. One of the identified corrective actions was increasing the size of the minimum flow line orifices. The Maintenance Request Forms for this work were reviewed and the Browns Ferry Plant engineer originating the maintenance was interviewed. The proper corrective action appeared to have been accomplished and no problems were identified.

4.2.1.2.4 Review of Engineering Change Notices

Four Engineering Change Notice (ECN) packages (P0157, P0795, P3098, and P7151) were reviewed. All appeared to be complete and satisfactory. ECNs P3098 and P7151 both involved the installation of flow switches in the core spray system and were reviewed in greater detail. ECN P3098 involved installation of two new flow switches (FE 75-80 and FE 75-81) because the transmitters (FT 75-21 and FT 75-49) associated with the original sensors (FE 75-21 and FE 75-49) were not environmentally qualified. However, the new flow switches would not respond properly, and ECN P7151 was initiated to replace the original transmitters with environmentally qualified transmitters used in conjunction with the original flow switches (FE 75-21 and FE 75-49). Both ECN packages appeared to have adequate technical justification for the changes. Changes to Configuration Control Drawing 2-47E814-01 for the core spray system, as a result of these ECNs, were reviewed to ensure that the drawing accurately reflected the design changes. No problems were identified.

Twelve calculations were reviewed to verify that the ECNs identified in the calculations were in agreement with the appropriate ECNs identified in the SYSTER documents. Although the two lists of ECNs were not always identical, the calculations did appear to contain the ECNs that would be appropriate to the calculation. No problems were identified.

4.2.1.2.5 Review of Configuration Control Drawings

The development and revisions of the Configuration Control Drawing (CCD) for the core spray system were reviewed. The as-constructed drawing 47W814-1, Revision D, the as-designed drawing 47W814-1, Revision 25, and the results of the system walkdown per Drawing Discrepancy Package 075-006 were used as the bases for the generation of drawing 2-47E814-1, Revision 0. Revision 0 was placed under configuration control, but the drawing did not become a CCD until Revision 3 was issued. All changes to drawing 2-47E814-1 from Revision 0 to Revision 6 were reviewed to understand their development. ECNs that affected the CCD were also reviewed. It appeared that TVA has adequately controlled the development of flow CCDs. No problems were identified.

BFEP PI 87-48 (Paragraph 4.1.1) currently requires that CCDs be updated within 48 hours of receipt of form Site Director Standard Practice (SDSP) 133 by NE Engineering Drawing Service. Further, SDSP 2.12 (Paragraph 6.1) requires that the Technical Information Services Unit shall distribute the CCDs to the Shift Operations Supervisor's Office, Applicable Control Rooms, Technical Support Center, and Electrical Shop within five working days after receipt of the revised CCD. These procedures ensure that up-to-date CCDs are available at critical locations. No problems were identified.

4.2.1.2.6 Review of Engineering Assurance Program

The work performed by Engineering Assurance since the second NRC inspection was reviewed. The work items were documented in the Engineering Assurance Oversite Review Reports EA-OR-002, and in the audit report attached to the memorandum from A. P. Capozzi to H. B. Bounds, dated February 24, 1989, reporting on the BFEP Engineering Assurance Audit BFT 88901 - Essential Calculations. The Oversite Review Report covered a review period of mid-1988 and identified a number of weak areas in the DBVP. Conditions Adverse to Quality Reports (CAQR) were prepared to ensure that the weak areas would be improved. During this third NRC team inspection, improvements were noted in some of the weak areas identified by Engineering Assurance. However, not all CAQRs have been completed.

Audit Number BFT 88901 was conducted by Engineering Assurance from December 1, 1988 to February 10, 1989, to evaluate the technical adequacy of the BFEP essential calculation program, and to evaluate the effectiveness of the actions taken to resolve CAQR BFE880646 regarding generic concerns with essential calculations. The results of the audit in the area of essential mechanical calculations appeared to be accurate and complete. The Engineering Assurance Program appears to be functioning properly.

4.2.1.3 Conclusions

The NRC team concludes that implementation of the DBVP is adequate in the mechanical systems area. However, several discrepancies were identified. TVA has proposed resolutions for each discrepancy and added new punchlist items to

ensure their successful completion. The NRC team found the proposed resolutions acceptable.

4.2.2 Nuclear Systems

4.2.2.1 Documents Reviewed

The NRC team reviewed the following documents during the third inspection:

(1) Calculation Cross Reference Information System (CCRIS) Manual.

(2) BFNP Reload Licensing Report, Unit 2, Cycle.6, TVA-RLR-002, Revision 2, July, 1988.

(3) ND-Q0064-88128, Revision 0, "Seal Leakage for Secondary Containment," B22 88 1109 101, November 8, 1988.

(4) ND-Q1064-88110, Revision 1, "Secondary Containment Penetration Seal Determination," B22 88 1102 107, October 26, 1988.

(5) ND-Q0999-88070, Revision 0, "Postaccident Doses to Cables in the Drywell," B30 88 0520 210, May 20, 1988.

(6) ND-Q2000-87032, Revision 0, "BFNP Supplemental Reactor Building High Energy Line Break Analysis," B45 87 1228 236, December 8, 1987.

(7) TI-ANL-73, Revision 0, "Environmental Response to High Energy Line Break (HELB) Outside Containment," NEB 82 0617 235, June 15, 1982.

(8) ND-Q2000-88021, Revision 1, "Reactor Building High Energy Line Break Analysis," B30 88 052420, May 19, 1988.

(9) Informal Memorandum, G. E. Gears to Those Listed, "BFN-Unverified Assumptions Identified in NTB Calculations," October 26, 1988.

(10) CCRIS listing of all NTB Calculations.

(11) Browns Ferry Engineering Project (BFEP) Engineering Assurance (EA) Audit BFT 88901, Essential Calculation B05 89 0224007.

(12) Browns Ferry Nuclear Plant (BFN) - Site Quality - Quality Assurance Department - Quality Surveillance - BFN Appendix R Program Assessment, R22 880921 817.

(13) Browns Ferry Nuclear Plant (BFN) - Personal Services Contract TV-72164A, Engineering Assurance Procured Services Audit 88P-95, B05 88 1014 002.

(14) BFN Nuclear Quality Assurance, Joint Audit Report No. BFK88901, "System Preoperability Checklist and System Plant Acceptance Evaluation Programs," November 18, 1988.

(15) BFN - Interim Assessment of the Effectiveness of Corrective/Preventive Action for CAQR BFE Nuclear Engineering (NE) Engineering Assurance (EA)

Audit BFE 88901 - Browns Ferry Engineering Project (BFEP) conducted October 31 - November 4, 1988, B05 88 1202 003.

(16) Nuclear Engineering (NE) Engineering Assurance (EA) Audit BFE 88803 - Browns Ferry Engineering Project (BFEP) B05 88 0810 007.

(17) TI-764, Radiolytic Hydrogen Generation in the BFNP Containment Following a MHA," April 11, 1978.

(18) TI-ANL-16, "Environmental Response of Reactor Building to High Energy Line Breaks in HPCI, RICI, RWCV, & Main Steam Systems," Revision 2, NEB (illegible).

(19) Punchlist Report for BFN, dated February 28, 1989.

(20) Configuration Control Drawings (CCDs), Issued Status, February 27, 1989.

(21) Memo from W. Wittich, Ebasco, to G. E. German, TVA, "Tennessee Valley Authority, Browns Ferry Nuclear Plants, Task N002A-Status Report," September 9, 1989.

(22) Memo from W. Wittich, Ebasco, to G. E. German, TVA, "Tennessee Valley Authority, Browns Ferry Nuclear Plants, Task N002A-Nuclear Calculations Status," September 26, 1989.

(23) NTB response to EA's Audit PRD No. BFT 890158901P, Revision 0, February 22, 1989.

(24) NTB's List of New Calculations to be performed before restart.

(25) Design Baseline and Verification Program Essential Calculation Consistency Review, "Harsh/Mild Environmental Data Calculations/Tabulations," TSD-N002A, Ebasco, August 22, 1988.

(26) Design Baseline and Verification Program Essential Calculation Consistency Review, "Reactor Transient and Accident Analyses," TSD-N002A, Ebasco, August 15, 1988.

(27) Design Baseline and Verification Program Essential Calculation Consistency Review, "Primary & Secondary Containment Accident Leakage Limits," TSD-N002A, Ebasco, July 25, 1988.

(28) NEP-3.8, TVA Nuclear Engineering Procedure, "Computer Software System Development, Procurement, Qualification, and Control" Revision 0, PCN-2, B05 88 1115 003, November 15, 1988.

(29) NEP-3.1, TVA Nuclear Engineering Procedure, "Calculations," Revision 1, PCN-3, B04 89 0103 500, December 27, 1988.

(30) TVA memorandum from J. M. Marshall to D. L. Kitchel, "BFN - Design Baseline and Verification Program (DB & VP) - SCR/NCR Summary Report," June 24, 1988.

4.2.2.2 Findings

4.2.2.2.1 Review of Open Items From the Second NRC Team Inspection

Eight systems-related concerns were identified in NRC Inspection Reports 50-259/88-07, 50-260/88-07, and 50-296/88-07. The concerns and the NRC team's evaluations of TVA's responses to the concerns follow.

(1) Concern

Nuclear Systems essential calculations have not yet been identified. Such an identification is required to satisfy the objectives of DBVP and should be done as soon as possible.

TVA Response

The Nuclear Technical Branch (NTB) DBVP calculations have now been reviewed and the essential DBVP calculations have been identified.

NRC Team Assessment

The team reviewed the status of the identification of essential calculations. From this review it was not evident to the team whether several categories of essential calculations, containing more than 100 calculations, were part of the original list of essential calculations. These categories included equipment qualification, Appendix R, and secondary containment calculations. TVA has committed to include these calculations in the list of essential calculations. This item is considered closed.

(2) Concern

The Engineering Assurance (EA) Group of the DBVP has not reviewed any nuclear calculations even through the calculation process is well under way.

TVA Response

At the time of the NRC audit in April 1988, most of the nuclear calculations available for the review by the Engineering Assurance Oversight Review Team (EA-ORT) were to satisfy DBVP needs related to identifying the scope of the program. Design change calculations were in the process of being technically reviewed and/or regenerated. EA was scheduled to review representative samples of these design change calculations after the process was further along. Ten items, including the safe shutdown anaylsis and a system requirement calculation to mitigate FSAR Chapter 14 accidents, were reviewed by EA-ORT before the audit, but were not made available to the NRC as they should have been.

In July 1988, EA performed a programmatic audit during which three nuclear design change calculations were reviewed and no technical deficiencies were identified. Further technical audits of nuclear calculations were scheduled during the last quarter of 1988.

In addition, in August 1988, EA requested three major engineering contractors (Bechtel, Ebasco, and Stone & Webster) to develop calculation improvement programs. Such programs are now in place and include: (a) independent peer reviews of existing calculations, (b) QA/QC surveillances utilizing checklists/guidelines covering "lessons learned" based on previously identified problems, (c) feedback to line organizations from (a) and (b) above, (d) strengthening the training of personnel on calculation procedural requirements, and (e) corrective action of any problems identified during the reviews and/or surveillances. EA has regularly monitored the effectiveness of the calculation improvement process at BFN since September 1988.

<u>NRC Team Assessment</u>

Since the time of the last NRC team inspection of DBVP, the team has determined that EA has performed seven audits involving at least 24 NTB calculations. The team judges this response acceptable and this item is considered closed.

(3) <u>Concern</u>

The NRC team reviewed a number of system calculation packages and found that some assumptions were not clearly stated and that others lacked proper reference to appendices and attachments.

<u>TVA Response</u>

Unverified assumptions in NTB DBVP calculations will be addressed and dispositioned, as required by the Volume 3 calculation review commitment, by restart of Unit 2.

<u>NRC Team Assessment</u>

The team verified that the new NEP-3.1 requires that assumptions are clearly stated and that existing unverified assumptions have been addressed when revising a calculation. This item is considered closed.

(4) <u>Concern</u>

Because certain types of nuclear calculations are configuration dependent, TVA needs to review those calculations after the plant configuration is reestablished.

<u>TVA Response</u>

The NE Engineering Assurance Branch will perform a plant configuration review on a sample of NTB calculations before Unit 2 restart to ensure that the calculated results represents the DBVP plant configuration.

NRC Team Assessment

TVA committed to have the EA Branch perform a sample review of the plant configuration dependency of NTB essential calculations. The NRC team considers this response acceptable and this item is considered closed.

(5) Concern

Nuclear Engineering Procedure NEP-3.1 does not require that a table of contents be provided for calculation packages. This procedure should be revised to require a table of contents.

TVA Response

Nuclear Engineering Procedure NEP-3.1 is in the process of being revised to require that a table of contents be provided for calculation packages. The procedure change notice to NEP-3.1 will be issued by November 15, 1988.

NRC Team Assessment

The team reviewed Nuclear Engineering Procedure NEP-3.1. Procedure Change Notice 2 to NEP-3.1 issued November 15, 1988, added a requirement for a table of contents along with a sample table of contents as an attachment. This response is judged acceptable by the team and this item is considered closed.

(6) Concern

In some instances, inputs to computer runs and computer codes used in the nuclear calculations were not always stated in the calculation packages. TVA should include this information in the applicable calculation packages.

TVA Response

NTB practice in the past has been to file the software printouts separately from the calculation and reference the location of the file in the abstract portion of the calculation. Now, Nuclear Engineering Procedure (NEP) 3.1, Calculations, issued in July 1986, instructs the calculation prepared to eliminate such problems. Section 4.1.2 states that the calculation prepared:

"Ensures that for all computer programs used to perform computations or analyses:

a. The program has been verified and documented in accordance with NEP 3.8.

b. The software version, computer input, and computer output are documented, retrievable, and referenced in the calculation document."

Moreover, Section 4.1.6.2 in this procedure specifies that the initiating manager, "ensures that the calculations and supporting documentation (including computer input and output) are issued as in NEP 3.1." Applicable personnel are trained in the use and application of NEP 3.1.

A review of the references listed in Section 4.2.2.1 of the audit report indicate that all calculations reviewed by the NRC were prepared prior to the issuance of NEP 3.1 except BFN-APS3-011. This calculation has been reviewed and no problems related to this concern were found.

During the calculation review program, if these types of documentation problems are identified, they would be corrected during the next revision of the calculation. Therefore, TVA considers that this concern has been addressed with the issuance of NEP 3.1.

NRC Team Assessment

The team reviewed the retrievability of computer inputs to calculation BFN-APS3-011 (RIMs No. B45 87-0709-238) "Calculation of the Offsite and Control Room Doses Due to a CAD Flow Rate of 210.8 CFM." The computer inputs to BFN-APS3-011 were listed as being available in Microfilm Tape No. RAD-170. A copy of the computer inputs for the STPISOP and STP was retrieved from microfilm storage along with the pertinent pages giving the input variable listing from the user's manuals for these codes. This exercise demonstrated retrievability of computer inputs to NTB calculations.

The team also reviewed Procedure Change Notice (PCN) 2 to Nuclear Engineering Procedure (NEP) 3.1 regarding software inputs to calculation requirements. PCN 2 added a requirement to list all computer programs used or referenced in the calculation on the cover sheet. In addition, Section 4.1.2 of NEP-3.1 states that the software version, computer input, and computer output are documented, retrievable, and referenced in the calculation document, and listed on the cover sheet or continuation sheet of the cover sheet.

Based on TVA's response to this concern and the team's own review of TVA calculations and engineering procedures, the team judges this response acceptable and this item is considered closed.

(7) Concern

Calculation TI-ANL-69 identified a possible safety concern. The reactor core isolation cooling (RCIC) turbine electronic overspeed trip (at 100% rated speed) will be actuated if flow is allowed in the pump discharge mini-flow line. Unless this trip is successfully overridden, no allowance can be made for cooling water provided by the RCIC system. TVA must review this problem to ensure that the turbine trip can be successfully overridden.

Additional Details Related to this Concern

In addition, many NTB calculations are required by other engineering

groups within TVA. It was not possible to determine if the required information or calculation results had been transmitted to the pertinent group as required or needed. Documentation should be available to show that follow-on actions to resolve problems identified by NTB calculations were accomplished as required. Also, documentation should be in place to show that the NTB calculations used as inputs by other engineering groups are the most current and correct versions. Letters of transmittal or other forms of documentation for the NTB calculations were not provided.

TVA Response

Calculation TI-ANL-69 was issued in April 1982. At that time less formal means were utilized to convey internally generated design information. NEP 3.3, Internal Interface Control, dated July 1, 1986, established requirements and methods to control internal design interfaces, and to request or convey design information across disciplines. Such practices ensure that internal design information is communicated in an effective and timely manner.

The fact that failure of the mini-flow valve to close may result in a RCIC turbine trip is not a safety concern because RCIC is not a single failure-proof system. Other valves and components can disable RCIC in the event of their single failure. The HPCI and ADS, in combination with the low-pressure core cooling systems, are also available in the event of such failure.

An NTB review of this calculation has indicated that it was performed to provide inputs needed for a Probabilistic Risk Assessment (RPA) being performed on the Browns Ferry Nuclear Plant.

Additionally, during the recently completed review of essential NTB DBVP and Equipment Qualification calculations, TI-ANL-69 was determined to be a desirable calculation, a classification created for important calculations that have no safety-related aspects.

NRC Team Assessment

The NRC team considers TVA's response to this concern acceptable. However, the team felt that an additional explanation should be added to the original calculation package to make other reviewers or users of this calculation aware of the possible safety concern regarding the RCIC turbine electronic overspeed trip. TVA's response was a memorandum from S. B. Burt, RPU Supervisor, Calculation Library, BFEP, to T. F. Newton, BFNP, Engineer for Nuclear Discipline, dated March 6, 1989 (RIMs No. B90 890306-001), requesting that the above explanation to this concern be added to the original calculation package. The team judged this response acceptable and this issue is considered closed.

(8) Concern

Procedures EN DES-EP 3.23 and NEP 3.8 do not require verification of the compatibility of public domain software with the system at TVA. Some computer code verification should be required to ensure software compatibility with the system and consistency of results.

Additional Details Related to this Concern

Prior to May 1979, there was no procedure in place to document, control, and verify computer codes used in TVA engineering calculations. This raises questions concerning the degree of technical review that was done on TVA engineering calculations utilizing computer codes before May 1979.

TVA Response

The governing procedure for computer software control is NEP 3.8 that is in the process of being revised to require verification of compatibility of public domain software and consistency of results with the computer system at BFN. The Procedure Change Notice (PCN) to NEP 3.8 will be issued by November 15, 1988. A survey to identify each application of public domain software has been completed. Certification for each software version utilized in DBVP and equipment qualification calculations has been requested from the software owner. This will be completed, as part of the Volume 3 calculation review commitment, by Unit 2 restart.

NRC Team Assessment

The team reviewed NEP 3.8, Revision 0-PCN2, dated November 15, 1988, and confirmed that requirements for qualification of public domain software used by TVA had been added and that these added requirements are acceptable. In further discussion with TVA personnel, the team learned that several public domain software codes, specifically RELAP4-Mod5, RELAP5-Mod1, and REPIPE were all run only on the CDC Cybernet system. These codes were CDC maintained software. Further, REPIPE is a CDC proprietary code. These codes were not run on the TVA computer system, and these versions of the codes are no longer being used by TVA. When these codes were used, they were run strictly on the CDC Cybernet system. Therefore no test cases need be run by TVA. In addition, TVA performed an audit of CDC's QA control (see TVA letter to CDC dated July 8, 1982, RIMs No. 82-0716B-0101). TVA's performance of an audit of CDC's QA control demonstrates to the team a commitment to software certification. Further, TVA has identified problems with the certification of software used for NTB calculations in the following Problem Identification Reports (PIR):

PIRGENNEB8606 (RIMs No. B45 861230-851) - SSFLOW
PIRGENNEB8607 (RIMs No. B45 861230-852) - RETRAN02-Mod3
PIRGENNEB8608 (RIMs No. B45 861230-853) - RELAP5-Mod2, Cycle 36.02
PIRGENNEB8610 (RIMs No. B45 861230-855) - ANVENT
PIRGENNEB8612 (RIMs No. B45 861230-857) - MONSTER
PIRGENNEB8701 (RIMs No. B45 870126-851) - BALLOON version 2.0 and 2.1
PIRGENNEB8703 (RIMs No. B45 870126-853) - STEAM TABLE version 2.0
PIRGENNEB8801 R1 (RIMs No. B45 880210-851)

and the following Significant Condition Reports (SCR):

SCRGENNEB8704 (RIMs No. B45 870123-851) - FENCDOSE
SCRGENNEB8706 (RIMs No. B45 870128-851)

Several other PIRs were identified as involving software documentation but were not reviewed by the team. The software which was identified as being not in complete compliance with ECB-EP-28.01 and its successor controlling procedure NEP 3.8, involved public domain software, vendor developed software (i.e., General Electric, Bechtel), and TVA internal software. Two significant trends were noted in these PIRs and SCRs. The first was that the Quality Information Request (QIR) log required by NEP 3.3 is not being properly maintained per the procedural requirements. The second was the failure to follow ECB-EP-28.01 in that computer codes were used in safety-related analyses prior to completion of verification documentation. The corrective action proposed to address the deficiencies identified in these PIRs and SCRs were reviewed by the team and judged acceptable. However, the lack of official action in addressing the problems identified by these PIRs and SCRs and the lack of documentation showing that action has been taken by TVA is a concern to the team. The team accepts TVA's response to open Item #17 with the provisions that the deficiencies identified in the PIRs and SCRs regarding computer software validation, certification, and documentation be addressed in a timely manner, and that their resolution be tracked as a punchlist item by the EA branch. This item is considered closed.

4.2.2.2.2 Essential Calculations

TVA contracted the identification of the DBVP essential calculations required for restart, and the classification of the remaining existing calculations, to Ebasco. Of the existing 360 NTP calculations, Ebasco identified 129 essential calculations and an additional 30 that were missing. Following the review of the classifications, it became evident to the NRC team that several categories of essential calculations were not included in the above 159 calculations. These categories included Equipment Qualification, Appendix R, and Secondary Containment. The team communicated their concern to TVA and TVA agreed that these types of calculations should be made a part of the essential calculations. After these types are included in the scope of the essential calculation, the team is satisfied that TVA has identified the majority of the essential calculations required for DBVP. Some old and some newly generated calculations are being currently added to this list. The NTB has agreed to punchlist each of the remaining calculations and close the punchlist items before Unit 2 restart.

In addition, about 30 other calculations, identified as missing and to be regenerated by NTB, also need to be audited by EA on a sample basis. The team believes that continuing EA audits of NTB calculations is a necessary part of the overall DBVP process, and that these audits should address the areas of environmental qualification, secondary containment and hazards, and regenerated or missing calculations. The team believes that any further EA audits on NTB calculations should be a punchlist item.

The team also addressed the subject of unverified assumptions in the essential calculations. The team was concerned that unverified assumptions contained in the NTB essential calculations may not be adequately identified and tracked so that they can be resolved before Unit 2 restart. The new procedure NEP 3.1 requires that existing unverified assumptions must be addressed before a calculation is revised. Moreover, the team has verified that the identification of these assumptions is in progress, with about 15 unverified assumptions identified so far. The NTB has agreed to punchlist all unverified assumptions and close the punchlist items before Unit 2 restart.

Another area of review was the configuration dependent calculations. The team was concerned that EA has performed a limited review of configuration-dependent calculations. The limited EA review has not revealed any problems. However, Ebasco has identified 31 calculations which may have been affected by plant modifications. NTB has agreed to examine these as well as other calculations which may have been affected by such modifications. NTB has further agreed to establish a punchlist item to review these calculations and address the concerns prior to Unit 2 restart. Moreover, EA will review the geometric configuration for conformance to as-built configuration as one of their attributes for all reviewed NTB calculations.

Another area of the NRC team review was the Calculation Cross Reference Information System (CCRIS). The purpose of CCRIS is to provide a computerized database system with search and update capabilities on essential information about TVA's calculations, and to provide cross reference capability to other supporting design documents. CCRIS is seen by the team as one of TVA's primary means of tracking and managing information generated and used in the calculations. As such, the team was interested in the effectiveness of CCRIS. The team's assessment of CCRIS is that it is effective in performing its intended function of tracking references through successive generations of calculations. However, many errors were found within the CCRIS database involving references that were used in the calculation but were not in CCRIS, calculations that were miscategorized (such as TI-ANL-16), etc. The team attributes most of these errors to improper inputting of data into CCRIS. Therefore, the team recommends that additional training be given to the users of CCRIS, with particular emphasis on the purpose and goals of CCRIS and the proper inputting of data into the system.

The NRC team reviewed nine NTB calculations. These calculations were selected to include previous EA audits, calculations identified by Ebasco as being possibly configuration-dependent, and a check of TVA's response to open items from previous NRC team inspections. The team had an exhaustive search performed by CCRIS of the input references to the calculations, and compared the results with the actual input references to the calculations. The calculations were also checked for unverified assumptions, configuration-dependency, and compliance with the applicable procedures in place at the time the calculations were prepared. The evaluation of each of those nine calculations follows:

° BFN NTB TI-517 R3 (RIMs No. B45-870722-235) Main Control Room Habitability During a Hazardous Chemical Release

This calculation related to system 31 and was identified by CCRIS as an essential calculation. An exhaustive search of the references used by this calculation using CCRIS was performed by the team. The review of the input references for this calculation with the CCRIS search revealed that several references cited as being sources of information for this calculation were not included in CCRIS. Specifically, NRC Regulatory Guide 1.78, 1.95, NUREG-0737, and the BFNP FSAR Section 2.2.3 were not included. This calculation was audited by the EA branch in audit EA-OR-002 which identified similar problems.

- BFN NTB APS-001 (RIMs No. B45 870709-238) Calculation of the Offsite and Control Room Doses Due to a CAD Flow Rate of 210.8 SCFM

This calculation related to system 31 and was identified by CCRIS as an essential calculation. An exhaustive search of the references used by this calculation using CCRIS was performed by the team. The team could not verify that the input references for the calculation were entered into CCRIS correctly. This calculation clearly stated that no unverified assumptions were involved, but the team was not able to verify this assertion. This calculation was identified by Ebasco as being not configuration-dependent.

- BFN NTB BFS6-013 (RIMs No. ND-Q0000-880002) Appendix R - Shutdown Board Room, Battery Board Room, and Control Building Analysis

This calculation was identified by CCRIS as an essential calculation. An exhaustive search of the references used by this calculation using CCRIS was performed by the team. The team could not verify that the input references for the calculation were entered into CCRIS correctly. This calculation clearly stated that unverified assumptions were used in the calculation. This calculation was identified by Ebasco as being configuration-dependent. The team review of this calculation confirmed that this calculation may be configuration-dependent. This calculation was also audited by the EA as a part of their Appendix R audit of NTB.

- BFN NTB ND-Q2000-87031 (RIMs No. B45-871228-235) Effects of Flooding on El. 565' Floor Due to RWCU Line Break in Pipe Trench (Formerly Calculation BFN NTB APS2-008)

A Bechtel calculation, this calculation was identified by CCRIS as an essential calculation. An exhaustive search of the references used by this calculation using CCRIS was performed by the team. This search was compared with the references listed in the calculation itself. All references were entered correctly into CCRIS. CCRIS also listed the inputs to calculation as being verified. This calculation stated that it involved no unverified assumptions but the team was not able to confirm this statement. This calculation was identified by Ebasco as being configuration-dependent.

- BFN NTB ND-Q2303-880067 (RIMs No. B30-880523-234) Normal N-16 Gamma Dose Rates at Valves 2-FCV-1-56 and 2-FCV-71-3 in the Main Steam Valve Vault

A Bechtel calculation, this calculation was identified by CCRIS as an essential calculation. An exhaustive search of the references used by this calculation using CCRIS was performed by the team. This search was compared with the references listed in the calculation itself. One important predecessor document was not entered into CCRIS. However, CCRIS listed the inputs for this calculation as being unverified. This calculation identified no unverified assumptions, but the team was not able to confirm this statement. This calculation was identified by Ebasco as being possibly configuration-dependent. The team review of this calculation for configuration dependency confirmed the Ebasco assessment.

- BFN NTB APS3-015 (RIMs No. B45 880113-235) Safety Limits for the Reactor Building Ventilation Exhaust Monitors

This calculation was identified by CCRIS as an essential calculation. An exhaustive search of the references used by this calculation using CCRIS was performed by the team. This search was compared with the references listed in the calculation itself. Three predecessor document entry errors were found, consisting of one repeat entry and two wrong revisions. However, CCRIS listed the inputs for this calculation as being unverified. This calculation clearly identified and referenced assumptions. This calculation was identified by Ebasco as being configuration-dependent. The team review of this calculation for configuration dependency confirmed the Ebasco assessment. Specifically, the refueling building detector location should be confirmed as being unchanged from the original calculation.

- BFN NTB NEB 84-1121-218 RO (RIMs No. NEB 84-1121-218) HPCI Suction Realignment: Condensate to Torus

This calculation related to system 73 and was identified by CCRIS as an essential calculation. An exhaustive search of the references used by this calculation using CCRIS was performed by the team. This search was compared with the references listed in the calculation itself. All references were entered correctly in CCRIS. However, the references were not cited separately but were contained in the body of the calculation. Since this was a small, six-page calculation, this was not that critical, but many of the older calculations were done similarly. Moreover, this calculation lacked a table of contents and did not specifically state whether there were any unverified assumptions or whether any assumptions were made in this calculation. It is the team's observation that these shortcomings were typical of many of NTB's older calculations. The calculation was audited by the EA branch in Audit ID BFT88901.

- BFN NTB ND-Q0074-880118 R1 (RIMs No. B30-880722-200) RHR Flow Analysis for BFNP

This calculation related to system 74 and was identified by CCRIS as an essential calculation. An exhaustive search of the references used by this calculation using CCRIS was performed by the team. This search was compared with the references listed in the calculation itself. All references were entered correctly in CCRIS. This calculation was audited by the EA branch in Audit ID BFT88901.

- BFN BTB ND-Q2000-880021 R1 (RIMs No. B30-880524-201) Reactor Building High Energy Line Break Analysis (Formerly calculation BFN NTB APS2-006 RO)

This calculation was identified by CCRIS as an essential calculation. An exhaustive search of the references used by this calculation using CCRIS was performed by the team. The team could not verify the input references used by this calculation with the CCRIS search. Unverified assumptions were noted on the cover sheet, and documented unverified assumptions were given on page 27, 27A1 R1 of this calculation. This calculation was identified by Ebasco as being configuration-dependent.

4.2.2.2.3 Review of Engineering Change Notices (ECNs)

The NRC team requested information on the resolution of an Engineering Change Notice (ECN) on the punchlist as a test of the changed document control by NTB. The team was given the punchlist report for the Base Line Nuclear Engineering (BLNE), dated February 28, 1989. The team identified only one punchlist item, 2-0033, which involved ECNs P7091-P7110, P0886, P0889, P0920, and P0921. Further examination of these ECNs revealed that all of these ECNs were referred to the electrical and civil engineering branches since these ECNs involved secondary containment penetration. Therefore, no further review was done in this area.

4.2.2.2.4 Configuration Control Drawings (CCDs)

The Nuclear Technology Branch (NTB) was not directly involved in the development of any Configuration Control Drawings (CCD); therefore, no further review was done in this area.

4.2.2.2.5 Configuration Testing

An additional method of evaluating the plant configuration is testing of the plant. Testing is currently being performed by TVA under a separate program, the Restart Test Program (RTP). The RTP has been reviewed by the NRC staff and has been found acceptable. The actual implementation of the program is being monitored by the NRC resident inspectors.

The satisfactory completion of the NRC staff review of the RTP conclusively closes a concern identified on page 7 of the NRC Inspection Reports 50-259/87-36, 50-260/87-36, and 50-296/87-36. This concern was conditionally closed in the NRC Inspection Reports 50-259/88-07, 50-260/88-07, and 50-296/88-07 (Item 4, page 24), the condition being the satisfactory completion of the NRC staff independent review of the RTP.

4.2.2.3 Conclusions

The NRC team concluded that the implementation of the DBVP is adequate in the nuclear systems area. However, several discrepancies were identified. TVA has proposed resolution for each discrepancy and added new punchlist items to ensure their successful completion. The NRC team found the proposed resolutions acceptable.

4.3 <u>Electrical Systems</u>

4.3.1 Documents Reviewed

The NRC team reviewed the following calculations and documents during the third inspection:

Electrical Calculations

(1) ED-Q0999-890015, "Slow Bus Transfers - Transient Voltage Study."

(2) ED-Q2000-87067, "Evaluation of Protection Provided for BFNP Containment Electrical Penetrations EA, ED, EF, FA, AA, AB, AC, AD, AE, AF."

(3) ED-Q2000-87241, "Cable Ampacity Study - Voltage Level V3 in Tray,-Conduit, and Conduit with Appendix "R" Fire Wrap."

(4) ED-Q2000-87548, "Cable and Bus Protection/Breaker Coordination for 4KV Switchgear and 480V Load Centers."

(5) ED-Q2000-87549, "Power Cable Protection Analysis for 480V Motor Control Centers."

(6) ED-Q2000-88086, "Cable and Bus Protection/Breaker, Fuse Coordination for 120VAC System."

(7) ED-Q2000-88187, "Volt Drop Study Due to Starting RHR Pumps A and D Simultaneously."

(8) ED-Q2065-87417, "Review of Reactor Building Harsh Environment Cables Required for System 64 MCEL Equipment Function."

(9) ED-Q2068-87420, "Review of Reactor Building Harsh Environment Cables Required for System 68 MCEL Equipment Function."

(10) ED-Q2073-87423, "Review of Reactor Building Harsh Environment Cables Required for System 73 MCEL Equipment Function."

(11) ED-Q2082-880557, "Undervoltage Analysis of BFN Electrical Aux. System During Diesel Generator Sequencing."

(12) ED-Q2090-87431, "Review of Reactor Building Harsh Environment Cables Required for System 90 MCEL Equipment Function."

(13) ED-Q2211-880585, "Shutdown Bus and Shutdown Board Transfer Times."

(14) ED-Q2254-88085, "Cable and Bus Protection/Breaker, Fuse Coordination for 125VDC System."

(15) ED-Q2268-87322, "Thermal Overload Heater Calculations - 480VAC Reactor MOV Board 2A."

(16) ED-Q3268-87351, "Thermal Overload Heater Calculations - 480VAC Rector MOV Board 3C."

(17) ED-Q4219-87356, Thermal Overload Heater Calculations - 480V Diesel Aux. Board B."

(18) ED-Q2999-88057, "Class 1E Electrical Boards Margin Study for 4KV, 480V, 120VAC, and 250V, 125V, 24VDC Systems."

(19) ED-Q2999-880562, "Appendix R Study of Cable Auto-Ignition Protection."

(20) ED-Q2999-880715, "Thermal Overload Heater Calculations."

(21) ED-Q2999-89047, "Cable Ampacity Study - Cables in Conduit."

(22) ED-Q2000-87041, "250VDC Unit Batteries Load Study."

(23) ED-Q2000-87042, "Shutdown Board Battery Study."

(24) ED-Q2000-87046, "Load Study Diesel Generator Batteries."

(25) ED-Q2000-87550, "Cable and Bus Prot/Breaker/Fuse Coordination, 250VDC."

(26) ED-Q2283-88084, "Cable and Bus Prot/Breaker/Fuse Coordination, 24VDC."

(27) ED-Q2000-87047, 125VDC System Voltage Calculations."

Engineering Change Notices

(28) E-2-P0507, RIMs B22881021369, "Provide a Suitable Substitute for the Inverters Presently Used in HPCI and Reactor FW Systems."

(29) E-2-P7124, RIMs B22880701500, "Reassignment of the Normal Control Power Feed of 480VAC Shutdown Boards 1A, 2A, and 1B from Unit Batteries Numbers 1, 2, and 3 to Control Power Batteries Designated SB-A, SB-B, and SB-C Respectively."

(30) E-2-P7117, RIMS B22881020507, "Reassignment of the Normal 480VAC Shutdown BD 2B From Unit Battery SB-D of Division II 4160 VAC Shutdown BD-D."

Other Documents

(31) RIMs L44890120802, "Letter from R. L. Gridley of TVA to USNRC, dated January 20, 1989, with enclosure, "Browns Ferry Nuclear Plant (BFNP) - Diesel Generator Evaluation Report."

(32) "TVA Nuclear Quality Assurance Joint Audit Report No. BFK88901, System Pre-Operability Checklist System and System Plant Acceptance Evaluation Programs."

(33) "Memorandum, A. P. Capozzi to H. B. Bounds, BFEP Engineering Assurance (EA) AUDIT BFT-88901 - Essential Calculations."

(34) RIMs B05881216004, "Memorandum, A. P. Capozzi to H. B. Kirkebo, "BFEP Unit 2 - Engineering Assurance (EA) Oversight Final Report EA-OR-002 - Design Baseline and Verification Program," with attachment "Engineering Assurance Oversight Review Report: BFNP Unit 2 Design Baseline and Verification Program EA-OR-002," dated December 24, 1988.

(35) CAQR BFE880646, RIMs R76880902942, "EA-originated CAQR on deficiencies in documentation of essential calculations noted in above EA audit."

(36) RIMs B05890227002, "Memorandum, A. P. Capozzi to H. B. Bounds, "BFNP - Interim Assessment of the Effectiveness of Corrective/Preventive Action for CAQR BFE880646 Regarding Essential Calculations."

(37) "Memorandum, H. B. Bounds to P. P. Carrier, "Browns Ferry Nulcear Plant (BFN) - Motor Operated Valves (MOV) Thermal Overload (TOL) Heaters Sizing Criteria."

(38) RIMs B22880617016, "Evaluation of Browns Ferry Nuclear Plant Cable Installation Concerns: Final Report."

(39) RIMs B22880617013, "Cable Issues Walkdown Report."

(40) RIMs B22880617015, "Project Topical Report: Cable Installation Requirements."

(41) RIMs B22880923004, "Cable Issues Supplemental Report: Cable Testing."

(42) RIMs B22881102301, "Unit 2, 250VDC Power Distribution System 57-3."

4.3.2 Findings

4.3.2.1 Review of Open Item From Second NRC Team Inspection

TVA responded to each of the electrical system concerns raised during the second NRC team inspection and identified in Inspection Reports 50-259/88-07, 50-260/88-07, and 50-296/88-07. The open items fell into five major categories and the Item Numbers appearing below correspond to those used in NRC Inspection Reports 50-259/88-07, 50-260/88-07, and 50-296/88-07. The third NRC team review and evaluation of these responses follow.

(1) Concern

Inadequate Documentation of Assumptions and References in Essential Electrical Calculations, Items (5) and (6), pp. 37-38.

In its previous review of a sample of the regenerated essential electrical calculations prepared by Bechtel Eastern Power Corporation under a contract from TVA, the team noted two types of fairly widespread weaknesses in documentation. First, several calculations depended on assumptions that were either not clearly identified as assumptions, not adequately justified, or not identified as unverified. Second, in some cases the citations to reference documents did not contain enough information to allow easy retrieval. Both of these weaknesses are contrary to the requirements of the applicable TVA procedure, NEP-3.1, the relevant portions of which were imposed contractually on Bechtel.

In response to the NRC team's concern, TVA tasked Bechtel to comprehensively review the electrical calculations, identify those which were deficient in the documentation of assumptions and references, and correct the deficiencies. Bechtel has completed its review, prepared a punchlist of deficient calculations, and is currently implementing the corrections. The NRC team reviewed

the Bechtel punchlist and a sample of the revised calculations which have already been delivered, and found them satisfactory. Therefore, this concern will be resolved upon delivery of the rest of the revised calculations (scheduled for March 31, 1989). This item is considered closed.

(2) <u>Concern</u>

Questionable Methodology for Confirming Adequate Short Circuit Protection of Containment Electrical Penetrations, Item (2), p. 36-37.

Several calculations were performed to confirm that penetrations are adequately protected against overheating due to short circuits inside the containment. These calculations are based on the general formula for the transient short-circuit temperature rise of a copper conductor derived from ICEA Standard P-32-382, 1969. The NRC team questioned whether this general equation is conservative, and why it was used instead of the penetration manufacturers' short-circuit heating test results.

TVA responded that the ICEA formula assumes adiabatic heating; i.e., that all of the Joule heat energy released by the passage of short-circuit current remains within the conductor. This is the most conservative approach possible and is fully satisfactory. TVA used this approach to avoid the need to retrieve obsolete vendor data.

TVA's response also claimed credit for still greater conservatism, on the ground that an insulation-damage temperature of 250 C was used in the calculations while the insulation actually used in the penetrations could withstand 400 C. However, this claim conflicted with information in the protection calculations, and TVA agreed to submit a revised response.

In view of the conservatism of the adiabatic-heating assumption, the NRC team considers the penetration protection issue from the previous inspection closed.

(3) <u>Concern</u>

Questionable Methodology of Vital Battery Sizing Calculation, Item (1), pp. 35-36.

This issue consisted of two sub-issues: (1) the procedures used to establish the load analysis and sequence of events for each study case did not show evidence of independent validation, and (2) the definitions of certain load profiles in the duty cycles were not found to be sufficiently conservative to yield reliable results.

In its response TVA committed to revise the battery calculations to better reflect plant loading conditions, and to consider the comments made by the NRC team concerning traceability of the data used in the load analyses. Review of the revised calculations showed improvements in the traceability of the data used, but still revealed shortcomings and apparent inconsistencies. After discussing the new findings with Bechtel representatives, TVA established a punchlist item to track the following corrective actions on all of the battery calculations:

(a) Clarify the cases analyzed in the calculations and justify why all of the cases in the analytical bases were not considered.

(b) Cross-reference the calculation sheets in the appendixes to the unverified assumptions in Section 4.0; that is, clearly identify unverified assumptions in the appendixes.

(c) Improve the system description in Section 5.0 by explaining the backup function of the battery boards.

(d) Improve the methodology description in Section 6.0 as follows:

- Explain that several sources of design input (i.e., operating inspections, walkdown data, drawings, G.E. technical manuals) were cross-checked to ensure reliable inputs.

- Where appropriate, indicate that data sources provided discrete information not subject to interpretation.

- Describe how each of the analyzed time periods in the duty cycle were established (i.e., transient, before operator action, steady-state, and random loads).

Implementation of the above punchlist item will resolve this concern for the battery calculations. This item is considered closed.

(4) Concern

Questionable Allowance for End-of-Life Conditions and Jumpered Cells in Vital Battery Test Procedures.

The TVA response to this concern indicated that controls are in place to maintain the configuration of the battery installations throughout the useful life of the batteries. Any modification, such as jumpering weak cells out, are controlled under "temporary alteration control procedures." These procedures require the performance of engineering calculations and testing to prove operability of such temporary changes in configuration before approval is granted. Therefore, the integrity of the system as designed is safeguarded by the above procedures. This issue is resolved and this item is considered closed.

(5) Concern:

Use of Incorrect Source Data from a Precursor Calculation in a DC System Voltage Calculation.

The TVA response to this concern stressed that the sampling process used by the Engineering Assurance Oversight review process focuses on representative samples of every system. The instance found by the NRC inspection team involved data transferred into a precursor calculation; that is, the calculation which received this data was a precursor to the calculation that was being sampled by EA. In view of this the technical review methodology is considered adequate under a sampling scope. This item is considered closed.

4.3.2.2 Review of Essential Electrical Calculations

The NRC team evaluated a representative sample of approximately 35 of the total of 102 essential electrical design calculations regenerated under the BFN DBVP and Electrical Calculations programs, as well as reports, correspondence, and other related documentation. The NRC team reviewed calculations dealing with the following aspects of the BFN electrical power system design:

- Standby diesel generator continuous and transient load capacity
- Vital battery sizing
- Slow bus transfer
- Power system protection and protective device coordination
- Selection of motor overload relay heaters
- Cables in harsh environments
- Appendix "R" compliance

The evaluation criteria used in the current inspection were the same as those enumerated under "General Approach and Evaluation Criteria" on pp. 34-35 of the second NRC team inspection report.

For the most part, the NRC team found that the electrical calculations were acceptable in both technical content and format. However, the inspection results raised several issues, which are discussed in the following paragraphs.

Vital Battery Sizing

The NRC team review of Engineering Change Notice (ECN) E-2-P7117 R1 identified a problem that related to the capacity estimates for Battery SB-D of Division II, 4160VAC Shutdown Board BD-D. The ECN's capacity estimates were considered in the battery calculation (ED-Q2000-87042) as an increase in the battery load. The NRC team noted that the battery calculations did not use the maximum transient current value for a minimum of one minute, as recommended in IEEE standard 485-1983, when performing voltage profile calculations. All other battery calculations except this one used the maximum transient current value recommended by the IEEE Standard. The calculation used a lower value of current based on the estimated duration of the current surge. If the maximum estimated current is used, the battery capacity is insufficient to support the duty cycle while maintaining a minimum required voltage of 210VDC. The current value used in the calculation results in an indication of adequate capacity; however, the estimated discharge difference between passing and failing using the two values is approximately one quarter (1/4) of an ampere-hour. In view of this, the NRC team concluded that the capacity of this battery is not adequate as a safety related power source. This is especially true for a battery which approaches the end of its useful life.

Unidentified, Unverified Assumption in Safety-Related Motor-Operated Valve (MOV) Overload Heater Calculations

Calculation ED-Q2999-880715, Revision 2 [20], checks the selection of the overload (OL) heaters in the motor starters which control the safety-related MOVs, to ensure that they provide an acceptable degree of motor protection while allowing the MOVs to perform their safety functions with a negligible likelihood of spurious tripping. Under TVA's updated design criteria for safety-related MOVs, the valves must be able to execute at least one full

open-close or close-open duty cycle without tripping the OL relay. The calculation declares that the existing heaters for several MOVs are satisfactorily based on an assumed valve stroke time of 120 seconds or less. However, no measured stroke time is given in the data sections of the calculations for four MOVs, although MOVATS-tested stroke times appear in the analogous data fields in the calculations for the other MOVs. Therefore, the 120 second minimum stroke time is an unverified assumption which clearly affects the functional ability of the valves involved, and should have been noted as such at the beginning of the calculation and docketed for verification.

TVA responded expeditiously by issuing Revision 3 of the calculation [21], in which the stroke time is explicitly identified as an unverified assumption, and by placing verification by testing on the pre-restart punchlist The NRC team considers this response satisfactory.

Long-Term Assurance of Standby Diesel Generator Governor and Voltage Regulator Tuning

According to the loading tests described in TVA's "BFNP Diesel Generator Evaluation Report" [23], the BFN diesel generators provide adequate transient voltages during the worst-case accident loading sequence, but their transient performance is fairly sensitive to proper adjustment ("tuning") of the engine governors and generator voltage regulators. It was not initially apparent how TVA plans to ensure that the proper control settings determined during the load tests will be maintained in the long term.

TVA agreed to revise the instructions for the 18-month load-acceptance surveillance test to provide for inspection and/or testing to confirm proper regulator and governor tuning. Development of an acceptable surveillance instruction will resolve this issue.

Unclear Description of Calculation Methodology

A number of otherwise sound calculations (notably the electrical boards margin study [18]) have methodology explanations which are not always clear. While this situation does not rise to the level of a deficiency in the essential calculations program, it is a fairly pervasive problem in the Bechtel-prepared calculations, and makes them less useful resources for future reference than they should be. The NRC team recommended that TVA review the explanatory material in any calculation which is under revision, and rewrite it more clearly where needed.

4.3.2.3 Design Change Document Control

The NRC team's review of TVA's handling of the engineering and design change process focused on the two key issues discussed below.

(1) Are safety concerns arising from engineering changes adequately evaluated?

The NRC team tracked the safety evaluation of an Engineering Change Notice (ECN) related to a potential single-failure situation, in which the loss of a vital battery could potentially disable the diesel generator feeding another engineered safety system division. The handling of this specific case indicated that TVA has adequate programmatic tools for identifying and evaluating potential safety issues resulting from plant modifications.

(2) Are appropriate ECNs and Design Change Notices (DCNs) being written to address the various plant modifications recommended by the essential electrical calculations program?

This general question followed from a specific concern about whether the fuse rating changes recommended by the power system protection and coordination studies (e.g., [4] and [6]) will actually be implemented before Unit 2 startup. In response, TVA pointed out that the Electrical Engineering Branch maintains a computerized system which tracks the status of all electrical ECNs/DCNs, including those resulting from the essential calculation program. The team reviewed the reports from this system and found that change notices arising from the reviewed calculations had been properly documented. The NRC team considers this approach satisfactory.

4.3.2.4 Configuration Control Drawings (CCDs)

Since CCDs are an essential product of the DBVP, and they will be used as fundamental source documents for a variety of engineering and operations purposes, the proper implementation of the CCD process is critical. The NRC team reviewed a sample of several dozen electrical CCDs from the viewpoint of accuracy and consistency with other documentation, and discovered one deficiency. In drawing No. 2-45E714-4, the control schematic of a motor-operated valve which had been removed from the plant under a completed ECN, and properly deleted from the predecessor drawings, had somehow reappeared during the contractor's drawing reconciliation process.

TVA informed the team that the affected drawing was one of a group of CCDs prepared by Ebasco and issued without TVA engineering review, which presumably would have revealed and corrected the defect. The drawing has been revised, and TVA has agreed to scrutinize the other unreviewed contractor-generated CCDs for other anomalies of this kind. When implemented, this will satisfactorily resolve the issue.

4.3.2.5 Other Areas of Review

As an adjunct to the NRC team inspection in the four major areas described above the team looked into two other aspects of the BFN DBVP as discussed below.

(1) Calculation Cross-Reference Information System (CCRIS)

CCRIS is a computerized data base intended to facilitate identifying all of the predecessor and successor calculations and other documents related to any design calculation. The NRC team obtained CCRIS computer runs on two randomly-selected electrical calculations, and checked the CCRIS entries against the calculations themselves. The team noted both errors in detail (most seriously, one calculation was incorrectly identified as not required for restart), and apparent delays (up to several months) in entering new information. These problems appear generic,

since similar deficiencies have also been identified by the TVA's EA group. CCRIS promises to become a valuable engineering management tool, but substantially more work is required in the areas of attention to detail and timeliness.

(2) Cable Installation Concerns

As an adjunct to the essential calculation inspection, the NRC team also evaluated BFN's approach to the generic concern about the possibility of damage to safety-related electrical cables in conduit, during both original installation and subsequent pulling of new cables into the same conduit. TVA has studied this issue through extensive plant walkdowns and analysis, and has prepared a series of reports which were reviewed by the team. The team found TVA's approach adequate to provide reasonable assurance that the cables have not suffered damage during pulling into the conduit, however, this issue is being reviewed by the NRC staff in detail.

4.3.3 Conclusions

The NRC team concluded that implementation of the DBVP is adequate in the electrical systems area. However, several discrepancies were identified. TVA has proposed resolutions for each of these discrepancies and added new punchlist items to ensure their successful completion. The NRC team found the proposed resolutions acceptable.

4.4 Instrumentation and Control Systems

4.4.1 Documents Reviewed

The NRC team reviewed the following documents during the third inspection:

Calculations and Calculation Related Documentation

(1) 2-PT-1-72, Setpoint Scaling Document.

(2) 2-PT-1-76, Setpoint Scaling Document.

(3) 2-PDT-64-20, Setpoint Scaling Document.

(4) 2-PT-64-56A, Setpoint Scaling Document.

(5) ED-Q2256-880569, ECCS ATU Undervoltage Relay Setpoint.

(6) ED-Q0090-87448, Radiation Monitor Demonstrated Accuracy.

(7) Memo B. B. Bounds (TVA) to A. P. Capozzi (TV), Browns Ferry engineering, Project Engineering Assurance (EA) audit.

(8) BFT88901, "Essential Calculations," B05 89 0224 007, February 24, 1989.

(9) Calculation ED-Q2074-88333, Revision 0, "Demonstrated Accuracy Calculation -- RHR Pump Auto Start Timers," September 29, 1988.

(10) Calculation ED-Q2064-88103, Revision 1, "Set-point Scaling Document 2-PT-64-56A," April 4, 1988.

(11) Electrical Design Standard OS-E18.1.10, Revision 0, "Instrument Set-points and Limits," November 21, 1983.

(12) Electrical Design Guide DG-E18.1.18, Revision 0, "Scaling and Set-point Calculations," March 31, 1986.

(13) Calculation MD-Q2074-87450, Revision 0, "Process Limit Basis for RHR Pump Auto Start Timer 10A-K124A," August 3, 1988.

(14) Calculation MD-Q2074-87440, Revision 0, "Process Limits - RHR Pump Timers, DBA with LOOP," May 21, 1988.

(15) "Browns Ferry Nuclear Plant, Set-point and Scaling, a Brief Overview," (draft), February 1989.

(16) Branch Instruction EEB-TI-28, Revision 1, "Set-point Calculations," October 24, 1988.

(17) Engineering Procedure PI 89-17, Revision 0, "Nuclear Engineering Set-point and Scaling Document Preparation and Control," March 2, 1989.

(18) EBASCO Engineering Procedure, E-30-TVA-BFNP, Revision 2, "Preparation, Review, and Approval of Calculations," March 25, 1988.

(19) Calculation ED-Q2074-88023, Revision 1, "Set-point Scaling Document 2-FS-74-50," January 27, 1988.

Design Change Control Documents

(20) ECN-P-0001, Recirculation Pump Trip.

(21) ECN-P-0095, Press. Suppr. Head Tank Level Alarm Setpoint Change.

(22) ECN-P-0126, RPS and ECCS Analog Transmitter Replacement.

(23) ECN-P-0129, Remove Steam Flow Density Compensation.

(24) ECN-P-0190, Install Junction Box for Surveillance Testing.

(25) ECN-P-0284, MSIV Acoustic Monitor System for NUREG-0578.

(26) ECN-P-0419, Add Control Stations, Secondary Containment Doors.

(27) ECN-P-0422, RPS Power Class 1E Interface.

(28) ECN-P-0451, RCIC DP Steam Line 3 Second Time Delay.

(29) ECN-P-0631, Relocate Radiation Monitors, RWC/RHRSW Systems.

(30) ECN-P-0672, Remove PS-3-57A, B, C, D From Service.

(31) ECN-P-0707, Replace RPS ATU Power Supplies.

(32) ECN-P-0842, Radio Transmitter, Transmission Line, Antenna.

(33) ECN-P-0889, Appendix R Conduit Re-Routing.

(34) ECN-L-1198, Condensate Setpoint PDS-2-130A, B.

(35) ECN-L-1463, Offgas System DPT and DPIS Range Changes.

(36) ECN-L-1579, Condenser Vacuum Setpoint and Sensing Switches.

(37) ECN-L-1659, Changed Setpoints of Heater Drains and Vents.

(38) ECN-L-1787, Offgas Recombiner Setpoint Change.

(39) ECN-L-1850, RHR Water Flow Indication at Backup Control Center.

(40) ECN-L-1867, Prim. Containment Independent Power Supplies.

(41) ECN-L-2030, Condensate Storage Tank Level.

(42) ECN-L-2079, Fuel Oil Tank Level Setpoint Change.

(43) ECN-P-3137, Change MS Pipe Class From P to M.

(44) ECN-P-3153, Main Steam Terminal Block Replacement.

(45) ECN-P-3160, MSIV Solenoid Junction Box 0.25 Inch Hole.

(46) ECN-P-3220, Amphenol Connector Replacement.

(47) ECN-P-3224, Fenwal Temp. Switch Wiring, Raychem Tubing.

(48) ECN-P-5217, ADS Error on FCD 730E483-1.

(49) ECN-E-2-P7116, ADS Modification for NUREG-0737.

(50) Work Item Information System, Non U2C5, DATABASE (PIOSYS4), September 21, 1988.

(51) Unit 2 Cycle 5 Engineering Change Notice E-2-P7151, Revision 0, Replace Core Spray Flow Switches, August 13, 1988.

(52) Partially Implemented Design Change Request 3503, Correct Category I Human Engineering Discrepancies, December 14, 1987.

(53) Unimplemented Design Change Request N3501, Addition of Differential Pressure Indicators Across Control Room HEPA Filters.

(54) System Evaluation Report 31, "Air Conditioning Cooling and Heating," May 16, 1988.

(55) Voided Engineering Change Notice P3141, Replace Unqualified Terminal Blocks in Drywell.

(56) Voided Design Change Request P2541, Change Scales on Reactor Pressure Vessel Level Indicators.

(57) Voided Design Change Request P2183, Provide Redundant Power to Automatic Depressurization System.

(58) Unimplemented Design Change Request 2321, Add Scram Pilot Air Indicators in Control Room.

(59) Unimplemented Engineering Change Notice P0173, Install Sump Pump Run Time Indicators, October 11, 1978.

(60) Voided Engineering Change Notice P0231, Install Excess Flow Check Valves in Instrument Lines Penetrating Containment.

(61) Voided Engineering Change Notice P0405, Add Second Set of Backup Scram Discharge Pilot Solenoid Valves, February 23, 1981.

(62) Closed Engineering Change Notice P0381, Replace GEMAC Transmitters with Rosemounts, December 6, 1988.

(63) Open Unit 2 Cycle 5 Engineering Change Notice P0126, Revision 1, Replace ECCS Switches with Transmitters.

(64) Drawing Change Notice 42324A, Redundant Power to RHR Recirculation Isolation Valves, September 28, 1988.

(65) Unimplemented Design Item Evaluation (RIMs B72 88 1130 006), Evaluation of ECN P0505, Scram Pilot Air Header Pressure Indication, November 2, 1988.

(66) Browns Ferry Engineering Procedure, PI 88-07, Revision 1, "Systems Plant Acceptance Evaluation," August 3, 1988.

(67) Browns Ferry Engineering Procedure PI 88-03, Revision 7, "Preparation and Control of Engineering Change Notice Modification Procedure," January 17, 1989.

(68) Browns Ferry Engineering Procedure PI-88-04, Revision 3, "Change Document Control," October 4, 1988.

(69) Equipment Qualification Documentation Package BFN2EQ-CABL-037, Revision 0, "The Okonite Company PXJ and PXMJ," May 23, 1988.

(70) Engineering Design Nonconformance Report BFNEEB8402, Terminal Blocks in the Drywell, September 18, 1984.

Configuration Control Drawings

(71) 2-730E929-03, ADS elementary diagram.

(72) 2-45E2647-2, Acoustic Monitors.

(73) 2-45E647-2, Panel 9-9 wiring diagram.

(74) 2-45E641-1, Instr. & Control Power System schematic.

(75) 2-45E779-1, Wiring diagram, 480V Shutdown Aux. Power.

(76) 2-730E930, Core Spray elementary diagram.

(77) 2-730E937, RHR elementary diagram.

(78) SYSTER 74, "Residual Heat Removal," Revision 0, May 20, 1988.

(79) As Constructed Drawing 2-47E2610-74-1, Revision 3, "Mechanical Control Diagram, Residual Heat Removal," November 23, 1988.

(80) As Constructed Drawing 2-45N765-4, Revision 0, "Wiring Diagrams, 4160V Shutdown Aux. Power, Schematic Diagrams," April 22, 1988.

(81) As Designed Drawing 45N745-4, Revision 9, "Wiring Diagrams, 4160V Shutdown Aux. Power, Schematic Diagrams," April 22, 1988.

(82) As Constructed Drawing, 45N765-4, Revision F, "Wiring Diagrams, 4160V Shutdown Aux. Power, Schematic Diagrams," April 22, 1988.

(83) Configuration Control Reconciliation Form, 2-45N765-4, April 16, 1988.

(84) Configuration Control Drawing 45E765-4, Revision 1, "Wiring Diagrams, 4160V Shutdown Aux. Power, Schematic Diagrams," November 21, 1988.

(85) Configuration Control Drawing 2-730E937, Sheet 1, Revision 2, "Elementary Diagram, Residual Heat Removal System," December 29, 1988.

(86) Configuration Control Drawing 2-730E937, Sheet 2, Revision 1, "Elementary Diagram, Residual Heat Removal System," December 30, 1988.

(87) Configuration Control Drawing 2-730E937, Sheet 4, Revision 1, "Elementary Diagram, Residual Heat Removal System," November 21, 1988.

(88) Configuration Control Drawing 2-730E937, Sheet 5, Revision 2, "Elementary Diagram, Residual Heat Removal System."

(89) Configuration Control Drawing 2-730E937, Sheet 6, Revision 0, "Elementary Diagram, Residual Heat Removal System," October 11, 1988.

(90) Configuration Control Drawing 2-730E937, Sheet 7, Revision 2, "Elementary Diagram, Residual Heat Removal System," January 5, 1989.

(91) Configuration Control Drawing 2-730E937, Sheet 8, Revision 1, "Elementary Diagram, Residual Heat Removal System," November 28, 1988.

(92) As Constructed Drawing 2-730E930, Revision 1, "Elementary Diagram, Core Spray System," January 5, 1989.

(93) Configuration Control Drawing, 2-45E670-19, Revision 3, "Wiring Diagram ECCS Division II Analog Trip Units, Schematic Diagram," December 21, 1988.

(94) Configuration Control Drawing 2-47E610-3-1, Revision 11, "Mechanical Control Diagram, Reactor Feedwater System," February 3, 1989.

(95) Instruction Manual 4471-1, Revision A, "Operations Manual Trip/Calibration System, Model 710 DU," January 1983.

(96) Temporary Alteration TACF 2-88-007-075, Revision 0, December 22, 1988.

(97) As Constructed Drawing, 1-730E920, Sheet 4, Revision 0, "Elementary Wiring Diagram, Residual Heat Removal, Browns Ferry Unit 1," September 28, 1988.

(98) Configuration Control Drawing 2-45E670-20, Sheet 2, Revision 1, "Wiring Diagram, ECCS Div II," November 18, 1988.

(99) Configuration Control Drawing 2-45E779-11, Revision 1, "Wiring diagram, 480V Shutdown Aux Power, Schematic Diagram," November 21, 1988.

(100) Drawing Change Authorization W0174 to 2-47A370-75-55, Revision 0, May 7, 1988.

(101) Drawing Change Authorization W0174A-017 to 2-47A370-74-56, Revision 0, May 7, 1988.

4.4.2 Findings

4.4.2.1 Open Items From Previous Inspections on the DBVP Program

The findings from the previous NRC team inspections of the DBVP were included in the NRC Report Nos.: 50-259/87-36, 50-260/87-36, and 50-296/87-36, and 50-259/88-07, 50-260/88-07, and 50-296/88-07. During this inspection, TVA provided responses to the NRC team for each of the concerns pertaining to instrumentation and control (I&C) systems raised during the first and second NRC team inspection. The third NRC team's review and evaluation of those responses follow.

(1) Concerns from the First NRC Team Inspection

The following three concerns were treated together because they all related to one underlying concern: that TVA did not conduct a point-to-point walkdown of instrument and control circuits.

- A comprehensive system wide walkdown or functional test of I&C systems was lacking.
- A true configuration baseline has yet to be established.
- Undetected double cross-wiring is possible because of the lack of a comprehensive configuration check.

TVA responded that while instrument and control circuits were not walked-down to exhaustively verify point-to-point wiring, system testing verified the baseline function configuration.

Furthermore, many I&C circuit attributes, such as nameplate data and setpoint and accuracy calculations input information, were field verified.

TVA's position is that any double cross-wiring errors would have surfaced during normal operation or surveillance testing. Their review of CAQRs revealed no deficiencies that may possibly have been caused by double cross wiring. Furthermore, the NRC team noted that the hypothesized double cross wiring of redundant circuits requires difficult-to-implement and easy-to-detect violations of electrical separation criteria.

TVA reviewed with the NRC team their basis for concluding that the important I&C design features, unverifiable by functional test, conform with the design baseline. The features reviewed included train separation, electromagnetic interference (EMI) shielding, grounding, instrument tube routing, condensing pot location, and Class 1E/non-1E signal isolator installation. These discussions are summarized below.

Train Separation

TVA is verifying train separation independent of the DBVP and the NRC is examining this program as a separate activity. The train separation verification effort includes field verification audits of raceway separation, cable routing, and internal panel wiring separation to assure that the as-constructed configuration conforms with the design basis.

EMI Shielding and Grounding

TVA maintained as-constructed connection diagrams. These diagrams document the integrity of instrument circuit shields and single point grounds. Connection diagrams were not walked-down as part of DBVP; however, they were extensively used for trouble shooting and modification during the extended outage. Only minor drawing discrepancies were identified. Furthermore, baseline functional testing identified no problems with EMI or ground-loops in instrumentation circuits.

Instrument Tube Routing and Condensing Pot Location

TVA field-verified instrument tube routing and condensing pot location. This effort generated isometric diagrams of instrument tube routing which were reviewed for conformance with baseline design requirements and commitments.

NRC Region II inspected instrument tube installations and found several instances in which the as-constructed configuration did not conform to design criteria and had not yet been evaluated by TVA. TVA attributes this finding to the fact that the field verification was still in progress. The effort will be complete before restart. TVA is tracking this as a punchlist item. Region II is also tracking resolution of their inspection findings.

Class 1E/non-1E Signal Isolation

At Browns Ferry, Class 1E instrument loops do not feed non-1E current loops.

Therefore, signal isolators are unnecessary. Nevertheless, analog trip units normally isolate trip and display portions of instrument loops. If these units were not in place, or were improperly installed, the trip and display circuits would not function. Consequently, functional testing verified isolator installation.

The NRC team concluded that TVA has adequately responded to the concerns expressed in the first NRC team inspection. These three items are closed.

(2) Concerns from the Second NRC Team Inspection

(a) Item 21 -- EECW Design Criteria Document BFN-50-7067.

An emergency equipment cooling water design criteria document stated that IEEE Standard 279-1971 was applicable to the system flow measurement which is a NRC Regulatory Guide 1.97 Type D variable. The applicability of the IEEE standard to other portions of the system was not stated.

In the TVA response, the design criteria document has been changed to state that IEEE Standard 279-1971 is applicable to any redundant instrument and control functions. This change was acceptable to the NRC team; hence, this item was closed.

(b) Item 22 -- Pressure Transmitter 2-PT-1-72 Downgrade.

TVA evaluated the function of approximately 70 Unit 2 instruments and determined that they could be downgraded to a non-safety-related status. The NRC team noted that pressure transmitter 2-PT-1-72 performed a safety-related containment isolation function and, therefore, should not be downgraded.

TVA reassessed all 70 instruments and determined that only four needed to be maintained as safety grade; namely, 2-PT-1-72, -76, -82, and -86. The other instruments had no safety-related function and could be downgraded. This response was acceptable to the NRC team, and this item was closed.

(c) Item 23 -- Verification of Retrievability of Calculations.

The NRC team noted that the TVA review of four specific calculations was limited to assuring their retrievability, and did not address whether the calculations were technically adequate. Each of these calculations was provided by an external equipment vendor.

TVA prepared the four calculations to answer a Sargent and Lundy audit finding which recommended that external vendor calculations be readily accessible since they had been reviewed and approved during the equipment procurement process. Based on the TVA statement that technical adequacy was determined in the procurement cycle, the team closed this item.

(d) Item 24 -- Flow Element Orifice Plate Calculation.

Flow element orifice plate calculation 110386BDP-1 addressed six safety-related and six non-safety-related applications, and found that all were satisfactory. The calculation then went on to extrapolate these findings to all other non-safety-related applications for Browns Ferry Unit 2. This extrapolation was deemed to be imprudent by the NRC team.

TVA revised the calculation to be ED-Q0000-88303, Revision 1, and removed all references to non-safety-related orifice plates. TVA stated that the revised calculation applies to the entire population of safety-related orifice plates in the plant. Based on this TVA response, the NRC team closed this item.

(e) Item 25 -- Separation Criteria for Sensing Lines.

Calculation 0330877SD, "Verification of Separation Criteria for Sensing Lines Calculations," had an attached Electrical Design Standard DS-E18.3.9 that seemed to emphasize control-to-protection separation rather than separation between redundant portions of the protection system. It also referenced 10 CFR 50 Appendix A General Design Criterion 24 for 18-inch spatial separation.

TVA revised the Electrical Design Standard to clarify the references listed and to more clearly define its purpose. TVA also provided an Instrument Society of America reference for other separation requirements. These changes were acceptable to the NRC team, and this item was closed.

(f) Item 26 -- RBCCW Time Delay Relay Setpoint Calculation.

Calculation ED-Q2070-88069 was listed as being essential, but stated that the reactor building closed cooling water pump time delay relays performed no safety function. The NRC team noted that these relays reconfigured the RBCCW system to one pump operation at the time of an accident, and that this reconfiguration was a safety-related function.

The initial TVA response to this item stated that there would be no adverse impact if both RBCCW pumps were loaded onto the diesel generator at the time of an accident. As such, the load shedding functions did not have to be safety-related, but were provided to assure RBCCW cooling to critical equipment upon loss of AC power. TVA considers this to be an operational/financial consideration.

The time delay relays do not have a safety-related function; however, they are designated as Class 1E devices because of their association with the vital diesel generator busses. The NRC team reviewed the General Electric design specification and concluded that the TVA determination was correct. On this basis, the team closed this item.

4.4.2.2 Review of Engineering Calculations

The sample of calculations reviewed was selected to include the following categories: (1) set-point and scaling calculations, (2) demonstrated accuracy

calculations for RHR pump timers, (3) process limit basis calculations that supported the set-point and/or demonstrated accuracy calculations, and (4) calculations that support Unit 2, Cycle 5 modifications. Several other calculations were examined to support close-out of open items from the previous inspection. Procedures, design guides, and other documents were examined as necessary to support the calculation review.

The technical content of the reviewed calculations was generally deemed to be adequate by the team; however, the following discrepancies were noted during this inspection.

a. Calculation 2-PT-64-56A for the drywell high-pressure setpoint had a misstatement of the single failure criterion as defined by IEEE 379-1972. It stated that the single failure of any channel will initiate the safety signal. The correct statement is that any single failure will not prevent initiation of a safety system. The team confirmed that the equipment, as designed, does meet the single failure criterion. TVA committed to correct the calculation.

b. When power was lost to some ECCS analog trip units, spurious operation of emergency core cooling systems was observed. Bechtel setpoint calculation EFD-Q2256-880569 proposed adding undervoltage relays to remove power to the ECCS ATUs. Two months later, the plant determined that changeout of ATU output relays would solve the problem, and documented the change by means of DCN H3828A. However, an ambiguous design existed since the Bechtel calculation was not superseded or voided. During the inspection, TVA voided the Bechtel calculation.

c. Calculations EDQ-2D74-88374, Revision 0, and MD-Q2074-87450 were revised by Ebasco after the initial approval, but without changing the revision number and without a documented review by the checker/verifier.

   TVA explained that the revision occurred before TVA officially accepted the calculation for project use, and the procedures in effect at that time allowed informal revision for such changes. Engineering Assurance had already identified this as poor practice and instigated procedure changes to require a new revision number for all calculation changes after final sign-off.

   Revision without review by the checker/verifier was inappropriate according to Ebasco procedure E-30-TVA-BFNP, Revision 2, which indicates that the checker/verifier performs the independent verification required by 10 CFR 50 Appendix B. TVA revised CAQR BFE880646, which addressed a similar problem regarding the TVA revision process, to require review of all Ebasco calculations and correction of any instances where independent reviews were not performed. The NRC team considered this planned action acceptable.

d. Calculation ED-Q2074-88333, Revision 0, used 0.13 seconds as the process limit for Train A RHR pump start during a design basis accident concurrent with loss of off-site power. This does not agree with, and it is less conservative than, the value of 0.11 seconds established by the predecessor calculation MD-Q2074-88440, Revision 0. Additionally, the relationship between the relay settings established by ED-Q20274-88333 and those established for the sequencing of other ECCS pumps was not clear.

TVA agreed that ED-Q20274-88333 is incorrect. In attempting to resolve the confusion about the relationship among the various ECCS pump sequencing time-delay relay settings, TVA found errors with this set of calculations, as a class. Problem Reporting Document (PRD) 890231 was issued to document and correct the erroneous process limit. TVA had already issued LER 259-88-036 describing unanalyzed electrical loading on safety-related electrical systems. The inconsistencies amoungst pump timer calculations will be resolved as part of the corrective action for this LER.

e. Calculation ED-Q2064-88103, Revision 1, used a seismic induced error of 0.5% of calibrated span, whereas the vendor specifies the error as 0.5% of the upper range limit. The vendor-specified error is the larger of the two, therefore, the calculation is not conservative. However, in this case, the difference between the two values is small and would not affect the end results of the analysis.

   TVA agreed that the calculation is in error and scheduled it for correction as DBVP punchlist item 2-2222.

f. Calculation ED-Q2064-88103, Revision 1, also assumed 18 months as the calibration interval for an instrument that is on an 18-month calibration cycle per BFNP-2 Technical Specifications. The Technical Specifications, however, allow a calibration interval extension by 25% under certain conditions. Therefore, the calculation should have used a calibration interval of 22.5 months.

   TVA agreed that the longer calibration interval should have been used. They also indicated that the project recently established a formal position that set-point and scaling calculations should account for the 25% extension. Consequently, they concluded that the identified problem may exist in other set-point and scaling calculations. TVA committed to review all Technical Specification instrument set-point and scaling calculations prepared before the formal position was established. All calculations that used incorrect calibration intervals will be revised. Those where the error affects the calculation conclusions will be revised prior to restart. Those where the error does not affect the conclusion will be scheduled for correction after restart. TVA documented this item and is tracking its resolution as DBVP punchlist items 2-2225 and 2-2226.

4.4.2.3 Review of Design Change Control Documents

The NRC team selected a sample of Engineering Change Notices (ECNs) to be implemented in Unit 2 during the Cycle 5 outage, to verify that design control and safety review procedures are being followed. A sample of unimplemented, partially implemented, and voided ECNs and Design Change Requests (DCRs) were also selected to assess the DBVP's effectiveness in ensuring that required modifications are implemented prior to restart. The NRC team also examined

procedures, environmental qualification records, and other documents as necessary to support this review.

The team noted that approximately half of these ECNs had been closed by TVA during the DBVP process.

The NRC team also noted that the procedure for systems plant acceptance evaluation, PI-88-07, Revision 1, incorrectly identifies several safety-related systems as not-safety-related. Examples are the Electrical Distribution System, and the Air Conditioning System (which includes the Control Room habitability subsystem). EA previously identified these errors and instigated procedure modifications that ensure all safety-related systems received an appropriate systems plant acceptance evaluation. The misidentification is being temporarily maintained by TVA to maintain consistency with the Q-List, which is also in error. A separate program exists to correct the deficiencies in the Q-List. PI-88-07 will be corrected in parallel with the Q-List, if the PI is still needed at that time. Q-List correction is being tracked as Corporate Committment Tracking System item SLT-88-930-001.

4.4.2.4 Review of Configuration Control Drawings

The NRC team reviewed a sample of Configuration Control Drawings (CCDs). The approach was to use the CCD control diagrams, schematic diagrams, and elementary diagrams to construct logic diagrams for these functions. The logic diagrams were then compared against the descriptions in the FSAR and the SYSTER to verify agreement with the As-Constructed configuration. Some of the drawings needed to complete this task were not yet issued as CCDs. In these cases the current As-Constructed drawings were used. These drawings will become CCDs following the resolution of minor drawing discrepancies.

The As-Constructed vs. As-Designed reconciliation process was also reviewed for one Configuration Control Drawing.

A number of elementary diagram errors were noted by the team on the reviewed configuration control diagrams. Some appeared to originate with the computer-aided-design (CAD) process, and others seemed to originate from Ebasco mark-ups of the drawings. The following problems were noted:

- ADS elementary diagram 2-730E929 Sheet 1 showed relays 2E-K25 and 2E-K26 and 2E-R25 and 2E-R26 respectively. This appears to be a CAD error.

- ADS elementary diagram 2-730E929 Sheet 2 showed the core spray interlock relay 14A-K27A as 10A-K27A. This appears to be a CAD error.

- ADS elementary diagram 2-730E929 Sheet 3 showed safety relief valve 2E-K11B as 2E-K11D.

- RHR elementary diagram 730E937 Sheet 6 shows pressure sensor 2-PS-74-8A as 2-PS-74-8. This appears to be an Ebasco error.

- RHR interlocks from pump discharge pressure switches to the ADS permissive circuitry were incorrectly shown for the RHR B and D pumps. Pressure switches 31A and 31B on RHR pump B were shown connected to relay K102B, and pressure switches 42A and 42B on RHR pump D were shown connected to relay K103B. Loss of one battery or one diesel could disable both redundant trains of ADS.

Due to the quantity of errors identified during the inspection, TVA concluded that a detailed comparison of CAD generated drawings against the last hardcopy revision is needed to purge CAD entry errors. TVA is tracking this action as Engineering Assurance action item E-051.

The team also noted that the ECCS energize-to-operate circuits have a bus voltage monitor relay that is connected at the circuit fuses rather than at the end of the circuit string. This arrangement does not detect the potential for open circuit wiring to ECCS actuation relays; however, such open circuits would be readily detectable during periodic surveillance tests. TVA provided such a justification, and the team accepted this justification.

The review also identified several cases in which the logic diagrams contained in the FSAR are in error or out of date. Since FSAR figures were not used as design basis input, the DBVP did not identify these discrepancies. Nevertheless, the FSAR should be revised to show the correct figures.

4.4.2.5 Other Areas of Review

Engineering Assurances (EA)

The team reviewed the instrumentation and control sections of the Engineering Assurance Oversight final report. EA exhibited a very thorough review process as indicated by the number of observations made in the report. It was noted, however, that EA reviewed a fairly small sample of Ebasco-generated calculations in the I&C area. In view of the number of problems uncovered in this area by the NRC team inspection, the NRC team concluded that EA should review an additional sample of the existing Ebasco I&C calculations.

Syster Review

The NRC team reviewed the nuclear boiler (Syster 1) Syster for ECNs that affected the automatic depressurization system. Portions of the Neutron Monitoring (System 92), Reactor Protection System (System 99), Residual Heat Removal (System 74), and the Ventilation System (System 30) were also reviewed during the inspection. No Syster problems were noted during these reviews.

Control Logic Diagrams

As noted during the discussion of CCD review, the BFNP-2 control logic diagrams are out of date. TVA had recognized this deficiency and removed these drawings from drawing control stations. This was expedient, in the short-term, to reduce the number of drawing updates needed to support Unit 2 restart.

Logic diagrams are theoretically unnecessary to operate the plant, maintain design control, or fulfill regulatory requirements. Nevertheless, correct and up-to-date logic diagrams are extremely useful documents that can both expedite design, operations, and maintenance, and reduce the risk of error. Therefore,

the NRC team concludes that TVA should correct the logic diagrams at some point after restart.

Dissemination of Operating Experience Information

In the process of assessing the relationship of NRC Information Notice 89-10 to the design basis verification process, the NRC team found the I&C engineering staff was unfamiliar with the issue raised by the notice. This was somewhat surprising since the notice specifically deals with BWR instrumentation installation problems. While TVA had determined that the notice was not directly applicable to BFNP-2, it appears that TVA has not instituted formal measures to factor industry experience into the design process.

4.4.3 Conclusions

The NRC team concluded that implementation of the DBVP is adequate in the Instrumentation and Control systems area. However, several discrepancies were identified. TVA has proposed resolutions for each of these discrepancies and added new punchlist items to ensure their successful completion. The NRC team found the proposed resolutions acceptable.

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