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EXECUTIVE SUMMARY

A U.S. Nuclear Regulatory Commission (NRC) Plant Design Change Inspection at Browns Ferry Nuclear Plant, Unit 3, was conducted by the Special Inspection Branch of the Office of Nuclear Reactor Regulation (NRR) from November 16 through December 4, 1992.

The purpose of this performance-based inspection was to verify that the process for the design of modifications to Unit 3 appropriately implemented NRC regulations and the Tennessee Valley Authority's (TVA's) commitments, and that the design controls for the design and field changes were adequate. This was accomplished by inspecting selected design change notice (DCN) packages issued for Unit 3 during 1991 and 1992, as well as DCNs for Unit 2 which were also applicable to Unit 3. The team reviewed DCNs and field changes to DCNs (FDCNs), as well as calculations, drawings, procedures, and other documents pertinent to the DCNs.

The team's sample review of the documentation for design changes indicated that the design change process was adequately implemented and controlled. In general, the design change process complied with the regulatory requirements and licensing commitments. The design documents were generally thorough and exhibited good attention to detail and were readily accessible and retrievable. TVA's engineering personnel were competent and were able to respond effectively to the team's questions. They were knowledgeable of some of the industry initiatives, such as the reactor level instrumentation and electromagnetic interference qualification issues.

While the team's observations indicated that the overall design change process was properly implemented and controlled, the team had several specific concerns. The team was concerned about the lack of evaluation of the radiological dose to the operator while performing local manual draining of the hardened wetwell vent line during emergency venting of the containment and the lack of evaluation of the ground-level release due to the open drain valves. At a meeting with the NRC staff on December 16, 1992, TVA agreed to change the design to eliminate manual operation of the drain valves during venting and evaluate the consequences of ground-level release of radioactive materials from open drain valves during various plant transients.

The team's other concerns were related to: (1) inadequate consideration of operating conditions in the flow and condensation calculation for the wetwell vent which resulted in non-conservative water accumulation rates and failure to consider water hammer effects in the vent pipe and structural adequacy of the stack deck, (2) inadequate evaluation of the control air system excess flow check valve setpoint that could result in loss of control air to a unit during transient events, (3) unsubstantiated assumptions in the electrical calculations, such as assuming 480 V for short circuit calculations instead of the prefault bus voltage of 508 V which would result in unacceptable short circuit margins, and (4) inadequate verification and justification of field changes. TVA agreed to revise the calculations in response to the team's comments.

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1.0 INTRODUCTION

The Tennessee Valley Authority (TVA) submitted plans to the U.S. Nuclear Regulatory Commission (NRC) for the restart of Browns Ferry Nuclear Plant (BFN) Units 1 and 3, based on the regulatory requirements, corrective action programs, commitments, Technical Specification improvements, and internally identified deficiencies and concerns that had been resolved before the restart of Browns Ferry Unit 2 (BFN-2). The NRC concurred with the scope of the plans provided by TVA and noted that the NRC would verify TVA's implementation of the plan before restart of either unit. TVA management's plan for restart activities for BFN-3 is different from its plan for BFN-2 because the design change process and the implementation of modifications for BFN-3 is managed by TVA utilizing the services of contractors, while TVA itself performed these activities for BFN-2.

This performance-based inspection was conducted to verify that the process used for designing modifications to BFN-3 appropriately implemented the regulations and TVA's commitments, and that the design controls employed for the design and field changes were adequate. To accomplish this goal, the team inspected selected design change notice (DCN) packages that had been issued for BFN-3. The team found that most of the DCNs issued were either minor in scope or were not safety-related. Therefore, the team also reviewed DCNs previously issued for BFN-2 that TVA also planned to apply to BFN-3. A total of 31 DCNs were selected for review from civil/structural, mechanical, electrical, and control and instrumentation disciplines. This sample included modifications for BFN-2 and BFN-3 and modifications common to all three units.

Design documentation reviewed by the team included calculations, drawings, field changes, safety evaluations, and procedures that were associated with the selected DCN. The team reviewed 20 field changes to DCNs (FDCNs) and 35 calculations.

Findings in this report have been categorized as either deficiencies or observations. Deficiencies are either (1) the apparent failure of TVA to comply with a requirement or (2) the apparent failure of TVA to satisfy non-legally binding requirements such as written commitments and applicable codes, standards, guides, or accepted industry practices. Observations are items considered appropriate to call to management attention but that have no direct regulatory basis.

Deficiencies identified during this inspection are discussed in detail in Appendix A. Observations are discussed in the report and are listed in Appendix B.

2.0 CIVIL/STRUCTURAL DESIGN CHANGES

2.1 Scope of Review

The civil/structural review covered design changes to piping and pipe supports, structural steel and concrete, and commodities (commodities are items, such as ventilation ducts, duct supports, conduits, conduit supports, cable trays, and cable tray supports). Since NRC Region II staff had reviewed

the piping and pipe support area extensively, the team concentrated its inspection effort on DCN packages that were mainly in the structural steel and commodity areas. The team selected 5 DCNs, 7 FDCNs, 11 TVA calculations, and such associated documents as condition adverse to quality reports (CAQRs), drawings, safety assessments, walkdown packages, and related design criteria.

2.2 DCN W18184A, "Structural Modification to the Core Spray Platform for Unit 3 to Meet 79-14 Piping Analysis"

This DCN modified the core spray valve access platform to ensure it met the requirements of design criteria document BFN-50-C-7100, Revision 4. Calculation CD-Q3303-922364, Revision 1, "Evaluation of Unit 3 Core Spray Valve Access Platform," evaluated this platform by using information contained in Walkdown Package PLT-3-48N928-100 to perform a structural analysis to determine the adequacy of members of the platform. Calculation CD-Q3303-922514, Revision 1, "Thermal Evaluation of Core Spray Valve Access Platform," evaluated the adequacy of the platform for thermal loads. During a walkdown, the team found that the stiffener plates installed by the modification at the edge of the platform differed from the installation shown on the DCN. TVA explained to the team that an advance approved FDCN (F20193A) was issued to address this condition. At the request of the team, TVA engineering staff reviewed the advance approved FDCN, and the team agreed with TVA's conclusion that the advance field approval was adequate.

2.3 DCN W17537A, "Modify Upper Drywell Platforms"

This DCN (together with DCN W17536A) modified the drywell platforms at various elevations to be consistent with the revised seismic and piping loads and to correct the as-built conditions which did not comply with the design criteria. The modifications required adding, strengthening, and replacing steel members of the platform.

Calculation CD-Q3303-910404, Revision 1, "Qualification of Upper Drywell Platforms El. 628" indicated that some welds were not accessible for measurement of the as-built weld sizes. Applying the available weld information on only two sides of the tube steel and assuming no welding on the other sides, the connections could not be qualified. TVA indicated that a minimum of 1/8" fillet weld all around was assumed to qualify the connections. TVA indicated to the team that all accessible welds in this area were measured to be between 1/8" to 3/8" fillet welds and there was visual evidence (e.g., some portion of the weld) that the non-accessible welds had been installed. On this basis, TVA considered it reasonable to assume a value of 1/8" for non-accessible welds. The team concurred with this approach.

Calculation CD-Q3303-910853, Revision 6, "Qualification of Upper Drywell Platform, El. 604'" contained a steel member size different from the computer model. TVA explained that the computer analysis indicated that tube steel 3X3X1/4 was adequate; however, due to the weld requirement, a larger size of 4X4X1/4 was used, which was conservative.

2.4 DCN W17409A, "Seismically Qualify Class I HVAC Duct and Duct Supports"

The ducts and duct supports that were qualified in this DCN were located in the Unit 3 reactor building and the qualification was completed prior to the restart of Unit 2.

Calculation CD-Q3031-883828, Revision 1, "Duct Work Stress Analysis for System 3-SWHAVC-107-00", used heavier concentrated weights in the computer analysis than the actual weights and stated that the approach was conservative. The team agreed that this was conservative for downward loading cases but would not be conservative for uplift analysis. TVA clarified that these loads were applied at supports or near supports only and, therefore, uplift was not a loading condition required to be analyzed. The team agreed with TVA's explanation.

Calculation CD-Q3031-884553, Revision 1, "Ductwork Stress Analysis for System 3-SWHVAC-50-00", used the seismic input from Calculation CD-Q0031-883523, "TVA BFNP SSE Response Spectra for Class I Seismic HVAC Duct and Duct Support Design" which only contained operating basis earthquake (OBE) spectra. Also, CEB 88-05-C, "Master Acceleration Response Spectra (MARS) Report for Seismic Class Structures" only provided OBE spectra. For safe shutdown earthquake (SSE) spectra, all OBE values were to be multiplied by a factor of 2 because Browns Ferry used the same damping value for both SSE and OBE. The team reviewed the seismic inputs and found them adequate.

Some of the ductwork and duct supports were located on the reactor building enclosure at El 700' where the acceleration response spectra (ARS) curves generated were applicable only for 1/2% and 1% damping values. In order to generate the spectra for 7% damping, TVA developed a formula to extrapolate it from the spectra for 1/2% and 1% damping values. The team reviewed Calculation CD-Q0031-884502, Revision 1, "TVA BFNP SSE Response Spectra With 7% Damping Value Extrapolated From Response Spectra With Lower Damping for Reactor Building Superstructure". This calculation used the formula mentioned above and demonstrated that the extrapolated value was always conservative. The team reviewed this calculation and found its conclusions acceptable.

2.5 DCN W17563A, "Modification of The Torus Access Platform in The Reactor Building at El. 551'"

This DCN investigated the temperature effects on steel members of the torus access platform to resolve the concern expressed in CAQR BFP 900244 that the steel members in the torus room were locked in place by the concrete floor thereby preventing their thermal expansion. TVA resolved this Unit 3 concern by extrapolating to Unit 3 its Unit 2 calculation dealing with the same concern. The team agreed with this approach because the Units 2 and 3 platform designs were identical.

Calculation CD-Q3303-921831, Revision 1, "Unit 3 Torus Access Platform Evaluation" evaluated the structural adequacy of the Unit 3 reactor building platform at El. 551'. The team reviewed the calculation and found that the

calculation was well prepared and was adequate. Minor discrepancies such as, incomplete as-built member size information did exist but they did not affect the results.

2.6 DCN W17536A, "Modification Lower Drywell Platform at El. 563'"

This DCN is similar in scope to DCN W17537A and addressed the modification of the lower drywell platform at El. 563' because of the revised seismic and piping loads. In some cases, the as-built conditions were not in accordance with the applicable design criteria and new loading requirements. The modifications required adding, strengthening, and replacing steel members of the platform to meet the design criteria or the new loading requirements.

Calculation CD-Q3303-920111, Revision 0, "Load Combinations and Allowable Stresses Used in Analysis of Lower Drywell Platforms" reduced the 17 load combinations, listed in design criteria document DC-BFN-50-C-7100, Attachment F, to five load combinations. Thermal load was also eliminated from consideration in Unit 3 platforms which are similar in design to Unit 2 platforms, based on the results of Unit 2 calculations which indicated that no modifications were required due to thermal load.

Calculation CD-Q3303-910605, Revision 1, "Walkdown Review and Configuration Comparison for Lower Drywell Platform at El. 563'-1/2", qualified the platform by modifying the Unit 2 STRUDL model with the Unit 3 walkdown data to minimize the effort required to qualify the platform.

The team had no concerns with the above calculations reviewed under this DCN.

2.7 Review of FDCNs

The team reviewed FDCNs F19778A, F17882A, F02460A, F18159A, F18187A, F19206A and F19375A. These FDCNs covered such field changes as, relocation of pipe supports due to physical conditions in the plant, relocation and redesign of tube track supports to facilitate testing of valves, core drilling of concrete walls to provide access to condenser tubes, relocation of anchor bolts due to rebar interference. The team found that these FDCNs were adequately reviewed and approved.

The team noted an inconsistency in the plant elevations shown in the plan and elevation of support 55 in drawing DCA W16714-072. TVA agreed to revise the drawing to correct this discrepancy.

2.8 Conclusions

The team concluded that the design changes in the civil/structural discipline were technically adequate and in accordance with NRC regulations, TVA procedures, and industry standards. The calculations reviewed were well prepared and assumptions used were adequately justified. Minor errors did exist in the calculations but they did not affect the outcome of the calculations.

3.0 MECHANICAL DESIGN CHANGES

3.1 Scope of Review

The mechanical review assessed the technical adequacy of the design modifications currently being performed and determined the validity and thoroughness of the processes used to generate these modifications.

The evaluation sample included the review of 14 DCNs, 5 FDCNs, 11 mechanical or nuclear calculations, 7 standards/procedures, and miscellaneous other TVA documents pertaining to the DCNs. The team also walked down those modifications in Unit 3 that were installed and accessible.

The DCNs were selected from the total current DCN list according to their potential for safety significance or significance with respect to such other areas of concern as instrument air systems and hardened wetwell vents for BWR Mark I containments. The FDCNs were all related to the DCNs selected and were also chosen for their potential safety significance.

3.2 DCN W17491A, "Unit 2 Torus to the Common Header Portion of the Hardened Wetwell Vent" and DCN W17337A, "Install the Common Header Portion of the Hardened Wetwell Vent"

Hardened wetwell vents are currently being installed at Browns Ferry in response to Generic Letter 89-16 to reduce the vulnerability of BWR Mark I containments to severe accident challenges. Such challenges, which are beyond the original plant design bases, have the potential to overpressurize the primary containment and thereby threaten its integrity.

DCNs W17491A and W17337A produced the designs for the vent line for Unit 2 and the common vent header for all three units, respectively. Calculation MD-Q0999-920051 provided the supporting analyses.

The venting system is designed so that it cannot be fully operated from the control room. The operator must enter the reactor building, the yard, and the stack to carry out the necessary manual drain valve manipulations to drain the vent line. However, the DCNs did not consider the dose to the operator due to the manual operation of the drain valves (see Appendix A, Deficiency 93-201-01).

TVA stated that the vent was designed only for the TW event (a transient event followed by the failure of long-term decay heat removal) which, according to TVA did not involve core damage or any significant source term, and therefore operator exposure for the required manual drain valve operations was not significant. However, the team considers that the various design bases for the hardened wetwell vent, such as, Generic Letter 89-16, Installation of a Hardened Wetwell Vent, indicate that transient events entailing release of fission products into the reactor coolant should be considered in the design and operation of the vent system.

At a meeting with the NRC staff on December 16, 1992, TVA stated that the manual drain valves in the reactor building and in the yard would be replaced

with float operated automatic type drain valves, and TVA will investigate the feasibility of keeping the stack deck drain valve normally open provided that the consequences of ground-level radioactive material release during various plant transients were acceptable. The NRC staff agreed with this approach.

Calculation MD-Q0999-920051 contained numerous errors, omissions, and other weaknesses which resulted in the adequacy of the design to be indeterminate in several areas. These areas were: inadequate consideration of the effect of wetwell sprays and low pressure operation on the rate of condensation in the vent pipe; lack of documentation of the structural capacity of the stack deck to support water loads; inadequate flow and pressure drop analysis of the system piping; and failure to consider water hammer effects. TVA agreed to revise the calculation to correct these discrepancies and to make the necessary design corrections. (See Appendix A, Deficiency 93-201-02).

3.3 DCN W17416A, "Control Air Dryer Replacement"

This modification included changes to the piping and valving arrangements on the control air system dryer skids and installed excess flow check valves in the control air system supply lines to each plant unit. These check valves were intended to close on a pipe break in one unit to isolate the break from the rest of the system and prevent loss of control air to the other two units.

Although this modification considered the "normal" flow rate to each unit and specified a valve setpoint with an actuation margin above this rate, it did not consider the transient flow rates for such events as plant trip where the main stream isolation valves (MSIVs) and other air-operated equipment are required to change state. Such events would substantially increase the flow rate above the steady-state level. For example, the team's review of the air usage rate for the outboard MSIVs (Calculation MD-Q0032-870334) indicates that such transients have a high potential to cause spurious isolation of the system (see Appendix A, Deficiency 93-201-03).

In addition, it did not appear that provisions for reopening the valve, once it had isolated, were adequately considered. This aspect was not mentioned in the DCN.

Although spurious isolation has no direct safety significance, it would needlessly divert the operator to cope with loss of control air to a unit, and it may cause needless challenges to safety-related systems.

TVA has agreed to perform a more rigorous evaluation of the transient flow demands with respect to the actuation setpoint, and make design changes as required.

3.4 DCNs W17810A, W17811B, and W18298A, "Replace and Reroute Reactor Water Cleanup System Piping"

The basic modifications included in these DCNs entail replacing the existing reactor water cleanup (RWCU) piping, which had suffered attack from intergranular stress corrosion cracking (IGSCC), with stainless steel grades much less susceptible to IGSCC. These modifications also rerouted the piping

to provide a cold leg suction to the RWCU pumps to improve their reliability. The team found no discrepancies in these modification packages.

FDCN 19573A to DCN 18711 B was issued to repair an indication of IGSCC which was not previously discovered in the piping. The repair was done under a General Electric (GE) Field Design Deviation Request (FDDR), and the FDDR cover sheet indicated that GE also performed the design verification. In order to incorporate the FDDR into the Browns Ferry documentation system, an FDCN cover sheet was attached and signed as accepted by the design verifier as well as other TVA engineers. TVA stated that the signature of the design verifier only recorded that the package was being accepted from GE, not that the signee had actually performed a design verification. However, TVA's existing procedures did not allow the design verifier to sign the FDCN cover sheet on a contractor's document without actually performing a design verification (see Appendix A, Deficiency 93-201-05).

3.5 DCN B00004C, "Replace RHR Service Water Supply Isolation Valves"

This modification was generated to replace cast iron disk butterfly valves in the residual heat removal (RHR) service water system with stainless steel disk valves. The modification was made to address repeated failures of the valve disks.

The modification package contained no indication of the nature of the failures, how they were discovered, their potential safety impact, the causes of the failures, how the modification addressed these causes, or analyses to show that the replacement valves were adequate. In response to the team's concerns about the lack of information in the DCN, TVA provided a report that evaluated these failures and offered resolutions to the problem. This report noted the probable cause of failure as static or dynamic overpressurization and addressed all of the above topics, except for the safety impact of the failures. It also described how this modification, other modifications, and operating procedure changes were aimed at resolving the problem. The team had no further questions.

3.6 DCNs G-18384A and G-18054A, "Modify Valve Packing Configuration"

These are generic modifications to be performed on valves for routine packing replacement. The modifications consist of (1) replacing the asbestos packing material with graphite material, (2) removing the lantern rings and removing and plugging the leakoff lines, and (3) installing live loading devices. The modifications provide extended packing life, lower maintenance for packing adjustment, and elimination of potential crud traps.

Presently, Generic Letter 89-10 and 10 CFR Part 50, Appendix J, Type C tests are performed after completion of the modifications and before the systems are declared operational. After the system is pressurized to the normal operating pressure, substantial tightening of the packing to stop leakage of newly repacked valves may be required, thereby affecting the net closing and opening

force available at the disk after subtraction of the packing friction force and consequently invalidating the Generic Letter 89-10 and Type C test results.

TVA procedures do not require retesting valves for seat leakage (Type C test) after the stem packing had been retightened to stop stem leakage observed during system pressurization. TVA should ensure that stem packing adjustments of newly repacked valves do not adversely affect the thrust requirements to maintain the required valve leak tightness (Observation 93-201-01).

3.7 DCN W18207A, "Hydrogen Water Chemistry Recirculation Sample Taps"

TVA committed to the NRC to implement hydrogen water chemistry (HWC) in BFN-2 as one of the measures to control IGSCC. This modification installs two taps-one supply and one return - in the sampling and water quality system to allow future connection of the new HWC recirculation sample panel. It also replaces an existing stellite seated valve with a non-stellite seated valve. The team found no discrepancies in this DCN package.

3.8 DCN W18209A, "Relocate/Reroute Sensing Lines for H_2 and O_2 on Offgas System"

This modification is part of the implementation of hydrogen water chemistry at BFN-2. It covers the taps, tubing, and valves for sampling the offgas system effluent for hydrogen and oxygen. It also reroutes the sample lines to downstream of the offgas dehumidification coil in order to supply a dry sample to the HWC monitoring system. The team found no discrepancies in this DCN package.

3.9 DCN W17695A, "Drywell Outage Cooling"

During plant outages, the drywell is presently cooled by the drywell coolers which are supplied with cooling water from the reactor building closed cooling water (RBCCW) system. During summer months, the temperature of this water is too high to maintain drywell temperatures at reasonable levels for personnel. Therefore, this modification is being installed to provide an outage chilled water system which can supply water to the drywell coolers at much lower temperatures, thereby increasing the capacity of these coolers and lowering the drywell temperature.

This DCN adds two 150-ton, air-cooled chiller units; chilled-water recirculation pumps; and the necessary valves, piping, tanks, civil, electrical and I&C features to provide chilled water to all three plant units. The piping for this system penetrates secondary containment and connects to the existing RBCCW piping which is isolated from its normal cooling water source during outages and is supplied by this system. The team found no discrepancies in this DCN package.

3.10 DCN W17872A, "Control Air to the Offgas Building and Stack"

In the original plant design, control air is supplied to the offgas building and the stack from the Unit 1 control air system only. Therefore, not only will loss of control air in Unit 1 cause the shutdown of Unit 1, but it will also cause the loss of control air to the offgas building and the stack forcing Units 2 and 3 to shut down. This deviates from FSAR Section 10.14.2.2 and Appendix F.4.g which state that incidents in any one unit shall not directly affect the operation of the other units.

This modification is being installed to provide a new 1-1/2" air header connecting Units 2 and 3 control air piping to the Unit 1 control air supply to the off gas building and stack. This will allow continued operation of the other two units if control air is lost in any one unit. The team found no discrepancies in this DCN package.

3.11 DCN W18083A, "Changeout MOV Motor Pinion Gear Keys"

This modification changes the hardware on the motor operators of several valves in the recirculation system, the high pressure coolant injection (HPCI) system, and the residual heat removal (RHR) system. The modification incorporates vendor recommendations, in response to generic industry failures in these valves, to make the hardware stronger and more reliable.

The first hardware change removes the tripper fingers from the 28" recirculation pump suction flow control valve motor operators. This change eliminates the impact loads on the worm shaft gear associated with the clutch mechanism returning from the manual operation position to the motor-operation position. Removal of the tripper fingers assures that the clutch automatically returns to the motor-operation position immediately when the manual engagement lever is released. The second hardware change replaces the motor pinion gear keys in several HPCI and RHR valves with higher stronger keys. The team found no discrepancies in this DCN package.

3.12 Review of FDCNs

The team reviewed mechanical FDCNs F18769A, F18429A, F19924A, F19573A, and F0824A. These FDCNs covered field changes, such as, changes to bolt materials, sizes and quantities, revisions to secondary containment leakage rates to account for the new penetrations for the drywell chiller modifications, and replacement of a defective nozzle on a reactor water cleanup system heat exchanger. Except for FDCN F19573A (discussed in Section 3.4 of this report), all other FDCNs were adequately prepared, reviewed, and approved.

3.13 Conclusions

The design control procedures and programs to integrate and coordinate design modifications into plant activities were comprehensive. The DCN documentation appeared to cover all of the areas that are required in the procedures, and the overall design process appeared to be adequate. Plant documentation was relatively easy to retrieve. The DCN packages were found to be generally in

compliance with regulatory requirements and invoked applicable code requirements.

The team identified weaknesses (described in Appendix A) in the conceptual design of the hardened wetwell vent and in the calculation supporting the design. Also, the team found that the transient flow rates due to a unit trip had not been properly evaluated in arriving at the setpoint for the control air excess flow check valves.

4.0 ELECTRICAL DESIGN CHANGES

4.1 Scope of Review

The electrical review concentrated on the review of DCNs for BFN-2 and BFN-3 selected on the basis of their applicability to safety systems, or to systems important to safety. The team also reviewed field-implemented changes to DCNs. Other documentation reviewed included TVA design criteria documents, as well as applicable procedures. In the electrical discipline, the team reviewed five DCNs, two FDCNs and eight calculations. Two implemented DCNs were inspected in the field.

4.2 DCN W17666A, "Install Automatic Load Tap Changer (LTC) on CSST A"

Station Service Transformer CSST A is the preferred source for the 4-kV ac Auxiliary Power System (APS), which includes the emergency shutdown buses. This DCN installed an automatic load tap changer (LTC) on this transformer in response to a concern that the normal operating voltage was low during maximum load conditions. The DCN also changed the 161-kV capacitor timing relay, as required for the stable operation of the new LTC.

The team questioned TVA on such technical issues related to the DCN as the effect of the newly created electrical and physical asymmetry due to the addition of the tap changer at the end of the winding, the effect on the windings due to high transient voltages, and the testing procedure and test acceptance criteria. The team accepted TVA responses to these questions.

The team reviewed drawing W17666-036, which showed a circuit sub-fed from the main PT fuses. There was no documentation to confirm that the new fuses would properly detect faults and coordinate with main fuses. In response to the team's question, TVA performed a coordination study that showed that the new fuses would provide proper protection and coordination.

4.3 DCN W17720B, "Replace Transformers TS3A and TS3B with 1000/1333 kVA AA/FA Transformers, Add 4kV section with two Breakers"

Though the DCN for this activity had not been formally issued for Unit 3, the team selected this design change because many calculations for Unit 3 in support of the DCN had been issued. The team reviewed a similar design change for Unit 2 (ECN P7039) which had been implemented in the field.

Transformers TS3A and TS3B supply the 480V shutdown boards, which include the emergency shutdown loads. These transformers were replaced with higher capacity transformers.

Several calculations in support of the DCN contained unsubstantiated assumptions and other discrepancies. TVA had independently found a few of the same concerns, and they were already being tracked for correction. TVA agreed to expand their corrective actions to include those issues identified by the team in this report. Among the team's concerns, the assumption of 480V prefault bus voltage in the calculation was of particular importance because it affected the final result of the short circuit calculations on the 480V system. In this case, TVA had made a non-conservative and unsubstantiated assumption regarding the prefault bus voltage, which, when corrected by TVA during the inspection, resulted in a short circuit current margin of (-)4% for the breaker in question. In this case, the breaker interrupt capacity would have been exceeded by fault conditions. This condition will be corrected after the source of the power supply to the control bay chiller motor is changed to the new HVAC board (see Appendix A, Deficiency 93-201-04).

The team inspected the Unit 2 transformer field installation and found that building heating and floor drain pipes were routed above the transformers. Also, fire protection piping was routed near the Unit 2 and Unit 3 transformers. The DCN package provided no evidence that the piping had been reviewed for seismic II/I concerns and potential spray hazards as required by TVA procedure SSP-9.3, Appendix D.

TVA stated that design change control procedure BFEP PI 89-06 indicated that the pipe rupture impact analysis would not be affected because no new targets are introduced if existing parts are replaced without relocating them. However, the team noted that there was not a like-kind replacement, in that the original transformers were of the sealed type suitable for outdoor installation, but the new transformers are of the open ventilated type. TVA submitted a walkdown data package in which the piping in the area had been inspected during 1988 in accordance with TVA procedures for assessing seismic II/I hazards. The walkdown package for this area identified piping that either met the TVA criteria for piping position retention and pressure boundary integrity or required modifications. The required modifications have been completed. In addition, TVA revisited the area after the team inspection and concluded that the piping was adequately supported per TVA Design Criteria BFN-50-C-7306, "Evaluation Criteria for Seismic Induced Pressure Retention and Position Retention II/I Hazards". The team concurred with TVA's resolution of this issue.

4.4 DCN W18620, "Replace Water Chiller Circuit Breakers and Reroute Cables Due to Appendix R Concerns"

The DCN concerns coordination of circuit breakers. The DCN also addressed 10 CFR Part 50, Appendix R, concerns and their resolution. The DCN was well prepared and adequate.

4.5 DCN W17274, "Replace Unit C&D LCUN-29 250-VDC Batteries with C&D LCUN-33 Batteries"

New 250-VDC batteries of higher capacity were required to be installed in place of original batteries in all the units. The 250-VDC batteries supply the emergency shutdown loads. This DCN deals with the modification for Unit 3 only.

The team performed a field inspection of the modification for Unit 1, which was complete. The team found that there were many pipes routed above the batteries. The team questioned whether the piping had been reviewed for seismic II/I concerns. TVA provided walkdown packages for this area, similar to the one discussed in Section 4.3 of this report. The walkdown packages identified the piping and found the piping acceptable. TVA revisited the battery room after the inspection and concluded that the piping was adequately supported per TVA design criteria. The team concurred with TVA's resolution of this issue.

The team found that TVA design criteria document BFN-50-7200C specified battery voltage to be used for short circuit calculations as 240V. The team determined that the value of 240V was not conservative, since the open circuit battery voltage for a fully charged battery is 247V. TVA had already found this error and was in the process of revising the criteria.

4.6 DCN W17779, "Relocate Control Bay Water Chiller 3B from Shutdown Board 3B to the New HVAC Board B"

This DCN modified the power supply to the control bay water chiller 3B motor from shutdown board 3B to the new HVAC control board B. The team found discrepancies in Calculation ED-Q3000-910442, "480V short circuit calculations" which is related to the DCN. Attachment 6 to the calculation showed the motor load as 171 amperes, while in Attachment A1, a value of 181.15 amperes was used. Also, in Attachment 6 it was assumed that the motor accelerating time was 6 seconds without adequate justification. TVA had already discovered these discrepancies and was in the process of taking corrective action to address them.

4.7 Review of FDCNs

DCN W17724A, Section 2A, "Post Modification Tests", required that a transformer core megger test be performed. This test requirement was deleted under FDCN F19486A. The deletion of the test was not supported by any analysis or technical justification. In response to the team's question, TVA provided an evaluation to justify the omission of the megger test (see Appendix A, Deficiency 93-201-05).

DCN W17667A which installed the load tap changer was modified by FDCN F19576A, to defeat the emergency runback relay for LTC operation. The team found no analysis that supported the adequacy of the field modification. In response to the team's question, TVA offered technical reasons for the field change which were accepted by the team (see Appendix A, Deficiency 93-201-05).

4.8 Conclusions

Having reviewed the selected DCNs, FDCNs and calculations in the electrical discipline, the team concluded that the preparation, review, verification, and approval of these documents were adequate and that the design process was controlled. The design documents were easily retrievable. In general, the DCNs addressed the technical issues adequately and specified appropriate regulatory, industry standard, and TVA criteria.

The team found that substantiation and validation of assumptions in calculations were not always adequate. However, such instances were few, considering the number of calculations reviewed. TVA had independently found some of these problems and was in the process of taking corrective actions.

5.0 CONTROL AND INSTRUMENTATION DESIGN CHANGES

5.1 Scope of Review

The team selected a sample of seven approved DCNs that represented the following areas: modifications to Class 1E or Technical Specifications instrumentation; a variety of applications such as, control room and field instrumentation of various types; setpoint and instrument tolerance calculations; field complete DCNs; and multi-discipline interfaces.

The safety-related DCNs that were approved and field-complete to date for Unit 3 were limited to human engineering improvements to control room panels. The remaining safety-related approved DCNs (not field complete) for Unit 3 were limited to instrument sensing line modifications and an interim modification for disabling signals from Unit 3 while shut down. Therefore, the team selected two additional approved DCNs from Unit 2 to achieve the sampling objective, particularly for safety-related calculations. TVA stated that the Unit 2 modifications and supporting calculations would be essentially replicated for Unit 3, except for differences in configuration details.

On the foregoing basis, the team reviewed five DCNs for Unit 3 and two DCNs for Unit 2. The team also reviewed five FDCNs for one of the Unit 3 DCNs, and one FDCN for another Unit 3 DCN. In support of the Unit 2 DCNs, the team reviewed four setpoint and scaling calculations and a calculation for condensing chamber volume displacement.

5.2 DCN W16726A, "Modify Panel 3-9-4 to Correct Human Engineering Discrepancies (HEDs)"

This DCN resolved 21 HEDs identified during TVA's control room design review, as applied to the control room panel modifications. The design changes involved replacement of recorders; relocation and rearrangement of control switches, indicators, and recorders; modification of indicator scales to conform with human engineering standards; installation of new labeling and switch position escutcheons; replacement of switch handles with tactile-coded handles; and replacement of indicating light lenses.

The team reviewed the DCN modification criteria, safety assessment, and safety evaluation. These aspects of the DCN were generally comprehensive, well referenced and clearly presented. However, the team noted the lack of a fire hazards analysis for lithium batteries included in some of the digital recorders being installed in the control room. Unlike the analog recorders that are being replaced, some of the digital recorders have lithium batteries for memory backup. Depending on the electrolyte composition and cell configuration, lithium batteries can present a fire or explosion hazard when shorted or inadvertently charged. No fire hazard analysis had been performed to identify or evaluate the special properties of lithium batteries as a potential hazard.

TVA stated that discussions with the vendor indicated that if the batteries were to ignite, the consequences of the damage would be bounded by those of a single failure, and damage would be confined within divisional boundaries established by physical separation criteria for the panel. TVA also retrieved schematic drawings from the vendor showing circuit protection features. On that basis, the team did not have a safety concern for the recorders in question. However, the team concluded that the Appendix R evaluation and other evaluation procedures that support DCN preparation did not appear to provide for identification and evaluation of potentially hazardous batteries that might be added to the control room as a part of future additions of digital instrumentation (Observation 93-201-02).

The team also reviewed the configuration documents for the DCN, including wiring diagrams, physical arrangement drawings, scale information, and documents related to procurement.

Relocation of certain control switches in this modification required that devices and panel wiring be physically separated in accordance with TVA's design criteria identified in BFN-50-728, "Physical Independence of Electrical Systems," Revision 3. The team reviewed the panel connection diagram and concluded that the design change maintained the required physical independence through appropriate use of barriers, air space, and routing/ termination in accordance with BFN-50-728.

This DCN and similar DCNs included procurement of Class 1E (RG 1.97 Category 1 or 2) digital recorders, requiring qualification to IEEE Std. 323-1974. IEEE Std. 323-1974, Section 6.2 has a requirement to include specifications for the range of electromagnetic interference (EMI) and other electrical characteristics, and to test to these specifications. TVA's specifications for EMI qualification testing of the recorders were stipulated by Standard Specification E18.14.01, "Electromagnetic Interference Testing Requirements for Electronic Devices," Revision 1.

The team observed two weaknesses in the EMI specification used in procurement of the Class 1E recorders. First, the specification used a surge withstand capability (SWC) test specification that was originally intended for electrical protective relays (based on IEEE Std 472-1974) and was less conservative than current practice (such as ANSI C62.41-1980, "IEEE Guide for Surge Voltages in Low Voltage AC Power Circuits") for SWC qualification of microprocessor equipment served from low voltage distribution. No field data

were available to justify the design basis EMI environment specified by the test. Also, no requirements were provided for electrostatic discharge (ESD) qualification. The digital recorders contain more sensitive devices than the analog recorders being replaced.

In response to the team's concerns, TVA provided a recent Engineering Bulletin dated October 23, 1992, "Implementation of TVA SS-E18.14.01 Electromagnetic Interference (EMI) Testing Requirements for Electronic Devices." According to TVA, the requirements of this document would apply to future procurements. This bulletin included requirements for testing SWC to ANSI C62.41 and electrostatic discharge to IEC 801-2, together with other improvements.

The team concluded that the recorders had not been demonstrated to be rigorously qualified to IEEE Std 323-1974 with respect to SWC and ESD. However, TVA stated that if the digital recorder was to fail as a result of inadequate qualification, a diverse analog meter would be available in all cases and would in any case be the operator's primary source of information for emergency operating instructions. In addition, no digital (microprocessor-based) hardware was used for reactor trip or engineered safety features functions, so the team was not concerned about other digital Class 1E hardware that might have these qualification weaknesses. On the foregoing basis, the team concluded that this recorder application was acceptable. The team acknowledged that TVA had taken proactive action by tracking developments in EMI qualification, participating in industry initiatives, and by upgrading its older qualification standards (Observation 93-201-03).

The team also reviewed the commercial dedication effort in progress for the Class 1E digital recorders. Problems with EMI testing and resolution of TVA's comments on the vendor's verification and validation (V&V) were being addressed. TVA has required the commercial dedication and V&V to meet the intent of RG 1.152 and ANSI/IEEE-ANS-7-4.3.2-1982, "Application Criteria for Programmable Digital Computer Systems in Safety Systems of Nuclear Power Generating Stations." The team found this approach acceptable.

5.3 DCN W17133, "Modify Panel 3-9-5 to Correct Human Engineering Discrepancies (HEDs)"

This DCN was similar in nature to DCN W16726A previously discussed, except that in addition to the device relocations, recorder replacements, and other enhancements, Class 1E analog meters with digital displays were added for reactor pressure and water level. TVA had noted that the meter had not passed the EMI test and would be retested. In response to the team's query, TVA indicated that this type of meter is only used in non-safety applications on Unit 2; therefore, there was no safety concern.

The team reviewed the DCN modification criteria, safety assessment, and safety evaluation. Except for the previously observed lack of a fire hazards analysis for the lithium batteries used in certain recorders, these aspects of the DCN were generally comprehensive, well referenced, and clearly presented.

The team observed the work in progress in the Unit 3 control room on panels 3-9-4, 3-9-5, and other panels. The team reviewed the full-scale mockup of

the Unit 3 control room, and TVA engineers gave a good and thorough explanation of the review and implementation process, using "before and after" overlay drawings on the mockup. The team sampled HED resolution documentation, and found no problems.

The various phases of control panel modifications appeared complex and somewhat fragmented, since multiple DCNs could overlap panels. However, based on the team's review of the documents and discussions with TVA, it appeared that TVA was managing the program adequately.

5.4 DCN W17463A, "Reroute the Unit 3 Reactor Vessel Water Level Instrument Legs"

This DCN responded to Generic Letter 84-23 which identified permanent plant improvements to reduce reactor water level indication errors. The DCN rerouted the reference leg piping that was inside the drywell to reduce the amount of piping in the drywell that would be subject to high temperature following an accident. Flashing of the reference leg water due to high temperature would result in erroneous level indication.

This first stage of the design change was limited to rerouting of the piping and installing new condensing chambers. The second stage of the modification will connect the rerouted reference legs to the instrumentation. The team did not review the second stage since engineering had not been completed.

The team reviewed the DCN modification criteria, safety assessment, and safety evaluation. These aspects of the DCN were comprehensive, well referenced, and clearly presented.

The team also reviewed calculation ED-Q3003-920101, "Volume Displacement Calculation for Reactor Vessel Water Level Instrumentation," Revision 0, March 26, 1992, and found it acceptable. This calculation verified the adequacy of the condensing chamber volume for serving its associated transmitters.

To assess TVA's approach to setpoint and instrument tolerance calculations, the team reviewed Setpoint and Scaling Calculation (SSC) ED-Q2003-880126 (Unit 2), Reactor Vessel Level 2-LT-3-58A, Revision 6. The calculation was performed to the requirements of TVA's Electrical Engineering Branch Instruction EEB-TI-28, "Setpoint Calculations," Revision 1. The calculation was technically sound, comprehensive, well referenced, and auditable. The team noted no problems with the assumptions or methodology, and the calculation addressed appropriate design basis conditions.

5.5 DCN W18724, "RCIC Turbine Steam Flow Condensing Chamber Removal"

This DCN corrected a loop seal in the RCIC turbine steam flow instrument (elbow taps) line due to a low point between the piping elbow tap and the condensing chamber. Since the line is normally cold and the elbow is in a vertical plane, condensation was creating a loop seal between the condensing

chamber and the steam line. This produced erratic measurement of steam flow. A high RCIC steam flow signal is used for primary containment isolation system (PCIS) Group 5 isolation of primary containment.

To correct the problem, the DCN removed the condensing chambers and rerouted the instrument water legs to eliminate the low point seal. Setpoint and scaling calculations were not yet available for the Unit 3 configuration, so the team reviewed calculation ED-Q2071-900029, "RCIC Turbine Steam Flow 2-PD-71-1A,-1B" Revision 4, that supported a similar modification to Unit 2. The calculation was performed to the requirements of the TVA's Electrical Engineering Branch Instruction EEB-TI-28, "Setpoint Calculations," Revision 1. The team generally found the calculation to be technically sound, comprehensive, well referenced, and auditable.

5.6 DCN H2735A, "Disable Units 1 and 3 Common Accident Signals"

This DCN addressed CAQR BFP880406 which had noted that common accident signals from Units 1, 2, and 3 core spray logic initiation could potentially cause spurious actuation of the diesel generator autostart logic, RHR pump autostart logic, and core spray pump autostart logic. The DCN addressed this problem by isolating (disconnecting) Units 1 and 3 common accident signals while Units 1 and 3 are in a defueled state.

The team reviewed the safety evaluation, modification criteria, and checklists for the DCN and found them acceptable. The team also reviewed the implementing elementary diagram 3-730E938, sheet 4, Revision 2, and DCN connection diagrams to verify that no sneak circuits or other unintended functions were introduced by the modification. The team did not find any such concerns.

5.7 DCN W17073A (Unit 2), "Main Steam Line High Flow Transmitter Noise"

Differential pressure transmitters are used to monitor main steam flow and provide an input to the PCIS. High steam flow is an indication of a main steamline break. TVA had noted that the venturi flow element was developing a differential pressure signal containing process noise sufficient to result in spurious channel trips due to spikes in the transmitter output of approximately 5 msec duration. This DCN added a filter capacitor at the transmitter input to the analog trip unit, to attenuate the spikes and preclude spurious actuation.

In adding the capacitor, it is necessary that the effect on response time and accuracy of the channel be evaluated. FSAR Section 14.6.5.1.1.e allows 0.5 second for development of the automatic isolation signal, and a 10-second closure time for the valves. To verify that these effects had been properly considered, the team reviewed Setpoint and Scaling Calculation ED-Q2001-900099, Revision 2, February 14, 1992. The calculation was performed to the requirements of TVA's Electrical Engineering Branch Instruction EEB-TI-28, "Setpoint Calculations," Revision 1. The calculation was technically sound, comprehensive, well referenced, and auditable. No problems were identified with the assumptions or methodology, and appropriate design basis conditions were noted and addressed in the calculation.

5.8 DCN P0533 (Unit 2), "Improved Torus Temperature Monitoring"

Technical Specifications 3.7.A.1(c), (d), (e), and (f) stipulate limiting conditions for operation (LCO) based on suppression pool (torus) water temperature values greater than 95°F, 105°F, 110°F, and 120°F under certain associated operating conditions. No safety-related automatic actions are initiated by torus temperature, but the LCOs require operator action. This DCN was initiated to comply with the Mark I program acceptance criteria (NUREG 0783) and to satisfy the intent of Regulatory Guide 1.97 by providing an adequate measurement of bulk temperature for use in abnormal plant operations.

The team reviewed the instrumentation aspects of this DCN, and setpoint and scaling calculation ED-Q2064-880081 "Bulk Torus Temperature" 2-TE-64-161A thru H, Revision 4. The calculation was performed to the requirements of TVA's Electrical Engineering Branch Instruction EEB-TI-28, "Setpoint Calculations," Revision 1, October 24, 1988. The team found the calculation to be technically sound, comprehensive, well referenced, and auditable. Generally, no problems were noted with the assumptions or methodology, and appropriate design basis conditions were identified and addressed in the calculation. In response to the team's question regarding lack of evaluation of temperature stratification in the torus, TVA provided information on temperature detector locations and acceptable instrument error values. On this basis, the team found no problems with the calculation.

5.9 Review of FDCNs

The team reviewed field changes described in FDCNs F-18494A, F18202A, F18295A, F18393A, and F18701A. The first four FDCNs were issued against DCN W17133A (discussed in Section 5.3 of this report) and the last FDCN was issued against DCN W17463A (discussed in Section 5.4). The team found the FDCNs were well prepared and reviewed.

5.10 Conclusions

The team found no deficiencies or unresolved items in the control and instrumentation design discipline. Two observations were identified involving the lack of a fire hazard analysis for lithium batteries being added to the control room (as a part of digital recorders), and the lack of contemporary SWC and ESD qualification for recently procured Class 1E recorders. As described in this report, after discussions with TVA, the team concluded that none of these items were safety significant.

Beyond these observations, the team found no problems in the review of the DCNs, calculations, drawings, and supporting engineering documentation. The engineering instructions/procedures and design products were generally thorough and exhibited good attention to detail.

The team noted the thoroughness in the setpoint and scaling calculations that were non-safety-related but indirectly important to safety (such as RHR service water temperature and RCIC steam flow indication).

Despite the team's observation regarding EMI qualification of past

Despite the team's observation regarding EMI qualification of past procurements, TVA's recent upgrading of its EMI testing requirements to reflect more current practice for microprocessor applications and its participation in industry initiatives in this area represent a strength for future procurements. The team was also impressed by the depth of knowledge and skills of the TVA engineering staff for the variety of technical issues addressed during the inspection.

APPENDIX A

SUMMARY OF DEFICIENCIES

DEFICIENCY 93-201-01

FINDING TITLE: Failure to Evaluate the Radiological Consequences due to the Operation of the Vent Drain Valves (Section 3.2)

BASIS:

Generic Letter 89-16 states that as a mitigation measure, a reliable wetwell vent provides assurance of pressure relief with significant scrubbing of fission products.

In the summary discussions on the installation and operation of the hardened vent for BWRs with Mark I containments in Federal Register, Vol. 55, No. 122, June 25, 1990, it is stated that the incremental occupational radiation dose for the proposed operation of the hard pipe vent path was insignificant (unmeasurable) because the vent path would be operated from the control room. In the background discussions in the same document it is stated that the vent was intended to provide a scrubbed pathway for containment pressure relief for rare situations involving core damage.

BWR Owner's Group Emergency Procedure Guidelines, Revision 4, requires venting of the primary containment irrespective of the offsite radioactivity release rate when the suppression chamber pressure exceeds the primary containment pressure limit.

Section 3.2 of the ANSI N45-2.11-1974, which is specified in TVA's plant modification and design change control procedure SSP-9.3, states that the design input shall include environmental conditions such as nuclear radiation anticipated during construction and operation.

DESCRIPTION OF CONDITION:

DCNs W17337 and W17491 (References 1 and 2) provide the hardened wetwell vent common header and vent line from the Unit 2 torus to the common header, respectively. This line is being installed in response to Generic Letter 89-16 (Reference 3) to reduce the vulnerability of BWR Mark I containments to severe accident challenges.

One of the design features of these DCNs is that there are three normally closed manual drain valves which must be manipulated in order to effect venting. Two of the drain valves are on the vent line itself, one inside the reactor building and one in a drain pit in the yard. The third is located in the drain line for the deck area at elevation 665'-6" inside the stack. The DCNs did not evaluate the radiological consequences due to the operation of the drain valves.

TVA stated that this modification was intended to address the TW event only (Reference 4), i.e., the transient event with failure to remove long term

decay heat, and that for this event there was no significant radioactive source term.

However, based on References 3, 4, and 5 (design bases for these DCNs), the team believes that transient events which entail fuel failure are to be considered in the design, and that the operation of the vent, including any attendant operation such as draining, is expected to be conducted remotely from the control room to minimize exposure to the operator.

Reference 3 states that, "First, it is recognized that all affected plants have in place emergency procedures directing the operator to vent under certain circumstances (primarily to avoid exceeding the primary containment pressure limit) from the wetwell airspace. Therefore, incorporation of a designated capability consistent with the objectives of the emergency procedure guidelines is seen as a logical and prudent plant improvement." Emergency procedures do not differentiate between types of accidents; they respond to symptoms. The BFNP emergency procedures (Reference 6), and the BWR Owners' Group (BWROG) Emergency Procedure Guidelines (Reference 8) require venting irrespective of offsite radioactivity release rate.

Reference 5 states in the summary section that, "The incremental occupational dose for the proposed operation of the hard pipe vent path is insignificant (unmeasurable) because the vent path would be operated from the control room," indicating the intent that the operation be from the control room to minimize operator exposure.

At a meeting with the NRC staff on December 16, 1992, TVA stated that the manual drain valves in the reactor building and in the yard would be replaced with float operated automatic type drain valves, and that TVA will investigate the feasibility of keeping the stack deck drain valve normally open, provided that the consequences of ground-level radioactive material release during various plant transients were acceptable. The NRC staff agreed with this approach.

REFERENCES:

1. DCN W17337 A, "Install the Common Header Portion of the Hardened Wetwell Vent"

2. DCN W17491 A, "Unit 2 Torus to the Common Header Portion of the Hardened Wetwell Vent"

3. Generic Letter 89-16, September 1, 1989, "Installation of a Hardened Wetwell Vent"

4. NUREG/CR-5225, November, 1988, "An Overview of BWR Mark-I Containment Venting Risk Implications"

5. Federal Register, Vol 55, No 122, Monday, June 25, 1990, Notices, "Installation and Operation of Hardened Vent from Suppression Pool Airspaces of Boiling Water Reactors (BWRs) with Mark I Containments"

6. 2-EOI-2, BFNP Emergency Operating Instruction, "Primary Containment Control"

7. ANSI 45.2.11-1974, "Quality Assurance Requirements for the Design of Nuclear Power Plants"

8. BWR Owners' Group, "Emergency Procedure Guidelines", Revision 4, NEDO-31331, Class I, March 1987

DEFICIENCY 93-201-02

FINDING TITLE: Discrepancies in Hardened Wetwell Vent Calculation (Section 3.2)

BASIS:

10 CFR Part 50, Appendix B, Criterion III, requires, in part, that design control measures shall provide for verifying or checking the adequacy of design.

Section 4.1 of ANSI N45.2.11 which is specified in TVA's plant modification and design change control procedure SSP-9.3, requires, in part, that design activities shall ensure that applicable design inputs are correctly translated into specifications, drawings, procedures, and instructions.

DESCRIPTION OF CONDITION:

DCNs W17337 and W17491 (References 1 and 2) provide the hardened wetwell vent common header and vent line from the Unit 2 torus to the common header, respectively.

The design analyses of the flow and moisture conditions inside the pipe and the stack during the operation of the hardened wetwell vent are contained in Calculation MD-Q0999-920051 (Reference 4). This calculation was not adequately verified for completeness, accuracy, and adequacy as evidenced by the following technical discrepancies:

1. The estimated amount of moisture in the vent line did not address two potentially large sources: wetwell spray and flashing of the wetwell when the containment pressure is reduced. This additional water would affect the flow capacity of the vent, the accumulation rate and mass of water on the deck inside the stack, and the potential for water hammer in the line.

2. The analysis did not consider the moisture removal rate in the pipe at lower pressure conditions such as would be present subsequent to its initial opening, and for the steady state flow rates corresponding to lower than the design decay heat rate conditions.

3. The stack deck drain line capacity computation used a drain flow rate that corresponded to the relatively low condensation rate at the end of eight hours rather than early in the event when the condensation rate is several times higher. The calculation assumed a water depth of 3 feet on the stack deck without considering the ability of the deck to support such a load. The structural integrity of this deck under the most conservative conditions of water accumulation was not evaluated.

4. The flow performance of the vent line is based on an assumption of "no flow area restrictions in the line." However, the internal diameter (I.D.) of the three in-line butterfly valves is less than the I.D. of the

pipe, and they each have a three inch wide disk in the middle of the flow path. This error impacts the flow capacity of the vent, and the condensation rate in the line.

5. The computation of the condensation in the vent during its initial heatup only considers heatup of the pipe; it does not consider the heatup of the surrounding media during this phase. This produces a non-conservative result.

6. The calculation concludes that, even with the vent line full of water, it is functional because there is sufficient pressure to blow the water out. However, it fails to consider the structural integrity of the pipe for static water loads, water hammer loads, and other dynamic loads associated with blowing a slug of water out of the pipe. It also fails to consider the rapid deposition of this large volume of water on the stack deck, with the resultant potential for structural failure of the deck.

TVA has agreed to revise this calculation to resolve the deficiencies mentioned above and other minor discrepancies identified during the inspection.

<u>REFERENCES</u>:

1. DCN W17337 A, "Install the Common Header Portion of the Hardened Wetwell Vent"

2. DCN W17491 A, "Unit 2 Torus to the Common Header Portion of the Hardened Wetwell Vent"

3. Calculation MD-Q0999-920051, Revision 0, "Stack Evaluation During Wetwell Purge"

4. Anchor-Darling Drawing 94-15973, Revision F, "14", ANSI 150# Class Lugged Style Butterfly Valve with Limitorque Manual Operator"

5. Anchor-Darling Drawing 94-15972, Revision E, "14", ANSI 150# Class, Fail Close, Wafer Style Butterfly Valve with Bettis Air Operator"

6. 10 CFR Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants"

7. ANSI N45.2.11-1974, "Quality Assurance Requirements for the Design of Nuclear Power Plants"

DEFICIENCY 93-201-03

FINDING TITLE: Control Air System Excess Flow Check Valve Setpoint (Section 3.3)

BASIS:

Section 4.1 of ANSI N45.2.11, which is specified in TVA's plant modification and design change control procedure SSP-9.3, requires, in part, that design activities shall assure that applicable design inputs are correctly translated into specifications, drawings, procedures, and instructions.

Generic Letter 88-14, requested that licensees verify that the design of the instrument air system is in accordance with the intended function.

DESCRIPTION OF CONDITION:

The BFNP control air system is a common system serving all three units. Because of a concern that a piping failure in one unit could cause plant trips in all three units upon loss of the common system pressure, DCN W17416A was prepared. The DCN provided automatic isolation of the control air to the unit in which the failure would occur. The isolation was effected by installation of an excess flow check valve in each of the individual unit supply lines upstream of the dryers. In the event of pipe failure in one unit, the increased flow rate would actuate the excess flow check valve, and the system common air receivers would not be depressurized. Only the unit experiencing the break would lose control air.

The normal control air system flow rate to each unit was estimated at 490 standard cubic feet per minute (scfm). The excess flow check valve setpoint was established at 915 scfm, accounting for setpoint tolerance and additional flow during regeneration of the air dryers.

Although the excess flow check valves will provide the desired pipe break isolation, plant transients can also cause actuation of these valves and isolation of control air to the unit experiencing the transient. For example, a unit trip will cause the MSIVs to close and other air operated equipment to actuate. The demand of the MSIVs alone for this event is estimated at 1,040 scfm for the outboard valves (Reference 1). The selection of the setpoint for the excess flow check valves did not consider and appropriately document the control air flow rates during various plant conditions (Reference 2). Therefore, for any plant transient that involved MSIV closure or other large control air demand, the control air to that unit could automatically isolate. This appears to have not been considered in the preparation of this DCN.

REFERENCES:

1. Calculation MD-Q0032-870334, Revision 2, "Control Air System - Pipe Sizing Flow"

2. Calculation Md-N0032-920165, Revision 1, "Control Air System Flow Rate During Pipe Failure"

3. DCN W17416A, "Control Air Dryer Replacement"

4. Generic Letter 88-14, "Instrument Air Supply Problems Affecting Safety-Related Equipment"

5. ANSI 45-2.11-1974, "Quality Assurance Requirements for the Design of Nuclear Power Plants"

DEFICIENCY 93-201-04

FINDING TITLE: Document discrepancies and unsubstantiated assumptions in calculations (Section 4.3)

BASIS:

10 CFR Part 50, Appendix B, Criterion III, requires, in part, that design control measures shall provide for verifying or checking the adequacy of the design.

ANSI N 45.2.11-1974, Section 3.1, requires, in part, that applicable design inputs, such as design basis, regulatory requirements, and codes and standards, shall be identified, and documented, and their selection shall be reviewed and approved.

DESCRIPTION OF CONDITION:

The following calculations contained unsubstantiated assumptions and other discrepancies:

a) Calculation EEB/ED-Q3999-920106, Revision 0, "Input Data", Sheet 3: The reference to maximum voltage on all boards was not clear, since this maximum voltage was stated as two possible values: 270V and 280V. TVA agreed to revise the calculation to use the correct maximum voltage.

b) Calculation EEB/ED-Q3999-920106, Revision 0, "Input Data", Sheet 4: There was no basis for assuming a maximum of 10 contacts in a circuit. The team found that the scheme shown in Figure 2 of Attachment 1.1 of the same calculation displayed 11 contacts connected in series. TVA agreed to add detailed wiring/block diagrams in the next revision of the calculation so that the number of contacts in a particular path could be identified.

c) Calculation EEB/ED-Q3999-920106, "Input Data", Sheet 4: There was no basis for assuming 0.1 ohm resistance for each contact. The team found that this value was not supported by the vendor documents. TVA agreed to obtain the correct resistance value and revise the calculations.

d) Calculation ED-Q3057-920329, Revision 0, Attachment A, Section 5.0: There was no verification of the assumed impedance of 8% for the new transformers. A small variation in the impedance could affect the short circuit rating of the equipment. In response to the team's comment, TVA provided adequate supporting information for the assumed impedance value and agreed to revise the calculation to incorporate the justification for the assumption.

e) Calculation ED-Q3057-920329, Revision A, Attachment A, Section 6.0: There was no basis for assuming that a voltage of 480V was the most conservative value that should be considered. In response to the team's question, TVA investigated the prefault bus voltage and found it to be 508V, rather than the 480V assumed in the calculations. TVA further calculated that with the revised voltage value the short circuit margin was (-) 4%, which is not

acceptable. TVA indicated that the problem would be resolved by relocating the power supply to a 150 HP chiller motor to another bus. TVA agreed to revise the calculation.

f) Calculation ED-Q3057-920035, Section 2.0: TVA had no documentation to justify the elimination of the small transformer and the cable losses from the assumed loading conditions. In response to the team's question, TVA prepared a detailed evaluation to support the assumption. The team found this adequate. TVA agreed to revise the calculation to incorporate the supporting document.

g) Calculation ED-Q3057-920035, Section 4.0: There was no documentation to support the statement that "service factors were conservatively considered equal to one." In response to the team's question, TVA prepared a detailed evaluation of the actual motor loads and concluded that motor horsepower ratings will not be exceeded. TVA agreed to revise the calculation to incorporate the supporting document.

h) Calculation ED-Q3057-920329, Attachment A, Section 2.0: There was no documentation to support the assumption that a static load of 200 kVA was conservative. In response to the team's question, TVA prepared a calculation to verify the assumption. TVA agreed to revise the calculation to incorporate the supporting document.

<u>REFERENCES</u>:

1. Calculation EEB/ED-Q3999-920106, Revision 0, "CCVD For Unit 3 DC Circuits"

2. Calculation ED-Q3057-920329, Revision 0, "480V Short Circuit Calculations"

3. Calculation ED-Q3057-920035, Revision 0, "Emergency Diesel Generator Loading"

4. ANSI N45.2.11-1974, "Quality Assurance Requirements for the Design of Nuclear Power Plants"

5. 10 CFR Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants"

DEFICIENCY 93-201-05

FINDING TITLE: Inadequate Justification for Basis for Approval and Inadequate Design Verification of FDCNs (Sections 3.4 and 4.7)

BASIS:

Section 8 of ANSI N45.2.11, which is specified in TVA's plant modification and design change control procedure SSP-9.3, requires, in part, that the impact of the design changes to approved documents, including field changes, be carefully considered, and such changes be justified.

10 CFR Part 50, Appendix B, Criterion III, Design Control, requires, in part that design changes, including field changes, shall be subjected to design control measures commensurate with those applied to the original design. Criterion III also requires, in part, that the design control measures shall provide for verifying or checking the adequacy of design, such as by the performance of design reviews, by the use of alternate or simplified calculational methods or by the performance of a suitable testing program.

DESCRIPTION OF CONDITION:

a) FDCN F19486A

DCN W17724B, Section 2A, "Post Modification Tests," required that core megger test be performed on the unit service station transformer. This test requirement was deleted under FDCN F19486A. The justification for the deletion of the test was not documented. Block 16 of the FDCN cover page required inclusion of basis for approval, but no basis for the approval was stated.

In response to the team's comments, TVA's contractor prepared a memorandum (Reference 5) that justified the field change on the basis that the transformer core was not affected by the modification, a megger test was done prior to the modification and the risk involved in disconnecting the core strap to perform the test and reinstalling the strap was not commensurate with the advantages of repeating the megger test. The team agreed with the justification provided, but this change should have been properly justified and the design should have been verified before the FDCN was implemented.

b) FDCN F19576A

DCN W17667A was modified by FDCN F19576A, to defeat the emergency run back relay (27A) for LTC operation. Two relays were added to the LTC control circuit to provide a means of defeating the emergency run back feature when the LTC controls are in manual mode. No justification was provided in the FDCN for this change.

In response to the team's question, TVA stated that the reasons for the field change were that the automatic LTC movement could occur in the

manual mode and this was undesirable during maintenance activities because the manual mode is utilized to ensure personnel protection. The team agreed with this explanation. However, the required justifications should have been included in the FDCN and the design should have been appropriately verified before the change was implemented.

c) FDCN 19573A

DCN W18711B replaced and rerouted the reactor water cleanup piping which was subject to intergranular stress corrosion cracking (IGSCC). FDCN 19573A was issued to repair IGSCC indications at one location that was not previously discovered.

The repair was done under a GE Field Design Deviation Request (FDDR), and the FDDR cover sheet indicated that the design verification was also performed by GE. In order to incorporate the FDDR into the Browns Ferry documentation system, an FDCN cover sheet was attached and signed by TVA engineers in various positions of responsibility, including the design verifier. When the team asked how the TVA engineer who signed as the design verifier performed this task with the seemingly inadequate information that was in the package, the TVA engineers stated that this signature only meant that the package was being accepted from GE, not that the signee had actually performed a design verification. The existing procedures (References 8, 9, and 10) do not allow signing the cover sheet of the FDCN if no verification was performed by TVA. There were no specific exclusions of this requirement in the procedures for contractor generated documents produced in accordance with contractor's approved procedures.

<u>REFERENCES</u>:

1. DCN W17724B, "USST Modification"

2. FDCN F19486A, "Delete Test Requirement"

3. DCN W17667A, "Install automatic Load Tap Changer (LTC) on CSST 'B'"

4. FDCN F19576A, "Defeat Emergency Run Back Relay (27E)"

5. Bechtel Interoffice Memorandum, from Carl Hurty to Warren Banner, dated December 2, 1992

6. DCN W18711B, "Replace Reactor Water Cleanup Piping"

7. FDCN F19573A, "Repair IGSCC Indications"

8. Site Standard Practice, SSP-9.3, Revision 4, "Plant Modifications and Design Change Control"

9. Site Standard Practice SSP-9.5, Revision 0, "Design Engineering"

10. Site Engineering Practice SEP-9.5.6, Revision 0, "Design Verification"

11. ANSI N45.2.11-1974, "Quality Assurance Requirements for the Design of Nuclear Power Plants"

12. 10 CFR Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants"

APPENDIX B

LIST OF OBSERVATIONS

During the plant design change inspection at the Browns Ferry Nuclear Plant, Unit 3, the U.S. Nuclear Regulatory Commission's inspection team made the following observations. The sections to which these observations apply are given in parentheses.

Observation 93-201-01, "Inadequate Requirements for Ensuring Valve Performance After Stem Packing Replacement" (Section 3.6)

Observation 93-201-02, "No Evaluation of Lithium Batteries as Potential Fire Hazard" (Section 5.2)

Observation 93-201-03, "Inadequate Qualification of Digital Recorders for Electromagnetic Interference Testing Requirements" (Section 5.2)

[illegible]

APPENDIX C

EXIT MEETING ATTENDEES

NAME	ORGANIZATION
E.T.Knuettel	TVA Licensing
O.S.Mazzoni	NRC Consultant
J.F.Williams	NRC Project Manager
R.N.Lilleston	TVA Recovery Support PE
J.Valente	TVA Recovery Manager
J.E.Maddox	TVA Engineering Manager
R.R.Baron	TVA Site Quality Manager
O.V.Zeringue	TVA VP BFN Operations
B.A.Wilson	NRC RII,Chief DRP Branch 4
D.C.Prevatte	NRC Contractor
H.Wang	NRC Inspector
S.K.Malur	NRC Team Leader
J.M.Leivo	NRC Contractor
C.A.Patterson	NRC Senior Resident Inspector
R.A.Musser	NRC Resident Inspector
G.D.Pierce	TVA Site Licensing Manager
P.J.Rush	NRC NRR Intern
J.T.Munday	NRC Resident Inspector
C.M.Crane	TVA Maintenance Manager
J.W.Smithson	TVA Special Projects Manager
D.B.Harrison	TVA Recovery Manager
R.H.Wright	TVA Electrical Engineer
D.T.Langley	TVA Electrical Engineer
P.Salas	TVA Compliance Manager
J.R.Rupert	TVA Engg. & Modifications Manager