50-390 WATTS BAR TVA

DESIGN BASELINE & VERIFICATION PROGRAM REV. 3
CORRECTIVE ACTION PROGRAM PLAN

w/memo dtd 11/19/90 #9011280064

WATTS BAR NUCLEAR PLANT

DESIGN BASELINE AND VERIFICATION PROGRAM (DBVP)

CORRECTIVE ACTION PROGRAM PLAN

REVISION 3

Prepared by: ______________________
DBVP Manager

Approved by: ______________________ 7.13.90
Manager WBN Engineering

______________________ 7/20/90
WBN Site Licensing Manager

Concurred by: ______________________
WBN Site Quality Manager

____
Vice President of Nuclear Engineering

____
WBN Program Manager

____
Watts Bar Program Team

Title: PROGRAM DESCRIPTION FOR WATTS BAR DESIGN BASELINE AND VERIFICATION PROGRAM (DBVP)		REVISION LOG
Revision No.	**Description of Revision**	**Date Approved**
0	Initial issue.	07/21/86
1	This is a general revision to reflect revised scopes of work to be more consistent with the content of the BFN and SQN DBVPs. Changes include addition of calculation activity, addition of testing requirements activity, addition of system evaluations, performance of vertical slice review by an independent contractor outside the DBVP in lieu of previously scoped DBVP verifications, and normal quality assurance/engineering assurance oversight role.	10/06/88
2	This revision addresses comments made by NRC in the presentation of this plan on February 7, 1989. Changes include the addition of logic diagrams to the DBVP scope, clarification that the portion of the fire protection system necessary to mitigate a design basis event is within scope, and clarification with regard to primary and secondary safety-related features to be included in the calculation effort.	03/29/89
3	Deleted reference to the no-longer existing Engineering Assurance organization. Added Fuel Handling and Storage System (System 79) to the DBVP Systems List in Attachment 2. Deleted System 86, Diesel Starting Air System" from the Attachment 2 list and added a parenthetical note to System 82 that it includes "Diesel Starting Air System".	07/27/90

WATTS BAR NUCLEAR PLANT

DESIGN BASELINE AND VERIFICATION PROGRAM (DBVP)

TABLE OF CONTENTS

DESIGN BASELINE AND VERIFICATION PROGRAM

1.0 INTRODUCTION

The Watts Bar Nuclear Plant (WBN) Design Baseline and Verification Program (DBVP) assures that the WBN licensing basis, design basis, calculations, and safety-related plant functional configuration for unit 1 and common features are in agreement, and establishes the necessary systems and procedures to maintain this baseline. The DBVP also establishes test requirements for the WBN Prestart Test Program.

TVA became aware of inconsistencies and omissions in the WBN licensing and design basis documentation as the result of several activities, including:

- Conditions Adverse to Quality (CAQs)
- Employee concerns
- TVA self-evaluations, including lessons learned from Sequoyah (SQN) and Browns Ferry Nuclear Plants (BFN)
- Industry experience and reviews
- Regulatory reviews

Upon investigation, TVA determined that there were instances of the following conditions:

- Inconsistencies between the WBN Final Safety Analysis Report (FSAR) and WBN design documentation.
- Incomplete and some inconsistent design input information.
- Missing, incomplete, and out-of-date design calculations.
- Disagreements between the actual plant configuration and the as-constructed drawings.

Attachment 1 lists the CAQs and employee concerns which form the basis for the DBVP, and which are being corrected through DBVP activities.

The following related causes appear to have contributed to the conditions described above:

- Lack of effective licensing and design change control procedures and data bases to ensure that design requirements were maintained consistent with the FSAR and other commitments to NRC;
- Insufficient definition of design criteria and system description information at the level of detail needed to control design changes.

- Lack of a complete calculation listing to establish the full scope of calculations needed for WBN and procedures to ensure the calculations are maintained consistent with the WBN design;

- Lack of an effective definition of drawings to be maintained under configuration control, and an ineffective system for keeping appropriate drawings as-constructed as plant changes are made.

TVA has determined that the underlying root cause of this situation was ineffective design and configuration control measures.

TVA has developed the WBN DBVP to correct the situation that had developed and to prevent the recurrence of such a situation by eliminating the root cause. The DBVP has the following major components:

- Licensing Verification

- Design Basis

- Calculations

- Configuration Control

- Testing Requirements

The DBVP establishes a baseline of information for each of these areas, including data bases that facilitate the identification of affected documents as changes to the plant are made. Improved design change control procedures will be generated to address the development and maintenance of a single set of plant drawings that are to replace the existing sets of "as-designed" and "as-constructed" drawings.

The program will be performed in accordance with the TVA Quality Assurance Program. This will include inspections and audits by the QA organization.

This revision to the DBVP supersedes revision 2 to the WBN DBVP plan dated March 29, 1989, which was previously submitted to the Nuclear Regulatory Commission (NRC).

2.0 OBJECTIVES

The objectives of the WBN DBVP for each program activity are:

2.1 Licensing Verification

- Assure that commitments to NRC are captured in the appropriate highest level controlling document.

- Establish procedures and systems to maintain compatibility between commitments and controlling documents.

2.2 Design Basis

- Establish a plant design basis document (DBD) that contains or references appropriate engineering requirements including design basis commitments.

- Establish procedures and systems to maintain the design basis consistent with changes to the plant, technical requirements, and licensing commitments.

2.3 Calculations

- Assure the existence and retrievability of calculations that are technically adequate and consistent with the "safety-related" plant design.

- Establish a process for statusing calculations that will maintain calculations current with plant design changes.

2.4 Configuration Control

- Develop and implement an improved design change control system.

- Establish a single set of configuration control drawings (CCDs) and verify that the configuration of the portions of plant systems that mitigate plant design basis events reflect functional requirements.

2.5 Testing Requirements

- Assure that preoperational test scoping documents (which define system and component preoperational test requirements) are current and consistent with the DBD.

3.0 SCOPE

The WBN DBVP applies to Unit 1 and common features. The scope of specific program areas is as follows:

3.1 Licensing Verification

The Licensing Verification activity includes verification of docketed WBN commitments associated with design, construction, operations, maintenance and inspection identified in the following types of documents:

- Final Safety Analysis Report (FSAR)

- NRC Safety Evaluation Report (SER) and Supplements

- Draft WBN Fuel Load License and Appendices (includes Final Draft Technical Specifications)

- 10 CFR 50.55(e) Final Reports

- Responses to NRC regarding: Violations/Deviations
Bulletins and Circulars
Generic Letters
Confirmation of Action Letters
Show Cause Letters

- Correspondence referenced in the SER and Supplements

- Correspondence since SER Supplement 4.

3.2 Design Basis

The Design Basis activity includes the development and consolidation of design basis engineering requirements and licensing commitments for the plant features that perform a primary or secondary safety function as defined by the Watts Bar FSAR Section 17.2.1.

3.3 Calculations

The Calculations activity includes the identification, statusing, and evaluation for technical adequacy of those calculations that are necessary to establish or support the plant systems or design features which perform a primary or secondary safety function as defined by the Watts Bar FSAR Section 17.2.1.

3.4 Configuration Control

The Configuration Control activity includes the development and implementation of an improved design change control process which will be utilized for subsequent plant changes. CCDs will be developed for the following categories of safety-related control room drawings:

- Flow Diagrams

- Electrical Single Lines

- Control Diagrams

- Schematics

- Logic Diagrams

These drawings will be verified to agree with plant functional configuration for the primary safety-related portions of plant systems. In addition, system evaluations will be performed for those portions of the systems identified in Attachment 2 that are necessary to mitigate the design basis events for WBN.

3.5 <u>Testing Requirements</u>

The Testing Requirements activity includes a review of preoperational test scoping documents for the tests identified in Table 14.2-1 of the WBN FSAR.

4.0 DESCRIPTION OF PROGRAM ACTIVITIES

The DBVP will be performed through baselining efforts in five program areas as described in Sections 4.1 through 4.5 below. The flowchart for the DBVP, including program interfaces, is provided in diagram format in Attachment 3. Quality Assurance oversight of DBVP activities is described in Section 4.6.

4.1 <u>Licensing Verification</u>

The Licensing Verification activity will assure that licensing commitments have been incorporated into appropriate WBN controlling documents. This verification will apply to the docketed commitments contained within the source documents identified in Section 3.0 above. Commitments will be reviewed to determine the controlling TVA or vendor document that implements the commitment.

A Licensing Document Commitment Matrix (LDCM) cross referencing the commitment to its implementing document will be established. This matrix will be used as a tool for maintaining consistency between licensing commitments and implementing documents when future changes in licensing commitments or plant design are made. This matrix will facilitate identifying the pertinent sections of the FSAR and other licensing commitments that could be affected when a proposed change to a WBN document is considered.

As inconsistencies are identified between licensing commitments and implementing documents, an Open Item Report (OIR) will be generated, tracked, and controlled in an open item management system. If an open item is determined to be a CAQ, it will be tracked and controlled by the TVA CAQ system.

4.2 <u>Design Basis</u>

The Design Basis activity involves the review of existing criteria contained in either design criteria documents or system descriptions. The review will assure that these documents contain the licensing commitments and engineering requirements that make up the design basis of WBN. In order to accomplish this review, licensing commitments and design requirements have been reviewed by senior TVA engineers familiar with plant design and categorized as to whether they contain design input associated with plant structures, systems, components or general design topics.

The categorized commitments and requirements (C/R) have been entered into a relational C/R data base with sorting capability for a specific structure, system, component, or design topic. Selected sorts appropriate for each design criteria or system description have been generated, and the commitments or requirements appropriate for each document have been identified. Existing documents will be revised or new documents issued as required to ensure that the design basis for WBN is correct, complete, and in accordance with licensing commitments and engineering requirements.

The Design Basis activity includes the preparation of a new design criteria document that addresses WBN design basis events. These criteria will provide safety limits and safety functions for each event's mitigation scheme, and will identify the required systems for each event.

As inconsistencies are identified between the licensing commitments/design requirements and the existing criteria, OIRs will be generated, tracked, and controlled in an open item management system. If an open item is determined to be CAQ, it will be tracked and controlled by the TVA CAQ system.

4.3 Calculations

The Calculation activity includes the review for technical adequacy of those safety-related calculations associated with problem areas and selected calculations for areas where problems have not been identified, and the development of any missing calculations necessary to support plant design. A list of calculations which are necessary to establish or support the plant systems and features which perform either a primary or secondary safety function will be generated for each of the engineering disciplines.

As inconsistencies are identified between calculations and other design documents, OIRs will be generated, tracked, and controlled in an open item management system. If an open item is determined to be a CAQ, it will be tracked and controlled by the TVA CAQ system.

Details of the Calculation activity are provided in Attachment 4.

4.4 Configuration Control

The Configuration Control activity ensures that the functional configuration of primary safety-related systems is accurately depicted on plant control room drawings and that these drawings are in conformance with design basis requirements. The Configuration Control activity includes the implementation of an improved means of design change control; the development and functional verification of CCDs for safety-related control room drawings; and the performance of system evaluations to confirm functional consistency between the DBDs, CCDs, and associated safety-related calculations.

An improved means of design change control for WBN will be developed consistent with the corporate TVA approach identified in TVA Nuclear Performance Plan Volume I. This change control process is based on the design change "package" process as described by the INPO Good Practice TS-402, "Plant Modification Control Program."

A single series of baseline drawings called CCDs will be developed that combine the former "as-designed" (AD) and "as-constructed" (AC) drawings for the control room drawings. The primary safety-related portions of the CCDs will be verified to match plant configuration and will have remaining plant modifications identified against them. To provide assurance that the CCDs match plant functional configuration, a walkdown of the primary safety-related portions of the systems will be performed for flow, control, and single line drawings.

The walkdowns will include an evaluation of the systems and components identified on the flow, control, and single line drawings sufficient to assure that the drawings match the plant functional configuration. The portions of the systems to be walked down will be identified in a system baseline boundary calculation for the system. These system walkdowns will be conducted in a manner similar to the walkdowns conducted in the SQN and BFN DBVPs.

Systems and components which cannot be confirmed through walkdowns (for example electrical circuits represented on schematics) will be tested or the results of previous tests evaluated in order to ensure functional performance consistent with the drawings. The portions of the systems requiring this test or test document evaluation will be defined by the system baseline boundary calculation. These tests or evaluations will be conducted in a manner similar to those performed in the SQN and BFN DBVPs. Utilizing baselined schematics, the logic diagrams will then be confirmed.

Subsequent to the confirmation of the CCDs through the performance of walkdowns and/or testing, system evaluations will be performed for the portions of the systems listed in Attachment 2 which are necessary to mitigate the design basis events for WBN. These design basis events are defined in WBN design criteria WB-DC-40-64, and include the design basis events defined in Chapter 15 of the WBN FSAR. The portion of each system to be addressed within the associated system evaluation will be defined in the system baseline boundary calculation. These evaluations will be functional assessments of each system's proposed configuration at fuel loading. The requirements for system configuration as defined by the DBD, calculations, and preoperational test scoping documents will be compared to the CCDs to ensure that the system meets functional requirements and will perform as intended.

Outstanding design changes will be reviewed to identify those planned for implementation before or after fuel loading. Design changes that are planned for implementation after fuel loading will receive an Unimplemented Design Item Evaluation (UDIE). The UDIE is a safety evaluation to ensure that the effect of not implementing the change until after fuel loading does not compromise plant safety or WBN licensing commitments. The system evaluations will confirm the functional capability of the systems to perform their intended safety functions, and will identify the open items that must be completed to establish an acceptable configuration for fuel loading. Procedures will be established to ensure that design changes initiated after the completion of the system evaluation receive a comparable evaluation to determine requirements for implementation before or after fuel loading.

As inconsistencies are identified between the design basis, the system CCDs, or the constructed plant, OIRs will be generated, tracked, and controlled in an open item management system. If an open item is determined to be a CAQ, it will be tracked and controlled by the TVA CAQ system.

4.5 Testing Requirements

The Testing Requirements activity will begin with a review of preoperational test scoping documents (i.e., documents which define system and component functional test requirements) against the DBD. Functional testing requirements which have changed due to a change in the plant design basis will be identified and the scoping documents revised as appropriate. Revised preoperational test scoping documents will serve as input to the WBN Prestart Test Program. A review of the preoperational test results package for previously tested systems against the updated scoping document will be performed to ensure validity of the test, or to identify areas in which additional testing is required. For systems that have not been preoperationally tested, the plant preoperational test instruction will be reviewed against this updated scoping document.

Any discrepancies between the updated scoping documents and associated preoperational test documents (test instructions/test results) will be resolved in accordance with the requirements of the preoperational testing program as described in Chapter 14 of the WBN FSAR.

Discrepancies between the DBD, the scoping documents, and the preoperational test documents will be identified as open items, tracked, and controlled in an open item management system. If it is determined that an open item is a CAQ, it will be tracked and controlled by the TVA CAQ system.

4.6 Quality Assurance Oversight

Activities affecting the quality of plant design or configuration will be conducted in accordance with documented procedures which receive a QA review. Activities will be monitored through scheduled audits and/or surveillances.

In addition to the QA activities, findings identified by QA, and NRC against the DBVPs at SQN and BFN will be reviewed for applicability to similar WBN DBVP activities. Any such findings determined to be applicable to WBN DBVP activities will be identified as OIRs and tracked to resolution.

5.0 PROGRAM INTERFACES

The program interfaces include both those between major DBVP activities as well as those with other WBN special programs. Internal program interfaces are depicted in Attachment 3, and include:

- Licensing commitments that are design input are verified against the DBD.
- The DBD is supported by calculations.
- The DBD provides system functional requirements to the test requirements activity for the review of preoperational test scoping documents.
- The DBD, calculations, and preoperational test scoping documents define the functional requirements against which the CCDs and outstanding design changes will be compared during the performance of system evaluations.

External program interfaces with other WBN special programs are characterized as follows:

- The DBD interfaces with other WBN special programs that involve the preparation or revision of design criteria or system descriptions. Examples include the Hanger and Analysis Update Program (HAAUP) and the Conduit Support Program. The DBD activity provides procedural controls for the preparation or revision of these design criteria or system description documents to ensure proper incorporation of applicable commitments and requirements in accordance with the DBVP open items management system.

- Revised preoperational test scoping documents will provide the system functional testing requirements to the WBN Prestart Test Program.

- The calculation program interfaces with other special programs that involve the preparation or review of calculations. An example of such an interface includes the HAAUP effort to regenerate or review pipe stress and pipe support calculations.

- The configuration control activity will utilize DBVP accepted inputs from other programs for the verification of CCDs and for the system evaluations. An example of such inputs includes HAAUP walkdown data.

6.0 PROGRAM IMPLEMENTATION

The DBVP will be conducted by a program management team as shown in Attachment 6. This team is responsible for procedure development and management of program activities and interfaces. Program activities are performed by the normal line organizations or by contractors where appropriate.

Procedures to control DBVP activities will be issued prior to the initiation of the activity. Procedures that control DBVP activities only are to be contained within the DBVP Program Manual, which is a part of the Watts Bar Engineering Project (WBEP) Manual. Procedures produced by the DBVP, which are intended for project use beyond the conclusion of the DBVP, are issued as project procedures in the WBEP Manual. DBVP activities requiring procedural control are identified in Attachment 6.

The status of the DBVP as of August 1, 1988, is shown in Attachment 7.

7.0 PROGRAM DOCUMENTATION

Deliverables from the DBVP include the following documents:

- New Design Change Control Procedures

- Licensing Document Commitment Matrix database

- Commitment/Requirement data base

- Watts Bar Design Basis Document
- Complete Calculation Cross Reference Index System (CCRIS)
- New or revised calculations
- Configuration Control Drawings
- System Evaluations, including UDIEs
- Revised Preoperational Test Scoping Documents

Any discrepancies identified during the DBVP will be documented, tracked, and controlled in an open item management system. If an open item is determined to be a CAQ, it will be tracked and controlled by the TVA CAQ system.

A final report, describing the results of each area of the DBVP will be produced at program completion.

8.0 CONCLUSION

The DBVP is an integrated effort to ensure that the plant licensing basis is properly embodied within plant design; that the plant design basis is supported by analysis; and that functional plant configuration is properly supported by the design basis. DBVP will also ensure that an effective design change control process will be implemented to maintain configuration control. Performance in each program area will be summarized in a report with significant observations identified.

Attachment 1

BASIS FOR DESIGN BASELINE AND VERIFICATION PROGRAM

I. CONDITIONS ADVERSE TO QUALITY	SUBJECT
<u>Design Basis Area</u>	
CAQR WBP 870443	Insufficient Design Input
<u>Licensing Verification Area</u>	
CAQR WBT870165	FSAR not current with respect to plant design
<u>Calculations Area</u>	
See Attachment 4	

II. EMPLOYEE CONCERNS	SUBJECT
<u>Design Basis Area</u>	
EC 20103-WBN-01 EC 30711-WBN-01	Lack of Adequate Design Criteria

Attachment 1

BASIS FOR DESIGN BASELINE AND VERIFICATION PROGRAM

Configuration Control Area

EC 20406-WBN-02 EC 20601-WBN-02 EC 20601-WBN-03	Lack of adequate Design Change Control Process
EC 20601-WBN-01 EC 30713-WBN-02	As-Constructed Drawings do not match plant configuration

Calculations Area

See Attachment 4

III. AUDIT FINDINGS — SUBJECT

Test Requirements Area

QWB-A-86-0017-D01	Inadequate preoperational test scope definition

Attachment 2

WBN SYSTEMS WITHIN THE SCOPE OF THE DBVP
CONFIGURATION CONTROL ACTIVITY

Designation	System
1/15	Main Steam System (and Steam Generator Blowdown System)
3	Main and Auxiliary Feedwater System
13	Fire Detection System
18	Fuel Oil System
26	High Pressure Fire Protection
30	Ventilating System
31	Air-Conditioning (Cooling-Heating) System
32	Control Air System
33*	Service Air System
39	CO_2 Storage, Fire Protection, and Purging System
41*	Layup Water Treatment
42*	Chemical Cleaning
43*	Sample and Water Quality System
46	Feedwater Control System
52*	System Test Facility
57	Associated Electrical Systems
59*	Demineralized Water & Cask Decontamination System
61	Ice Condenser System
62	Chemical and Volume Control System
63	Safety Injection System
65	Emergency Gas Treatment System
67	Essential Raw Cooling Water System
68	Reactor Coolant System
70	Component Cooling System
72	Containment Spray System
74	Residual Heat Removal System
77	Waste Disposal System
78	Spent Fuel Pit Cooling System
79	Fuel Handling and Storage System
81*	Primary Makeup Water System
82	Standby Diesel Generator System (including Diesel Starting Air System)
83	Hydrogen Recombination System
84	Flood Mode Boration System
85	Control Rod Drive System
88	Containment Isolation System
90	Radiation Monitoring System
92	Neutron Monitoring System
94	In-Core Flux Detectors
99	Reactor Protection System
211	6.9-kV Shutdown Power

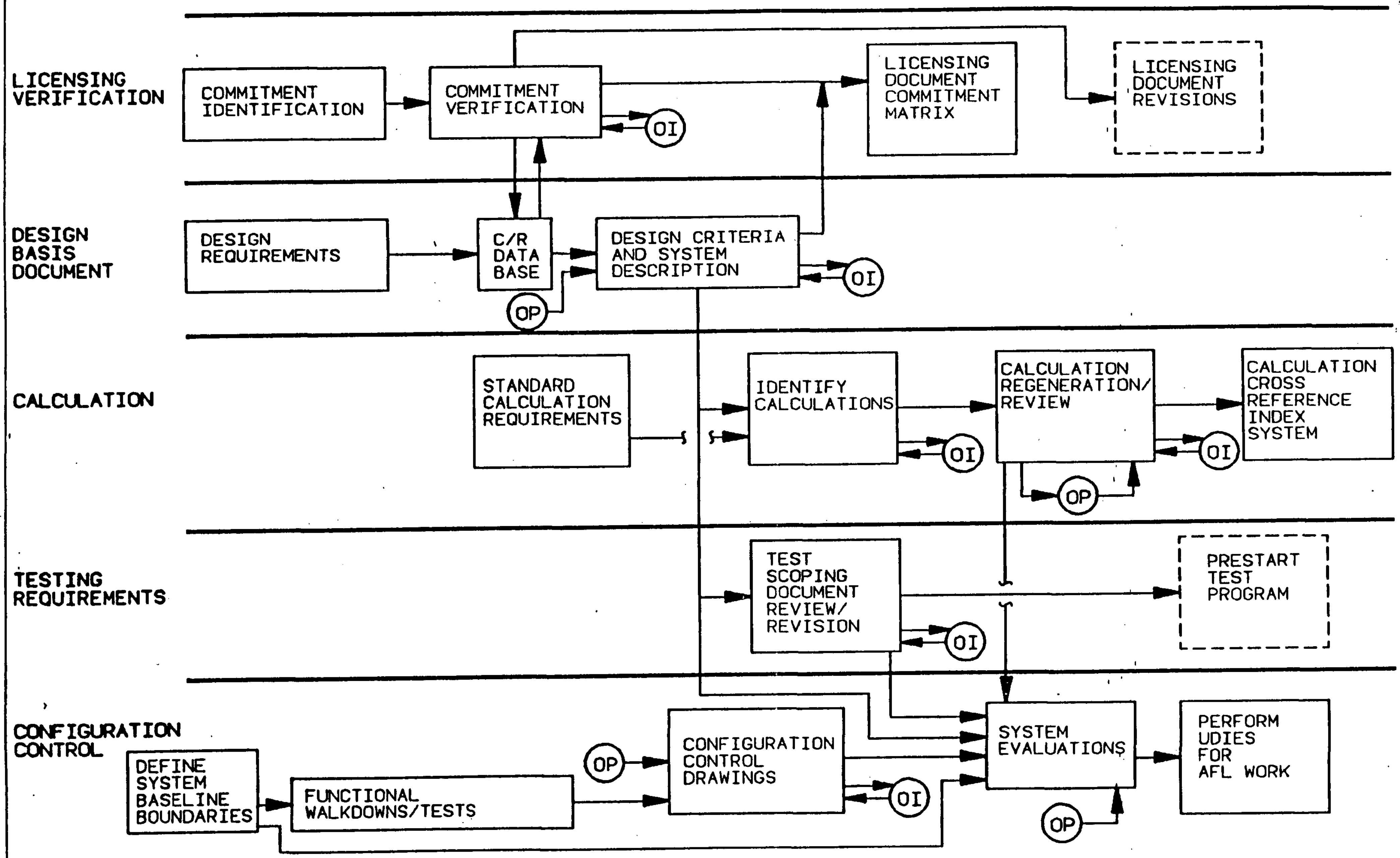
*Containment Isolation Function Only

Attachment 2

WBN SYSTEMS WITHIN THE SCOPE OF THE DBVP
CONFIGURATION CONTROL ACTIVITY

Designation	System
212	480-V Shutdown Power
213	Reactor Motor Operated Valve Power
214	Control & Auxiliary Vent Power
215	Diesel Auxiliary Power
228	Plant Lighting
232	Reactor Vent Power
235	120-VAC Vital Power
236	125-VDC Vital Power
251	Sound-Powered Telephones
268	Permanent Hydrogen Mitigation System
271	Containment and Auxiliary Buildings (Reactor Components Handling Systems Only)

ATTACHMENT 3: F[illegible]CHART FOR WBN
DESIGN BASELINE & VERIFICATION PROGRAM



OI REFLECTS INTERNAL DBVP INTERFACE WITH DBVP OPEN ITEM MANAGEMENT SYSTEM

OP REFLECTS DBVP INTERFACE WITH OTHER WBN SPECIAL PROGRAMS

Attachment 4

DESIGN BASELINE AND VERIFICATION PROGRAM CALCULATION ACTIVITY DESCRIPTION

TABLE OF CONTENTS

WATTS BAR CALCULATION ACTIVITY DESCRIPTION

1.0 INTRODUCTION

Over the past several years, the TVA design control program has been the focus of a number of internal and external reviews. These reviews include audits by TVA's quality assurance organizations, inspections conducted by the Nuclear Regulatory Commission (NRC), and evaluations performed by the Institute of Nuclear Power Operations (INPO). Review findings have shown that TVA's nuclear power plant design basis and calculations are not adequately documented. Calculations have been identified as missing, incomplete, or not updated as the plant configuration has been altered through approved design and construction modifications. Further, a composite calculation listing had not been established that specifically defines the full scope of safety-related calculations needed for WBN.

Calculation deficiencies were initially identified in the electrical discipline area. Subsequent assessments by TVA management have concluded that similar conditions could exist in the other engineering disciplines. The root cause of this situation can be attributed to ineffective procedural controls, inadequate training, failure to follow procedures, and incomplete design reviews.

In order to prevent recurrence, the design control aspects of this condition have been addressed by TVA through an improved design change control process under the Configuration Control Activity of the DBVP. To ensure that safety-related calculations are adequate and in place prior to receipt of an operating license, the plan described herein has been formulated. Conditions Adverse to Quality (CAQ) and employee concerns being addressed by the calculation activity are identified in Appendix A.

2.0 OBJECTIVES

The fundamental goal of the Watts Bar Calculation activity is to assure the existence and retrievability of design calculations that are both technically adequate and consistent with the current plant design. In order to achieve this goal, the following specific objectives have been established:

1. Identify calculations

2. Verify the existence and retrievability of the calculations and generate any calculations determined to be missing.

3. Assure that the calculations are technically adequate.

4. Assure that calculations are consistent with the plant design.

5. Establish a process that will maintain calculations current with the plant design.

3.0 SCOPE

The scope of calculations encompassed by this plan consists of those which are necessary to establish or support the unit 1 and common safety-related plant systems or design features necessary to ensure:

1. The integrity of the reactor coolant pressure boundary;

2. The capability to shut down the reactor and maintain it in a safe shutdown condition; or

3. The capability to prevent or mitigate the consequences of an incident which could result in potential offsite exposures comparable to those specified in 10 CFR 100.

The scope of this program also encompasses those calculations necessary to establish or support plant features which must either:

1. Retain adequate structural integrity because its failure could jeopardize to an unacceptable extent the achievement of a primary safety function or because it forms an interface between Seismic Category I and non-Seismic Category I plant features; or

2. Perform a function that is not a primary safety function but whose failure or unwanted action could jeopardize to an unacceptable extent the achievement of a primary safety function.

The criteria stated above will be used in the review of the WBN design calculations to determine which calculations are within the scope of the calculation program.

4.0 DESCRIPTION OF CALCULATION ACTIVITY

The Calculation activity has been structured to accomplish the five objectives identified in Section 2.0. The plan to achieve each of these is described below.

4.1 Identification of Calculations

Calculations will be identified by reviewing the following:

1. Standard calculation types required by each TVA engineering discipline.

2. System Descriptions (SD) and Design Criteria (DC) which constitute the WBN Design Basis Document (DBD).

Each TVA engineering discipline has defined the standard calculation types which are to be used in identifying WBN safety-related calculations. These standard calculation types are defined in References 1 through 4. The extent of applicability of each standard calculation type to WBN will be determined. This will be accomplished primarily by means of reviewing applicable design output documents to identify specific safety-related plant features which require supporting calculations within each calculation type. This review will be oriented towards physical design features. Additionally, the DBD development effort includes provisions to identify the design basis requirements for WBN which should be supported by calculations. The resulting list of WBN calculations will be compared to the SQN calculations list in order to finalize the WBN list.

4.2 Verification of Existence and Retrievability

Watts Bar calculations have been transferred from diverse filing locations to a central location on site. Copies of joint Sequoyah Nuclear Plant (SQN)/WBN calculations and other applicable calculations that are not specific to WBN will also be identified and filed in this location. A consolidated WBN calculation list will be created reflecting calculations in this central file.

Existing safety-related calculations will be entered into a computerized data base using the Calculation Cross Reference Information System (CCRIS) software program. This data base will replace and consolidate various calculation indexes that currently exist and will also contain additional calculation information including cross reference documents, category type, and RIMS accession number. Existing calculations that are of a type no longer performed for WBN (e.g., support variance calculations) will not be entered into CCRIS. Their existing manual calculation log, however, will be maintained.

Upon completion of CCRIS data entry, the resulting calculation list, sorted by category type, will be compared to the list of required calculations to determine those that are missing. Missing calculations will be generated in accordance with current calculation procedures. Completion of these efforts will achieve a complete set of engineering calculations, which will be filed in a central location on site and verified as retrievable.

4.3 Assurance of Technical Adequacy

The technical adequacy of existing WBN calculations will be established through the generation of new calculations, the technical review of affected calculations in identified deficient areas, or a review of selected calculations in those areas where problems have not been previously identified. The combination of these methods will provide adequate confidence in the technical adequacy of WBN calculations.

The determination of the methodology to be applied to each calculation type has been or will be made based upon an evaluation of identified problem areas. This evaluation will consider both WBN deficiencies and those calculation-related deficiencies identified at SQN. Calculation inadequacies identified by other WBN special programs, the TVA CAQ process, and the WBN Vertical Slice Review will be reviewed for specific and generic impact to WBN calculations.

TVA has determined that the generation of new calculations is appropriate in the following two major areas. Electrical calculations will be regenerated prior to Unit 1 fuel loading based on CAQR WBNEEB8571, which documents lack of adequate control for electrical calculations, and the results of internal calculation reviews and SQN experience. Additionally, pipe stress analysis calculations will also be regenerated prior to Unit 1 fuel loading as described in the HAAUP.

Calculations associated with other deficient areas, as identified in the evaluation described above, will be reviewed for technical adequacy or new calculations generated in accordance with current calculation procedures. Documentation of the technical reviews of existing calculations will be maintained for examination and future reference. As the technical review of the calculations identifies inadequacies, the affected calculations will be revised or new calculations generated. Unacceptable calculations will normally be revised in conjunction with the review process unless circumstances justify deferral based on other planned work or work in progress. Calculations which are technically acceptable but contain discrepancies will be tracked to ensure their correction when the calculation is next revised.

For calculations which are not regenerated or reviewed based on known deficiencies, a review of selected calculations will be performed to confirm that additional inadequacies do not exist. Evaluations will be made of the extent of applicability of any identified technical deficiencies. If these technical deficiencies are determined to be programmatic or have a root cause which could have caused other deficiencies, the scope of review within that calculation type will be increased to ensure that technical deficiencies are found and corrected.

Discrepancies encountered in the review process will be identified as OIRs, tracked, and controlled in an open items management system. If an open item is determined to be a CAQ, it will be tracked and controlled by the TVA CAQ system, including an evaluation for reportability as appropriate.

4.4 Assurance of Consistency With Plant Design

Assurance of consistency with plant design will be established concurrent with the assurance of technical adequacy. The consistency review will be performed for the same calculations reviewed for technical adequacy. Consistency of calculations with current plant design will be assured by one or more of the following methods, as applicable:

1. Reconciliation with as-built conditions as determined by field walkdowns.

2. Reconciliation with current revisions of applicable design output (drawings, specifications, etc.).

3. Reconciliation based on resolution of test deficiencies.

Walkdown or testing information being developed for other WBN programs will be used as available and applicable. An example of such a program includes walkdowns associated with HAAUP.

Completion of these reconciliation activities and any corrective actions that may evolve from the technical adequacy reviews will provide assurance that calculations reflect the current plant design.

4.5 Establishment Of A Calculation Maintenance Process

Maintenance of calculations to reflect ongoing design changes and/or plant modifications will be accomplished by means of procedural controls requiring the use of cross reference information contained in the CCRIS database. Procedural requirements will be implemented to require the identification and update of calculations that are either necessary to support the design change or that may be affected by the change. Upon implementation of CCRIS, identification of such existing calculations will be accomplished by searching the database for calculations that are either predecessors or successors to the design document being changed.

Changes to design documentation which do not entail physical modifications will also be checked against the CCRIS database for potential impact on calculations. Additionally, when calculations are revised for any reason, the CCRIS data base will be utilized to identify any subsequent successor document that may also require update. Ongoing updates to the CCRIS database when any new or revised calculations are issued will ensure that cross reference information, as well as the calculation, is kept current.

5.0 CALCULATION ACTIVITY INTERFACES

An interface exists with the DBD area of the DBVP. The Design Basis activity will identify the calculations (existing and missing) which are required to support the plant design basis. In turn, the Calculation activity will assure that those calculations required to support the DBD are current and technically adequate. Furthermore, system functional requirements specified by calculations will provide input to the system evaluations in the Configuration Control activity.

Additionally, the Calculation activity will interface with other WBN programs that either rely on data obtained from existing calculations or that will require the preparation of new or revised calculations. One such program is HAAUP, which will interface with the Calculation activity for both of these reasons. Other programs having similar interfaces include the conduit support, equipment seismic qualification, and electrical issues.

6.0 CALCULATION ACTIVITY DOCUMENTATION

Calculation activity work products will be prepared in accordance with procedures. These work products will include:

- Complete CCRIS data base
- New or revised calculations
- An open items tracking system and OIRs
- Task or activity summary reports, if appropriate

These work products, as well as ongoing program activities, will be subject to QA audits or surveillance to assure completeness and traceability of program documentation.

Any discrepancies identified during the Calculation activity will be documented, tracked, and controlled in an open item management system. If an open item is determined to be a CAQ, it will be tracked and controlled by the TVA CAQ system.

A final report, describing the results of the Calculation activity will be produced at program completion.

7.0 CONCLUSION

Upon completion of the Calculation activities, WBN will have the safety-related engineering calculations in place with assurance that they are technically adequate and up to date. Calculations that have been reviewed will have documentation available to demonstrate technical adequacy. A user-accessible data base of calculations complete with interdependency cross reference, will be available. Finally, a system will be in place to ensure that calculations are maintained up to date to reflect any future design changes over the life of the plant.

8.0 REFERENCES

1. Electrical Engineering Procedure Method PM 86-02 "Electrical Calculations" dated July 17, 1987 (B43 870717 903).

2. Civil Engineering Branch Instruction CI-21.53 "Calculations" dated July 17, 1988 (B41 880715 001).

3. Mechanical Engineering Branch Instruction, "Design Calculation," MEB-I-23.2, dated November 6, 1987 (B44 871106 002).

4. Nuclear Technology Branch Instruction, "Calculation Classification and Categorization," NTB-I-25-3.1.4, dated July 13, 1988 (B45 880712 255).

APPENDIX A

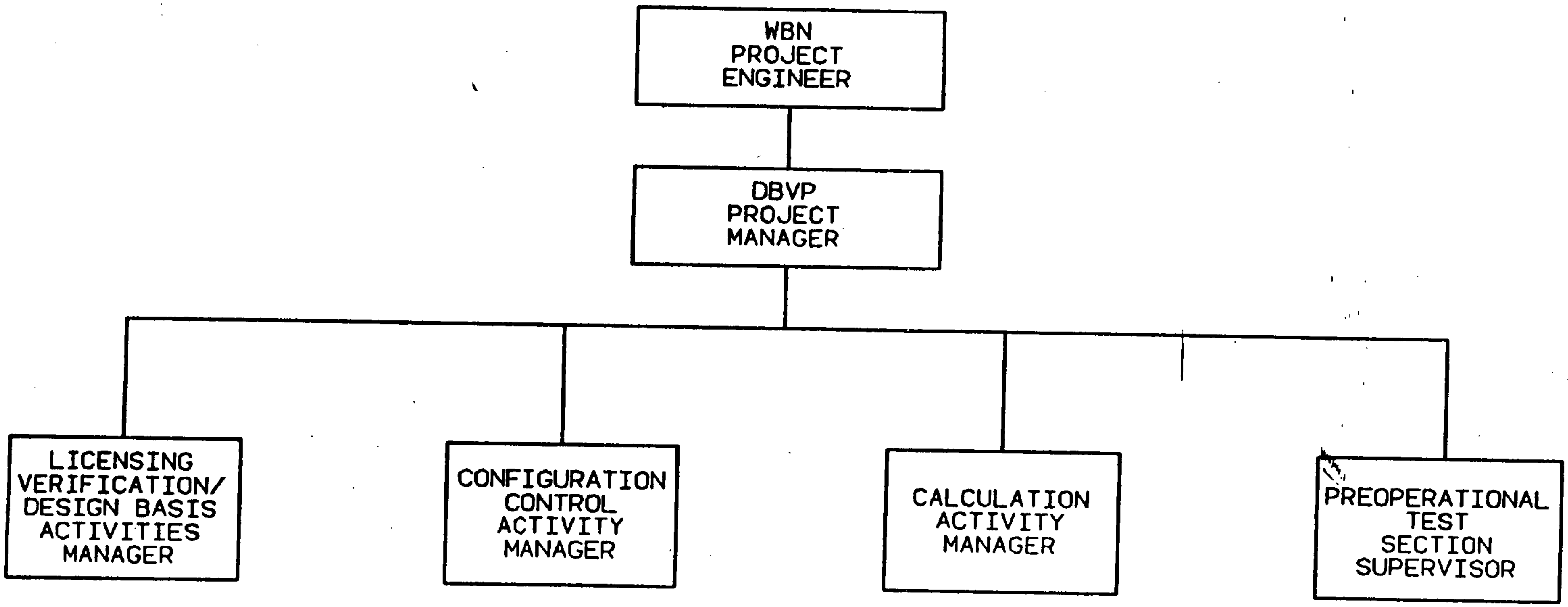
BASIS FOR DESIGN BASELINE AND VERIFICATION PROGRAM CALCULATION ACTIVITY

CONDITIONS ADVERSE TO QUALITY REPORTS	SUBJECT
WBF 870038	Seismic Reanalysis for Condensate Demineralizer Waste Evaporator Building
WBF 870039	Technical Adequacy Review of Seismic Analysis for Additional Diesel Generator Building
WBP 870396	Seismic Reanalysis for Diesel Generator Building and Waste Packaging Area

EMPLOYEE CONCERNS	SUBJECT
Report 201.6(A)	Incorporation of Requirements and Commitments in Design
Report 205.1(A)	Control of Design Calculations
Report 215.6(A)	Hanger Loads on Structures
Report 21200	Pipe Support Program

SIGNIFICANT CONDITION REPORT	SUBJECT
WBNEEB8571	Lack of Electrical Calculations Control

ORGANIZATION FOR THE WBN DESIGN BASELINE AND VERIFICATION PROGRAM



ATTACHMENT 6

DBVP ACTIVITIES REQUIRING
PROCEDURAL CONTROL

Compilation of Licensing Commitment Units

Commitment Unit Verification

Maintenance of Licensing Commitments Consistent with Plant Design

Preparation of Commitment/Requirement Data Base

Preparation of Design Basis Document

Maintenance of the Design Basis Document

Identification of Required Calculations

Selection of Calculations for Technical Review

Preparation of Design Change Notices

Preparation of Plant Modification Packages

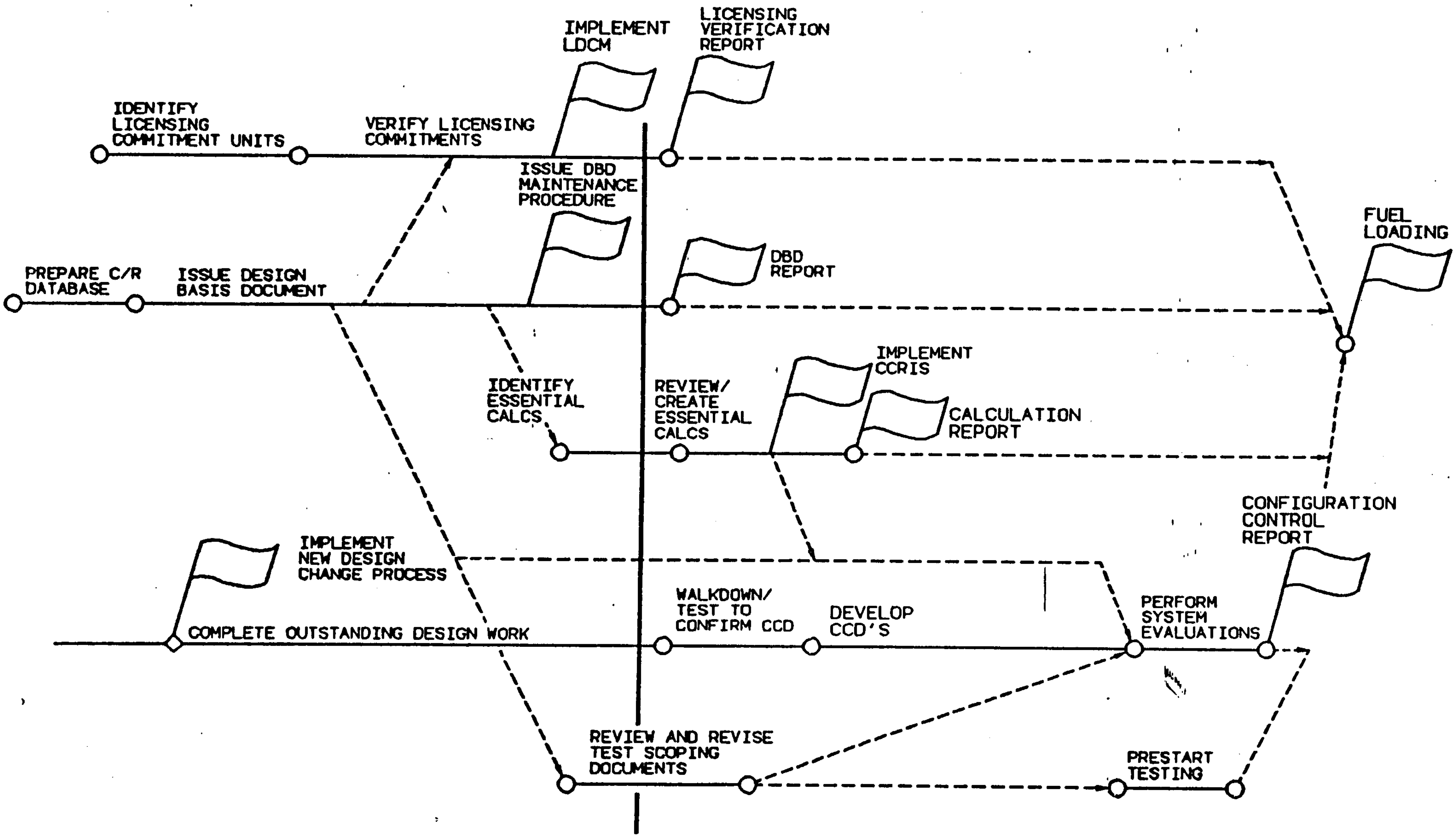
Preparation of ECN Modification Packages

Configuration Control Drawing Preparation and Control

Walkdowns

Performance of System Evaluations

ATTACHMENT 7
DBVP STATUS



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

November 20, 1989

Docket Nos. 50-390
and 50-391

Mr. Oliver D. Kingsley, Jr.
Senior Vice President, Nuclear Power
Tennessee Valley Authority
6N 38A Lookout Place
1101 Market Street
Chattanooga, Tennessee 37402-2801

Dear Mr. Kingsley:

SUBJECT: NRC INSPECTION REPORT NOS. 50-390/89-12 and 50-391/89-12

A Nuclear Regulatory Commission (NRC) team inspected the Watts Bar Unit 1 (WBN-1) facility September 11 through 15, 1989. During the inspection, the team reviewed the adequacy of the WBN-1 Corrective Action Program (CAP) Plan for the Design Baseline and Verification Program (DBVP). The team also interviewed responsible personnel from the Tennessee Valley Authority (TVA) about TVA's implementation of the WBN-1 DBVP CAP Plan.

The NRC team found that the DBVP CAP Plan contained the essential elements to achieve its goals and objectives. Therefore, the CAP, when fully implemented, will ensure that the Watts Bar plant configuration will be in conformance with the licensing design basis. However, the NRC team identified several items that TVA needs to address.

The enclosed inspection report details the scope, objectives, and findings of the NRC inspection and identifies the areas examined during the inspection (Enclosure 1). Your attention is directed to the items detailed in Section 3, Summary, of the inspection report. Your response to these items is requested within 30 days of receipt of this letter.

The responses directed by this letter and its enclosure are not subject to the clearance procedures of the Office of Management and Budget as required by the Paperwork Reduction Act of 1980, PL 86-511.

~~8912040101 4pp.~~

In accordance with Section 2.790 of the NRC's "Rules of Practice," Part 2, Title 10, Code of Federal Regulations, a copy of this letter and its enclosure will be placed in the NRC Publice Document Room. If there are any questions concerning this inspection, please contact this office.

Sincerely,

B. D. Liaw, Director
TVA Projects Division
Office of Nuclear Reactor Regulation

Enclosure:
Inspection Report Nos. 50-390/89-12
and 50-391/89-12

cc w/enclosure:
See next page

cc:
General Counsel
Tennessee Valley Authority
400 West Summit Hill Drive
ET 11B 33H
Knoxville, Tennessee 37902

Mr. F. L. Moreadith
Vice President, Nuclear Engineering
Tennessee Valley Authority
400 West Summit Hill Drive
WT 12A 12A
Knoxville, Tennessee 37902

Dr. Mark O. Medford
Vice President and Nuclear
Technical Director
Tennessee Valley Authority
6N 38A Lookout Place
Chattanooga, Tennessee 37402-2801

Manager, Nuclear Licensing
and Regulatory Affairs
Tennessee Valley Authority
5N 157B Lookout Place
Chattanooga, Tennessee 37402-2801

Program Manager
Watts Bar Nuclear Plant
Tennessee Valley Authority
P. O. Box 800
Spring City, Tennessee 37381

Mr. D. E. McCloud
Acting Site Licensing Manager
Watts Bar Nuclear Plant
Tennessee Valley Authority
P. O. Box 800
Spring City, Tennessee 37381

Mr. Richard F. Wilson
Vice President, New Projects
Tennessee Valley Authority
6N 38A Lookout Place
Chattanooga, Tennessee 37402-2801

Honorable Robert Aikman
County Judge
Rhea County Courthouse
Dayton, Tennessee 37321

Honorable Johnny Powell
County Judge
Meigs County Courthouse
Route 2
Decatur, Tennessee 37322

Mr. Michael H. Mobley, Director
Division of Radiological Health
T.E.R.R.A. Building, 6th Floor
150 9th Avenue North
Nashville, Tennessee 37219-5404

Regional Administrator, Region II
U.S. Nuclear Regulatory Commission
101 Marietta Street, N.W.
Atlanta, Georgia 30323

Senior Resident Inspector
Watts Bar Nuclear Plant
U.S. Nuclear Regulatory Commission
Route 2, Box 700
Spring City, Tennessee 37381

Dr. Henry Myers, Science Advisor
Committee on Interior
and Insular Affairs
U.S. House of Representatives
Washington, D.C. 20515

Tennessee Valley Authority
Rockville Office
11921 Rockville Pike
Suite 402
Rockville, Maryland 20852

DISTRIBUTION: (w/enclosure)
DCS (Docket Nos. 50-390, 50-391)
PDR
LPDR
ADSP R/F
TVA R/F
TVA TP R/F
DCrutchfield
BDLiaw
RPierson
BWilson, RII
KBarr, RII
DTerao
GGeorgiev
BGrimes, NRR
FMiraglia, NRR
SBlack
RAuluck
EJordan, AEOD
ACRS (10)
OGC
Inspection Team
TQuay
RBorchardt, EDO
MCallahan, CA/GPA

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

UNITED STATES NUCLEAR REGULATORY COMMISSION

OFFICE OF NUCLEAR REACTOR REGULATION

TVA PROJECTS DIVISION

Report Nos.:	50-390/89-12 and 50-391/89-12
Licensee:	Tennessee Valley Authority 6N 38A Lookout Place 1101 Market Street Chattanooga, Tennesseee 37402-2801
Docket Nos.:	50-390 and 50-391
Construction Permit Nos.:	CPPR-91 and CPPR-92
Facility Name:	Watts Bar Units 1 and 2
Inspection Conducted:	September 11-15, 1989

Inspector: G. Georgiev, Team Leader — 11-8-89 Date

Consultants: S. Traiforos, R. McFadden, N. Rivera, G. Johnson, N. Tsai, M. Partridge

Approved by: Robert C. Pierson, Assistant Director for Technical Programs, TVA Projects Division, Office of Nuclear Reactor Regulation — 11-14-89 Date

~~8912040107~~ 32pp.

INSPECTION TO REVIEW ADEQUACY OF
DESIGN BASELINE AND VERIFICATION
CORRECTIVE ACTION PROGRAM PLAN

1 BACKGROUND INFORMATION

The Watts Bar Nuclear (WBN) Plant Design Baseline and Verification Program (DBVP) was established to ensure that the WBN licensing basis, design basis, calculations, and safety-related plant functional configuration are in agreement and to establish the necessary systems and procedures to maintain this baseline. The DBVP included five major areas: (1) licensing verification, (2) design basis, (3) calculations, (4) configuration control, and (5) testing requirements. The DBVP will generate design change control procedures to address the development and maintenance of a single set of plant drawings that will replace the existing sets of "as-designed" and "as-constructed" drawings.

The Tennessee Valley Authority (TVA) first submitted its DBVP Corrective Action Program (CAP) Plan for Watts Bar Unit 1 to the Nuclear Regulatory Commission (NRC) on May 27, 1988. The CAP Plan was subsequently revised twice and resubmitted to the NRC on October 20, 1988 (Revision 1) and on June 29, 1989 (Revision 2).

2 SCOPE

From September 11 through September 15, 1989, an NRC team reviewed and assessed the adequacy of the WBN DBVP CAP Plan. The NRC team focused on the programmatic aspects of the DBVP. The implementation of the program, which is in an early state of completion and will be evaluated during subsequent inspections.

The NRC team divided its inspection of the DBVP CAP Plan into four areas: civil/structural, mechanical and nuclear, electrical, and instrumentation and control. The general scope of this inspection included a review of the information in the DBVP CAP Plan and associated supporting documentation in relation to each specific area as well as interviews with TVA personnel cognizant of a particular area. The NRC team reviewed the content of the WBN DBVP CAP Plan, which encompassed five activities: (1) licensing verification, (2) design basis, (3) calculations, (4) configuration control, and (5) testing requirements. The team considered the applicable DBVP Cap Plan activities in each of the four major areas it examined. Any additional inspection activities, findings, and conclusions for each of these areas are discussed in Section 4, Inspection Details. The specific documents reviewed are listed in Appendix A for each of the four areas.

3 SUMMARY

The NRC team found that the DBVP CAP Plan contained the essential elements to achieve its goals and objectives; nonetheless, the team identified some items that TVA needs to address. These items are listed below.

(1) The DBVP specifies that all safety-related calculations associated with problem areas are reviewed for technical adequacy. Other selected areas where problems have not been identified also will be reviewed on an as-needed basis. The NRC team finds this commitment needs to be clarified. A more precise description of what or what will not be reviewed should be included in the DBVP.

(2) The DBVP specifies that the Quality Assurance (QA) organization will monitor activities through scheduled audits or surveillances, but it does not specify how many audits and surveillances will be performed and when those audits will be performed. This level of effort should be defined.

(3) The DBVP interfaces with various other ongoing programs, but it does not contain a logic or flow diagram to show how those programs communicate with each other. These activities need to be defined.

(4) The raw service water system and fuel handling and storage system have not been included in the DBVP CAP Plan. These two systems shall be included in the DBVP.

(5) The NRC team review revealed that commitment/requirement (C/R) unit (B43 860902 902) involved a response to NRC Circular 79-02. TVA's response to NRC Circular 79-02 is inaccurate. TVA needs to review the information contained in the circular and revise its response.

4 INSPECTION DETAILS

The NRC team sampled several items for review from each of the four areas: civil/structural, mechanical and nuclear, electrical, instrumentation and control. The team inspection findings and conclusions for each of the areas and their activities follow.

4.1 Civil/Structural Area

4.1.1 Findings

Licensing Verification

The licensing verification activity was initiated to ensure that licensing commitments have been incorporated into the appropriate WBN controlling document.

The team found that TVA's verification activity adequately included the WBN commitments made in such docketed material as the Watts Bar Final Safety Analysis Report (FSAR), the NRC Safety Evaluation Report (SER) and its supplements, 10 CFR 50.55(e) final reports, responses to NRC regarding violations/nonconformances, bulletins/circulars, generic letters, etc., and correspondence referenced in the SER and its supplements. A total of 961 commitments/requirements (C/R) had been verified and included in the design bases C/R tracking system by September 11, 1989.

TVA developed the licensing document commitment matrix (LDCM) for cross-referencing between the C/R tracking system and the implementing documents to verify incorporation of C/R into the appropriate controlling document. The team identified one potential weakness in the C/R tracking and implementing systems for the LDCM.

The commitment licensing summary dated August 3, 1989, shows the cross-referencing between Commitment Unit F03060A000006, and one implementing document, WN-DC-40-31.50. From the open item tracking data base of September 7, 1989, the team found that open item OIDB-4306, Commitment Unit FS03060A000006 was or should be related to two other implementing documents, specifically, WB-DC-40-36 and -64. However, the implementing document report printed on September 13, 1989, shows that Commitment Unit FS03060A00000 is not included in Implementing Documents WB-DC-40-36 and -64. In this case, the LDCM, when updated, should show that the Commitment Unit FS03060A000006 is incorporated into three implementing documents, i.e., WB-DC-40-31.50, -36, and -64. This example raised the team's concern for the potential that a given commitment may not have been incorporated into all affected implementing documents.

Design Basis

The design-basis activity generates design basis documents that incorporate all design-basis engineering requirements and licensing commitments. The design-basis documents are the same as the implementing documents previously discussed in the licensing verification activity.

The team reviewed Design Criteria WB-DC-40-24 (R3) with respect to the Criterion B techniques for (1) combination of modal responses in the analysis of structures with the response spectrum method, and (2) combination of the effects from the three earthquake components. The Criterion B techniques resolved the inconsistencies that the team initially identified from the corresponding Criterion B techniques specified in FSAR Sections 3.7.2 and 3.7.3. The team also reviewed Design Criteria WB-DC-40-31.5 and found the criteria for the seismic analysis and design of buried piping to be consistent with the criteria previously accepted by the staff for application to the Sequoyah and Browns Ferry nuclear plants. The team therefore concluded that both Design Criteria WB-DC-40-24 and WB-DC-40-31.5 appeared to be adequate.

On the basis of its review of samples of the civil/structural design criteria, the team concluded that the design-basis activity appeared to be acceptable.

Calculations

The calculation program in the civil/structural area has a two-phase structure. During Phase 1, TVA reviewed the retrievability of all safety-related calculations and identified 12 missing calculations for which new calculations must be generated. A list of the required safety-related calculations is being developed, and the calculations will be categorized in accordance with features or areas. There will be a total of about 30 categories.

Phase 2 of the calculation program will include the following activities:

(1) generation of the 12 missing calculations
(2) review of the technical adequacy of those safety-related calculations associated with problem areas and selected calculations for areas where problems have not been identified
(3) assurance of consistency with plant design by means of field walkdowns and using available walkdown information developed in other concurrent programs such as the hanger analysis and update program (HAAUP)
(4) maintenance of both cross-discipline and within-discipline interfaces for the various concurrent programs and CAP plans
(5) review for generic impact the lessons learned from other industry plants and, in particular, from the resolutions of the conditions adverse to quality reports (CAQR), employee concerns, and Vertical Slice Review discrepancies
(6) resolution of the CAQRs that identify inconsistencies between calculations and design documents
(7) establishment of a calculation maintenance process by implementation of a calculation cross-reference information system (CCRIS)

At the time of the inspection, the calculation program was about 10 percent complete.

The team expressed concern with the sufficiency of activity in that, for areas believed to have no problems, the review of technical adequacy will be done for selected calculations only and, in the absence of a specific guideline, the selection will depend largely on engineering judgment. Other than this concern, the team believed that the calculation program contains the necessary activities to accomplish its intended goal.

Additional Items

In addition to the review for programmatic adequacy of the DBVP activities, the team reviewed the quality assurance oversight activity. In 1989, TVA conducted one engineering assurance (EA) technical audit (WBT89901) and one nuclear quality audit and evaluation (NQA&E) technical audit (WBA89923). The EA technical audit identified two civil/structural areas for improvements. The NQA&E technical audit generated one CAQR (WBA890383923) for the HAAUP and identified several areas for programmatic improvements to the DBVP. The team found the quality assurance oversight program to be adequate.

4.1.2 Conclusions

The NRC team concluded that the DBVP CAP Plan contained the essential elements needed to achieve its goals and objectives in the civil/structural area. The team identified two potential weaknesses in the program:

(1) There may be a lack of assurance that each commitment/requirement is consistently implemented into all affected documents.

(2) The calculation program is vague in its criterion for selecting the calculations for technical adequacy review for those areas believed to have no problems.

4.2 Mechanical and Nuclear Systems

4.2.1 Mechanical Systems

4.2.1.1 Findings

Licensing Commitment Documents

For Watts Bar, TVA has committed to capture the licensing commitments of the plant in the design-basis documents (DBDs) for each system. To accomplish this objective the various Watts Bar licensing documents (e.g., FSAR and letters to the NRC) have been reviewed by TVA and its contractors to identify and categorize all licensing commitments. These commitments were captured in one of two data bases: (1) the commitments/requirements data base and (2) the licensing documentation commitment matrix data base. The C/R data base is a temporary program to aid in the disposition of licensing commitments and will not be used once all commitments are captured elsewhere. The LDCM will be maintained throughout the life of the plant.

TVA and contractor personnel reviewed licensing documents in detail to identify commitments and requirements. The FSAR was one of the documents reviewed and it was marked to identify unique commitments and requirements. Portions of FSAR Section 6, Emergency Core Cooling Systems (ECS), were reviewed by the NRC team to assess the means used to capture these commitments in DBDs. These individual commitments were identified by a "commitment unit number" placed in the margins of a copy of the FSAR.

One such commitment, which had two parts, from page 6.3-11 of the FSAR regarding piping design for the safety injection system (SIS), was identified as Commitment Unit FS060302002013 and Commitment Unit FS060302002013A. The FSAR states: "All piping joints are welded except for the pump and butterfly valve flanged connections. Weld connections for pipes sized 2-1/2 inches and larger are butt welded. Reducing tees are used where the branch size exceeds one-half of the header size. Branch connections of sizes that are equal to or less than one-half of the header size conform to the American National Standards Institute (ANSI) code. Branch connections 1/2 inch through 2 inches are attached to the header by means of full-penetration welds, using pre-engineered integrally reinforced branch connections." The FSAR further states: "Minimum piping and fitting wall thicknesses as determined by ANSI B31.1.0-1967 Ed. formula are increased to account for the manufacturer's permissible tolerance of minus 12-1/2 percent on the nominal wall and an appropriate allowance for wall thinning on the external radius during any pipe bending operation in the shop fabrication of the subassemblies."

Commitment/Requirement WBNNEBLHC1205 states that Commitment Unit FS060302002013 is captured in DBD N3-63-4001, Revision 4, Section 2.2.10, "Codes and Standards." Commitment/Requirement No. WBNNEBLHC1206 states that Commitment Unit FS060302002013A also is captured in Section 2.2.10. However, Section 2.2.10 only references the various codes and standards applicable to the overall system design. Section 2.2.10 references Table 2.2-1, which identifies the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code Section III as the design code for the system piping. Section 2.2.16, "Piping Design," of the DBD contains none of the specific requirements, such as the required use of reducing tees, identified in the FSAR. Thus, while DBD N3-63-4001, Revision 4, does reference an appropriate general design code for piping, it does not appear that the specific design requirements found in the FSAR are captured in the DBD.

Commitment Unit FS060302002018 from the FSAR was reviewed by the NRC team. The first paragraph of this commitment involves shielding of the ECCS recirculation loop piping and components external to the containment. The second paragraph involves discharges from ECCS pressure relieving devices (i.e., relief valves) outside containment being directed to the pressurizer relief tank located inside containment. The shielding requirement was found to be captured in paragraphs 2.2.11.14 and 3.5 of DBD N3-63-4001, Revision 4, for the safety injection system. The relief valve discharge requirement was not found to be covered in DBD N3-63-4001 (i.e., in paragraphs 2.2.17, 3.2.2.9, 3.2.3.4, or 3.2.5.7 all relating to relief valves). However, DBD N3-68-4001 for the reactor coolant system, paragraph 3.2.5, "pressurizer relief tank," describes all relief valve discharges that are piped to the tank. Table 3.2.5-1 of this DBD lists these relief valves and includes relief valves from the safety injection system. Thus, the FSAR commitments appear to be captured by the reactor coolant system DBD, but not the SIS DBD.

Commitment Unit FS060302002007 from the FSAR also was reviewed by the NRC team. This commitment involves the supply of component cooling system (CCS) water to the coolers of pumps in the safety injection system (SIS) and residual heat removal (RHR) system. This commitment is covered by C/R WBNNEBLHC1193 and identifies the DBDs for the SIS (N3-63-4001, Revision 4), CCS (N3-70-4002, Revision 1) and RHR system (N3-74-4001, Revision 3). The NRC team reviewed these DBDs and found the commitment to be adequately captured. Specifically, the descriptions of the SIS and RHR pumps stated that water from the CCS cooled the pump coolers (paragraphs 3.2.1.1 and 3.2.2.1 of the SIS DBD, and paragraph 3.2.1 of the RHR DBD) and the safety functions of the CCS described in paragraph 2.1.1 of the CCS DBD includes providing water to these specific pump coolers.

The NRC team concluded that the program to capture and document the licensing commitments and requirements appeared to be functioning adequately although specific cases did exist where the DBDs did not appear to capture specific details of the licensing commitment.

Development of Configuration Control Drawings

TVA is preparing configuration control drawings (CCDs) to provide a set of control room functional drawings that capture the actual plant configuration for safety-related systems. These drawings are prepared by the following process:

(1) Prepare a boundary calculation for the system. The boundary calculation identifies the limits of the safety-related portions of the system in question. This boundary is prepared by marking the system functional boundaries on an "as-constructed" drawing. The boundary is based on the licensing commitment made with respect to that system.

(2) Prepare a detailed walkdown procedure for the system within the boundary calculation.

(3) Walk down the system using the boundary calculation and walkdown procedure. Compare the physical system with that shown on the boundary calculation as-constructed drawings. The walkdowns are performed by Watts Bar plant operators who are familiar with the plant systems.

(4) Prepare a walkdown package that identifies any differences between the physical system and the configuration shown on the as-constructed drawings.

(5) Prepare a CCD based on the results of the walkdown.

TVA stated that the walkdowns for eight of the 24 systems have been completed. The NRC team selected to review the development of the CCD for the main/auxiliary feedwater system. The NRC team reviewed main/auxiliary feedwater system boundary calculation (WBN-03-D053-EPM-HLM-070589, Revision 0). The boundary appeared to be correctly identified. One minor difference was noted: the boundary for the auxiliary pump suction piping was not the same on Drawing 47W803-2 as on Drawing 47W610-3-3. However, the system was walked down correctly in accordance with the correct boundary on Drawing 47W803-2.

The NRC team reviewed Main/Auxiliary Feedwater System Walkdown Procedure TI-93.9, Revision 0. The procedure appeared to be complete and adequately covered the required portions of the walkdown. One minor discrepancy was noted: Appendix C of the procedure lists Drawing 47W862-2, Revision E, as a part of the walkdown package, but the drawing was not included as an attachment to the procedure. However, a copy of the drawing was included in the package used by the plant operators to walk down the system. The applicable parts of the system shown on Drawing 47W862-2, Revision E, consisted of four isolation valves.

The NRC team reviewed parts of the completed main/auxiliary feedwater system walkdown package. The package appeared to be complete and contain the information required by the walkdown procedure. The walkdown team appeared to be intimately familiar with the system and its components. The use of Watts Bar operators to perform the CCD walkdowns as opposed to using contractor personnel, as was being done for other walkdowns, was considered by the NRC team to be a positive feature of the CCD development program. The Watts Bar walkdown team identified many discrepancies, but the walkdown team leader stated that none of the differences were significant in nature. Many of the discrepancies involve the manner in which the as-constructed drawings depicted the physical system or involved errors in the computer-aided-design (CAD) drawings used to perform the walkdown.

Essential Calculations

TVA has committed to re-establish all essential mechanical calculations. Mechanical Engineering Branch Instruction (MEB-I) 23.2, "Design Calculations," was reviewed by the NRC team and it gives detailed instructions for handling new, superseded, and obsolete calculations.

Attachment 3 to the instruction has lists of the types of essential and desirable calculations required for six different categories of calculations. These lists are to be used as check lists to ensure that all required essential calculations have been identified. The Watts Bar MEB (now a part of the Watts Bar Mechanical-Nuclear-Materials (M-N-M) Branch) has prepared a list of all calculations it considered essential. Further, the branch has identified whether the calculations (1) are adequate as is, (2) require an independent review for technical adequacy, or (3) must be regenerated. A copy of the list of mechanical calculations was given to the NRC team. This list was not reviewed for completeness at the time of the inspection. The NRC team also was given a copy of the initial list of the combined M-N-M Branch calculations. This list gives each M-N-M calculation presently in existence or required for plant startup, identified as of September 8, 1989. The Branch committed to maintain and update this list until the calculation cross-reference information system (CCRIS) is fully implemented. The list identifies each calculation as missing, essential, desirable, superseded, obsolete, generic, or file (mostly obsolete calculations that still contain useful information). This list was not reviewed for completeness at the time of the inspection.

There is a difference between the scope of review of mechanical calculations as committed to in Attachment 4 to the DBVP CAP Plan, Revision 2, and what the M-N-M Branch stated that they intend to do. Attachment 4 states:

> For calculations which are not regenerated or reviewed based on known deficiencies, a review of selected calculations will be performed to confirm that additional inadequacies do not exist. Evaluations will be made of the extent of applicability of any identified technical deficiencies.

The M-N-M Branch stated that 100 percent of all calculations generated before about June 1986 (i.e., before TVA Nuclear Engineering Procedures (NEP) 3.1 was implemented) were being given a "technical adequacy review" by an engineering contractor. This amounted to about 70 percent of the essential mechanical calculations. All technical adequacy reviews were expected to be completed by the end of 1989. Calculations generated after implementation of NEP 3.1 have already been reviewed per the NEP 3.1 requirements. This included any new calculations that need to be generated. The NRC team considered the planned level of calculation review to be satisfactory, but that TVA should formally commit to that level of review.

Watts Bar Quality Assurance Overview

The Watts Bar Quality Assurance organization (formerly Engineering Assurance) performed two audits of the Watts Bar DBVP during 1989. The first audit was conducted March 20 through April 5, 1989 (Technical Audit WBT89901), and the second was conducted July 3 through August 3, 1989 (Technical Audit WBA89923). The NRC team reviewed the reports of each audit and determined that the scope and depth of the audits appeared satisfactory to identify systematic DBVP deficiencies. The DBVP CAP is not specific with regard to future audit activities. WBN QA has verbally committed to performing future audits to a specified schedule; however, this verbal commitment should be formalized.

4.2.1.2 Conclusion

The NRC team concluded that the DBVP CAP contains the essential elements needed to achieve its goals and objectives in the mechanical systems area. However, the NRC team noted that the following details of the design bases were not captured in the design-basis document manuals:

1. The detailed piping design requirements contained in FSAR Section 6.3.2 for the safety injection system (SIS) are not found in the SIS Design Basis Document Manual, N3-63-4001, Revision 4. From documentation reviewed during the inspection, the team could not determine that those detailed piping requirements are captured in other documents.

2. The detailed requirements for the routing of the ECCS relief valve discharge piping contained in FSAR Section 6.3.2 for the SIS are not found in the SIS Design Basis Document Manual N3-63-4001, Revision 4. Proper identification of the routing is found in the Design Basis Document Manual N3-68- 4001, for the reactor coolant system (RCS) in its description of the pressurizer relief tank.

4.2.2 Nuclear Systems

4.2.2.1 Findings

Licensing Verification

The licensing verification activity ensures that licensing commitments have been incorporated into appropriate WBN controlling documents. The scope, methods, and documentation requirements for the compilation of the licensing commitment units to be verified during the licensing verification is controlled by Project Procedure WBEP-EP LV.01. These licensing commitments were compiled by TVA. The verification of the commitment units is controlled by Project Procedure WBEP-EP LV.02. Most of the verification has been performed by contractors and has been reviewed for acceptance on a sample basis by TVA.

The team performed a limited review of the Licensing Document Commitment Matrix that cross-references the licensing commitments to its implementing document. No problems were identified during this review.

Design Basis

The design-basis activity ensures that licensing commitments and engineering requirements that make up the design basis of WBN are contained in either design criteria documents or system descriptions.

The procedure that controls the preparation of the C/R data base is WBEP-EP DB.01.

The team performed a limited review of a hard copy of this data base that contained 1328 C/R for the NEB and 310 C/R for the NTB. No problems were identified during this review.

The main objective of the design basis effort is to establish a design-basis document (DBD) through the incorporation of the C/R into the design criteria and the system descriptions. The procedure that controls the DBD is WBEP-EP DB.02. The team finds this approach to be acceptable.

Calculations

TVA provided the NRC team with a list of combined mechanical, nuclear, and materials calculations. The calculation titles were provided, but the identification code for each calculation was incomplete. The identification code not only varies among these groups but within a group based on prevailing identification rules. In addition, the classification was not uniform among the above three groups (e.g., safety related vs. essential). For these reasons, the team could not determine the completeness of this list. According to TVA personnel, this list is not final and will be augmented as new calculations are generated.

A list based on calculation categories, such as the ones listed in NTB-I-25-3.1.4, should be generated. Moreover, consistency should be established among the above three groups on the calculation classification.

The team could not identify a procedure for WBN review of the calculations generated by outside contractors. Such a procedure is necessary for the successful completion of this effort.

Section 4.3 of the DBVP CAP Plan is vague about the degree of review needed to ensure the technical adequacy of calculations. During this team inspection, TVA committed to a 100 percent review of the nuclear and mechanical calculations generated before the release of NEP 3.1 and 80 percent review of the calculations generated thereafter. Moreover QA committed to a 30 percent review of the nuclear and mechanical calculations.

Configuration Control

The raw service water system and the fuel handling and storage system were omitted from the list of systems within the scope of DBVP, Attachment 2, of the DBVP CAP Plan. However, these systems were correctly included in the safety system functional requirements calculation (WBN-OSG4-121). The DBVP CAP Plan should be revised to include these systems.

The safety system functional requirements calculation defines the systems and portion of systems (boundaries) required to mitigate the design-basis events, as determined in two other calculations: the design-basis events list and the design-basis event design criteria. The boundary calculations for the DBVP CAP systems are generated using the safety system functional requirements calculation.

The design-basis events list calculation is currently being revised to address a concern in the most recent QA audit. A review of a system boundary calculation by the team revealed that the calculation was not self-supporting; that is, the calculation had to be used in conjunction with the safety system functional requirements calculation (WBN-OSG4-121). This could have been avoided by transferring the relevant information to the system boundary calculation. Such a transfer would serve also in minimizing the revisions of the safety system functional requirements calculation, which has to be revised every time one of the system boundaries is revised.

In Section 1.0 of the DBVP CAP Plan, it is stated that a single set of drawings, the configuration control drawings (CCDs), will replace the existing sets of as-designed and as-constructed drawings. Considering that the CCDs are non-dimensional, the concern is raised on how a physical (dimensional) set of drawings will be established reconciling the as-designed and as-constructed drawings. The team was not able to identify a program that would accomplish this and would interface with the DBVP.

According to TVA, no CCDs have been generated as yet.

Testing Requirements

The DBVP CAP Plan does not elaborate on how safety system functional requirements, generated as part of the DBVP, will be used to revise the preoperational test scoping documents. The team did not find any reference to DBVP in the governing procedure, Watts Bar Engineering Project (WBEP) Procedure 8.02, Preoperational and Noncritical Systems Testing. The DBVP CAP Plan implies that a valid preoperational test will not be repeated. The team was told that the Prestart Test Program will do a 100 percent testing. DBVP CAP should be revised to reflect the latest TVA position.

Additional Items

The team reviewed the following additional items related to the DBVP CAP activities discussed above.

(1) Potential Generic Condition Evaluations (PGCEs)

The team reviewed a list of generic CAQs generated during the evolution of the Sequoyah and Browns Ferry DBVPs that might potentially impact WBN. According to TVA, only eight PGCEs were generated during the evolution of the Sequoyah and Browns Ferry DBVPs. Of these eight only two have resulted in significant condition reports for WBN.

(2) DBVP CAP Procedural Controls

The team reviewed the status of the development of procedural controls listed in Attachment 6 to the DBVP CAP Plan. Two procedures, the "Preparation of Plant Modification Packages" and the "Performance of System Evaluations," have not been issued.

The list should be enhanced to show the procedure controls for testing. Moreover, many administrative letters applicable to the DBVP were not listed. One such letter, AL.04, covers the management of the DBVP open items, an issue of great importance considering the complexity of the DBVP CAP Plan.

(3) Interfaces Among Programs

Approximately 30 corrective action program plans and special programs are described in the WBN Performance Plan. One of the the team's concerns was the interface among these ongoing programs and the DBVP CAP Plan. Such an interface should be in place to ensure that the complete scope of WBN activities is covered in a consistent manner, there is no duplication of effort, and problem areas that may affect more than one program are identified.

The team was provided with an interface matrix relating these programs through the governing procedures. The procedure governing the preparation of the plant modification packages, although listed in Attachment 6 of the DBVP CAP Plan, was not listed in the interface matrix.

The effectiveness of this method of interfacing the various ongoing programs at WBN will be reviewed during a later team inspection on the implementation of the DBVP CAP Plan.

(4) Miscellaneous

A typing error in Section 6.0 of DBVP CAP should be corrected. The program management team is not shown in Attachment 6 but in Attachment 5.

4.2.2.2 Conclusion

The NRC team concluded that the DBVP CAP Plan contained the essential elements needed to achieve its goals and objectives in the nuclear systems area. However, the team identified several concerns that are summarized below.

(1) TVA should provide a categorized list of safety-related calculations to support the DBVP CAP Plan.

(2) TVA should provide a procedure for reviewing calculations generated by contractors.

(3) The DBVP CAP Plan should be revised to include the two omitted systems.

(4) A methodology should be provided for updating the test scoping documents so that they are in conformance with the system functions as determined by the DBVP CAP Plan. Moreover, the DBVP CAP should be revised to reflect the 100-percent testing performed under the Prestart Test Program.

(5) Attachment 6 of the DBVP CAP Plan should be enhanced to show the procedural controls for testing and the DBVP-CAP-related administrative letters.

4.3 Electrical Systems

4.3.1 Findings

TVA Review of Essential Calculations

According to the DBVP CAP Plan, paragraph 4.3.15, TVA intends to review for technical adequacy only those essential design calculations associated with problem areas and selected calculations for areas where problems have not been identified. The plan does not explain how calculations not associated with problem areas will be selected for review; consequently, it does not adequately ensure that the review program will reveal deficiencies in the non-problem areas. TVA must establish some procedure to provide this assurance. Potentially satisfactory approaches would include reviewing all or a statistically adequate random sample of non-problem essential calculations or developing a reliable set of indicators of deficiencies. TVA has decided to regenerate the entire set of essential WBN electrical calculations so this concern applies only to civil/structural and mechanical/nuclear calculations.

Coordination Among WBN Recovery Programs

The DBVP CAP Plan does not clearly explain the information flow among the numerous and varied WBN recovery programs that the DBVP depends upon for data. For example, the regeneration of essential electrical calculations, a key component of DBVP, will depend on an electrical walkdown program providing cable lengths and characteristics, protective device settings, and other information that will not be available from the physical configuration walkdowns planned as part of DBVP. It is not clear how the DBVP program manager will ensure that the required information will be available when needed. More information is required on the procedures governing the interfaces among mutually supporting programs.

TVA informally provided the inspection team with the DBVP matrix of interfaces among the various programs (WBEP-1333L). This helps to clarify what programs affect others, but does not illustrate information flow or mutual dependencies. The team concluded that TVA needs to develop a flow diagram in order to effectively convey the ways in which the various programs are to fit together.

Scope of Quality Assurance (QA) Audits

The DBVP CAP Plan properly calls for the WBN QA organization to audit the DBVP and its implementation. However, the plan does not specify what will be audited and when; therefore, the inspection team could not determine whether the audits will provide adequate engineering quality assurance. More information on the scope and scheduling of QA audits is needed.

Licensing Commitments

The objectives of the DBVP CAP Plan for this activity are to ensure that commitments to NRC are captured in the appropriate WBN controlling documents, such as design-basis documents (DBDs) and system description documents. The NRC team reviewed a sample of commitments and requirements (C/R) from the C/R data base to determine the adequacy of the implementation of the plan. Many of these commitments are made in such documents as the FSAR, which has been thoroughly evaluated and certified correct by TVA and approved by NRC. However, some of these commitments involve WBN project responses to NRC circulars or generic letters or responses from vendors and such commitments may not have been thoroughly evaluated or approved at the appropriate level. The review revealed one C/R unit (B43 860902 902) involving a response to an NRC circular (Circular 79-02) that could not be verified in accordance with the DBVP plan objectives. The commitment included in the response did not seem to be technically consistent with the issues raised in the NRC circular. According to Instruction WBEP-EP LV.0216, a commitment unit is to be reviewed, and if that commitment is not verifiable, an open item report is to be generated. The instruction (WBEP-EP LV.02) does not explicitly cover technical verification of commitments other than requiring that the commitment be verifiable by a particular discipline.

This issue was discussed with WBN electrical engineering representatives and they made an informal decision to generate an open item report for the commitment. The DBVP instruction on commitment unit verification should be expanded to ensure technical adequacy and consistency of commitments included in TVA responses to NRC or vendor responses to TVA.

Design-Basis Documents

The team reviewed the complete set of design-basis documents related to the WBN electrical power systems. The design-basis documents consist of design criteria and system descriptions and are intended to incorporate all essential technical requirements of the front-line and supporting safety systems, whether derived from the licensing basis of the plant or from sound engineering and operational practices. The team found the electrical DBDs to be generally satisfactory for their limited purpose of capturing the plant design basis although there were significant system-to-system inconsistencies in level of detail as well as several errors and ambiguities. These same problems also were discovered during an audit of the DBDs by the WBN Quality Assurance organization and have been addressed by the resulting condition adverse to quality reports. As a result, they will not be discussed further in this report.

Safety System Functional Requirements Calculation

This calculation (B04 89 0911 400) is derived from the design-basis documents and is intended to summarize the minimum functional requirements of the front-line and supporting safety systems to be used with the testing and essential calculation elements of DBVP. The bulk of the calculation is a table listing the key functions of each system during each design-basis event (DBE). While the information given appears accurate, it typically consists only of a restatement of the general function of the system with a general citation to the underlying DBDs. The team decided that the safety system requirements calculation appeared to add little or nothing to the DBDs because the information it is apparently intended to provide is either already well known to its intended users or available only by searching through the cited DBDs. To be a useful design-basis recovery and documentation tool, the calculation should give detailed data on the limiting pressures, flows, voltages, currents, etc., that are required during each DBE and references to the DBDs should cite the specific paragraph or table where additional details can be found. (The analogous calculation developed by the Browns Ferry DBVP is an example of a useful system requirements document.)

System Boundary Calculations

These calculations consist of as-constructed drawings of the front-line and supporting safety systems (e.g., P&IDs, electrical single-lines, and control schematics). The drawings are marked by the respective TVA system engineers to show the boundaries of the systems to be subjected to configuration confirmation and control under DBVP. The NRC team inspected the complete set of electrical power boundary drawings and found them satisfactory. In many cases, however, the system boundary line had been drawn through component symbols, making it difficult to determine whether the affected components are inside or outside the boundary.

Walkdown Procedures

The procedures for DBVP electrical system walkdowns have not been written, but the NRC team did evaluate TVA's general DBVP walkdown procedure (WBEP CC.01), which essentially is a set of recommendations for writing system-specific DBVP walkdown procedures. The general procedure appeared adequate in view of the limited purpose of WBN DBVP walkdowns (i.e., confirming physical configuration); however, the procedures could be improved by an explanation of the correlation between the walkdowns conducted under it and the other walkdowns and functional testing programs that support DBVP.

The team also reviewed the walkdown procedure for the safety injection system, which is typical of completed system-specific walkdown procedures, and concluded that it conforms to the general procedure and, if adequately implemented, will ensure that the appropriate information is obtained.

Essential Electrical Calculations

The NRC team reviewed TVA's list of essential electrical power design calculations and found it contains all of the necessary calculations to confirm the design basis of WBN's front-line and supporting auxiliary electrical power systems. As noted earlier, TVA has determined that the most of the existing essential electrical calculations are either unretrievable or technically deficient; therefore, TVA decided to regenerate the entire set under a contract with Sargent & Lundy Engineers. However, none of these new calculations had been completed and issued at the time of this inspection.

Quality Assurance/Engineering Assurance

The WBN QA organization has assumed the functions (and incorporated some of the personnel) of the former Engineering Assurance department of the TVA Division of Nuclear Engineering. To date the QA organization has performed two audits of DBVP. The NRC team reviewed the reports on these audits and the resulting condition adverse to quality reports and replicated the QA audit of the electrical design-basis documents and the electrical system boundary calculations. The team found the audits to be quite thorough and insightful; technical adequacy appeared to have been fully considered, as well as the adequacy of documentation and verification.

In addition to the documented DBVP CAP Plan definition, QA will perform vertical-slice evaluations of sample systems as indicated in a presentation to the NRC team.

Testing Requirements

The DBVP CAP Plan calls for a review of preoperational test scoping documents (TSDs) defining system and component test requirements against the corresponding design-basis documents (DBDs). This will be performed for all systems and components that reflect the final configuration of the plant under the prestart test program. As a self-regulating activity, a nuclear quality audit and evaluation (NQA&E) report indicated that existing TSDs do not provide sufficient details of test methods and test equipment to effectively assess functional configuration. This audit report also stated that the DBVP CAP plan has not been effective for identifying and tracking discrepancies between TSDs and DBDs. The audit report recommended that instructions for preparation of TSDs include a higher level of detail and that engineering change notices (ECNs) be evaluated for impact on TSDs.

4.3.2 Conclusion

The NRC team concluded that the DBVP CAP Plan contained the essential elements needed to achieve its goals and objectives in the electrical area. However the team identified four items that TVA needs to address:

(1) TVA intends to review for technical adequacy only those essential design calculations associated with problem areas and selected calculations for areas where problems have not been identified. The plan does not explain how calculations not associated with problem areas will be selected for review. TVA has stated to the NRC team that the entire set of essential electrical calculations will be regenerated for the Watts Bar. TVA needs to formalize this commitment.

(2) The DBVP CAP Plan does not clearly explain the information flow among the numerous and varied WBN recovery programs that the DBVP depends upon for data. TVA needs to develop a flow diagram in order to effectively convey the ways in which the various programs are to fit together.

(3) The DBVP CAP Plan properly calls for the WBN QA organization to audit the DBVP and its implementation. However, the plan does not specify what will be audited and when. TVA needs to define the scope and schedule of those audits.

(4) The NRC team review revealed that C/R unit (B43 860902 902) involved a response to an NRC circular (Circular 79-02) that could not be verified in accordance with the DBVP plan objectives. The commitment included in the response did not seem to be technically consistent with the issues raised in the NRC circular. TVA needs to review the information contained in NRC Circular 79-02 and revise its response.

4.4 Instrumentation and Control (I&C) Systems

4.4.1 Findings

Licensing Verification

The NRC team reviewed the categories of licensing documents that TVA is using to identify I&C-related licensing commitments and confirmed that TVA is examining the appropriate documents. The team also examined selected licensing commitments and verified the I&C-related commitments have been translated into design-basis documents.

Design Basis

The NRC team reviewed the categories of documents that TVA is using to identify I&C-related engineering requirements and confirmed that TVA is examining most of the appropriate documents. However, operator instrumentation and control needs as defined by operating procedures and the detailed control room design review system function and task analysis are not being reviewed to identify system design requirements related to operations in that system descriptions do not provide details regarding the key information and control capabilities necessary to support operator functions in system operation. For example, the reactor coolant system (RCS) description does not discuss the required characteristics of pressurizer pressure indication and pressurizer heater controls to operate the RCS under both normal and abnormal conditions.

The team also sampled other system descriptions to determine if they provided sufficient I&C details. These system descriptions provided a sufficiently detailed basis for the identification of system functional test requirements except for System Description N3-3A-4002 covering the main feedwater system. This system description does not discuss the I&C functions that the feedwater system provides to other systems, such as the measurement of steam generator water level or feedwater flow for input to the reactor protection system.

Calculations

The NRC team examined the preliminary list of essential electrical calculations to confirm that set point, scaling, and demonstrated accuracy calculations are planned for a sample set of safety-related instruments. The team found the necessary calculations planned for a typical instrument for each parameter sampled. Presumably, the final calculations will be generic in nature so that a calculation covering one instrument channel will cover all other channels measuring a given parameter to perform a given set of functions.

Configuration Control

The NRC team examined the system boundary calculations for three systems and confirmed that the necessary I&C functions are contained within the controlled envelope.

The team also examined the safety system functional requirements calculation that purportedly forms the basis for the system boundary calculations. The team found this calculation has several deficiencies:

(1) The calculation is so general in nature that it does little to support the system boundary calculations. For example, it refers to a voluminous system description without identification of, or pointers to, the specific functional requirements for the RCS's functional requirement to maintain core cooling during various design-basis events. Discussions with one system engineer and review of boundary calculations performed by other system engineers provided evidence that the functional requirements calculation was not rigorously used in the performance of boundary calculations.

(2) The calculation is incomplete in some areas. For example, with regard to the RCS requirement to maintain pressure boundary integrity, it refers only to a table of pressure boundary valves in the system description. The calculation does not discuss the function of reactor vessel and head penetration seals, head to reactor vessel seals, or reactor coolant pump seals in maintaining the RCS pressure boundary.

(3) The calculation overstates requirements in some areas. For example, post-accident monitoring (PAM) is identified as a required function of almost every system, even those with no PAM function.

(4) The calculation purports to determine the minimum set of systems or portions of systems required to mitigate design-basis events. It does not, in fact, do that. Another calculation, WB-DC-40-64, which is referenced as input to the safety system functional requirements calculation, determines the minimum set of required systems.

The impact of these deficiencies in the safety system functional requirements calculation is not clear. System boundary calculations appeared to be adequate despite these deficiencies, and TVA stated that system descriptions rather than the functional requirements calculation will be used as the basis for future DBVP activities.

Testing Requirements

Part of the examination of the design-basis documents discussed above under "Design Basis" was directed at confirming their adequacy as the basis for identifying I&C testing requirements. The use of system descriptions as the primary basis for establishing I&C testing requirements is appropriate provided the concerns discussed under "Design Basis" are adequately addressed.

During the plant tour, the NRC team noted one pair of vital inverters were attached to the floor differently from another identical pair: one pair was welded to steel embedded in the floor, while the other pair was attached using anchor bolts. After the team questioned if both configurations were seismically qualified, TVA's preliminary determination showed that only the welded configuration is qualified. TVA prepared CAQR WBP890460 to document and track the resolution of this finding.

4.4.2 Conclusion

The NRC team concluded that the DBVP CAP Plan contained the essential elements needed to achieve its goals and objectives in the instrumentation and controls area. However the team identified three items that TVA needs to address:

(1) System descriptions should be strengthened to discuss the key system instrumentation and controls needed to support operator activities under both normal and abnormal conditions. Required characteristics of key instruments and controls (e.g., range, accuracy, location, display/control type, display/control integration) should be included in the system requirement definition, at least by reference.

(2) The main feedwater control and injection water system description should discuss the key instrument and control functions that the feedwater system supplies to other plant systems.

(3) The impact of the deficiencies noted in the safety system functional requirements calculation should be examined and appropriate corrective action taken. As a minimum, the calculation should be voided if its errors are not corrected.

5 PERSONS CONTACTED

Licensee Employees:

J. Adair, Lead Civil Engineer
G. Atwood, Licensing Verification Manager
C. Bowman, Sr. Engineering Specialist
R. Clerk, Nuclear Engineer
K. Jones, Startup Manager
F. Koontz, Jr, Lead Mechanical Manager
J. Lyons, Engineering Startup Manager
D. Malone, Technical Audit Manager
P. Mandova, Project Engineer
G. Mauldin, Program Manager
J. McGinnis, Operations Support Manager
J. Palatinus, Configuration Manager
C. Riedl, Nuclear Engineer
A. Robertson, QA evaluator

APPENDIX A
DOCUMENTS REVIEWED

CIVIL/STRUCTURAL AREA:

Watts Bar Nuclear Plant Nuclear Performance Plan, Vol. 4, Section III: Corrective Actions.

Watts Bar Nuclear Plant Design Baseline and Verification Program (DBVP) Corrective Action Program Plan, Rev. 2, March 29, 1989.

Watts Bar Nuclear Plant Units 1 and 2 Lack of Complete Controlling Design Input Requirements, WBRD-50-390/87-21 and WBRD-50-391/87-25, CAQR WBP870443, 10 CFR 50.55(e), revised final report.

TVA CAQR No. WBP870443, Rim No. T42 870709 989.

TVA CAQR No. WBT870165, Rim No. T42 890815 837.

TVA Memorandum from A. P. Capozzi to P. E. Mandava, "Watts Bar Engineering Project (WBEP) Engineering Assurance (EA) Technical Audit WBT89901 - Design Baseline and Verification Program," Rim No. B05 890414 005.

TVA Memorandum from P. E. Mandava to A. P. Capozzi, "Watts Bar Nuclear Plant (WBN) - Engineering Assurance (EA) Technical Audit WBP89901 - Design Baseline and Verification Program (DBVP)," Rim No. B26 890518 302.

TVA Memorandum from D. L. Malone to D. E. Douthit, "Nuclear Quality Audit and Evaluation (NQA&E) Technical Audit Report WBA89923, Watts Bar Nuclear Plant (WBN) Design Baseline and Verification Program (DBVP), Including Design Change Control," RIMS No. L19 890818 800.

WBN Design Bases Commitment/Requirement Tracking System, September 11, 1989.

Watts Bar Engineering Project, Project Manual, Project Procedure No. WBEP-5.10, "Maintenance of Design Basis Document," RIMS No. B26 890531 375.

Watts Bar Engineering Project Licensing Verification Procedure WBEP-EP LV.01, "Compilation of Licensing Commitment Units," WBEP-8537d, October 7, 1987.

TVA Commitment Licensing Summary (08-03-89 Listing) for Commitment Units:
- FS03060A000006
- FS030702007002
- FS030703000002
- FS030703006001
- NRE08600200001
- NRE08600200002

Open Item Tracking Database OIDB-4306 and -4242 (09-07-89 Listing).

TVA Implementing Document Report (09-13-89 Listing) for Implementing Documents:
WB-DC-20-3(R1)
WB-DC-20-24(R3)
WB-DC-40-31.50(R5)
WB-DC-40-31.5 (R2)
WB-DC-40-36
WB-DC-40-64(R1)

Watts Bar Nuclear Plant Final Safety Analysis Report (FSAR), Sections 3.6 and 3.7.

WBEP-5.10, Attachment B, C/R Data Sheet, RIMS No. B54 890602 036.

WBN DBVP Interface Matrix (09-14-89 Handout).

Watts Bar Nuclear Plant Design Criteria WB-DC-20-24 (R3), "Dynamic Earthquake Analysis of Category I Structures and Earth Embankments," Rim No. B26 880726 015.

Watts Bar Nuclear Plant Design Criteria WB-DC-20-31.5 (R2), "Safety Related Buried Piping Systems Seismic Analysis," RIMS No. B26 880725 012.

MECHANICAL AREA:

Watts Bar Nuclear Plant Design Baseline and Verification Program (DBVP) Corrective Action Program (CAP) Plan, Rev. 2, March 29, 1989.

Mechanical Engineering Branch Instruction, MEB-I 23.2, Rev. 2, "Design Calculations."

Watts Bar Nuclear Plant - Mechanical, Nuclear and Materials Calculation List, September 8, 1989.

Mechanical Safety Related Calculation List, September 14, 1989.

Nuclear Quality Audit and Evaluation Technical Audit Report WBA89923, Watts Bar Nuclear Plant Design Baseline and Verification Program, including Design Change Control and attached Conditions Adverse to Quality Reports (CAQRs) WBA 890379923, 890380923, 8990381923, 890382923 and 890383923.

Watts Bar Engineering Project Engineering Assurance Technical Audit WBT89901 - Design Baseline and Verification Program and attached CAQR WBE 90178901.

DBVP Interface Matrix, September 14, 1989.

CAQR WBP870443, Rev. 1, Provision and Maintenance of Adequate Design Input Per NEP - 3.2.

CAQR WBT870165, Rev. 4, Accuracy of FSAR Statements for all TVA Plants.

Following portions of Design Basis Document Manual

N3-3A-4002, Main Feedwater System
N3-3B-4002, Auxiliary Feedwater System
N3-63-4001, Rev. 4, Safety Injection System
N3-68-4001, Reactor Coolant System
N3-70-4002, Revision 1, Component Cooling System
N3-74-4001, Rev. 3, Residual Heat Removal System

Portions of Section 6 of Watts Bar Final Safety Analysis Report, Emergency Core Cooling Systems.

Boundary Calculation WBN-03-D053-EPM-HLM-070589, Rev. 0, Auxiliary/Main Feedwater System.

Auxiliary/Main Feedwater Walkdown Procedure, TI-93.9, Rev. 0.

Auxiliary/Main Feedwater Walkdown Package and Accomplished in Accordance With Walkdown Procedure, TI-93.9, Rev. 0.

(20) Licensing Documentation Commitment Matrix (LDCM):

Commitment Unit FS060302002007 and backup documents
Commitment Unit FS060302002013 and backup documents
Commitment Unit FS060302002013A and backup documents
Commitment Unit FS060302002018 and backup documents

Licensing Commitments/Requirements:

WBNNEBLHC1193
WBNNEBLHC1205
WBNNEBLHC1206

NUCLEAR AREA:

Watts Bar Nuclear Plant Design Baseline and Verification Program (DBVP) Corrective Action Program Plan, Rev. 2, March 29, 1989.

Design Bases Events List, WBN-OSG4-107, B26 1988 0307 015, Rev. 0, March 1, 1988. Rev. 1 is under preparation.

Design Criteria No. WB-DC-40-64, Design Basis Events Design Criteria, Rev. 1, June 1, 1989.

Safety System Functional Requirement, WBN-OSG4-121, B04 1989 0911 400, Rev. 1, September 7, 1989.

CAQR WBP870443, Rev. 1 (July 8, 1987) and Rev. 0 (June 8, 1987). Requirement violated: Provide and maintain adequate design input.

Watts Bar Engineering Project (WBEP) Engineering Assurance (EA) Technical Audit WBT89901 - Design Baseline and Verification Program, April 14, 1989, B05 '89 0414 005, and resulting CAQR WBE890178901.

Nuclear Quality Audit and Evaluation (NQA&E). Technical Audit Report WBA89923, Watts Bar Nuclear PLant (WBN), Design Baseline and Verification Program (DBVP), Including Design Change Control, July 3 - August 3, 1989, L19 890818 800, and resulting CAQs and WBAs.

Watts Bar Engineering Project Procedure WBEP 8.02, Preoperational and Noncritical Systems Testing, B26 '89 0309 016, Rev. 1, March 9, 1989.

WBN Unit 1 Baseline Boundary - Systems 03 and 46, B26 89 0808 551, Rev. 0, July 25, 1989.

Nuclear Technology Branch Instruction NTB-I-25-3.1.4, Calculation Classification and Categorization, B45 '88 0712 255, Rev. 0, July 13, 1988.

WBN Nuclear Performance Plan, Volume 4, May 1989.

Watts Bar Nuclear Plant, Mechanical-Nuclear-Materials Calculation List, Memorandum from F.A. Koontz to Those Listed dated September 8, 1989.

Project Procedure WBEP-EP LV.01, Compilation of Licensing Commitment Units, Rev. 2, B26 1988 0317 005, February 24, 1988.

Project Procedure WBEP-EP LV.02, Commitment Unit Verification, Rev. 0, B26 1988 0317 006, March 11, 1988.

Project Procedure WBEP-EP DB.01, Preparation of Commitment/Requirement Data Base, Rev. 0, No RIMS Number, November 18, 1986.

Project Procedure WBEP-EP DB.02, Preparation of Design Basis Document, Rev. 4, B26 1988 0518 026, May 10, 1988.

ELECTRICAL AREA:

Calculations

B26 89 0510 538 - Auxiliary Power Systems Database (TELAS)

B04 89 0911 400 - Safety System Functional Requirements

B26 89 0905 407 - WBN Unit 1 Baseline Boundary, System 211

B26 89 0901 498 - WBN Unit 1 Baseline Boundary, System 212

B26 89 0901 405 - WBN Unit 1 Baseline Boundary, System 213

B26 89 0901 404 - WBN Unit 1 Baseline Boundary, System 214

WBN-215-D053-EPE-ECM-060589 - WBN Unit 1 Baseline Boundary, System 215

B26 89 0901 499 - WBN Unit 1 Baseline Boundary, System 228

B26 89 0905 408 - WBN Unit 1 Baseline Boundary, System 232

B26 89 0901 401 - WBN Unit 1 Baseline Boundary, System 235

B26 89 0901 403 - WBN Unit 1 Baseline Boundary, System 236

B26 89 0901 499 - WBN Unit 1 Baseline Boundary, System 228

B26 89 0901 402 - WBN Unit 1 Baseline Boundary, System 251

<u>Procedures and Other Policy Documents</u>

Project Manual Project Procedure, Watts Bar Engineering Project (WBEP) CC.01, Walkdown of Functional Configuration

Site Instruction I-93.8, Design Baseline and Verification Project Walkdown of Safety Injection (System 63)

DBVP Instruction WBEP-EP LV.02, Commitment Unit Verification

<u>Reports and Correspondence</u>

Letter, S.A. White of TVA to USNRC, Watts Bar Nuclear Plant (WBN), "Corrective Action Program (CAP) for the Design Baseline and Verification Program (DBVP) for Unit 1 and Common Features," October 20, 1989.

TVA internal memorandum, D.L. Malone to D.E. Douthit, L19 89 0818 800, "Nuclear Quality Audit Report WBA89923, Watts Bar Nuclear Plant (WBN) Design Basis and Verification Program (DBVP), Including Design Change Control" and attached draft CAQRs, July 18, 1989.

TVA internal memorandum, A.P. Capozzi to P.R. Mandava, "Watts Bar Engineering Project (WBEP) Engineering Assurance (EA) Technical Audit WTB-9901 - Design Baseline and Verification Program and attached draft CAQRs, April 14, 1989.

<u>Nonconformance Reports</u>

SCR-6297-S, Control of As-Constructed Drawings

Design Basis Documents

Design Criteria:

- WB-DC-30-4, Divisional separation
- WB-DC-30-5, Cables
- WB-DC-30-22, Electrical raceways
- WB-DC-30-23, Human factors
- WB-DC-30-27, Ac and dc control power
- WB-DC-30-28, Low and medium voltage power
- WB-DC-30-32, Grounding
- WB-DC-40-28.1, Fifth emergency diesel generator

Licensing Commitments

B43 860902 902, Characteristics of AC Power Inverters Which Prevent Loss of Related Instrumentation/Control Systems During Operations

B43 860807 873, Vital AC & DC Power Systems Electrical Protection During Post LOCA Flood

Miscellaneous

WBEP-1333L, DBVP Interface Matrix.

WBN Calculations List - Electrical, September 13, 1989.

Electrical Controls and Instrumentation, September 6, 1989.

NRC IE Circular 79-02, Failure of 120 Volt Vital AC Power Supplies.

INSTRUMENTATION AND CONTROL AREA:

Detailed Design Criteria, WB-DC-30-7, "Watts Bar Nuclear Plant, Post Accident Monitoring Instrumentation," Rev. 2, September 22, 1988.

DNE Calculation B26890808551, "Watts Bar Nuclear Plant, Unit 1, Baseline Boundary Systems 03 and 46," Rev. 0, July 25, 1989.

DNE Calculation B450911400, "Safety System Functional Requirements," Rev. 1, September 7, 1989.

DNE Calculation B26890629556, "Watts Bar Nuclear Plant, Unit 1, Baseline Boundary System 31," Rev. 0, June 12, 1989.

General Design Criteria, WB-DC-30-16, "Watts Bar Nuclear Plant, Instrument Sensing Lines - Slope and Separation," Rev. 2, July 14, 1988.

TVA memorandum from J. E. Hutson to P. R. Mandava, "Watts Bar Nuclear Plant Design Input Memorandum on the Design Criteria for Post Accident Monitoring Instrumentation, WB-DC-30-7," DIM-WB-DC-30-7-2, April 5, 1989.

TVA memorandum from C. A. Chandley, to P. R. Mandava, "Watts Bar Nuclear Plant Design Input Memorandum on the System Description for Main Feedwater Control and Injection Water, N 3-1-4002," DIM-N3-1-4002-1, March 23, 1989.

Project Procedure WBEP-EP DB.02, "Preparation of Design Basis Documents," Rev. 4, May 10, 1988.

Project Procedure WBEP-EP-DB.01, "Preparation of Commitment/Requirement Data Base," Rev. 0, November 18, 1986.

System Description N3-3A-4002, "System Description for Main Feedwater Control and Injection Water," Rev. 2, September 16, 1985.

System Description, N3-99-4003, "System Description for Reactor Protection System," Rev. 2, July 29, 1988.

System Description, N3-68-4001, "System Description for Reactor Coolant System."

ATTACHMENT C:

REPORT WRITING AND INSPECTION GUIDANCE FOR CONTRACTORS

Since the reorganization of the USNRC in 1987, team inspections have become a favored approach to evaluating licensee performance and diagnosing problems affecting safety at plants nationwide. As the scope and complexity of these team inspections evolved, and as the agency made greater use of consultants to supplement our limited inspector resources, the need for consistent and concise written input from consultants became obvious as team leaders struggled to combine into a well written final document the widely varying inputs from a diverse group of specialists. The purpose of this document is to offer guidance to those contractors supporting the inspections on the preparation of written inspection report input

Each of the several types of inspections performed by NRR has evolved over time, and as the process continues to be refined the appearance of the finished product changes in terms of format, emphasis, and style. For that reason, the team leader to whom you will submit your work will provide you in advance with an example report (usually the most recent rendition), and provide specific guidance on any changes planned for the report to which you will be contributing. For example, the format for the recent Oyster Creek SSOMI (Design) report drew heavily on the "strengths and weaknesses comparison" utilized in the Indian Point 3 inspection in 1987. However, the Oyster Creek format differed by the incorporation of a separate section where findings were summarized under engineering discipline headings, an approach found in the Dresden SSOMI from 1986. Team members were provided with copies of both reports, along with specific guidance on which attributes of each were to be incorporated into the Oyster Creek product. Finally, team members were provided specific guidance on one approach to presenting the inspection findings not previously found in SSOMI reports, that of presenting thoroughly documented deficiencies in an appendix.

Understanding the form of the finished product will go a long way toward helping you organize your written input. Here is some advice on how to actually write and submit your input in a manner that bests serves the needs of this inspection.

1. <u>Choice of word processing programs.</u> Consultants in the past have submitted report input using virtually every known word processing program, resulting in significant and costly delays in publication of the final report. The NRC uses Display Write exclusively. Headquarters uses DW4, but submittals in any DW version will work. Although, the folks who write and administer contracts have been asked to consider requiring DW use as a contractual stipulation it is not yet a requirement. Presently, if you submit input in some program other than DW, or submit it in typed hardcopy, it has to be retyped here. We have had some <u>limited</u> success in converting ASCII files to DW, but it is presently not an acceptable alternative. Finally, when you get your input onto DW and put it in the mail to us, please include a hardcopy printout and a copy of the disc in whatever size you can provide it. On the hardcopy, please indicate the filename. Our address:

(Team Leader's Name), Mail Stop 9A1
USNRC
Washington DC 20555

Our address for overnight express mail:

(Team Leader's Name), Mail Stop 9A1
USNRC
One White Flint North
11555 Rockville Pike
Rockville, MD 20852

Our Telefax Number: (301) 492 0259, 492 0960, 492 1137
(Verification: (301) 492 0262)

When setting up your Display Write formats, please use the following settings:

- o typestyle 87 (12 pitch or 12 characters/inch)
- o left margin at 13 (1 inch)
- o right margin at 90 (1 inch)
- o first line of type on line 6
- o last line of type on line 58
- o left justified
- o do not use bold or underline

2. Editorial requirements. A great deal of editorial time can be saved if your input conforms to the following editorial requirements. In addition to these major items, the team leader can provide, at your request, a copy of the U.S. Government Printing Office Style Manual as a handy reference on the preferred treatment of all of the editorial aspects of written material.

a. All inspection reports are written in past tense and active voice. This is true no matter how contrived the wording might sound. Use of past tense describes things as they were at the time of the inspection, not as they are or will be at some undetermined point in the future. Even use of the future tense to describe licensee commitments is not used, preferring instead to describe what they said they would do using the past tense. Thus, a statement that "the licensee has a corrective action program" becomes "the team's review determined that the licensee had a corrective action program". The statement that "the licensee will complete repairs prior to startup" becomes " the licensee committed to complete repairs prior to startup". HINT: If you have trouble thinking in the past tense, don't think in terms of what the licensee did, but in terms of what the team did. Handy phrases include ones like "the team determined" or "the team reviewed".

Use of active voice rather than passive voice gives some life to the report for the reader and helps make the material more concise and to the point. Thus, the statement "the maintenance was performed by the licensee" becomes "the licensee performed maintenance".

Like good print journalism, your statements should answer the questions "who, what, where, when, and how". Since the reader usually can't direct his unanswered questions to anyone knowledgeable, it is important that you answer all his questions for him in advance. For example, the statement "the deficiency was resolved" barely answers the "what" but doesn't begin to answer "who, where, when, or how". A more to the point statement might be "prior to startup the licensee corrected all wiring deficiencies in the control room by replacing 29 of 54 unsatisfactory splices".

b. <u>All references to documents should be complete.</u> If you refer to a licensee procedure, a number is not sufficient; include the full title of the procedure, including revision number and date, as well as the actual title. Likewise, reference to industry codes and standards, NUREGS, Regulatory guides, and so on all require identification. Thus, the phrase "the licensee failed to comply with the piping code of record" is incomplete and needs to specify the code, such as ANSI/ASME B31.1, "Power Piping", 1983. Phrases like "contrary to regulations" or "contrary to the licensee's procedure" are incomplete and need to include the specific regulation or procedure. For example, a statement like "the licensee's procedure controlling diesel generator operation" is not sufficient and needs to be supplemented with the applicable procedure's title, number, revision, and date.

c.<u>Acronyms and abbreviations should not be used alone.</u> The nuclear industry is so fond of acronyms and abbreviations it sometimes sounds as though we speak in a foreign tongue. That's why they should not be used alone, without definition or explanation, in written input. Reference to common industry terms like ATWS, GEMAC, Rosemonts, 79-14 programs, SEP, PRA, and so on assumes a level of reader knowledge that may not be realistic. Likewise, it is a disservice to the reader to define some obscure, plant specific acronym on page 1 and then repeat it on page 30 without repeating the definition. Currently, we define acronyms and abbreviations within the report text rather than attaching a separate page of abbreviations to the report.

d.<u>Additional information to be provided</u> along with your input includes (1)a list of persons contacted <u>and</u> their titles (which is not necessarily the same as their job description), and (2)a list of documents reviewed, complete with accurate title, revision number, and date.

3. <u>Guidance on Content</u> is provided to help improve the overall quality of the report input.

a. <u>Provide sufficient background</u> information and detail to permit a relatively uninformed reader not familiar with the facility, its design or operating history, or your particular professional specialty, to grasp the big picture. No need to write a book, just enough background to help the reader put into perspective what you are saying in your report. For example, if you discover a deficiency of some sort, it could be of value to the reader to know if this deficiency is common to all plants of this design or vintage, how that deficiency has manifested itself through operational or maintenance problems in the past, or whether there is an enforcement history related to this issue. Likewise, a vague reference to something like the 79-14 program needs to be enhanced by a simple phrase describing it as "a regulatory initiative requiring seismic analyses for as-built safety-related piping". This approach is sound when describing technical issues, as well. For example, recent report input made reference to "the 49/50 relays", which is a plant specific component, the number of which doesn't tell the reader a thing. When rewritten, the "49/50" became "thermal and instantaneous overcurrent relays numbers 49 and 50", and included a brief description of their role in the circuitry.

b. Answer the "so what" question for the reader. As a specialist it may be obvious to you why your finding is significant, but perhaps it's not so obvious to the broad range of readers trying to digest the report.

c. Describing the safety significance of your issue should follow logically as you answer the "so what" question. Again, provide just enough detail to allow the reader to assign the proper safety perspective as he/she reads. Note here that simply being out of compliance with some regulatory requirement does not speak to safety significance. Likewise, describing the technical basis behind your issue may not adequately describe the safety significance.

d. Include the legal (regulatory) basis for your concern. In addition to the technical basis, describe whether your finding is contrary to some regulatory requirement. No need to write a comprehensive Notice of Violation here, just a reference to the procedure or regulation which has or has not been fulfilled. Be sure to state clearly just how the licensee failed to comply, including dates. However, if your finding lacks legal basis, don't assume that it therefore has no merit. Inspectors regularly find deficiencies to which no regulation applies, and yet the issue may have safety significance and deserve a full treatment. While the legal basis is an important element of a thorough inspection, remember that we are here to enhance safety, not merely to ensure regulatory compliance. With that goal in mind, we will pursue items of safety significance even when no obvious legal basis exists.

e. Provide examples to substantiate your findings. If you have several, include them all in your writeup and allow the team leader to choose from the samples as he compiles the report. Having specific technical examples of engineering deficiencies is necessary to document and defend your finding, but it is equally important for documentation of the type of subjective, judgmental observations common to management reviews. As a sound approach, document your case as though you had to defend your position in a court of law. Realize that as a minimum you may have to defend your position at the exit before a room full of defensive and argumentative high powered three piece suits.

f. If the licensee takes corrective action or commits to some corrective action, include that information. Before you leave site, work with the team leader to confirm with licensee management the concise wording of their commitment to avoid future confusion and embarrassment. If the licensee takes some action while the inspection is still ongoing, describe what remains to be done as well as what was completed.

Finally, a word about objectivity. All reports should avoid opinion and unsubstantiated conjecture. Well researched and validated facts must be presented in a logical manner that leads the reader to a documented, indisputable conclusion. The regulatory and/or safety connection should be obvious. Information presented in the final report represents the "word" of the federal government, which makes it all the more essential that we give it a quality, professional treatment. The accuracy of data presented in your input is a direct measure of that professionalism and objectivity.

Inaccuracies diminish the validity of our findings and erode the credibility of the agency and individual team members.

Hopefully, these suggestions on content and format will help you as a consultant submit report input tailored for our use. Input not conforming to these guidelines and requiring major revisions by the team leader as he compiles and edits the report will be returned to the author for rewriting.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

November 6, 1987

Docket Nos. 50-327/328

Tennessee Valley Authority
ATTN: Mr. S. A. White
Manager of Nuclear Power
6N 38A Lookout Place
1001 Market Street
Chattanooga, Tennessee 37402-2801

Dear Mr. White:

SUBJECT: SEQUOYAH UNIT 2 INTEGRATED DESIGN INSPECTION (IDI)

The NRC committed at the July 8, 1987 entrance meeting for the Integrated Design Inspection, that the IDI report would be issued on or before November 6, 1987. In keeping with our committed schedule, this letter conveys the results and conclusions of the Integrated Design Inspection of the Sequoyah Nuclear Power Plant, Unit 2.

The inspection focused on the essential raw cooling water (ERCW) system, although other areas were covered as delineated in the enclosed inspection report. Activities included examination of design, design bases, design procedures, records, and inspection of the systems as installed at the plant. Emphasis was placed on reviewing the adequacy of design details as a means of measuring how well the design process had functioned for the selected samples.

The IDI uncovered several areas of programmatic weaknesses in the Sequoyah design process. As discussed previously, in Mr. J. G. Keppler's letter of October 9, 1987, the major programmatic weakness discovered by the IDI team relates to the technical adequacy of the structural calculations for safety-related buildings. The team found these calculations deficient for the following reasons: (1) the calculations contained simplifying assumptions for which there was no apparent technical basis, (2) the dimensional data used in the calculations does not agree with detailed structural drawings, and (3) the calculations available for review during the IDI did not evaluate certain fundamental design considerations or design loading conditions. Further, the team was concerned with the placement of rebar in reinforced concrete and the seismic analysis of the steel containment vessel. As a result of these concerns, the IDI team could draw no conclusions regarding the structural capacity of the plant to withstand design basis events based on the structural calculations reviewed during the inspection. At our September 11, 1987 exit meeting and in Mr. J. G. Keppler's October 9, 1987 letter, you were requested to conduct additional independent technical reviews in this area.

~~8711200007 5pp.~~

The IDI team also identified a major programmatic deficiency with TVA's review of vendor seismic qualification documents. Nine examples were found where vendor supplied components were not seismically qualfied in accordance with the TVA procurement documents.

In addition, the IDI team identified a potential generic concern regarding pipe support design. Of a sample of eight pipe supports reviewed, the IDI team found that three of the pipe support analyses contained nonconservative assumptions and incorrect dimensional data. The team notes, however, that these three pipe support calculations were scheduled to be regenerated.

Other areas of concern identified by the IDI team include inconsistent application of the piping design code of record, inadequate environmental qualification of equipment located in mild environments and the improper specification of the ERCW system design pressure.

Across all disciplines, the IDI team found examples that indicated that TVA had reduced much of the design conservatism that normally exists in nuclear power plants. The sense of the IDI team was that TVA traded-off design margins for increased engineering analysis. While this apparent design philosophy is not unacceptable, the reduced design margins result in a diminished capacity to accommodate initial design errors without requiring plant modification.

Several general observations can be made regarding TVA as a result of the in-depth IDI review. One item observed by the team was an apparent lack of timely corrective action in the Division of Nuclear Engineering (DNE). For example, the problems discussed above regarding the seismic analysis of the steel containment vessel and the unrelated issue of the ERCW design pressure were known to TVA in 1985 and 1986 respectively; however, up to the time of the IDI, DNE had not resolved these items.

A second observation can be made regarding design verification. In view of the problems previously discussed regarding the adequacy of the structural calculations, the use of incorrect dimensional information on pipe support and equipment calculations and the improper use of the piping codes of record, the IDI team concluded that weaknesses existed in TVA's design verification process during the initial plant design. Design verification, as required by 10 CFR 50, Appendix B, if properly implemented, should have detected these types of errors.

A third area that needs the attention of TVA management is the lack of timely implementation of changes to station operating procedures resulting from design changes made by the Division of Nuclear Engineering. For example, a "temporary change" made in 1982, disconnected the wiring and logic for the automatic operation of the ERCW traveling screen. However, for the next five years TVA did not have a procedure for manually operating the ERCW traveling screens to remove debris.

Finally, the IDI team as a group discussed the overall findings of the inspection. One central theme that emerged from this discussion was that the Division of Nuclear Engineering appeared to lack a systems integration function. The design of a nuclear plant is complex in that many systems and components have multiple functions and interact with each other in ways that are not always obvious. These subtle interactions, if not understood and evaluated can cause severe safety problems. In reviewing a number of the findings, it appeared to the team that systems interactions were not always considered. The IDI team believes that TVA would benefit from the establishment of a multi-discipline review group, composed of senior technically oriented people, familiar with systems design, plant operations and the accident analyses methods and assumptions contained in the FSAR. This group could then assess the impact of future design changes on plant safety.

The attached report contains all of the deficiencies identified in Mr. J. G. Keppler's letter of October 9, 1987 as restart items as well as the remainder of the team's findings. In reviewing the findings initially categorized as non-restart items, the IDI team has identified three additional deficiencies that are required to be addressed before Sequoyah restart. These items appear in the IDI report as Deficiencies D2.3-1, D2.4-1 and D4.3-9 and have been discussed with your staff by telephone. None of the restart items previously identified in Mr. J. G. Keppler's October 9, 1987 letter have been changed in the final report.

The enclosed IDI report identifies deficiencies regarding errors, procedural violations and inconsistencies. Unresolved items are identified where more information is needed to reach conclusions. Other observations are identified where it was considered appropriate to call your attention to matters which are not deficiencies or unresolved items, but which are recommended for your consideration. You are requested to respond in writing to the deficiencies and unresolved items within 60 days after receipt of this letter.

In your assessment of individual deficiencies identified in the inspection report, you are requested to address the cause, the extent to which the condition may be reflected in the unreviewed portion of the design, action to correct the existing condition, action to prevent recurrence, and any other information you consider relevant. For unresolved items, the response should provide information needed to reach conclusions concerning acceptability of the specific feature or practice involved.

We have received your response of October 29, 1987 addressing the restart issues transmitted to you in Mr. J. G. Keppler's letter of October 9, 1987. During the IDI follow-up inspection, the week of November 2, 1987, the team will assess your responses by reviewing the supporting documentation such as new calculations, revised drawings, etc. We will notify you of any changes regarding our request that you conduct independent reviews of structural calculations or changes to any other restart issue as a result of our inspection.

In accordance with 10 CFR 2.790(a), a copy of this letter and the enclosures will be placed in the NRC Public Document Room.

Should you have any questions concerning this inspection, please contact me at (301) 492-9663.

Sincerely,

Stewart D. Ebneter

Stewart D. Ebneter, Director
TVA Projects Division
Office of Special Projects

Enclosure:
Inspection Report
50-327/87-48, 50-328/87-48

cc w/enclosure: See next page

Mr. S. A. White
Tennessee Valley Authority

Sequoyah Nuclear Plant

cc:
General Counsel
Tennessee Valley Authority
400 West Summit Hill Drive
E11 B33
Knoxville, Tennessee 37902

Mr. R. L. Gridley
Tennessee Valley Authority
5N 157B Lookout Place
Chattanooga, Tennessee 37402-2801

Mr. H. L. Abercrombie
Tennessee Valley Authority
Sequoyah Nuclear Plant
P.O. Box 2000
Soddy Daisy, Tennessee 37379

Mr. M. R. Harding
Tennessee Valley Authority
Sequoyah Nuclear Plant
P.O. Box 2000
Soddy Daisy, Tennessee 37379

Mr. D. L. Williams
Tennessee Valley Authority
400 West Summit Hill Drive
W10 B85
Knoxville, Tennessee 37902

County Judge
Hamilton County Courthouse
Chattanooga, Tennessee 37402

Regional Administrator, Region II
U.S. Nuclear Regulatory Commission
101 Marietta Street, N.W.
Atlanta, Georgia 30323

Resident Inspector/Sequoyah NP
c/o U.S. Nuclear Regulatory Commission
2600 Igou Ferry Road
Soddy Daisy, Tennessee 37379

Mr. Richard King
c/o U.S. GAO
1111 North Shore Drive
Suite 225, Box 194
Knoxville, Tennessee 37919

Tennessee Department of
Public Health
ATTN: Director, Bureau of
Environmental Health Services
Cordell Hull Building
Nashville, Tennessee 37219

Mr. Michael H. Mobley, Director
Division of Radiological Health
T.E.R.R.A. Building
150 9th Avenue North
Nashville, Tennessee 37203

Dr. Henry Myers, Science Advisor
Committee on Interior
and Insular Affairs
U.S. House of Representatives
Washington, D.C. 20515

U.S. NUCLEAR REGULATORY COMMISSION

OFFICE OF NUCLEAR REACTOR REGULATION

DIVISION OF REACTOR INSPECTION AND SAFEGUARDS

SPECIAL INSPECTION BRANCH

Report No.: 50-327/87-48 and 50-328/87-48
Docket No.: 50-327/328
Licensee: Tennessee Valley Authority
Facility Name: Sequoyah Nuclear Plant, Unit 2
Inspection At: TVA - Office of Nuclear Power, Chattanooga, TN
TVA - Division of Nuclear Engineering, Knoxville, TN
Sequoyah Nuclear Plant, Soddy Daisy, TN
Inspection Conducted: July 8 and 9, 27-31, August 10-21, August 31-September 4, September 9-11, 1987
Inspection Team Members:

Team Leader	E. V. Imbro, Section Chief, SIB/NRR
Co-Team Leader	R. E. Shewmaker, Senior Structural Engineer, EB/OSP
Mechanical Systems	R. W. Parkhill, Senior Operations Engineer, SIB/NRR
	J. R. Houghton, Consultant, Houghton Engineering
Mechanical Components	A. V. duBouchet, Consultant
	V. P. Ferrarini, Consultant, EAS, Inc.
	R. J. Masterson, Consultant, EAS, Inc.
Civil-Structural	H. B. Wang, Operations Engineer, SIB/NRR
	A. I. Unsal, Consultant, Harstead Engineering Associates, Inc.
	O. P. Mallon, Consultant, Gibbs and Hill, Inc.
Instrumentation and Control	J. M. Leivo, Consultant, J. M. Leivo Associates
	S. T. Chen, Consultant, Gibbs and Hill, Inc.
Electrical Power	R. H. McFadden, Consultant, Science Applications International Corporation
	J. T. Haller, Consultant

Robert E. Shewmaker — 10/30/87
Robert E. Shewmaker
IDI Co-Team Leader
Date

Approved By:
E V. Imbro — 10/30/87
Eugene V. Imbro, Chief
Team Inspection Appraisal and Development Section 2
IDI Team Leader
Date

8711200044 ~~91pp~~

TABLE OF CONTENTS

LIST OF DEFICIENCIES, UNRESOLVED ITEMS AND OBSERVATIONS

	ITEM	TITLE
D2.2-1	(Deficiency)	Design Pressure of ERCW System
D2.2-2	(Deficiency)	Procedure Not Available to Limit ERCW Pump Discharge Pressure
D2.2-3	(Deficiency)	Overpressurization of Auxiliary Air Compressor Coolers
D2.2-4	(Deficiency)	Overpressurization of Station Air Compressor Coolers
D2.2-5	(Deficiency)	Evaluation of Failure of ERCW Non-Seismic Piping
D2.2-6	(Deficiency)	Inadequate Procedure For Determination of Boundaries for Fluid Systems
D2.2-7	(Deficiency)	Determination of ERCW Pump House Ambient Temperature for Environmental Qualification (Mild)
D2.2-8	(Deficiency)	ERCW Supply Temperature Limitation
D2.3-1	(Deficiency)	Inadequate Substantiation of Design Commitments for ERCW Piping
D2.3-2	(Deficiency)	Inadequate Professional Engineer Certification For ASME Section III Design Specifications
D2.3-3	(Deficiency)	ERCW Screenwash Pump Not Included in TVA ASME XI Pump Inservice Test Plan
D2.3-4	(Deficiency)	ERCW Screenwash Pumps Not Procured to ASME SECTION III
D2.4-1	(Deficiency)	Improper Application of Critical Crack Criteria
D2.4-2	(Deficiency)	Containment Integrity During Design Basis Flood

D2.5-1	(Deficiency)	Incorrect Operational Modes Data For ERCW
D2.5-2	(Deficiency)	Kerotest Packless Y-Pattern Valves Used for Throttling
D2.5-3	(Deficiency)	Environmental Qualification (Mild) ERCW Pump House Components
D2.5-4	(Deficiency)	Inadequate Substantiation of Procedure for ERCW Screenwash Pump Manual Operation
D3.2-1	(Deficiency)	Nozzle Thermal Displacements of Containment Spray Heat Exchanger 2B
D3.2-2	(Deficiency)	ERCW Cold Thermal Mode
D3.2-3	(Deficiency)	Control of Design Drawings
D3.2-4	(Deficiency)	Piping Modeling Error
D3.2-5	(Deficiency)	Design Drawing Inconsistencies
D3.2-6	(Deficiency)	Missing Pipe Clamp
D3.2-7	(Deficiency)	ERCW Piping Spool Pieces
D3.2-8	(Deficiency)	Valve Operator Fundamental Frequencies
D3.3-1	(Deficiency)	ERCW System Pipe Support Calculations N2-67-2A
D3.3-2	(Deficiency)	Pipe Support Discrepancies
D3.3-3	(Deficiency)	Incorrect Pipe Support Allowable Stresses
D3.3-4	(Deficiency)	Pullout Loadings for Baseplate and Anchor Bolts
D3.3-5	(Deficiency)	Incorrect NCR Corrective Action
D3.4-1	(Deficiency)	Motor Operated Valve Design Pressure
D3.4-2	(Deficiency)	Seismic Qualification of Turbine Driven Auxiliary Feedwater Pump 2A

D3.4-3	(Deficiency)	CCW Heat Exchanger Calculation
D3.4-4	(Deficiency)	CCW and CS Heat Exchanger Nozzle Loading
D3.4-5	(Deficiency)	Vendor-Supplied Flexible Hose
D3.4-6	(Deficiency)	ERCW Upper Containment Vent Cooler Frequency Calculation
D3.4-7	(Deficiency)	Chiller Unit Seismic Qualification
U3.5-1	(Unresolved Item)	Piping Code of Record
D3.5-2	(Deficiency)	Use of Selected B31.1 Code Rules
D3.5-3	(Deficiency)	Unistrut Clamp Load Testing
D3.6-1	(Deficiency)	Design Review for ERCW Equipment
D4.2-1	(Deficiency)	Stability of ERCW Access Cells
D4.2-2	(Deficiency)	Calculations Were Not Checked or Verified
D4.2-3	(Deficiency)	Vertical Response Spectra of the Steel Containment Vessel
D4.2-4	(Deficiency)	Auxiliary Building Seismic Model Does Not Represent The As-Built
D4.3-1	(Deficiency)	Auxiliary Building Base Slab Design
U4.3-2	(Unresolved Item)	Development Length of Base Slab Anchor Rods
U4.3-3	(Unresolved Item)	Negative Moment Reinforcement In Base Slabs And Walls
D4.3-4	(Deficiency)	Load Combination for Concrete Slab
D4.3-5	(Deficiency)	Shear Calculations for Slabs and Walls
D4.3-6	(Deficiency)	Minimum Reinforcement for Walls
D4.3-7	(Deficiency)	Vertical Seismic Load on Auxiliary Building Roof Truss

D4.3-8	(Deficiency)	Overturning of Tanks Located on the Auxiliary Building Roof
D4.3-9	(Deficiency)	Masonry Block Wall Evaluation for Bulletin 80-11
D4.4-1	(Deficiency)	Design of ERCW Pumphouse Structure Roof to Resist Tornado Missiles
D4.4-2	(Deficiency)	Analysis of Pile Supports for the Buried ERCW Pipeline
D4.6-1	(Deficiency)	Discrepancies Between Design Calculations and Construction Drawings
D4.6-2	(Deficiency)	Anchor Bolt Design for Tank
D4.6-3	(Deficiency)	Seismic Analysis of Steel Tanks
D4.7-1	(Deficiency)	Rawl Expansion Anchors
D5.2-1	(Deficiency)	Inconsistency of ERCW Safety Classifications in FSAR
D5.2-2	(Deficiency)	Inadequate Tag Identification of Control Switches in Control Room Panels
D5.2-3	(Deficiency)	Ineffective ERCW Alarms
D5.2-4	(Deficiency)	Inadequate Electrical Isolation of Non-1E Traveling Screen Speed Switch
D5.2-5	(Deficiency)	Inadequate Separation of Redundant Main Control Board Wiring
U5.2-6	(Unresolved Item)	Adequacy of Electrical Separation of Isolation Device Inputs and Outputs
U5.2-7	(Unresolved Item)	Use of Common Penetrations for Redundant Instrument Lines
05.2-8	(Observation)	Criteria for Use of Common Process Connections for Redundant Instrument Lines

O5.2-9	(Observation)	Consideration of Hydraulic Pulsation as Root Cause for ERCW Pressure Gauge Failures
D5.2-10	(Deficiency)	Adequacy of ERCW Instrumentation Provided for Detection of Breaks in Non-Seismic ERCW Piping
D5.3-1	(Deficiency)	Inadequate Shutdown Capability Outside Control Room: Traveling Screen/ Screenwash Circuits
D5.4-1	(Deficiency)	Adeouacy of Freeze Protection for Instrument Lines in the ERCW Pumping Station
D5.4-2	(Deficiency)	Seismic Qualification of Westinghouse Switches
U5.4-3	(Unresolved Item)	Adequacy of Seismic Qualification for Field Located Relays, Timers and Terminal Blocks
D5.6-1	(Deficiency)	Inadequate Specification of Background Radiation for ERCW Effluent Liquid Radiation Monitors
D5.6-2	(Deficiency)	Inadequate Specification of Pressure and Temperature Ratings for ERCW Effluent Liquid Radiation Monitors
U5.8-1	(Unresolved Item)	Instrumentation and Control Design Documentation Deficiencies
D6.2-1	(Deficiency)	Insufficient Demonstration of Worst Case Loading in Diesel Generator Loading Analysis
D6.2-2	(Deficiency)	Insufficient Demonstration of Adequate Class 1E Motor Starting and Running Voltages
O6.2-3	(Observation)	ERCW Pumping Station Lightning Protection
D6.2-4	(Deficiency)	Absence of Neutral Grounding and Ground Fault Detection on 480V Auxiliary Power Systems

06.2-5	(Observation)	Greater-Than-Rated Short Circuit Interrupting Duties on Shutdown and Unit Board Circuit Breakers
06.2-6	(Observation)	Motor Torque Transients Due to Automatic Fast Bus Transfer
D6.3-1	(Deficiency)	Inadequate Voltage Drop Calculations for 125V dc and 120V ac Control Circuits
D6.6-1	(Deficiency)	Unsubstantiated Motor-Operated Valve Performance at Degraded Voltage

LIST OF ABBREVIATIONS

ACI	American Concrete Institute
AERCW	Auxiliary Essential Raw Water Cooling
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
APS	Auxiliary Power System
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
BBC	Brown-Boveri Corporation
CAQR	Condition Adverse to Quality Report (TVA document)
CCS	Component Cooling Water System
CCW	Condenser Circulation Water
CEB	TVA Civil Engineering Support Branch
CFR	Code of Federal Regulations
CPM	Counts Per Minute
CS	Containment Spray
CSSC	Critical Systems, Structures and Components List (TVA document)
DBVP	Design Baseline Verification Program
DIM	Design Input Memorandum
DNE	Division of Nuclear Engineering of TVA
ECN	Engineering Change Notice (TVA document)
EEB	TVA Electrical Engineering Support Branch
EQ	Environmental Qualification
ERCW	Essential Raw Cooling Water System
ESF	Engineered Safety Features
FCR	Field Change Request
FSAR	Final Safety Analysis Report for Sequoyah Nuclear Plant
GDC	(10 CFR 50, Appendix A) General Design Criteria
HVAC	Heating Ventilation and Air Conditioning
ICEA	Insulated Cable Engineering Association
IDI	Independent Design Review
IEEE	Institute of Electrical and Electronics Engineers
ISI	Inservice Inspection
IST	Inservice Testing
ITE	ITE Circuit Breaker Company
LCO	Limiting Condition of Operation
LCVC	Lower Containment Ventilation Cooler
LOCA	Loss of Coolant Accident
MCR	Main Control Room
MEB	TVA Mechanical Engineering Support Branch
MELBA	Moderate Energy Line Break Analysis
MIC	Microbiologically Induced Corrosion
MOV	Motor Operated Valve
MR	Maintenance Request (TVA document)
NCR	Nonconformance Report
NEB	TVA Nuclear Engineering Support Branch
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association

NPSH	Net Positive Suction Head
NRC	Nuclear Regulatory Commission
OL	Operating License
PE	Professional Engineer
PIR	Problem Identification Report (TVA document)
PMT	Post Modification Test
PSAR	Preliminary Safety Analysis Report
PSF	Pounds per Square Foot
QA	Quality Assurance
QAP	Quality Assurance Procedure
SCR	Significant Condition Report (TVA Document)
SEAOC	Structural Engineers Association of California
SI	Surveillance Instruction (TVA document)
SMS	Status Monitoring System
SOI	System Operating Instruction (TVA document)
SQN	Sequoyah Nuclear Plant
SQP	TVA Sequoyah Project
SSD	Self Drilling Anchor
SSE	Safe Shutdown Earthquake
TACF	Temporary Alteration Control Form
TEFC	Totally Enclosed Fan Cooled
TVA	Tennessee Valley Authority
UCVC	Upper Containment Ventilation Cooler
WP	Work Package (TVA document)
WR	Work Request (TVA document)

1.0 INTRODUCTION AND SUMMARY

1.1 OBJECTIVES

In August 1982 the staff of the U.S. Nuclear Regulatory Commission (NRC) undertook a number of initiatives to improve assurance of quality in design and construction of nuclear projects. One of these was to develop and implement an integrated design inspection (IDI) program to assess the quality of design activities, including examination of the as-built configuration. The objective was to expand the NRC examination of quality assurance into the design process. The approach was intended to provide a comprehensive examination of the design development and implementation for a selected system. Six such inspections were completed on plants which were under construction and nearing the final phase of operating license review.

In the summer of 1987, the NRC Office of Special Projects was involved in reviewing many aspects of problems which related to the Sequoyah Nuclear Plant. A large percentage of the issues known at that time related to what appeared to be design and engineering issues. TVA had during the course of a review of the nuclear program, instituted several separate programs looking horizontally across the safety systems at Sequoyah and focusing on the specific concerns. One of these TVA programs, the Design Baseline and Verification Program (DBVP), reviewed all design changes made to Sequoyah since the operating license was issued; its premise being that the original design of Sequoyah was in accordance with its licensing basis. As a result of NRC inspections of TVA's Calculation Review Program, which augmented the DBVP, concerns were raised which related to the original design, particularly with the structural design of steel used to support safety-related components. The NRC was concerned that TVA had not done a comprehensive review of the original design. Such a review could be accomplished by evaluating a vertical slice of the design, taken through one or more safety systems, that would include significant aspects of the interactions and interfaces which occurred throughout the period of engineering, design and construction. Consequently, the staff of the NRC was of the opinion that the techniques of the IDI process could be beneficial in helping to assess the subject of design adequacy of the Sequoyah plant.

As a result of these concerns the NRC notified TVA in a letter dated June 2, 1987 of the need to have an independent third party design/construction verification performed on at least one safety-related system. This was to provide additional assurance that all major engineering design and construction problems had been identified and resolved prior to the restart of Sequoyah Unit 2. The main focus of such an effort would be to ascertain that no major problems have been overlooked. Discussions between TVA and the NRC were held during the early part of June on how such an effort could be accomplished. TVA outlined its position in a letter dated June 12, 1987 noting their proposal of having the TVA Engineering Assurance organization methodology applied by an independent review team from TVA's Office of Nuclear Power instead of the independent third party review requested by NRC. The TVA proposal was rejected by the NRC and as indicated in the June 12, 1987 letter, the NRC undertook the review.

The NRC objectives set forth were to verify (1) the validity of the design inputs and assumptions, (2) the validity of and conformance to the design specifications, (3) the validity of the analyses, (4) the proper implementation of system interface requirements, (5) proper component safety classifications and (6) that proper control was maintained of design changes.

The sample system on which these objectives would be pursued had to meet certain requirements. These criteria were that the sample system must (1) be essential to plant safety, (2) be designed primarily by TVA rather than the NSSS vendor, (3) be representative of other safety systems, and (4) be a system whose design required internal interfaces within the design organization as well as external interfaces with vendors or service organizations. The essential raw cooling water (ERCW) system met these criteria and was selected by the NRC as the system on which the vertical slice review would be performed.

1.2 REPORT FORMAT AND DEFINITIONS

The areas examined during this inspection are addressed by discipline in the following chapters. The disciplines are addressed in the following order: mechanical systems, mechanical components, civil/structural, instrumentation and control and electrical power. Deficiencies, unresolved items, and observations are defined below for the purposes of this report and are included in the appendices to this report by discipline. These are referenced in the text of the report as they are discussed. It should be noted that these definitions, while consistent with other IDI reports, are somewhat different than those used in the staff reports of inspections conducted of the TVA DBVP and Calculation Review programs.

1. Deficiencies - Errors, inconsistencies or procedure violations with regard to a specific licensing commitment, specification, procedure, code or regulation are described as deficiencies. Followup action is required for licensee resolution and NRC evaluation of the resolutions.

2. Unresolved Items - Unresolved items are potential deficiencies which require more information to reach a conclusion. Licensee response and NRC evaluation are required.

3. Observations - Observations represent cases where it is considered appropriate to call attention to matters that are not deficiencies or unresolved items. They include items recommended for licensee consideration but for which there is no specific regulatory requirement. No licensee response is required.

In our evaluation, we found design actions that were being well executed. Some of these positive findings are described in the text of the following sections. They are not flagged and numbered in the text nor listed at the front of this report since followup is not required.

1.3 INSPECTION EFFORT

The selection of the essential raw cooling water (ERCW) system for this inspection effort was based on the fact that it met the general criteria as outlined in the objectives of the task. It also represented a system which interfaced with many of the safety-related systems which was considered to balance the fact that the system operates at low temperatures and pressures when compared to other safety-related systems. It was also known to be a system which had undergone major modifications prior to the operation of Sequoyah Unit 2 that required design efforts of a significant magnitude. Therefore, the potential for identifying weaknesses in design control for the ERCW system was seen to be present.

While the system focus for the IDI team was the ERCW system, other generic technical areas were reviewed by the IDI team in order to evaluate areas outside the scope of the system selected or to expand the review in a particular area of interest. For example, the team evaluated (1) the structural design of safety-related buildings, (2) common hazards, e.g., moderate energy line breaks, flooding and seismic II/I, (3) the design execution for the plant electrical auxiliary power supply system, (4) the ASME Section XI, In-service Test Program and (5) the development of selected floor response spectra. These illustrate technical areas that would not have been specifically covered if the review had been restricted to the ERCW system. The team also reviewed the operating and maintenance history of the ERCW system, by reviewing Licensee Event Reports and Maintenance Requests, to assess whether any trends were evident that were indicative of problems with the system design.

The inspection was an interoffice NRC effort conducted with contractor assistance. Team members were selected to provide technical expertise and design experience in the disciplines listed. Most of the team members had previous experience as employees of architect-engineering firms or reactor manufacturers working on large commercial nuclear power plants. All team members are registered professional engineers, averaging 22 years of experience with substantial design and supervisory design experience.

A date of June 1, 1987 was established as the cut-off date for evaluation purposes and the team examined the design as it existed on that date unless the work was related to any deficiencies already identified and documented by TVA prior to June 1, 1987, with corrective action underway. In some instances, however, the team did review work dated after June 1, 1987, where time permitted, but only to resolve a specific question raised by the team. This approach allowed the IDI team to evaluate the significance of an item. For instance, a subsequent analysis might show whether or not an error, previously made, had any effect on the design.

Beginning in mid-June the team leaders requested background information related to the ERCW system from TVA in order to begin to prepare the IDI team. The team initially began its effort on July 7, 1987 when the team orientation meeting was held in Bethesda, Md. The initial team kick-off meeting with TVA was held as a public meeting in Chattanooga at the TVA complex at 1:00 p.m. on July 8, 1987. A transcript of that meeting was made. The team leaders and discipline leaders then met with TVA in Knoxville on July 9, 1987 to review the availability of design documentation in the disciplines down to the level of individual design calculations or documents. During the period of July 13-24, 1987 the team members spent several days in their offices reading and studying background documents and planning for the IDI field effort. On July 27 and 28, 1987 the IDI team was at the Sequoyah site, to familiarize themselves with the specific field configuration of the ERCW and the adjacent structures, systems and components. The IDI team began conducting inspections at Knoxville in the area of engineering and design as well as the design control process during the period of July 29-31, 1987. Reviews by the IDI team members continued the week of August 3-7, 1987 in the members' home offices. The IDI team returned to the field from August 10-21, 1987 to continue the review of Sequoyah Unit 2. Another week of in-office review and evaluation was completed as well as one additional week in the field during the period of August 24 - September 4, 1987. The IDI team returned to Knoxville on September 9, 1987 with the exit meeting being held on September 11, 1987. This meeting was also a public meeting with the proceedings transcribed.

During the inspection the IDI inspection team reviewed the organization's staffing and procedures and interviewed personnel to determine the responsibilities of and the relationships among the entities involved in the design process. Primary emphasis was placed upon reviewing the adequacy of design details (or products) as a means of measuring how well the design process had functioned in the selected sampling area. In reviewing the design details, the team focused on the following items:

1. Validity of design inputs and assumptions.
2. Validity of design specifications.
3. Validity of analyses.
4. Identification of system interface requirements.
5. Potential indirect effects of changes.
6. Proper component classification.
7. Revision control.
8. Documentation control.
9. Verification of as-built condition.
10. Application of design information transferred between organizations.
11. Design verification methods.

The IDI team inspected five engineering disciplines within the Sequoyah project. The five disciplines were mechanical systems (Section 2); mechanical components, including piping and pipe support design and equipment seismic qualification (Section 3); civil/structural design, including building design and structural analysis and electrical cable tray and conduit supports (Section 4); instrumentation and control (Section 5); and electrical design, including ac and dc power distribution systems and electrical components (Section 6).

1.4 OVERALL CONCLUSIONS

1.4.1 Summary Conclusions

The purpose of the Integrated Design Inspection is to evaluate the adequacy of the Sequoyah original design. This was accomplished by performing an in-depth, multi-discipline review of a representative vertical slice of the overall plant design in order that conclusions can be made regarding the adequacy of the TVA design process. The essential raw cooling water (ERCW) system was selected for this review since it is (1) a safety-related system designed by TVA, (2) the ERCW system travels through many, if not all, of the safety-related plant buildings, and (3) the ERCW system interfaces with other plant systems and components supplied by the NSSS vendor or other component vendors and engineering service organizations.

During the multidiscipline inspection, the IDI team reviewed calculations, drawings, procurement documents and design change documentation, including field change requests (FCRs), nonconformance reports (NCRs) and engineering change notices (ECNs). Since Sequoyah is an operating plant, the IDI team also reviewed maintenance requests (MRs) and licensee event reports for the ERCW system to evaluate its operating history. The team's review of the operating history, with the exception of the freezing of instrumentation lines in the ERCW pumphouse, did not uncover any systematic or recurring failures that would be indicative of design problems.

The determination of design adequacy was made by verifying that the design documents correctly and consistently implemented NRC regulations, FSAR licensing commitments and national industry standards committed to in the FSAR. Where TVA committed to national industry standards, the IDI team was careful to review the design of the ERCW system against the version of the standard committed to in the FSAR. (Sequoyah was designed in the late sixties, and early seventies and many of the industry standards have been revised during the intervening years.)

The IDI team identified 74 deficiencies, 7 unresolved items, and 5 observations. Of the 74 deficiencies and 7 unresolved items, 64 were identified as restart items, based on the application of the restart criteria submitted by TVA in Volume 2 of their Nuclear Performance Plan. The restart criteria are reproduced in Appendix A1 of this report.

During the course of the IDI, the team discovered positive and negative attributes of the TVA design process used for Sequoyah. On the positive side, the IDI team found that TVA, as a result of the Design Baseline and Verification Program, has developed a complete and comprehensive set of design criteria. In addition, in the electrical design area, TVA has developed an entirely new set of calculations to support the electrical design. The IDI team found this set of calculations to be complete and comprehensive. Finally, considering the vintage of the Sequoyah design, the team noted, for the most part, that the design basis documents, including calculations, drawings and procurement documents, are readily retrievable.

The negative results of the IDI however, outweigh the positive attributes of the TVA design process. The IDI team found several areas of programmatic weakness in the Sequoyah design process, as well as specific design deficiencies.

The major programmatic weakness discovered by the IDI team related to the technical adequacy of the structural calculations for safety-related buildings. The team noted fundamental omissions in structural calculations wherein certain design loads and design conditions were not considered. In addition, the IDI team found many cases where calculational assumptions had no factual basis when compared to the actual plant design. The team also found many nonconservative discrepancies between the analyzed configuration of the equipment supports and that shown on the detailed support drawings. Further, the IDI team found problems with the design of reinforced concrete, regarding the placement of reinforcing steel and the seismic analysis of the steel containment vessel (SCV). As a result of the above concerns regarding the adequacy of the structural calculations, the IDI team could not reach a conclusion(s) regarding the structural capacity of the plant to withstand design basis events. While it may ultimately be shown that the structures are adequate, the IDI team could not draw a favorable conclusion based on the calculations available for review during the inspection. In view of the wide range of concerns regarding the adequacy of structural calculations, combined with the knowledge that the Civil Engineering Branch has not performed a current review of calculations (as have the other three engineering branches) the NRC, during the exit meeting, requested that a substantial sample of structural calculations be reviewed. This review is to be conducted by personnel external to TVA that were not involved with the original design of Sequoyah.

The IDI team also identified a major programmatic deficiency in TVA's review of vendor seismic qualification reports and equipment seismic qualification. In the mechanical components discipline, the IDI team found nine examples where components were not qualified in accordance with the requirements specified in the TVA procurement documents. In addition, in the civil/structural discipline the team found unconservative errors in a vendor calculation to determine the natural frequency of a tank. TVA review and certification of vendor seismic qualification documents is an FSAR commitment, it is also required by the TVA procurement documents. Failure to perform a design review may result in incorrect or unverified assumptions or calculational errors that may affect the seismic qualification of safety-related equipment. This programmatic deficiency should be addressed by TVA, as it has generic implications regarding the seismic qualification of vendor supplied components.

The IDI team identified a potential generic concern regarding the design of pipe supports. The team found, in three of eight pipe supports reviewed, that TVA used nonconservative assumptions and incorrect dimensions in their structural analyses. These errors may also affect the support anchor bolt qualification. This generic concern should be addressed by TVA. The IDI team notes that the three pipe support calculations containing errors were scheduled to be regenerated by TVA.

Another area of concern resulting from the IDI is the inconsistent application of the code of record for piping systems. TVA has a rather complex set of FSAR commitments in this area. While the ANSI B31.1.0 - 1967, "Power Piping," is the piping design code of record, the FSAR allows TVA's use of the equations from section NC-3600 of the ASME III Boiler and Pressure Vessel Code, Winter Addenda, 1972 to be used in conjunction with the B31.1.0 - 1967 code. TVA has inconsistently applied both codes. This has resulted in instances where TVA analysts select the combination of criteria from both standards that results in the least stringent set of requirements.

The IDI team also discovered problems with the environmental qualification of equipment located in a mild environment. In the ERCW pump house, for example, the team found several safety-related components that were not qualified to the extremes of temperature that can occur inside the structure. This subject of equipment qualification for mild environments does not appear to have been adequately considered during the design process. TVA should address the generic implications related to this concern.

In the mechanical system discipline, the IDI team found that the design pressure of the ERCW was inadequately substantiated. Contrary to the piping code of record, B31.1 - 1967, TVA placed reliance on administrative control of pumps and valves to maintain the ERCW system operating pressure below its design pressure. In addition, the TVA calculation did not account for variations in system alignments and the effect of equipment being valved out of the system during maintenance. Further, the team found that the design pressure of the safety-related auxiliary air compressors and the nonsafety-related station air compressors was approximately one-half of the ERCW system design pressure, i.e., 70 psig vs 150 psig. No overpressure protection was provided for these components, an obvious code violation.

Across all disciplines, the IDI team found examples that indicated that TVA had engineered-out much of the design conservatism that normally exists in nuclear power plants. The sense of the IDI team was that TVA traded-off design margins for increased engineering analysis. While this apparent design philosophy is not unacceptable, the reduced design margins result in a diminished capability to accommodate initial design errors without requiring plant modification.

Several general observations can be made regarding TVA as a result of the in-depth IDI review. One item observed by the team was an apparent lack of timely corrective action in the Division of Nuclear Engineering (DNE). For example, the problems discussed above regarding the seismic analysis of the steel containment vessel and the unrelated issue of the ERCW design pressure were known to TVA in 1985 and 1986 respectively; however, up to the time of the IDI, DNE had not resolved these items.

A second observation can be made regarding design verification. In view of the problems previously discussed regarding the adequacy of the structural calculations, the use of incorrect dimensional information on pipe support and equipment calculations and the improper use of the piping codes of record, the IDI team concluded that weaknesses existed in TVA's design verification process during the initial design. Design verification, as required by 10 CFR 50,

Appendix B, if properly implemented, should have detected these types of errors. However, in spite of the fact that calculations were signed off as being checked, errors went undetected. TVA needs to strengthen their design verification program. The creation of the engineering assurance function will provide a technical overview which should detect continuation of this problem in future work. However, TVA should address the generic implications for calculations that have not been recently regenerated or reviewed as part of their Calculation Review Program or other ongoing programs.

A third area that needs the attention of TVA management is the lack of timely implementation of changes to station operating procedures resulting from design changes made by the Division of Nuclear Engineering. For example, a "temporary change" made in 1982 disconnected the wiring and logic for the automatic operation of the ERCW traveling screen. However, from that time until the present (five-years) TVA did not have a procedure for manual screen operation.

Finally, the IDI team as a group discussed the overall findings of the inspection. One central theme that emerged from this discussion was that the Division of Nuclear Engineering appeared to lack a systems integration function. The design of a nuclear plant is complex in that many systems and components have multiple functions and interact with each other in ways that are not always obvious. These subtle interactions, if not understood and evaluated can cause severe safety problems. In reviewing a number of the findings it appeared to the team that systems interactions were not always considered. The IDI team believes that TVA would benefit from the establishment of a multi-discipline review group, composed of senior technically oriented people, familiar with systems design, plant operations and the accident analyses methods and assumptions contained in the FSAR. This group could then assess the global impact of future design changes on plant safety.

The following sections, 1.4.2 through 1.4.6, contain a general discussion of the findings and conclusions for each discipline. The specific deficiencies, unresolved items and observations of the IDI team are presented in Appendices A2 through A6 of this report. These findings are numbered so that they correlate to the discipline summaries presented in Sections 2 through 6 of this report.

1.4.2 Mechanical Systems

The mechanical systems discipline for the Sequoyah IDI reviewed the ERCW system for implementation of licensing commitments. The scope included a review of the thermal and fluid design bases of the system; the procurement specifications; the governing codes; interfaces with the other design disciplines; hazards analyses including moderate energy line break, flooding and seismic II over I considerations; test procedures; interfaces with operations and maintenance; and finally, various types of design changes (i.e., FCR, ECN and CAQR).

Within the mechanical systems scope of review the IDI team identified a number of acceptable design related activities being performed by TVA. The new and recently revised calculations were generally clear and supported the stated objective. Where problems were identified, a corrective action was promptly defined, but not necessarily implemented. The design criteria documents were generally up to date reflecting the current licensing commitments. An effective ASME inservice inspection program is in place. A comprehensive moderate energy line break analysis has been performed. Finally, an extensive surveillance program is in place for erosion and corrosion control including microbiologically induced corrosion, with system modifications proposed for long term resolutions.

In reviewing the deficiencies and unresolved items applicable in the mechanical systems discipline, the IDI team identified four trends that bound most of the findings. These trends indicate that TVA needs to improve design control, prompt implementation of corrective action, design verification, and FSAR updating.

Deficiencies in the area of design control comprised the most pronounced trend throughout the review of the mechanical systems discipline. Deficiencies identified by the IDI team that had design control weaknesses included system design execution within MEB as well as design interface with operations. The ERCW system's design pressure calculation did not substantiate lowering the original system design pressure of 160 psig to 150 psig, partly because the calculation contained unverified assumptions regarding river level and isolation of components out for maintenance. Also components within the ERCW system had design pressures from 10 to 100 psi lower than the system design pressure without any approved resolution in place and no code acceptable overpressure protection provided. Additionally, for the ERCW design pressure issue, no operating procedure was approved to limit the ERCW header pressure as recommended by the associated design pressure calculation. For mild environmental qualifications of ERCW components none of the four equipment specifications reviewed by the IDI team had environmental temperature ranges that were compatible with the design drawings which document the environmental requirements. The IDI team also found that there was considerable confusion with regard to the piping code in effect. Specifically, the design pressure calculation erroneously referred to ASME Section III for piping design, the FSAR was inconsistent with regard to the code in effect for piping design and the screenwash pumps were not purchased to ASME III. After implementation of a temporary change to disconnect the instrumentation that automatically cycles the screenwash pumps, no procedure for manual operational was issued to periodically operate these pumps to ensure that the traveling screens were cleaned. Finally, MEB was unaware of vendor recommendations and restrictions regarding the use of a specific type of Kerotest valve for throttling applications.

Another trend identified by the IDI team concerns the timeliness of corrective action implementation. The team noted that TVA generally identified and proposed corrective actions in a timely manner, but these problems were not always promptly corrected. The ERCW design pressure calculation initially was approved on December 11, 1986 with a recommendation to operations to limit header design pressure. However, no operational procedure had been issued to implement this recommendation and MEB had not made the formal request to operations until July 31, 1987 after the IDI had identified the problem. With regard to the temporary modification that was made to disconnect the instrumentation for automatic cycling of the screenwash pumps, no operating procedure was issued to ensure manual operation of the traveling screens and screenwash pumps, between the time that the temporary change was made (10/7/82) and the period of the IDI inspection. As a result of testing performed, a problem was identified by TVA with waterhammer in the ERCW piping to the upper containment ventilation coolers and a corrective action was recommended. The problem and proposed resolution was identified in a December 11, 1979 memorandum and the corrective action was implemented via ECN 5009, Rev. 4, dated July 29, 1987, six and one-half years after the problem was identified. Finally, the IDI team recognizes that the erosion and corrosion problems associated with the ERCW systems are significant. They are being effectively monitored via comprehensive surveillance programs and when necessary piping is either replaced or repaired with scab plates. However, the problem has been known since Unit 1 received its operating license and even though a number of ECN's have been developed and some partially implemented, the problem still remains uncorrected. For correction of the ERCW valve cavitation erosion problem, TVA plans to provide a constant flow ERCW system concurrent with installation of the new component cooling water plate heat exchangers. Complete installation of the component cooling water plate heat exchangers is currently scheduled to be after both units go through two additional refueling outages. Even though the IDI team recognizes the scope of these changes, it is felt that prompt resolution of corrective action has not been diligently pursued by TVA.

The third trend identified in the mechanical systems discipline of the IDI team is with regard to design verification. The principal examples supporting this trend were two calculations that were identified by the team where an adequate design verification would have precluded a subsequent IDI deficiency. First, the environmental qualification mild temperature limits for the ERCW pumphouse at elevation 705 feet were not technically justified. The supporting calculation had unrealistic heat gains and losses and did not consider the worst case failure of HVAC equipment. Secondly, the IDI team identified an error in the operational modes calculation of the ERCW system associated with the lower containment ventilation cooler. Specifically, the temperature inside containment for the ERCW system fluid was erroneously assumed to be in equilibrium with the LOCA environmental temperature and the environmental temperature used was incorrectly determined from the environmental design drawings.

For the last trend in the mechanical systems discipline the IDI team identified two examples where the FSAR was not properly updated. First, during a design basis flood, TVA has made arrangements to cut a hole in the free standing steel containment vessel to prevent the accumulation of water on the outside of the containment. This proposed action which is a breach of containment integrity has not been formally submitted to and approved by the NRC. Secondly, a change was made to a design criterion associated with moderate energy pipe breaks which is a reduction of a licensing commitment and therefore the associated licensing document must be updated and resubmitted to the NRC.

Finally, the IDI team identified one deficiency that is not included within the aforementioned trends. MEB had failed to fully evaluate the consequences of a rupture of the non-seismic ERCW piping to the station air compressors upon the functionality of the ERCW system. MEB had designed the system to isolate the non-seismic portion via operator action subsequent to high flow alarms in the control room. However, the design failed to adequately consider the loss of ERCW fluid through postulated pipe breaks in the non-seismically designed piping.

1.4.3 Mechanical Components

The team reviewed a selected sample of the equipment, piping and pipe supports installed in the ERCW system at SQN Unit 2 with respect to the following criteria:

1. TVA's procurement documents were reviewed to confirm that TVA had incorporated the seismic and quality control requirements appropriate to the safety-related function of the equipment. The team also reviewed the vendor's seismic qualification reports to confirm the implementation of these criteria.

2. Piping subsystems, either rigorously analyzed or alternately analyzed, were reviewed to confirm that TVA evaluated the piping subsystem materials, geometry and loads in accordance with the appropriate licensing commitments and technical criteria.

3. Pipe supports installed in both rigorously analyzed and alternately analyzed piping subsystems were reviewed to confirm that TVA's specification and evaluation of pipe support types, locations, orientations, and loads are in accordance with the appropriate licensing commitments and technical criteria.

The team concluded that the majority of TVA's documents, calculations and drawings were prepared in accordance with TVA's licensing commitments and design criteria. During the course of the inspection, the team also favorably noted the technical competence of TVA's engineers, as well as the scope and detail of TVA's engineering procedures and design criteria. The team finally noted TVA's ability, in general, to retrieve reports, calculations and drawings in a timely manner.

Sections 3.2 through 3.6 of the inspection report summarize each of the deficiencies which the team identified in the mechanical components discipline during the inspection. A number of these deficiencies are considered to be isolated. However, the team identified two generic deficiencies during the course of the inspection which warrant TVA's review:

1. Vendor equipment seismic qualification reports were not consistently prepared in accordance with the requirements of TVA's equipment procurement documents. TVA accepted these reports apparently without design review.

2. Pipe support calculations were not consistently prepared in accordance with TVA's design criteria. TVA should confirm that its on-going pipe support regeneration program, which the NRC's Office of Special Projects (OSP) is currently monitoring, addresses the team's concerns for this generic deficiency.

The team concludes that the documentation reviewed, except for the generic deficiencies noted above, supports the qualification of the ERCW system equipment, piping and pipe supports with respect to the licensing commitments and technical requirements detailed in TVA's FSAR and design criteria.

1.4.4 Civil/Structural

The team identified generic problems in the TVA design of reinforced concrete structures such as TVA's minimum steel requirements; TVA's calculation of reinforcing steel strength development length; TVA's lack of reinforcement for negative moment; and TVA's failure to consider shear in the design of walls and slabs.

The team found that calculations for the seismic analyses to generate floor response spectra were not totally checked; that the seismic model of the auxiliary building does not represent the as-built structure; and that the computer program used to generate the floor response spectra might not be conservative.

The auxiliary building base slab was designed using incorrect loading data and the design of the auxiliary building floor slab at Elevation 669.0 did not consider the most critical load combination. These slabs should be reanalyzed to ensure their structural adequacy.

We found that the tornado generated missile protection design of the ERCW pumping station roof structure was incomplete; the ERCW piping pile support (rock fill) may not be stable; and the assumption made in performing the ERCW access cells seismic analysis is not justified.

The team identified a generic problem in the tank support design in that the tanks were assumed to be rigid without justification and the anchor bolts designed for tank supports were not checked for shear. We also found discrepancies between the design requirements and the construction drawings for equipment supports.

The team found that the vertical seismic design of the auxiliary building assumed the roof steel trusses to be rigid without justification and that the auxiliary building roof steel girders which supported tanks were not designed for seismic overturning moments.

The team's review of the pipe support base plates and anchors identified TVA drawings which allow the use of Rawl anchors. The Rawl anchors may not have the required factor of safety which is stated in the acceptance criteria.

In general, the results of the inspection in the civil/structural discipline are negative. The team found that TVA's calculation verification process needs improvement. TVA should increase its management involvement in the civil/structural area to ensure that technically qualified personnel are utilized to perform design verifications. The team was unable to confirm the structural adequacy of Sequoyah Nuclear Plant due to the unverified assumptions and undocumented engineering judgements contained in the structural calculations. In addition, in some cases the calculations did not consider all the design conditions. The team concluded that TVA needs to perform an independent design verification in the civil/structural discipline to ensure that the Sequoyah Nuclear Plant is adequately analyzed and designed.

1.4.5 Instrumentation and Control

The team identified a total of eleven deficiencies, four unresolved items, and two observations. Of these findings, the team found six deficiencies and two unresolved items of particular significance which are summarized in this section. These items are considered the most significant of the Instrumentation and Control findings because they involve nonconformance to FSAR technical commitments, represent more significant threats to system functionality under design basis conditions, and have concerns that could extend beyond the ERCW system scope. Further description of these items together with the remaining findings is provided in Section 5 of this report.

The team reviewed seismic qualification of the ERCW main control room panel switch modules, and determined that TVA had not adequately demonstrated conformance to the FSAR requirement that accelerations at switch mounting locations be less than 75 percent of the actual device test acceleration; thus, the seismic qualification of the main control board has not been adequately demonstrated. Also in the area of seismic qualification, an unresolved issue remains regarding extensive use of the notation "field to locate/procure" for modifications involving qualified panels and devices. The team is concerned that for these types of modifications, TVA may have had inadequate engineering controls on such field located components, and that this practice could violate the seismic qualification bases of either the component or the panel in which it is mounted.

In the area of circuit separation, isolation, and 10 CFR 50 Appendix R (Safe Shutdown From Outside the Control Room) requirements, the team identified two deficiencies and one unresolved item of particular significance. The team determined that fuses used to provide isolation of the non-Class 1E traveling screen speed switches from the Class 1E control circuit had not been properly coordinated with the control circuit fuse; thus a seismic event could render all four traveling screens inoperable. The team identified an additional circuit design deficiency in the traveling screen drives as well as the screen backwash pumps control cirucits that could result in the inoperability of all traveling screens and backwash pumps during a design basis control room fire.

In reviewing plant modifications, the team also identified many cases where input and output wiring for control relay modules used as isolation devices were bundled together within the switchgear enclosure such that non-Class 1E wiring is in contact with Class 1E wiring. This item remains unresolved until TVA demonstrates that no credible fault in the non-Class 1E wiring could be propagated into the Class 1E wiring; such propagation would be a violation of IEEE-279 and TVA separation criteria.

Regarding detection/mitigation of breaks in nonseismic ERCW piping, the team determined that TVA had not provided a calculation justifying the use of manual operator action, initiated by a high flow alarm and status light, to manually isolate a break in the nonseismic portion of the piping. The team concludes that timely and sufficient operator action to maintain the FSAR design basis flow values during a seismic event has not been assured.

In reviewing freeze protection features in the ERCW pumping station, the team determined that no heat tracing or qualified space heaters had been provided to prevent freezing of certain safety-related instrument lines, and that TVA had not performed an analysis adequately justifying the absence of qualified environmental control features in the ERCW pumping station; consequently, the team believes that there is inadequate assurance that the requirements of 10 CFR 50, Appendix A, Criterion 4 are met in the design.

In reviewing the ERCW process liquid radiation monitors, the team determined that the monitors would probably not function during design basis accident conditions due to accident background levels which would mask any measured level in the ERCW process. These monitors are required by the FSAR for detection and isolation of radiological leakage during an accident.

Regarding design controls, the team believes that many of these inspection findings may have resulted from weaknesses in communicating FSAR and other engineering requirements across discipline lines and maintaining multi-discipline cognizance of the design bases as the plant design evolved and was modified.

In general, the team concluded that with the exceptions noted in this report, the areas inspected appeared to be in compliance with licensing commitments. With the exception of the main control board seismic qualification deficiency, the number and significance of deficiencies identified generally met the team's expectations for this type of review; however, the team also notes that the ERCW system has comparatively simple and straightforward safety-related instrumentation requirements.

1.4.6 Electric Power

Because the electric power subsystems of the ERCW system are an integral part of the SQN auxiliary power system, the electrical power inspection developed into a broad evaluation of safety-related power supply design. The team's general conclusions were fairly favorable, with the exceptions noted below. TVA has moved aggressively and professionally to correct the major deficiencies identified in previous internal and NRC inspections, and the SQN electrical design and its documentation are now satisfactory in most significant respects.

The electrical inspection team identified five deficiencies requiring correction, and developed three additional observations about conditions for which corrective actions are advisable but not required. Most of the deficiencies involve inadequacies in the scope of the design calculations or failure of equipment purchase specifications to fully reflect design requirements, rather than shortcomings in the basic design itself.

The most significant deficiency is the lack of both system neutral grounding and ground fault detection throughout the 480V auxiliary power systems in the plant. This condition increases the risk of equipment failure and constitutes a technical violation of the "Single Failure" criterion. Ground fault detector circuits, preferably designed to provide effective high-resistance system grounding, should be installed at each Class 1E 480V distribution substation to alleviate this deficiency.

In addition, the team found that the worst cases of loading and/or supply voltage were not considered in several design calculations on standby diesel generator load capacity and voltage drops under load. Additional calculations are needed, either to demonstrate that the existing design incorporates the worst cases, or to correct the design if necessary.

We also found that the purchase specifications for several of the safety-related motor-operated valves in the ERCW system lacked any requirement for operation at degraded voltage, although the design calculations show that voltages may be severely depressed during accident conditions. TVA must verify by calculation or test that the MOVs involved will operate properly at the worst-case supply voltages. This condition reflects a substantial weakness in engineering quality assurance, in that significant design requirements were not consistently translated into purchase specifications.

Beyond these specific deficiencies, the team recommends that TVA consider improvements in several areas. First, the existing arrangement for fast automatic transfer of auxiliary power system loads from normal (main turbine-generator) power to alternate (off-site) power presents a risk of torque transients damaging motors and driven loads. TVA should consider installing synchronism-check relaying to control the transfer in order to minimize these transients. Second, the ERCW pumping station is highly exposed to lightning strikes, but has no air terminals (lightning rods) installed; while this building is reasonably well-protected by its inherent design, TVA should look into adding air terminals. Finally, most of the circuit breakers in the 6.9kV auxiliary power system can be subjected to short-circuit interrupting duties which exceed their nominal ratings under worst-case conditions, creating a risk of breaker failure and unavailability of the affected switchgear bus. TVA has acknowledged and agreed to correct this situation.

In general, the team concluded that the electrical power system design meets the relevant licensing commitments, with the exceptions as noted above.

2.0 MECHANICAL SYSTEMS

2.1 SCOPE OF INSPECTION

The mechanical systems discipline for the Sequoyah IDI reviewed on a sampling basis the ERCW system for implementation of licensing commitments. The scope included a review of the thermal and fluid design basis of the system, procurement specifications, the governing codes, interfaces with other design disciplines, hazards analysis, test procedures, interfaces with operations and maintenance and finally, design changes.

For the review of the ERCW system's thermal and fluid design the team reviewed the ERCW system's heat load basis and ensured that it was properly reflected in cooling flow requirements for the various required modes of plant operation. Types of calculations reviewed included those necessary to determine HVAC heating and cooling loads, pressure drop, design pressure, pump NPSH, system performance during various operating modes and system flow balancing. Also, the system's ability to perform its intended safety function was reviewed including the consequences resulting from a single failure.

Procurement specifications were reviewed to ensure that the equipment was in compliance with the current design status of the ERCW system. Attributes evaluated included, but were not limited to, seismic qualification, environmental qualification, duty requirements for heat exchangers, head and flow requirements for pumps, pressure/temperature rating and compliance with the governing code. Specifications reviewed included those for pumps, heat exchangers, valves, strainers, and traveling screens.

Discipline interfaces were reviewed including interfaces with site operations and maintenance. The team's purpose in this area was to assess the flow of design-related information. Attributes evaluated included seismic input to MEB from CEB for procurement; equipment nozzle allowables between MEB and CEB; system operating parameters transmitted from MEB to all other disciplines including pressure, temperature, waterhammer loadings, equipment performance restrictions due to maintenance activities and design requirements requiring implementation by operations.

Various test procedures were reviewed to ensure compliance with licensing commitments and the system design basis. Testing reviewed by the IDI team included compliance with ASME Section XI requirements, component hydrotest requirements in accordance with the governing code, system flow testing, surveillance instructions, pre-operational testing procedures and post-modification testing requirements.

Additionally, the team reviewed the ERCW hazards analysis and design changes. The hazards analysis review included a review of the moderate energy line break analysis, flooding effects, seismic II over I considerations and the effect of high energy pipe breaks on the ERCW system. The design change review included various field change requests, non-conformance reports, engineering change notices and condition adverse to quality reports to determine if they were adequately reflected in the design basis documentation.

Finally, the IDI team interfaced with the NRC as-built team to ensure the appropriate overlap of design and field reviews.

2.2 ERCW SYSTEM DESIGN

The IDI team's review of the fluid flow design basis of the ERCW system included the initial preoperational test scoping document; summary of equipment flow rates, heat loads and maximum outlet temperatures. Also, the team reviewed test results for ERCW Flow Verification Test, SI-566, Revision 11, dated 8/5/86 and new SI-566, Revision 16, dated 5/28/87. The team found that the ERCW system has had an evolving fluid flow design basis, with well documented summaries of flows, references to specific calculations, and transmittal of the revised design basis to operations. It also found that these design basis changes have been included in the ERCW Flow Verification Test, SI-566.

The team reviewed the TVA basis for roughness coefficient (C-factor) used with the Hazen-Williams equation for determining fluid flow pressure drop. Where the industry practice is normally to use a C-factor of 100, TVA elected to use a C-factor of 55 for the ERCW system, following TVA's identification of extensive corrosion to ERCW piping. The team's evaluation of this revised basis established that the new C-factor results in a conservative increase in design head loss three (3) times greater than that normally used for old cast iron pipe.

The IDI team reviewed the net positive suction head required (NPSHr) versus net positive suction head available (NPSHa) for the ERCW pump and the ERCW screenwash pump. The team assumed a worst case minimum water elevation at 636 feet and conservative head loss across the traveling water screen and found TVA's assumptions and the resulting design to be adequate.

The IDI team reviewed the design pressure including the ERCW system piping and interfaces with safety-related and nonsafety-related lower pressure systems. The review included TVA calculations applicable to design pressure, Significant Condition Reports (SCR's), and Engineering Change Notices (ECN's) issued for the addition of the new ERCW pumping station prior to the initial operation of Unit No. 2. The initial design pressure of the ERCW system and its components was 150 psig. With the modification to add the new ERCW pumping station, the design pressure was increased to 180 psig up to and including the isolation valves to the original ERCW intake pumping station and to the AERCW. The piping in the existing headers and branches downstream of these isolation valves was increased to 160 psig. However, no retest or rerating was performed for the existing piping and components. The increase in design pressure of the existing system was questioned in a TVA SCR, which noted that the system flow diagrams had the design pressure changed from 150 psig to 160 psig without any supporting justification within the referenced ECN's. Subsequently, TVA performed a detailed calculation including various modes of operation and determined that the system pressure would exceed 150 psig for some system components during low demand flow (two unit shutdown mode). The calculation erroneously assumed that the piping was designed to ASME Section III (not to actual code ANSI B31.1.0 - 1967) and administrative control was sufficient to assure that the system pressure would not exceed 150 psig. In addition, the

TVA established design pressure did not include the effect of higher river water level above the normal maximum water elevation of 683.0 feet, which is postulated to occur for the Design Basis Flood, nor the effect of isolating equipment for maintenance outages. Since the ANSI B31.1.0 - 1967 Code requires that where pressure reducing valves are used, one or more relief valves shall be provided on the low pressure side of the system, the IDI team concluded that the ERCW system design pressure cannot be established by relying on administrative measures, such as (1) using system valves for throttling and (2) switching pumps on and off. Therefore, TVA needs to establish a conservative design pressure and review component pressure ratings in accordance with the provisions of the code of record, ANSI-B31.1.0 - 1967 (Deficiency D2.2-1 and Deficiency D2.2-2).

In addition, TVA identified two ERCW system components that had a design pressure of 75 psig or less. These components are the auxiliary air compressor cylinder jacket cooler and aftercooler and the station air compressor cylinder jacket cooler and intercooler. The former is safety-related TVA Class C, while the latter is nonsafety-related TVA Class H (located in the turbine building). TVA presently utilizes administrative control to throttle both flow and pressure to these components and relies on this means to assure that overpressure does not occur. Since the ANSI B31.1.0 - 1967 Code (as well as the ASME Section III Code, 1971 Edition through Winter 1972 Addenda) clearly states that where pressure reducing valves are used, one or more relief devices or safety valves shall be provided on the low pressure side of the system, or the piping and equipment on the low pressure side shall meet the requirements of the full initial pressure, use of any administrative control is prohibited without relief/safety devices. The B31.1 Code further specifies that the combined relieving capacity provided shall be such that the design pressure of the low pressure system will not be exceeded if the reducing valve fails open. Therefore, TVA should provide a method of overpressure protection in compliance with Code overpressure protection requirements (Deficiencies D2.2-3 and D2.2-4).

The IDI team reviewed the interfaces between safety-related and nonsafety-related portions of the ERCW system and the interfaces between the ERCW system and systems cooled by the ERCW system. The review included the isolation provisions between safety-related portions of the system and nonsafety-related portions of the system as well as safety class boundaries (class breaks) identified on ERCW flow diagrams. The station air compressors, located in the turbine building, are nonsafety/non-seismically analyzed components which are supplied with cooling water from the ERCW system. The present ERCW system criteria and previously performed TVA calculation postulated a break in this non-seismic system. This resulted in a modification to the ERCW system to include high flow instrumentation and alarms for use in system isolation via operator action. When questioned by the IDI team on the timeliness of operator action, TVA provided a calculation which assumed a critical crack in the non-seismically analyzed piping. The IDI team took exception to the postulation of a critical crack and maintained that the pipe break should have been assumed as a double guillotine break, as identified in the system design criteria and in a previous TVA calculation for this interface. Therefore, TVA still needs to demonstrate that the ERCW system function has not been degraded for the time period between the postulated pipe break and closure of the motor operated valves, or incorporate a design change that ensures the ERCW system is not degraded by a rupture of the nonsafety-related piping (Deficiency D2.2-5).

Additionally, TVA does not have criteria or a controlled procedure for establishing safety class boundaries (class breaks) as a part of the Sequoyah Nuclear Plant design basis documents. The review by the IDI team questioned the adequacy of the assigned safety class boundaries to several interfaces between the ERCW system and systems which perform no safety function and identified several examples where problems exist. Therefore, the evident lack of safety class boundary criteria and procedure to establish boundaries raises the concern that proper application of safety class boundaries may not have been accomplished for all plant interfaces between safety and nonsafety-related systems, as well as between higher class and lower class safety systems. To alleviate this problem, TVA should develop a consistent set of criteria and review all plant safety systems for compatibility (Deficiency D2.2-5).

The IDI team reviewed various HVAC calculations recently revised by MEB to address problems identified by MEB from the DNE calculation review program. The problem identified by MEB involved using improper input data for the area HVAC calculations. To address this issue, MEB reviewed all the associated safety-related HVAC calculations for the sixteen areas in their design responsibility and regenerated new calculations. Of the sixteen HVAC areas reanalyzed, the following design changes were made: eight of the sixteen areas had the equipment qualification temperature increased 5°F but in one area, the qualification temperature increased 20°F; five of the sixteen areas had the cooler airflow increased to the pre-operational test values; and three of the sixteen areas had the ERCW flow rate increased with one of these areas requiring a change of piping material from carbon steel to stainless steel to obtain the required ERCW flow. Where the air or water flow rates were increased, the CAQR's required retesting to ensure the calculated values can be attained. The IDI team reviewed the HVAC calculations for the main control room air conditioner, the auxiliary feedwater and boric acid transfer pump space cooler; penetration room cooler at elevation 690 feet; and the safety injection system pump room cooler. Two of these calculations reviewed by the IDI team had no design changes associated with them while the remaining two calculations did have the proposed design changes documented in a CAQR. The IDI team found these newly regenerated calculations supported the stated objective, used well established methodology and were generally adequate. For the area where the environmental qualification temperature was being raised to 130°F (a 20°F increase), the IDI team verified that MEB was taking the appropriate action to ensure that all affected equipment in the room will be qualified to that new temperature limit. With proper implementation of the required corrective actions, the IDI team feels that the HVAC equipment will meets its design commitments.

The IDI team reviewed the ERCW system for proper consideration of waterhammer effects. The IDI team noted that pre-operational test procedure TVA-18C required that the ERCW system be monitored for evidence of waterhammer. Specifically, this procedure ensured that waterhammer from ERCW pump start-up and from a single pump trip during parallel pump operation had minimal vibration effects on the system. Additionally, a reversed and inverted check valve that discharges to atmosphere had been installed on the discharge of each ERCW pump to minimize waterhammer effects associated with pump start-up. The check valve permits air to be vented during pump start-up but closes when the valve begins to discharge water. Finally, as a result of testing performed in December 1979 to simulate a loss of offsite power, a waterhammer event was observed in the ERCW piping to the upper containment ventilation coolers (UCVC). The corrective action, implemented by ECN 5009, Rev. 4, dated 7/28/86, involved the addition of check valves in the supply lines to the UCVC to prevent water column separation on loss of power, thereby preventing the subsequent waterhammer on restart of ERCW pumps. The IDI team believes that the currently configured ERCW system is adequately protected from detrimental effects of waterhammer as a result of an adequate test program and design considerations. However, the installation of the check valve in the UCVC is an example of a corrective action not implemented promptly. Six and one-half years elapsed between identification of the problem and the implementation of corrective action.

The IDI team reviewed a portion of the calculation which established the mild environmental conditions for Sequoyah and provided the technical basis for the temperature shown on the environmental data drawings (TVA series 47E235). The portion of this calculation that was reviewed was that associated with establishing the maximum and minimum temperature limits in the ERCW pumphouse at elevation 705 feet. The IDI team's review of this calculation identified two problems. First, the maximum temperature limit was not based on technically justified heat gains and losses, but rather on unjustified assumptions. Second, the minimum temperature limit did not assume a failure of the non-Class 1E room heater and continued operation of the ventilation fan. Also, the minimum temperature limit calculation neglected to consider heat-losses through uninsulated concrete walls. As a result of these concerns, MEB needs to ensure that the entire calculation is revised and that a technically justified basis exists for establishing the mild environmental temperature limits throughout the rest of the plant. In response to the IDI team's specific concerns relative to the ERCW pumphouse at elevation 705 feet, MEB provided an updated analysis of the ERCW pumphouse mild environment temperature limits. This newer calculation dated 8/26/87 did verify the maximum temperature limit, however, it did not adequately establish the lower temperature limit due to non-conservative assumptions regarding room heat additions from electrical cables, non-emergency lighting and sump pump operation. MEB needs to revise the latest calculation to establish the lower temperature limit and provide freeze protection at this elevation of the ERCW pumphouse, if necessary (Deficiency D2.2-7).

In reviewing the design criteria for the ERCW system, the team noted that continued plant operation was implied if the river water temperature exceeded 83°F. The technical specification for the ERCW system requires that if the river water temperature exceeds 83°F the plant will be in hot standby in six hours. Therefore, the design criteria need to be updated to reflect the operating license requirements (Deficiency D2.2-8).

2.3 APPLICATION OF CODES AND STANDARDS

2.3.1 Design Codes

The IDI team's review of TVA's application of design codes and standards identified deficiencies with regard to piping; professional engineer (PE) certification of design specifications; and procurement of ERCW screenwash pumps to other than FSAR commitments. These are detailed as follows:

Piping Codes

The TVA FSAR commitment to piping codes applicable to design, procurement, material, fabrication, installation, and testing is complex. The design code of record for piping systems is ANSI B31.1.0 - 1967, however, the equations from ASME Section III 1971 Edition through Winter 1972 Addenda, Subsections NC-3600 were utilized for stress analysis to address the various service limits, i.e., Upset, Emergency and Faulted. The piping code of record was ANSI B31.7 - 1969 for material procurement, nondestructive examination (NDE), fabrication, installation, testing, and material identification, however, TVA committed in the FSAR to ASME Section III for procurement of components after April 2, 1973. Additionally, Code Cases applicable to ANSI B31.1.0 and ANSI B31.7 were invoked.

TVA, therefore, should revise the FSAR sections and all other design basis documents to properly reflect the design basis code of record for piping and other components presently identified as ASME Section III. In this regard, an evaluation should be made, justified, and submitted for NRC review for those cases in which different Codes, Addenda, and Code Cases are used to modify the code of record (Deficiency D2.3-1).

PE Certification Of Design Specifications

For design specifications applicable to safety related pressure retaining components, identified as TVA Class C and stated to be ASME Section III Code in the FSAR, the IDI team reviewed the PE Certification of several ERCW system valve specifications, the ERCW pump specification, the ERCW automatic strainer specification, and the ERCW screenwash pump specification. In general, the IDI team found that none of these design specifications had been revised subsequent to the request for bid stage of procurement, although technical requirements had been changed in the procurement documents. The design specifications, therefore, lacked the necessary PE recertification. ASME Section III, NA3250 includes the responsibilities for PE certification and as such requires that all pertinent design requirements be included in the design specification and certified by a PE. Since TVA revised significant component parameters (e.g., strainer design flow and ERCW pump total head) by revision to the purchase order instead of by revision and recertifiction of the design specification, they are considered in noncompliance with ASME Section III Code, NA3250 requirements.

TVA, therefore, should review and revise all ASME Section III Code design specifications, including PE recertification as necessary (Deficiency D2.3-2).

ERCW Screenwash Pump Design Codes and Standards

The ERCW screenwash pump design specification was prepared in accordance with ASME Section III, Class 3, in compliance with the FSAR commitment, but was procured as a non-ASME pump without change to the design specification. The pump, however, is seismically designed with a Class 1E motor and was constructed under a 10 CFR 50, Appendix B quality assurance program. Therefore, TVA should revise the FSAR to indicate the pump was not procured to ASME Section III requirements and provide justification for this safety-related pump not meeting its present FSAR commitment (Deficiency D2.3-3).

2.3.2 ASME Section XI Inservice Test Program

The IDI team reviewed the TVA ASME Section XI, Inservice Test Program (IST) identified in FSAR Sections 5.2 and 6.8 with emphasis on the specific Code edition and addenda used in the program for compliance with 10 CFR 50.55a of the Code of Federal Regulations. TVA Surveillance Instruction SI-114.2 identifies ASME Section XI 1977 Edition through Summer 1978 Addenda and specific requirements of 10 CFR 50.55a(b)(2), for inservice nondestructive examination piping welds in categories C-F, B-J, and C-G of the Code. TVA Procedure 1502.03 identifies ASME Section XI 1977 Edition through Summer 1978 Addenda as the baseline for establishing hydrostatic and pressure test boundaries, with upgrade to the 1980 Edition through Winter 1981 Addenda. TVA Procedure 1402.02 identifies ASME Section XI 1980 Edition through Winter 1981 Addenda for the repair and replacement program. TVA includes the entire Inservice Testing Program for pumps and valves in FSAR Section 6.8 and FSAR Appendix 6.8A. The ASME Section XI 1977 Edition through Summer 1978 Addenda is used as the baseline for this plan. The team identified a deficiency in this program applicable to lack of inclusion of the TVA Class C ERCW screenwash pumps in the Pump IST Program. These pumps are required to function during normal operation of the plant and following an accident. Since loss of function of these pumps results in inoperability of the ERCW traveling water screens (i.e., electrical interlock prevents traveling water screen operation with low screenwash pump discharge header pressure) which may eventually result in loss of function of the ERCW Pumps through lack of suction, the screenwash pumps should be included in the IST Program (Deficiency D2.3-4).

The TVA Mechanical Services Branch prepared instructions for use in determining safety class boundaries. These instructions provide guidance in the application of ASME Section XI program functions. The IDI team considers that this document adequately incorporates later industry standards and guidance from Regulatory Guide 1.26 and provides a necessary base for ASME-Section XI program functions. The Mechanical Engineering Branch, however, does not have a corollary document for design application of safety class breaks (Deficiency D2.2-6).

With the exception of not including the ERCW screenwash pumps in the IST program, the overall ASME Section XI program is considered to be in compliance with FSAR commitments.

2.4 HAZARDS ANALYSIS

2.4.1 Moderate Energy Line Break (MELB)

The IDI team reviewed documents related to the evaluation of effects of postulated pipe failures for moderate energy systems outside the containment. This review focused on the postulation of critical crack locations and the TVA evaluation and resolution of the effects of jet impingement, environmental effects, and flooding of safety-related systems, structures, and components as a result of the postulated crack.

The IDI team's review included TVA's use of the crack exclusion guidelines specified in SRP 3.6.2, Branch Technical Position MEB 3-1. A deficiency was written by the IDI team regarding the inclusion of the break exclusion guidelines in TVA's Design Criteria document SQN-DC-V-1.1.11, but not in the document submitted for NRC review, TVA Topical Report No. 72-22, as discussed below. In addition, the limitation of this break exclusion criteria to seismically analyzed piping was not clearly identified in TVA's design criteria document. The IDI team concluded that Rev. 3 of the TVA Topical Report included extensive analysis with additional analysis and evaluation of effects of moderate energy line break flooding included in the preliminary Rev. 4. The latter revision was based on input from Sargent and Lundy "Moderate Energy Line Break Flooding Evaluation Report," SL-4424. This report resulted in the generation and addition of the revised criteria for crack exclusion to TVA's Design Criteria document SQN-DC-V-1.1.11. However, the revisions of the Topical Report submitted to NRC did not include these criteria (Deficiency D2.4-1).

Therefore, with the exception of the single deficiency identified above, the TVA criteria, analysis, documentation, and resolution for moderate energy line breaks is considered by the IDI team to be conservative and in compliance with FSAR commitments.

2.4.2 Seismic II/I

The seismic II/I review conducted by the IDI team involved evaluating the consequences of non-seismic components falling on safety-related components as a result of the occurrence of a postulated seismic event. This review was performed as a part of the IDI team's walk down of the ERCW system at the Sequoyah site. During the walkdown, the team was cognizant of various non-seismically designed components such as drainage piping, fire protection piping, room heaters, etc. that could fall on safety-related components. Besides the ERCW pumphouse, the team examined the areas around the component cooling water heat exchangers and the auxiliary feedwater motor driven and turbine driven pumps. As a result of the IDI team's walkdown, no instances were identified where the falling of non-seismically supported components would impair the safety-related function of equipment.

2.4.3 High Energy Line Break Analysis (HELBA)

Since the ERCW piping is defined as a moderate energy piping system, no high energy breaks are postulated, and only low energy cracks are postulated for the purpose of evaluation of the effects of pipe failures on other safety-related systems including compartment environmental effects. The IDI team reviewed the ERCW systems drawings and identified two areas within the auxiliary building where both ERCW trains were located. During the walkdown at the site the team reviewed these two areas to determine if there was any high energy piping of another system with postulated breaks that would disable both ERCW trains. The team identified no high energy piping in the area that would affect the ERCW piping due to the postulation of pipe breaks. In addition, when the IDI team reviewed the engineering change notice associated with the safety upgrade of the lower containment ventilation coolers, the team noted that the associated components were evaluated for the effects of jet impingement and pipe whip. Therefore, it appears, based on the sample reviewed by the IDI team that the ERCW system is not subject to detrimental effects resulting from high energy line breaks.

2.4.4 Flooding

The IDI team reviewed the design provisions to prevent equipment flooding in the ERCW pumphouse and the TVA design criteria entitled "Flood Protection Provisions." Since the ERCW equipment is protected from a design basis flood by the ERCW pumphouse structure, the IDI team performed a walkdown of that building as well as reviewing ERCW pumphouse piping and equipment drawings (TVA series 37W206), concrete drawings (TVA series 31W211), and miscellaneous steel drawings (TVA series 3BN326) to determine possible water entry methods. Additionally, the IDI team determined that the deck drainage sump pumps provided adequate capacity and the sumps have an adequate volume to accommodate the maximum anticipated rainfall and inleakage to the ERCW pumphouse. The ERCW trains A and B are separated in individual train enclosures (train B of Units 1 and 2 share the same enclosure) to prevent internal flooding from one train disabling the other. Therefore, the IDI team feels that the ERCW pumphouse provides the necessary protection from flooding.

As a result of the IDI's team review of the design criteria entitled "Flood Protection Provisions," one problem was identified. In this design criteria document, TVA indicates that during a design basis flood it may become necessary to cut a hole in the free standing steel containment to prevent an external buildup of water pressure on the steel containment vessel. Cutting a hole in the steel containment vessel under the design basis flood is an obvious breach of containment integrity and as such would have to be formally reviewed and approved by the NRC. TVA could find no documentation of any such formal review and approval by the NRC (Deficiency D2.4-2).

2.5 DESIGN CONTROL

2.5.1 Discipline Interfaces

The objective of this portion of the inspection was to evaluate the interactions of the MEB with other disciplines as well as internal design coordination within MEB. Areas of interest related to MEB included discipline design interfaces with CEB and EEB, and the coordination of design related information with operations and maintenance or other site support organizations.

The team reviewed portions of the calculation which establish the maximum temperature and pressure at various locations within the ERCW system for various system service limits specified by ASME Section III (i.e., Normal, Upset, Emergency and Faulted). The data are mostly used by CEB as input data to the stress analyses, but they may be used by others for establishing the maximum temperature or pressure to which a particular component may be subjected. It was noted by the team that only the temperatures are given as a function of plant mode and that the pressure provided was the system design pressure. The correlation between the temperature data and the specific system piping was provided via a marked-up set of ERCW system flow diagrams with nodes depicting specific system piping. The team concluded that this calculation was reasonably thorough and generally supported the data used by CEB in the stress analysis. Since this calculation was performed subsequent to the procurement of the majority of plant components, it did not establish the pressure and temperature identified in the procurement documents, but rather reflects this information from other design input sources such as the flow diagrams and other earlier calculations. The team did identify one problem associated with the accuracy of these data, however, in that the specific data in question were not utilized by other design disciplines (Deficiency D2.5-1). This deficiency called attention to the fact that the subject calculation needs to be updated to reflect consistency with the MEB internal environmental drawings and the system operating modes. Additionally, since the environmental calculation was last revised, 11/5/85, HVAC heat load data have been regenerated. This would also necessitate an update of the environmental data. The team, however, does not anticipate any significant impact on the design resulting from an update of this ERCW operational modes calculation.

The team reviewed the coordination of equipment nozzle loadings between MEB and CEB (piping) by selecting the component cooling water heat exchangers (shell and tube) and the ERCW pumps as examples. For the component cooling water heat exchangers, the team observed a documented design coordination process between the equipment vendor, MEB and CEB which resulted in proper resolution of all associated comments. The vendor's allowable nozzle loadings generally met the TVA nozzle load standards with one exception. In this case, CEB document 82-1 permits the component cooling water heat exchanger nozzles to carry shear loads that are not specified by the vendor (Deficiency D3.4-4). The team reviewed the ERCW pump nozzle allowable loading documentation and noted that the initial seismic qualification performed by vendor did not include nozzle loadings. However, TVA (CEB) performed the associated seismic analysis including the nozzle loadings which, after coordination with the pump vendor, demonstrated that the pump was seismically qualified and that pump nozzle loadings were properly considered. These two examples demonstrate that in general, equipment nozzle loadings were adequately coordinated between the TVA cognizant design disciplines and the vendor.

The team reviewed the coordination between maintenance and MEB by reviewing the percent of tubes plugged associated within the component cooling water heat exchangers A, B, and C. The team requested the maintenance records for these heat exchangers and received a document entitled "Component Cooling Water Heat Exchangers - Pipe Plugging and Sleeving Data, Units 0, 1, 2," dated 7/24/87. This document was very thorough and contained a rigorous record of what tubes were either plugged or sleeved for all three heat exchangers. The sleeves used varied in length from 0.5 feet to 35 feet. The overall tube length is 50 feet. The "A" component cooling water heat exchanger had approximately 1% of its tubes plugged and 13% had sleeves. The "B" component cooling water heat exchanger had approximately 10% of its tubes plugged and 22% had sleeves. Finally, the "C" component cooling water heat exchanger had approximately 11% of its tubes plugged and 9% had sleeves. MEB had performed a calculation which bounded the aforementioned percentage of tubes plugged and sleeved to demonstrate that the associated heat exchangers could adequately meet the required duty by increasing ERCW flow as the percentage of tubes plugged is increased up to 20%. Also, MEB had provided guidance to maintenance to ensure that the percent of tubes sleeved was properly converted into a percent of tubes plugged. Additionally, the IDI team reviewed a computer list of maintenance requests and identified a total of six items to review in more detail. Of these six maintenance requests, three had no documentation available since retention was not required for that type of maintenance request. Of the three that were reviewed, the team identified no instance that would indicate that engineering was improperly omitted from a safety-related corrective action evaluation. Hence, the IDI team was satisfied that adequate coordination exists between MEB and maintenance based on review of these items.

Another interface involving the field, reviewed by the IDI team, involved the pipe wall degradation program in place for the ERCW system. The program is in place to ensure that wall thinning caused by microbiologically induced corrosion, erosion and valve cavitation is monitored, controlled, and corrected by replacement prior to it becoming a safety concern. Specifically, the IDI team requested to review the ERCW piping directly downstream of the ERCW system butterfly valve 2-FCV-67-146 used to throttle flow through the component cooling water heat exchanger "B." The governing surveillance instruction, SI-704, had identified the area in question as grid number 35 and had specified an acceptable wall thickness that was in accordance with the minimum wall thickness calculation performed by MEB. According to the subject surveillance instruction, any deviation from the specified acceptable wall thickness is repaired by maintenance or sent to CEB for further evaluation of pipe stresses. A CEB stress evaluation uses the minimum measured wall thickness at a specific grid point to be uniform around the piping circumference, to compute the stress to compare to the code allowable. If the calculated value is less than the code allowable, new acceptance criteria are established for the subject surveillance instruction at that specific grid point. If the calculated stress is more than the code allowable, then the piping is either replaced or repaired (scab plate attached). The IDI team is satisfied that the affected disciplines of CEB and MEB were adequately involved in the associated surveillance instruction to ensure that an adequate monitoring program is in place, even though timely resolution of the overall erosion/corrosion problem has not occurred. The subject of microbiologically induced corrosion is being evaluated by the NRC's Office of Special Projects.

During the field walkdown, the IDI team noticed that Kerotest valves were being throttled per surveillance instruction SI-682 to regulate the flow through various ERCW heat exchangers. When questioned as to whether Kerotest valves were suitable for throttling applications, TVA checked with the valve manufacturer who identified that packless, Y-type globe valves were not recommended for throttling applications. Later, TVA obtained a copy of the valve manufacturer's guidelines for throttling with these valves. These vendor guidelines are in the form of a graph which correlates flow rate against valve percent open and shows a region in which throttling is permitted if verified by a lack of disc noise or vibration. At the request of the IDI team, TVA reviewed the valves being throttled per SI-682 and identified four Kerotest valves of the type that are subject to the throttling restrictions of the valve manufacturer. TVA noted that all four valves were in the acceptable throttling region but TVA did not provide evidence that demonstrated that no disc noise or vibration was present as required by the manufacturer. Also, TVA was not aware of the restrictions placed upon this valve by the manufacturer and at the time of the inspection was not aware whether or not any such valves were used elsewhere in the plant for throttling applications. This issue demonstrates a lack of communication between TVA and the valve manufacturer, since TVA was not aware of the problem and there did not appear to be a programmatic method in place to bring the problem to TVA's attention (Deficiency D2.5-2).

The IDI team reviewed selected procurement specifications for inclusion of the proper seismic design requirements. The specifications reviewed included the ERCW pumps and the component cooling water heat exchangers (shell and tube). The team verified that the proper response spectra were included in the specifications and that the damping ratio was consistent with FSAR Table 3.7.1-3. Based upon this limited sample, the team feels that adequate coordination between CEB (structural design) and MEB was in place to ensure that the equipment was purchased to the required seismic criteria.

The IDI team reviewed selected procurement specifications augumented by vendor data, for compliance with the environmental design requirements. The specifications reviewed included the ERCW traveling water screens, ERCW screenwash pumps, ERCW automatic backwash strainers and ERCW pumps. Of the four specifications reviewed, none had environmental temperature ranges that were compatible with the design basis drawings. These inconsistencies raise the concern that other equipment may not be qualified for the mild environment in which it must function. This issue also demonstrates a lack of internal coordination within MEB since both the procurement specifications and environmental drawings were within the design responsibility of this discipline (Deficiency D2.5-3).

The IDI team reviewed discipline interfaces applicable to testing, including post-modification retest requirements of ECN'S, ERCW system flow balancing, and ERCW screenwash pumps manual operation. These interfaces included the various engineering design disciplinces and operations. For design changes, retest requirements are initiated by engineering. With the completion of the Design Baseline and Verification Program (DBVP), TVA established a procedure (SQEP-57) to identify test and retest requirements. This included post-modification tests (PMT), functional tests, surveillance instructions (SI's), and PMT scoping documents. This procedure assured coordination among site systems engineers and communication of detailed test requirements and subsequent test results between the project engineer and plant manager. Two examples of testing and test control, applicable to interface between engineering and operations are provided below.

The ERCW flow balancing requirements were initially fully prepared for preoperation testing through an engineering scoping document TVA No. 18, dated 4/3/81. The responsibility for this test procedure function shifted to operations with SI's, with the present procedure, SI-566, performed annually. With the ERCW system corrosion problems (ECN L-5009), updates were provided via engineering documents such as "Summary of Equipment Flows," dated 4/1/86. These flow balancing tests are based on combinations of significant modes for two unit operation including LOCA, Hot Standby, Shutdown, and Normal Operation. Post-modification tests or special tests are performed as required by site retest procedures as necessary. The IDI team reviewed the evolution of procedures and interviewed TVA engineering and test personnel relative to SI-566 and other flow tests which are included in modification retest requirements. The team found the procedures and interface between TVA engineering and operations to be adequate in performing this function, including the evaluation of test results and resolution of discrepancies.

TVA intended to incorporate a modification to replace the ERCW traveling screen differential pressure instrumentation with a bubbler type, but had difficulty in finalization of design and procurement of the instrumentation. TVA decided to temporarily disconnect the wiring and logic for the automatic operation of this system and institute manual operation of the screenwash pumps and traveling screens. However, TVA did not have an approved procedure between the time that the temporary change was made (10/7/82) and the period of IDI inspection. The IDI team reviewed the proposed revision to the TVA procedure, SOI 67.1, Revision 20, and found it technically adequate. However, TVA has not provided a timely approved procedure for manual operation of these safety-related pumps, used during all modes of plant operations (including periods of long term shutdown). Further, approval of a temporary change without controlled procedures in place is considered to be a potential generic concern and should be addressed by TVA (Deficiency D2.5-4).

2.5.2 Design Changes

TVA's design change process has undergone extensive evolution from pre-OL through present operations phase activities. Recently, a specific procedure, SQEP-13 was issued for controlling the transition between the past design change control process and the permanent Plant Modification Package (PMP) system. This procedure places improved controls over the configuration of the installed condition and applicability and control of ECN modification packages. It also establishes the relation, priority, and control of associated ECN's and the closure of predecessor ECN's and associated FCR's.

The IDI team reviewed those NCR's applicable to improper positioning of valves for ERCW flow balancing and isolation valves, and determined that the development and implementation of TVA procedures SI-566 and SOI 67.1 have adequately resolved these reports. For piping corrosion, NCR 8035, dated 12/30/80 resulted in ECN L-5009 (issued 6/26/81). This ECN is still being implemented as needed more than six years later without a definite schedule for completion. However, the development of the ERCW flow verification test procedure, SI-566, and an extensive investigation of microbiologically induced corrosion (MIC) through a developing TVA program have resulted in an adequate means of monitoring the problem.

Four recent significant condition reports (SCR's) were reviewed by the IDI team (issued mid-1986 and early 1987). One resulted in ECN L-6014 to provide freeze protection to ERCW Pump motor cooling coils through redesign of drainage capability, while another identified a problem with the design pressure of 160 psig for the ERCW system, resulting from the ECN 1229, issued in May 1974 and incorporated prior to Unit 2 commercial operation. The latter SCR identified the following corrective action: "An ECN will be prepared to change the system design pressure or replace equipment as appropriate." It also stated that "Mechanical Design Guide...assures design pressure will be adequately determined" and concluded, "Thus no additional action is required to preclude recurrence of this problem." No ECN was issued and the IDI team took exception to the adequacy of the design pressure calculation, which resulted in the IDI team generating several deficiencies (Deficiencies D2.2-1, D2.2-2, D2.2-3, and D2.2-4). Thus, the SCR identified the appropriate corrective action, but the stated corrective action was not implemented.

The IDI team reviewed the engineering change notice associated with upgrading the lower containment ventilation coolers (LCVC) to safety grade. This upgrade was determined to be necessary for a main steamline break. During this mode of operation, the temperature in the lower reactor compartment and pressurizer compartment was determined by TVA to increase above the environmental qualification limits for certain components; hence, TVA recognized the need to upgrade the LCVC to maintain these temperatures below the environmental qualification limits. This safety upgrade consisted of replacing the LCVC cooling coils since they did not meet cleanliness requirements (which would affect coil performance). Also, the cooling coil documentation was reviewed by TVA to ensure compliance with seismic category I requirements. In addition, the motors were upgraded (rewound) to Class 1E; the ductwork was upgraded to seismic category I; prior to maintenance activities in containment air filters will be installed to preserve cooling coil cleanliness; all associated electrical components were evaluated by TVA for compliance with Class 1E and equipment qualification requirements; electrical power will be provided by the plant's emergency power system; pipe whip and jet impingement upon the LCVC were evaluated for secondary side breaks; and the ERCW system was evaluated to ensure adequate flow is provided. The IDI team found the ECN for upgrading the LCVC to be comprehensive and adequately address all safety concerns.

ECN's reviewed by the IDI team , other than those mentioned above, identified two problems which are associated with code class breaks and are previously described (Deficiency D2.2-6).

As a result of the IDI's team review of the NCR's, SCR's, and ECN's, the team believes than an adequate process is in place for identification of problems and definition of corrective actions. However, the team feels that TVA needs to improve upon its implementation of corrective action to ensure problems are promptly corrected.

3.0 MECHANICAL COMPONENTS

3.1 SCOPE OF INSPECTION

The team reviewed a selected sample of the equipment, piping and pipe supports installed in the ERCW system at Sequoyah Nuclear Plant Unit 2 to assure that licensing commitments and applicable NRC regulations have been met.

TVA's procurement documents were reviewed to confirm that TVA had incorporated the seismic and quality control requirements appropriate for the safety-related function of the equipment. The team also reviewed the vendor's seismic qualification reports to confirm the implementation of these criteria.

Piping subsystems, either rigorously analyzed or alternately analyzed (field routed to generic qualification criteria), were reviewed to confirm that TVA evaluated the piping subsystem materials, geometry and loads with respect to the appropriate licensing commitments and technical criteria.

Pipe supports installed in both rigorously analyzed and alternately analyzed piping subsystems were reviewed to confirm TVA's consistent specification and evaluation of pipe support types, locations, orientations, and loads with respect to the appropriate licensing commitments and technical criteria.

The main steam supply line to the turbine driven auxiliary feedwater pump 2A was also included in the IDI scope of review because the auxiliary feedwater system can be connected to the ERCW system to provide an emergency ultimate heat sink. The steam supply line to the auxiliary feedwater pump turbine is subjected to thermal transients that pose a more difficult design problem. Therefore, a review of this piping was more likely to uncover design process weaknesses, if they existed, that might not surface during the ERCW system review.

A sample of SQN Unit 2 change documents and nonconformances (ECNs, FCRs, NCRs) was reviewed in order to evaluate TVA's compliance with the design control commitments and requirements in effect for SQN Unit 2. Documents were selected for review in the twelve-month time period prior to issuance of the operating license. This time period was selected because as start-up approaches issues may be more likely to be improperly dispositioned due to normal schedule pressures.

The team interfaced with the Mechanical Systems, Civil/Structural, Instrumentation and Control, and Electric Power disciplines to review inspection items with TVA internal (CEB, EEB, MEB, NEB) interfaces.

The team also interfaced with the NRC team that performed an as-built verification inspection at Sequoyah Nuclear Plant during the period August 3-14, 1987. The results of that inspection are documented in NRC Inspection Report Nos. 50-327/87-52 and 50-328/87-52. The IDI team specifically reviewed CEB's analysis and design of the hold-down bolts which restrain the ERCW pumphouse strainer to a sliding base plate. The NRC walkdown team noted that TVA had installed fewer bolts than originally called for by the strainer vendor, and questioned the adequacy of the installed design. The IDI team also reviewed CEB's calculation for the four anchor-bolted steel bars which allow the sliding base plate to move axially, but prevent lateral movement of the base plate, since the team considered these bars to be the critical restraint components for the strainer-base plate configuration. The team found that CEB's calculations adequately qualified each of these interfaces.

3.2 PIPING ANALYSIS

In the area of piping stress analysis, the team reviewed CEB's calculations with respect to TVA's FSAR licensing commitments, the detailed technical criteria specified in CEB's general civil design criteria, and the modeling techniques specified in CEB's Rigorous Analysis Handbook. The team also reviewed CEB's internal interfaces, as well as CEB's interfaces with EEB, MEB and NEB in order to evaluate the design process.

The team reviewed several rigorous and alternate analysis pipe stress problems associated with the ERCW system and one rigorously analyzed piping subsystem within the auxiliary feedwater system. From a piping stress analysis standpoint, the ERCW system generally does not pose a difficult design problem since it operates at relatively constant low temperatures and pressures. However, the ERCW system is routed through nearly the entire power plant from the ERCW pumphouse to the containment building. In addition to being attached to several building structures, the ERCW system is connected to several tanks and heat exchangers, as well as various heating, ventilation and air conditioning equipment, all of which require interface with virtually all plant design disciplines.

In addition to the ERCW system, the IDI team also reviewed one piping stress analysis problem from the auxiliary feedwater system. This piping system was included in the IDI scope of review because the auxiliary feedwater system is connected to the ERCW system to provide an ultimate heat sink and is subjected to thermal transients that pose a more difficult design problem. Therefore, a review of this piping was more likely to uncover design process weaknesses, if they existed, that might not surface during the ERCW system review. The problem reviewed (N2-3-9A) consists of turbine steam supply piping which starts at the auxiliary feedwater turbine pump nozzle, runs through the auxiliary building, and is terminated at connections to main steam lines Loop 1 and Loop 4 of Unit 2.

The steam supply line to the auxiliary feedwater pump turbine was reviewed in detail, including loading conditions, geometric modeling, equipment nozzle loads and thermal movements, purchase specifications and a sample of the pipe support calculations. This review indicated that this system met FSAR commitments, was easy to audit, and in general the design was considered to be adequate. No deficiencies were identified during the review of this system.

In general, the team found that the major portion of the pipe stress analysis documents reviewed were in accordance with TVA's licensing commitments and design criteria. CEB's design basis documents for piping and pipe supports such as engineering procedures and design criteria were generally considered to be detailed and based upon sound engineering principles. In general, the project was able to demonstrate a good record retrieval system by retrieving important pipe stress design records in a timely manner.

We identified a total of eight deficiencies during the piping analysis process review. Two of these deficiencies were related to the design input for thermal conditions. The thermal nozzle displacements were not consistently considered by both TVA and EDS, a TVA contractor, for containment spray heat exchanger 2B. For example, the nozzle displacements for the shell side and tube side inlet nozzles were considered, but no consideration was given to the displacements for the shell side and tube side outlet nozzles (Deficiency D3.2-1). In addition, TVA did not analyze an ERCW piping subsystem for the cold thermal mode which is specified in the FSAR. This cold thermal mode results from the fact that temperatures for inlet water from the ERCW pump house can range as low as 35°F. The TVA piping analysis does not consider the effect of this cold thermal mode on the piping system and associated pipe supports (Deficiency D3.2-2).

Several deficiencies in the design/construction interface were identified. The installed piping configuration should agree with the as-constructed piping physical drawings, the piping stress isometric drawings and the piping analytical model used in the piping analysis. Some as-designed piping physical drawings contain design information that does not appear on the piping isometric drawing and was not used in the latest piping analysis of record. The four examples of areas of disagreement found by the IDI team are: (1) Carbon steel to stainless steel replacements and typical configurations which do not agree with the as-constructed piping physical drawing (Deficiency D3.2-3); (2) A section of 4-inch piping shown on the piping physical drawing and associated mechanical flow diagram was incorrectly modeled in the piping analysis as 3-inch piping (Deficiency D3.2-4); (3) The piping isometric used for pipe stress analysis indicated a particular elbow as a 45° elbow, while the same elbow on the as-designed piping physical drawing was incorrectly shown as a 90° elbow (Deficiency D3.2-5) and (4) During the plant walkdown, the team discovered that a pipe clamp was missing near a flex hose connection to upper containment vent cooler 2B, however, the as-designed, as-constructed and piping isometric drawings all indicated that a support was specified (Deficiency D3.2-6).

The analysis of the ERCW system did not include proper consideration of temporary piping that can be installed in the essential raw cooling water system. For example, the spool piece which connects header 2B to the component cooling water surge tank cannot be installed without overloading the adjacent piping and supports. The ERCW system contains several such spool pieces which may have been fabricated to nominal rather than as-built dimensions (Deficiency D3.2-7).

The team identified TVA's failure to model the flexibility of a valve operator in a piping analysis calculation as required by the FSAR. A test report for a 3-inch valve documented resonance frequencies of 13 and 16 Hz; the valve operator should, therefore, have been modeled as a flexible structure in the piping analysis since the criteria use 25 Hz as the upper frequency value for which a component or structure is considered to be flexible. (Deficiency D3.2-8).

In summary, the team identified several deficiencies in the area of piping analysis. Several of these deficiencies such as thermal anchor movements at equipment nozzles and lack of a cold thermal mode analysis may prove insignificant due to the low thermal stresses in the ERCW system. However, if these or similar deficiencies were encountered in a system in which the thermal stresses were significant, the system could result in being overstressed. Several other deficiencies were felt to be isolated, such as the incorrect coding of a 3-inch pipe for a segment of 4-inch pipe.

The team concludes that TVA should address the generic implications of the deficiencies identified in the ERCW system by reviewing other piping systems installed at the Sequoyah Nuclear Plant for similar deficiencies, and evaluating their significance.

3.3 DESIGN OF PIPE SUPPORTS

In the area of pipe support design and analysis, the IDI team reviewed CEB's calculations with respect to TVA's licensing commitments, the detailed technical criteria specified in CEB's general civil design criteria, and the design and analysis procedures specified in CEB's Pipe Support Design Handbook.

The team reviewed a sample of the pipe supports installed in the ERCW and auxiliary feedwater piping subsystems. The team had originally selected these piping subsystems for review, as summarized in Section 3.2 of this report. The team reviewed approximately 50 pipe supports explicitly designed to load combinations derived from rigorous piping analysis. For each pipe support, the IDI team reviewed the piping stress isometric drawing, the piping analysis input data, and the pipe support detail sheet to confirm CEB's consistent specification of pipe support type, orientation, and location.

The team also verified that the pipe support load summary sheets correctly tabulated the pipe support design loads derived from each piping analysis, and that the calculation of record for each pipe support used the correct design loads. The team also checked each pipe support calculation to confirm that the pipe support configuration analyzed in the calculation matched the configuration shown on the pipe support detail sheet. Finally, each calculation was reviewed to confirm that CEB qualified the pipe support in accordance with TVA's FSAR commitments and CEB's general civil design criteria.

The team notes that CEB does not have documented pipe support calculations for a number of safety-class pipe supports at Sequoyah Nuclear Plant. However, the NRC's Office of Special Projects (OSP) is currently overviewing CEB's program to regenerate these missing pipe support calculations. The team has confirmed that the pipe support calculations which the team identified as missing during the inspection had been scheduled for regeneration by CEB.

CEB has implemented an Alternate Analysis Program, which the NRC's OSP is currently overviewing, to remedy generic deficiencies in TVA's original field routed piping program. TVA originally field routed some safety-class pipe and all position-retention piping in accordance with generic qualification criteria and typical pipe support details.

The team reviewed CEB's alternate analysis calculation for each safety-class field routed piping subsystem which the team selected for review to verify that CEB had addressed the required pre-restart inspection attributes, which include a review to confirm the lateral restraint of valve motor operators and an evaluation of the piping subsystem and supports if the thermal loads are greater than 200°F. The team also reviewed the load capacity calculations for several typical pipe supports and pipe clamps that were originally used to field route pipe at Sequoyah.

The team identified a total of five deficiencies during the course of this review. In one instance, the team reviewed the pipe support calculations for two large bore pipes that are supported by the same supplementary steel beam. However, one of the two pipe support calculations which evaluates the beam does not include the support load from the other large bore pipe. The team also found that one of the large bore pipe supports does not have sufficient clearance to accommodate the lateral motion specified for the pipe on the pipe support load summary sheet and in the pipe support calculation (Deficiency D3.3-1). The team reviewed ten pipe support calculations for two piping analysis problems and found that the structural model for one pipe support was based on an unconservative assumption, and that two other pipe supports were modeled with incorrect dimensions. Since the team documented errors in three of the ten pipe support calculations reviewed for these two piping analyses, the team believes that this deficiency has generic implications. However, the team notes that CEB had scheduled all three pipe supports for regeneration prior to Unit 2 restart (Deficiency D3.3-2). Contrary to CEB's commitment to maintain pipe support stresses below 0.9 of the material yield strength (F_y), the team noted that CEB's formulation of the normalized design load for the Faulted pipe support load combination, which is computed by dividing the unnormalized load by a factor of 1.6, could result in pipe support stresses which exceed 0.9 F_y for some types of stresses in linear supports. For example, the actual Faulted allowable stress in a linear support for bending about the weak axis is 0.75 x 1.6 = 1.2 F_y (Deficiency D3.3-3). The team reviewed the calculations for three of the typical pipe support designs originally used in TVA's field routing program. Each pipe support is composed of a tube strut welded to a surface mounted base plate. However, the calculations for the anchor bolt loads and base plate thicknesses only considered the bending moment induced into the base plate by the tube strut, and did not consider the effect of the tube strut axial tensile load on the base plate or on the bolts which anchor the base plate to the concrete surface. This omission could result in undersized base plates and anchor bolts for these typical pipe support designs (Deficiency D3.3-4). Finally, the team reviewed a nonconformance report (NCR) which TVA prepared on June 30, 1982 to address the use of vendor-supplied clamps on field route piping that were subjected to multiple loads. These clamps had originally been qualified for one-directional loading. The team concluded that CEB's corrective action to address the NCR was inadequate. The team considered CEB's method of evaluating the combined effects of tension and shear forces on the pipe clamp, for a range of clamp sizes to be inappropriate (Deficiency D3.3-5). In a related deficiency, the team also questioned TVA's installation of these clamps with A-307 bolts, for clamps which restrain the pipe thermal axial movement by friction, since neither the AISC or ASME NF codes permit the use of A-307 bolting material for friction connections. The use of A-307 bolting material is discussed further in Section 3.5.

As noted in Section 1.4.3, the team identified pipe support calculations as an area of generic concern at Sequoyah, based on the relative frequency of pipe support calculations which were not prepared in accordance with TVA's licensing commitments or CEB's pipe support design criteria. CEB should confirm that its on-going pipe support regeneration program addresses the team's concerns for this generic deficiency.

3.4 SEISMIC QUALIFICATION OF COMPONENTS

The objective of the team's review in the area of seismic qualification of components was to determine if the components and equipment installed in the ERCW system met FSAR seismic category I requirements.

The team reviewed TVA's equipment procurement documents to confirm that these documents incorporated the appropriate technical criteria and specified the appropriate levels of interface and design control. Special attention was given to the important interfaces between equipment allowable nozzle loading and applied piping loads, in addition to equipment seismic loadings and civil/structural considerations. The IDI team also reviewed the equipment seismic qualification documents prepared by the equipment vendor to confirm that the equipment was properly qualified to the specified technical and design control criteria.

The team reviewed the seismic qualification of numerous pieces of equipment including tanks, valves, heat exchangers, pumps, coolers, water chillers and an auxiliary feedwater pump turbine. The equipment review included an evaluation of the following attributes; safety class, compliance with FSAR commitments, seismic criteria, acceleration limits and vendor computed equipment support loadings to determine that they were properly interpreted and applied.

The team identified several deficiencies during the course of this review in the area of seismic qualification of components. These deficiencies were characterized primarily by vendor equipment qualification documents that did not meet the requirements of TVA's equipment procurement specifications. These document deficiencies had apparently not been identified during TVA's acceptance of the equipment and supporting documentation. The vendor seismic qualification calculation for the motor operated valves that regulate the flow of emergency makeup water to the turbine driven auxiliary feedwater pumps uses a design pressure of 50 psig, although the system design pressure is 150 psig. The valve operating loads which the vendor combined with seismic loads to qualify the valve were incorrectly based on the 50 psig design pressure (Deficiency D3.4-1). The vendor's documentation for the seismic qualification of the turbine-driven auxiliary feedwater pumps did not completely address the requirements of the procurement document. The axial thrust loading developed at the pump discharge nozzle due to the 1650 psig pump discharge pressure was not considered when evaluating pump baseplate and hold-down bolts. This concern also applies to the motor driven auxiliary feedwater pumps (Deficiency D3.4-2).

The equipment vendor's calculations for the component cooling water and containment spray heat exchangers were not performed in accordance with the technical requirements specified in TVA's procurement documents. The vendor's calculations appear to be unconservative with respect to TVA's requirements due to the fact that the heat exchanger vendor did not completely evaluate the heat exchanger nozzles or shell with respect to the applied loads and moments which CEB supplied to the vendor for that purpose. In addition, TVA did not install the component cooling water heat exchanger in accordance with the vendor's drawings. TVA installed the heat exchanger using three supports rather than two supports as shown on the vendor's drawings. No calculations were performed by TVA or their vendor to evaluate the effects of this additional support on the heat exchanger shell (Deficiencies D3.4-3 and D3.4-4).

The team reviewed the procurement documents for flexible hose used to attach ERCW piping to safety-related HVAC equipment. During this review it was observed that TVA took unsubstantiated exceptions to the criteria within their own procurement document to reduce the seismic and quality control requirements that the flex hose vendor was required to satisfy (Deficiency D3.4-5).

During the review of seismic calculations for the upper containment air cooler a calculation error was discovered. The calculational error resulted in the unconservative determination that the minimum frequency was greater than 25 Hz for the cooler. The correct frequency is below 25 Hz. Therefore, the equipment should have been considered flexible as stipulated in the purchase specification (Deficiency D3.4-6). In a related deficiency, the team noted that three out of the four cooling unit seismic qualification reports which the team reviewed had not been subjected to a design review in accordance with TVA's licensing commitments by either the vendor or TVA. As noted in Section 1.4.3, the team considers TVA's failure to ensure a design review for these documents to have potential generic implications. This is discussed in greater detail in Section 3.6.

The team reviewed the separate seismic qualification reports for shutdown board room chiller B and its associated control box, which is mounted on the chiller unit. These reports violated a key provision of the equipment procurement document requirement that no device location on the support structure be permitted to have a seismic acceleration greater than three-fourths of the actual device test acceleration (Deficiency D3.4-7). A related deficiency was identified by the IDI Instrumentation and Control discipline and involves two Westinghouse reports which separately qualify a Westinghouse vertical auxiliary panel and two types of Westinghouse switches. These documents also did not meet the same provision of FSAR Section 3.10.2, which requires that the switches on the panel be limited to seismic accelerations less than three-fourths of the actual switch test acceleration. For the control room switch and panel design, this FSAR requirement was not evident in the procurement documentation, nor was compliance with the requirement clearly demonstrated by test or analysis. This seismic provision is also an FSAR commitment for all panels supporting Class 1E electrical and control devices. This is discussed in greater detail in Section 5.4.

The IDI Instrumentation and Control discipline identified another unresolved item relating to the seismic qualification of electrical and control devices. In this case, the field is permitted to procure and install devices such as relays, timers and terminal blocks in previously qualified Class 1E panels without any apparent engineering review. This review is required to confirm that the original seismic qualifications of the panels and attached devices remained valid. This is discussed further in Section 5.4.

As noted in Section 1.4.3, the team concludes that generic problems appear to exist in the area of seismic qualification of equipment. Some vendor seismic qualification reports were not prepared in accordance with the requirements of TVA's equipment procurement documents. The team also notes that electrical and control devices attached to previously qualified panels did not receive engineering review and may therefore exceed acceleration limits. The IDI team concludes that TVA needs to review their seismic qualification reports for electrical and mechanical equipment and address these apparent violations of purchase documents and FSAR commitments.

3.5 APPLICATION OF CODES AND STANDARDS

During the course of the review, the team paid particular attention to TVA's application of codes and standards for the equipment, piping, and pipe supports installed in the ERCW system. Sequoyah was designed and constructed during the period when the industry was transitioning from ANSI-B31.1 - 1967 to ASME Section III for piping design. In the early 1970's, TVA upgraded their commitments in an attempt to partially use the newer ASME Section III Code for piping design. This was done in order to utilize the service limits (i.e., Normal, Upset, Emergency and Faulted) in ASME III since ANSI B31.1, "Power Piping," the design code of record for Sequoyah Nuclear Plant, does not provide design rules for piping analysis in sufficient detail to address the many load combinations and operating conditions committed to in the FSAR. As a result, TVA committed to the use of the equations and service limits specified in Section III of the ASME Boiler and Pressure Vessel Code, Subsection NC-3600 Winter 1972 Addenda. As noted in FSAR Section 3.9.2.5.2, TVA considers the ASME Code Winter 1972 Addenda to be equivalent to ANSI B31.1 - 1967, this concept has, in part, contributed to the problems discussed below. Of primary concern to the NRC is that the commitment to both ASME III and B31.1 - 1967 has resulted, on occassion, in instances where TVA analysts pick and choose the combination of criteria from both standards that results in the least stringent set of requirements. For example, the team determined that TVA used the piping material stress allowable limits specified in the ASME Code, instead of the more conservative stress allowable limits documented in ANSI B31.1 - 1967 and stipulated for use in FSAR Table 3.9.2-3. This item remains unresolved pending further review by TVA (Unresolved Item U3.5-1).

In a related item, the team reviewed an ERCW piping stress calculation (N2-67-2A) with an overstressed condition at a tee connection. The calculation originally used the stress equations of ASME III Subsection NC-3600, as permitted by the FSAR, to resolve the overstressed condition. However, when the overstressed condition could not be resolved using the ASME Code, it was concluded that the overstressed condition could be analyzed away using ANSI B31.1 - 1967. ANSI B31.1 - 1967 is less restrictive in this case than the ASME Code, since it does not require the use of a stress intensification factor for the seismic portion of the additive stresses. This is required by ASME Section III Subsection NC-3600. The team notes that this interpretation conflicts with the FSAR statement of code equivalency (Deficiency D3.5-2). This calculation strongly implies that some pipe stress analysts did not subscribe to the code equivalency belief, since it is clear from the above example that analysts were aware that using the less restrictive provisions of B31.1 could resolve an overstressed condition resulting from the use of the ASME Code. In general, the selective use of certain provisions of a code or standard is unacceptable. This subverts the inherent conservatisms provided by the code when it is used in its totality, as its authors intended.

During the team's review of pipe support design and analysis, it was learned that normalization of pipe support loads had been established as a common practice by CEB. Normalization of pipe support loads is performed by dividing the support load associated with a particular load combination and ASME III service limit by a normalization factor. The normalization factor is equal to the ratio of the allowable stress for the ASME III service limit of concern (e.g., Upset, Emergency or Faulted) to the allowable stress defined by ASME III for the Normal service limit. For the Faulted condition primary plus secondary allowable stress, TVA used a normalization factor equal to 1.6. This factor, when applied to the appropriate tensile and bending allowable stresses from the AISC specification, results in allowable stresses which exceed the maximum allowable of 0.9 times the yield strength for structural steel which is stipulated in the FSAR (Deficiency D3.3-3).

The team requested, but TVA could not provide, the documented basis for the normalization factors used for the corresponding Upset, Emergency, and Faulted service limits. This deficiency indicates that the code of record (or allowable stress) committed to in the FSAR was not properly followed. This concern is also being addressed by the NRC Office of Special Projects on a generic basis.

Finally, the team reviewed a pipe clamp test report for small bore pipe clamps used primarily in alternately analyzed piping subsystems. Since neither ANSI B31.1 - 1967 nor AISC provides rules or guidance relating to the establishment of allowable loads through testing, TVA used the load rating rules of ASME Section III Subsection NF to establish Unistrut pipe clamp allowable loads by test. The team notes that TVA, in implementing the load rating requirements of ASME Section III Subsection NF, failed to implement all of the Subsection NF requirements (Deficiency D3.5-3). Specifically, TVA did not take a 10% reduction in the test load as required by Paragraph NF-3261. In addition, Paragraph XVII-2461.4 in ASME Section III Mandatory Appendix XVII specifically prohibits the use of SA-307 bolting in a friction connection, due primarily to the uncertainty in the material's ability to maintain a consistent design preload, in this case for axial pipe load restraint. This deficiency indicates inadequacies in the implementation of ASME Section III, Subsection NF. TVA, however, is not committed to the NF provisions of ASME III as the FSAR code of record for pipe support design is B31.1 - 1967. TVA's use of ASME NF rather than B31.1 for the design of pipe supports is under current licensing review by the NRC's OSP.

In summary, several deficiencies were identified in CEB's application of codes and standards. The team determined that TVA was conversant with the various codes and standards but had difficulty in properly implementing certain code requirements. TVA's licensing commitments in the area of piping and pipe supports are complex. In the view of the IDI team, the complex set of commitments has been a source of confusion within TVA. This is evident from the inconsistent manner in which codes are applied, driven apparently by the need to obtain the least stringent set of requirements. For piping and pipe supports, TVA should provide written guidance and training to assure that analysts clearly understand the TVA licensing commitments in this area and know how to properly apply them.

3.6 DESIGN CONTROL

In addition to evaluating compliance to FSAR commitments and various design criteria requirements, the team reviewed equipment seismic qualification documents, piping analysis, and pipe support design and analysis with a focus on design process and design control. TVA's commitment to design control, as discussed in 10 CFR 50, Appendix B, Criterion III, is documented in Section 17.1A.3 of the Sequoyah PSAR and various specific design criteria.

3.6.1 Discipline Interfaces and Design Verification

The design criteria are key technical documents which provide pertinent information such as design and analysis methods, specialized requirements, loading combinations with respect to specific operating conditions, applicable allowable stresses and nozzle loads, and valve data. Secondary documents such as the Pipe Support Design Manual and the Rigorous Analysis Handbook provide instructions and guidelines for the proper implementation of the design criteria and FSAR commitments across various discipline interfaces. Seismic qualification requirements for equipment were generally addressed in an appendix to the equipment procurement document and required a vendor or TVA design review and certification.

In general, the team found that design control was adequate, but notes that many of the identified deficiencies illustrate weaknesses in certain aspects of the design process. In addition to the specific deficiencies and their deviation from commitments, the cumulative evaluation of the deficiencies suggest the following weaknesses in design and interface control:

1. The design process did not assure proper interface control;

2. The inadequate design review of vendor reports for the seismic qualification of equipment resulted in incorrect or incomplete responses to design requirements in procurement specifications going undetected;

3. Design verifications were not conducted in the depth required to identify design errors and omissions.

Some specific examples illustrating the above weaknesses are presented using the identified deficiencies.

Deficiency D3.3-1, "System N2-67-2A Pipe Support Calculation," describes a supplementary steel beam supporting two large bore pipes that was not analyzed for the loads from both pipes. This indicates that proper interface controls were not followed during the design process to assure that all applicable loads and load combinations were accounted for in the design of the structural steel. Another example, Deficiency D3.3-5, "Incorrect NCR Corrective Action," identifies a condition where the NCR corrective action for the evaluation of Unistrut pipe clamp test loads to properly qualify the clamps for prior usage resulted in an incorrect assessment of the test results. A review of this deficiency suggests that the design process followed did not consider some fundamental design concepts and may not have been properly design verified. Both of these are examples of inadequate interface control. Additional deficiencies that can be similarly categorized are Deficiencies D3.2-2, D3.2-3, D3.2-7, and D3.4-5.

As stated in Deficiency D3.4-4, "CCW and CS Heat Exchanger Nozzle Loading," the CCW and CS heat exchanger nozzle loadings evaluated by the vendor did not agree with the allowable nozzle loadings stipulated in the applicable TVA design criteria. This indicates that the vendor calculations and subsequent design review did not result in the correct application of specified design requirements. A second example, Deficiency D3.4-6, "ERCW Upper Containment Vent Cooler Frequency Calculation," indicates that the seismic qualification report for the cooler contained a natural frequency calculation error which, when corrected, resulted in a natural frequency below the 25 Hz limit required for consideration of the component as rigid. The required vendor design review for this equipment could not be provided by TVA. This suggests that either the lack of a required design review or an inadequate design review contributed to the failure to discover the incorrect calculation. Both of these are examples of inadequate review of vendor reports. Additional deficiencies that can be similarly categorized are Deficiencies D3.4-1, D3.4-2, D3.4-7, and D3.6-1.

Deficiency D3.2-8, "Valve Fundamental Frequencies," describes a 3-inch valve whose seismic qualification report documents frequencies below the 25 Hz limit required for consideration as rigid. However, the valve operator was not modeled as a flexible valve in the accompanying piping analysis. This indicates that design verification was not conducted in a manner adequate to identify design errors. Another example, Deficiency D3.3-4, "Pullout Loadings for Baseplate and Anchor Bolts," states that pullout loads for surface mounted baseplates and anchor bolts were not considered for some "typical" pipe supports for alternately analyzed piping. This also suggests that design verification procedures were not adequately implemented to identify design omissions. Both of these are examples of inadequate design verification. Additional deficiencies that can be similarly categorized are Deficiencies D3.2-1, D3.2-5, D3.3-2, and D3.4-3. The team concludes that TVA should address the generic implications of these identified inadequacies in the design control process.

3.6.2 Review of Change Documentation

In an attempt to provide an assessment of the design change process prior to issuance of the operating license, the IDI team reviewed several types of change documents that exhibited this aspect of design control. These documents consisted of nonconformance reports (NCRs), engineering change notices (ECNs), and field change requests (FCRs). The team's review concentrated on the nature of the requested or identified change or nonconforming condition, the corrective action taken by the responsible design organization, and the action required to prevent recurrence.

In general, the overall change process control appeared adequate. The description of the change or nonconforming condition was normally clearly stated and understandable, thus limiting the instances of potential incorrect corrective actions. The corrective actions reviewed, with the exception of Deficiency D3.3-5, essentially provided the necessary design input to properly address the nonconforming condition and establish confidence in the disposition of the changes.

The IDI team did, however, observe some inadequacies in the NCR blocks that specified "Action Required to Prevent Recurrence". Close scrutiny of four NCRs (2189 dated 6/4/80, 1090 dated 7/27/78, 25P dated 2/19/80 and SQNSWP8003 dated 2/15/80) revealed that the action described to prevent recurrence of the nonconforming condition was basically a commitment to discuss the nature of the NCR with the particular design or construction group responsible for future implementation of the design related function specified or implied by the NCR corrective action. For example, NCR 25P dated 2/19/80 stated that during a site inspection it was observed that two ERCW hangers were missing from the piping system. The action required to prevent recurrence stated "more care should be used in inspecting hangers." The IDI team requested some form of documentation (training records, meeting notes, etc.) to verify that this action had been taken. TVA could provide no objective evidence other than noting that this item may have been discussed during onsite informal weekly meetings. The other NCRs referenced above also contain similar statements with no formal documentation of the specific action taken to prevent recurrence.

Without formal documentation that the specified action was taken, the NCR may not have been properly closed out. The action required to prevent recurrence is important to the overall design change process since it may identify potentially adverse trends at an early stage, and provides a vehicle, when properly implemented, to prevent future occurrences. For future NCRs, TVA should develop a closure process to assure that the specified "Actions Required to Prevent Recurrence" are completed.

3.6.3 Design Control Conclusions

In summary, the overall Sequoyah design control process including design change document control appears to be adequate. TVA, however, when responding to the specific deficiencies, should also address the three design and interface control weaknesses identified previously with respect to generic implications. TVA also should develop a closeout process to provide assurance that for future NCRs that appropriate action has been taken to prevent recurrence.

4.0 CIVIL/STRUCTURAL

4.1 SCOPE OF INSPECTION

The scope of this portion of the inspection was to evaluate TVA's structural analysis and design practices by reviewing, on a sample basis, calculations, design criteria, quality assurance procedures, drawings of the reactor building, auxiliary building, ERCW pumping station, pipe supports, equipment supports, cable trays and supports, and HVAC ducts and supports. The team also evaluated the seismic analysis of category I structures by reviewing the formulation of the mathematical models, the methodology for generating the artificial earthquake and the application of the time history technique to generate the floor response spectra. The computer codes used in the process were also reviewed.

The team's approach in evaluating the design of reinforced concrete and structural steel structures was to review the calculations to determine whether they conform to the TVA licensing commitments and applicable NRC regulations. In general, the team reviewed TVA's design approach to ensure they adhered to design code requirements and generally accepted engineering practices. The team also conducted evaluations of equipment and component supports, pipe supports and HVAC support designs to determine whether these supports were designed in accordance with the FSAR commitments and related code requirements. The support drawings were also reviewed to ensure that the design requirements had been correctly translated from the calculations. Special features such as the design of buried piping and the ERCW rock fill dike were also evaluated to determine their structural adequacy.

The team's evaluation of the TVA design control in the civil/structural area involved issues such as communication and coordination among various design organizations, review of vendor supplied documents and procurement documentation to ensure they adhere to appropriate TVA design standards and procedures and QA procedures.

4.2 SEISMIC ANALYSIS OF STRUCTURES

The team's review of TVA's seismic analysis calculations concentrated on the formulation of the mathematical model and the generation of floor response spectra for three seismic Category I buildings, the reactor building, the auxiliary building, and the ERCW pumping station. With the exception of the steel containment vessel these buildings are generally reinforced concrete buildings.

4.2.1 ERCW Pumping Station

The ERCW pumping station is a reinforced concrete structure supported on sheet pile cells filled with tremie concrete (concrete placed under water). The sheet pile cells are founded on rock.

TVA performed the seismic analysis of the ERCW pumping station by preparing an idealized lumped mass model and using the time-history modal analysis technique. The ERCW pumping station was analyzed for horizontal ground motion in two directions and for vertical ground motion. The analysis was performed in accordance with FSAR commitments and no deficiencies were identified.

4.2.2 The ERCW Access Cells

Access to the ERCW pumping station is provided by a road supported by six sheet pile cells and interconnecting cells which are filled with tremie concrete. The ERCW piping and essential Class 1E conduits are also embedded in these cells. The cells were analyzed as a single "J-shaped" unit. Torsional effects were not considered in the analysis.

During construction, shrinkage gaps between the sheet piling and the fill concrete were identified. A beam was added to provide shear resistance between the cells in the horizontal direction but not the vertical direction. TVA design criteria SQN-DC-V-1.4.5 states that "the sheet pile sections serve only as forms for tremie concrete therefore, quality assurance is not required for these sheet pile sections." The calculations also predict that there will be vertical movement between adjacent cells. The inability to transfer vertical shear between the cells makes the original assumption of a single "J-shaped" unit invalid. Furthermore, even if the assumption were valid, torsional loads should have been considered in the analysis and design, since the "J-shaped" unit is not symmetrical (Deficiency D4.2-1).

4.2.3 Reactor Building

The reactor building seismic analysis consists of three separate analyses. These analyses are for the reactor interior concrete structures, the steel containment vessel, and the shield building. The team reviewed the development of the mathematical models which were prepared by TVA for these structures. The team found that none of these calculations have been totally checked (Deficiency 4.2-2). This deficiency could invalidate the adequacy of the seismic analyses.

In the winter of 1985, TVA found that the vertical response spectra for the steel containment vessel were inconsistent with the data stored in the computer. TVA decided to regenerate these curves using a new computer code "STARDYNE". The newly generated response spectra curves show a seven- to ten-fold increase in acceleration at the higher elevations in the containment, especially in the range between 20 Hz and 30 Hz (Deficiency 4.2-3). This deficiency indicates that the original computer code, "DYNANEL," used by TVA to generate response spectra curves may be in error or unconservative. This leaves in question the adequacy of equipment seismic qualification based on the earlier floor response spectra. TVA needs to evaluate the generic implications of the use of "DYNANEL" if it is found to be in error.

4.2.4 Auxiliary-Control Building

The team's review of the auxiliary-control building seismic analysis concentrated on the the development of the mathematical model for the structure and the generation of the floor response spectra. The team found that the calculation, "Auxiliary-Control Building Seismic Analysis," Rev. 3, 3/2/87, was not totally checked. In addition, the mathematical model was not updated as the design changed. Therefore, the mathematical model did not incorporate certain changes in wall sections. It also did not include the concrete columns as part of the seismic model, which could have an impact on the seismic responses (Deficiency 4.2-4).

4.3 AUXILIARY BUILDING STRUCTURAL DESIGN

The auxiliary building is a reinforced concrete structure composed primarily of flat slabs and shear walls. The team evaluated various portions of the auxiliary building to determine whether the analysis and design were in accordance with the FSAR commitments and the related codes.

4.3.1 Reinforced Concrete Design

The team reviewed the major reinforced concrete structural elements of the auxiliary building including the base slab, various intermediate slabs, the roof slab at elevation 778.0 and the walls on column lines A1, A15, A5, and A11.

The base slab is a two-foot thick slab placed against rock at different elevations. It is anchored to the rock by #11 reinforcing bars to minimize the bending stresses in the slab due to the hydrostatic uplift pressure. The review of TVA calculations showed that the net uplift pressure was incorrectly calculated since the TVA designer deducted the total building weight in calculating the hydrostatic pressure, instead of using only the weight of the base and fill slabs since most of the load is carried by the base directly below the walls (Deficiency D4.3-1). In addition, the review of TVA drawings showed that the #11 reinforcing bars used to anchor the slab into the rock do not have enough embedment length in the base slab to develop the full strength of the reinforcing bars (Unresolved Item U4.3-2). The team believes that the anchorage detail used by TVA for these #11 reinforcing bars does not agree with the ACI 318-63 building code requirements. Furthermore, TVA calculations for the base slab show that no reinforcement was provided at the rock face. The design of the slab shows that the slab was considered to be continuously supported at the rock anchors. The team is concerned that TVA did not check the effects of negative moments due to this lack of reinforcement (Unresolved Item U4.3-3). Based on the above concerns, the team concludes that TVA needs to evaluate the structural adequacy of the base slab.

The team reviewed the slab calculations for elevations 669.0, 653.0, and the roof slab calculation at elevation 778.0. The slab calculations were manual computations except for the roof slab where a finite element computer analysis was performed. TVA calculations for the slab at elevation 669.0 showed that the most critical load combination was not used for the design of the slab (Deficiency D4.3-4). The roof slab at elevation 778.0 is designed in accordance with the ACI 318-63 building code as committed to in the FSAR. However, the calculations reviewed by the team show that TVA failed to evaluate the shear stresses at the edges of the walls as required by the ACI code (Deficiency D4.3-5). The team is concerned about the lack of evaluation for shear due to the brittle nature of shear failure in reinforced concrete structures.

The team reviewed TVA calculations for the A1 and A15 column line walls the A5 and A11 column line walls and the A4 column line wall. The A4 column line wall, which is placed against rock, does not have any reinforcement at the rock face. The design of the wall shows that it was assumed to be fixed at the top and the bottom, but no consideration was given to the negative moments that would be developed as a result of these fixities. Due to the lack of reinforcement in the wall at the face of the rock, cracks might develop at the top and bottom of the wall. This would lead to an increase in the positive moment in the wall and also allow the seepage of water through the cracks. The review of TVA calculations for the A1 and A15 walls showed that these walls were designed to carry the loads as committed to in the FSAR. However, a minimum reinforcing steel area of 0.2 percent was provided in the horizontal direction at certain portions of the walls compared to a minimum of 0.25 percent required by the ACI 318-63 building code (Deficiency D4.3-6). Also, the TVA calculation showed that an error was made in calculating the minimum reinforcing steel areas where the percentage of steel was multiplied by an effective area of the wall rather than by the gross area as required by the ACI code. The team also reviewed a TVA calculation which evaluates the shear walls for horizontal seismic loads. This calculation showed that the shear stresses calculated were within the allowables as stated in FSAR section 3.8.4.4.1.

Due to the deficiencies found by the team, an overall conclusion on the structural adequacy of the concrete portion of the auxiliary building could not be reached.

4.3.2 Structural Steel Design

The team reviewed a TVA calculation for the auxiliary building structural roof framing at elevation 791.25. The roof slab is supported by girders which in turn are supported by the trusses. The major load carrying elements are the trusses which span 80 feet between the auxiliary building walls. The structural steel framing is designed to carry dead, live, and seismic loads in accordance with the Seventh Edition of the AISC code.

TVA calculations show that the rigid vertical seismic acceleration of the walls at elevation 791.25 was used as the vertical seismic acceleration of the trusses. No calculation or justification was provided to determine that the trusses were truly rigid in the vertical direction (Deficiency D4.3-7). The seismic loads on the trusses could have been underestimated if the natural frequency of the trusses were not in the rigid range (33 Hz or higher).

The auxiliary building roof framing also supports four tanks each weighing between 90 and 135 kips. Although the vertical loads from those tanks were considered in the design of the roof girders and trusses, TVA failed to take into account the overturning moments from these tanks during a seismic event (Deficiency D4.3-8).

The design calculations for the roof framing showed that the structural steel elements, in most cases, were stressed to the allowable limits. Therefore, the team believes that a reevaluation of the steel framing is necessary with respect to these two deficiencies. Such an evaluation would determine the structural adequacy of the roof girders and trusses.

4.3.3 Masonry Wall Design

Sequoyah Nuclear Plant has both reinforced and unreinforced masonry walls. The team reviewed the TVA calculation which contains the original design of the reinforced masonry block walls. This review did not show any deviations from the commitments made in FSAR Table 3.8.4-1. However, TVA's original calculations, as well as the analysis performed on the reinforced and unreinforced masonry walls to satisfy the requirements of IE Bulletin 80-11, are missing. TVA has identified these missing calculations and intends to regenerate these calculations after restart. The IDI team does not agree with this approach. TVA, prior to restart, needs to regenerate structural calculations for reinforced or unreinforced masonry whose failure could damage any systems required for safe shutdown (Deficiency D4.3-9).

Since the team could not review these calculations which evaluated the as-built condition of the reinforced and unreinforced masonry walls, the team cannot reach a conclusion on the structural adequacy of the masonry walls at Sequoyah.

4.4 STRUCTURAL DESIGN OF ERCW PUMPING STATION

The ERCW pumping station is a reinforced concrete structure, 98 ft. long and 67 ft. wide. Its foundation is at elevation 685 and the roof is at elevation 732. It is supported on a tremie concrete filled sheet pile structure at elevation 685. The foundation is supported on rock at elevation 618.

4.4.1 Structural Design of Pumping Station

The team reviewed the stability analysis of the structure, the analysis and design of the reinforced concrete structure, and the analysis and design of the structure to resist tornado induced load, including the tornado generated missiles.

The stability analysis and the reinforced concrete design of the ERCW pumping station were performed in accordance with FSAR commitments. The analysis and design of the structural steel roof system to resist tornado generated missiles was found to be incomplete. The analysis fails to demonstrate that the system will remain stable when struck by the postulated tornado missile which, in this case, is a utility pole. On impact of the utility pole, the structural members could become secondary missiles and cause the failure of safety-related components. The design also fails to demonstrate that the roof system will not be penetrated by smaller missiles postulated in the FSAR (Deficiency D4.4-1).

4.4.2 Stability of the ERCW Rock Fill Dike

Immediately west of the ERCW access cells, the ERCW piping and electrical conduits are supported by a pile supported structure embedded in a rock fill dike. The dike consists of 3" crushed stone with an embankment slope of four horizontal to one vertical. The summary of stability cases investigated for access dike shows that the dike will be unstable (factor of safety less than 1.0) using the properties of the rock fill material stated in the FSAR. Also, the vertical seismic forces were not considered in the analysis. Consideration of the vertical seismic forces will reduce the factor of safety even further.

The calculation does not demonstrate that the dike will be stable under all loading conditions including the vertical seismic loads. Since the ERCW piping and the essential Class 1E conduits are embedded in the dike, failure of the dike would probably cause the failure of the ERCW piping and the electrical conduits (Deficiency D4.4-2). Two laboratory tests were performed in 1979 to evaluate the actual properties of the rock fill material. By utilizing this information, TVA may be able to demonstrate that the rock fill dike will be stable during a seismic event. There is no evidence that these new data were ever considered by TVA in re-evaluating the calculation which showed the dike to be unstable.

4.5 BURIED PIPING

The team reviewed the recently prepared buried piping calculations and found that the calculations were prepared in accordance with the appropriate engineering and QA procedures. The calculations were prepared following the direction of TVA design criteria SQN-DC-V-13.5, Design Criteria for Seismically Qualifying Buried Piping Systems, Rev. 0, 9/5/72. A previous NRC inspection discovered that these calculations were missing. The IDI team confirmed that the seismic Category I buried piping had been adequately qualified by TVA.

4.6 ANALYSIS AND DESIGN OF COMPONENT AND HVAC SUPPORTS

The team reviewed various component supports, including tanks and HVAC duct supports to determine whether the design of the supports was in accordance with the FSAR commitments and related code requirements.

4.6.1 Component Supports

For component supports, the team reviewed the pertinent calculations and drawings for the containment spray pump foundation, the component cooling water heat exchanger supports, the component cooling water surge tank supports, the containment spray heat exchanger supports located in the auxiliary building, and the ERCW pump supports located in the ERCW pumping station.

For the containment spray pump foundation, the team reviewed TVA drawings 41N307-3 Rev. 5, 41N353-1 Rev. 5, anchor bolt detail drawing 41DS307 Rev. 0, and the vendor drawings for contract #71C30-92646. TVA could not locate the calculations for the design of the anchor bolts. TVA, apparently, provided the maximum size bolts that would fit into the bolt holes provided by the vendor.

The equipment weight is listed on the vendor drawing. TVA needs to perform additional calculations to make sure that the anchor bolts are adequately designed.

The team reviewed the containment spray heat exchanger support calculation, related TVA drawings, and the related vendor calculation. Prior to the team's review, TVA had issued a CAQR, SQP870188, to document the fact that the design of the heat exchanger support structure and its anchorage used loads less than specified by the vendor. The team's review of the design calculations and the drawings showed that the embedded plate thickness and the drawing were less than what was required in the design calculations (Deficiency D4.6-1).

For the component cooling water heat exchanger supports, the team reviewed the TVA calculation and related drawings. The available vendor drawings and calculations were also reviewed. TVA could not locate the design calculations for the concrete pads that support the heat exchangers. In addition, the walkdown by the team showed that the heat exchangers are supported on three supports rather than the two supports that are shown on the TVA drawing. The review of the calculations for the embedded plate showed that a thinner plate was provided on the construction drawing than what was required by the design calculations (Deficiency D4.6-1).

The team reviewed the TVA calculation and drawings related to the component cooling water surge tank supports. The team also reviewed the available vendor calculations and drawings related to this tank. The team found that the number of anchors shown on the TVA construction drawings was less than what was required by the design calculation and the spacing of the anchors was different than what the calculation required (Deficiency D4.6-1). The team also noted that the hold down bolts for the tank were designed only for tension forces; the shear forces were not considered in the design as required by the AISC code. TVA failed to design these hold down bolts for the combined effect of both tension and shear forces (Deficiency D4.6-2).

The team reviewed the TVA calculation and drawing related to the design of the ERCW pump supports. The vendor drawing for the sump was also reviewed. The TVA design calculation and drawing showed that TVA used a smaller size hold down bolt for these pumps than what was indicated on the vendor drawing. However, the TVA calculation showed that this smaller size bolt was adequate to carry the design loads. The team did not find any deficiencies in the design of the support for the ERCW pumps.

Relating to the support design of the component cooling water surge tank, the team reviewed the available vendor and TVA calculations for the seismic analysis of the tank during the review of the steel framing calculations of the auxiliary building roof at elevation 791.25. The team also reviewed the seismic analysis calculations for the demineralized water tank that are supported on the roof of the auxiliary building. The team noted that TID 7024 Chapter 6 was used to determine the dynamic loads on the demineralized water tank and its supports. TVA used a similar procedure, TID 25021, for the seismic calculation of the component cooling water surge tank. These procedures, as well as TVA design criteria SQN-DC-V-13.6, specify that the tank be considered rigid when full of fluid. TVA specification 72C-53-92725-2 for tanks require that a lumped mass model of the tank be prepared to calculate the natural frequency of the tanks. The vendor calculations for the demineralized water tank could not be located and the TVA calculations for the support design failed to consider the flexibility of the tank. The vendor calculations for the component cooling water surge tank showed that the frequency of the tank was incorrectly calculated since the shear flexibility of the tank was not considered. The team believes that TVA needs to perform additional analyses to determine the validity of the assumption that the tanks are rigid (Deficiency D4.6-3).

Overall in the component support design area, the team concludes that there are two generic problems where additional TVA reviews are warranted. First, it appears that there are discrepancies between the design calculations and the construction drawings. Second, TVA should determine whether the tanks are rigid as assumed in order to justify the adequacy of the design of the tank supports.

4.6.2 HVAC Duct Supports

The team selected four HVAC duct supports from TVA drawing 47W920-9 Rev. 29 for review. This is a typical duct support drawing designed for both Sequoyah and Watts Bar Nuclear Plants. The review of the design calculations showed that the supports were designed by using the Watts Bar seismic response spectra accelerations which are higher than the Sequoyah plant spectra.

TVA design criteria SQN-DC-V-13.8 contains information on the design of HVAC duct supports. It includes span lengths for different sizes of ducts which should not be exceeded to maintain the rigidity of the ducts. The team's review showed that the span lengths listed in this design criteria were not exceeded for the supports reviewed.

The team reviewed the TVA calculation and TVA drawings relating to duct support 47A055-15. Similarly, the TVA calculation was reviewed in conjunction with the pertinent drawing for duct supports 47A055-83 and 47A055-84. The team reviewed the above mentioned calculations and drawings to determine whether the TVA design criteria requirements were met and whether the drawings reflected the analysis performed. The team did not identify any deficiencies in the HVAC duct support area. The team notes that TVA has an outstanding CAQR, SQT870843, relating to the overall generic design deficiencies in HVAC ducts and duct supports. The corrective action for this CAQR was not complete at the time of this inspection and was therefore, not available for the team's evaluation.

TVA recently upgraded the duct supports of the lower compartment cooling system to seismic category I. The team reviewed the TVA calculations performed for upgrading these duct supports. These recent support calculations were performed by the use of the STRUDL computer program and appear to include the requirements of TVA design criteria and the AISC code.

4.7 ANALYSIS AND DESIGN OF PIPE SUPPORT BASE PLATES AND ANCHORS

TVA is currently reanalyzing and regenerating some 5000 pipe support calculations. The Base Plate II computer program is being used to evaluate the anchor bolt loads due to base plate flexibility. The NRC acceptance criteria states that the self drilling anchors (SSDs) should have a factor of safety of five for long term operation and a factor of safety of 2.8 for short term or restart. The team reviewed five pipe supports, and three of them specified the use of Rawl SSDs. Rawl SSDs have a lower ultimate strength than what was used to establish the allowable bolt loads (Phillips SSDs). One of the supports, H10-727, would not meet the short term or restart criteria if the correct ultimate strength of the Rawl anchors was used and the allowable bolt loads were not increased for increased concrete strength (Deficiency D4.7-1). TVA issued CAQR SQF870101 in June of this year to address this deficiency.

4.8 ANALYSIS OF ELECTRIC CABLE TRAY AND CONDUIT SUPPORTS

The team reviewed the design of the electrical cable tray and conduit supports in the ERCW pumping station. The analysis and design appeared to be complete and in accordance with the FSAR commitments. The team did not identified any deficiencies.

4.9 APPLICATION OF CODES AND STANDARDS

The original design of the concrete portions of the auxiliary building were in accordance with the requirements of the ACI 318-63 building code as committed to in the FSAR. TVA has used later versions of the same code, ACI 318-71 and ACI 318-77, for modifications and reanalysis performed on the auxiliary building. Portions of the Seismology Committee Structural Engineers Association of California Code (SEAOC) were also used for evaluations of shear walls. In certain cases, minimum steel percentages in walls were provided as specified by the TVA Temperature and Shrinkage Standard.

The IDI team's review of the design calculations for the concrete portions of the auxiliary building showed that there were deviations from the ACI 318-63 code requirements. TVA used a lower percentage of steel for horizontal reinforcement in walls than what was required by the code. No justification was provided for the use of a lower percentage of steel. Also, the anchorage detail used in the rock anchors for the auxiliary building base slab did not adhere to the code requirements. These findings are described in detail in section 4.3.1.

In the calculation for minimum steel requirements, a TVA standard was sometimes used. This standard varied from the ACI code requirements for minimum steel percentages, and it allowed TVA to exclude reinforcement at the rock face for slabs and walls placed against rock. The IDI team did not review the TVA standard to determine its validity.

The team also noted that certain slabs and walls were not evaluated for shear stresses at the edges as required by the ACI 318-63 code. The team feels that this was an example where the requirements of the ACI Code were not followed properly.

The analysis and design of the ERCW pumping station was performed in accordance with codes and standards committed to in the FSAR.

For the design of the structural steel portions of the auxiliary building, TVA committed to the use of the Seventh Edition of the AISC code. The design calculations reviewed by the team showed that the objectives of the code were met, except in one case, where the team identified that shear forces were not considered in the design of anchor bolts. The AISC code requires that shear and tension forces be considered jointly for the design of anchor bolts.

4.10 DESIGN CONTROL

4.10.1 Discipline Interfaces

During the review of the design of the concrete and structural steel portions of the auxiliary building, the team evaluated the interface of TVA's civil/structural group with other TVA groups. In some cases, the loads were obtained from other groups, and appear to be appropriate. However, in previous inspections, the NRC has identified TVA's failure to properly consider pipe support loads on structural steel elements.

During the review of the seismic analysis of the reactor and auxiliary buildings, the team noted that the interfaces between TVA's Civil Engineering Branch (CEB) and other engineering branches appeared to be appropriate. The equipment weights were obtained from other engineering branches and the floor response spectra were issued to other engineering branches in accordance with proper procedures and guidelines. The team did not identify any deficiencies in this area.

4.10.2 Review of Change Documentation - FCRs, NCRs, ECNs

The team reviewed several NCRs. The preparation, evaluation and disposition of these NCRs was thorough and consistent with FSAR commitments. No deficiencies were identified.

5.0 INSTRUMENTATION AND CONTROL

5.1 SCOPE OF INSPECTION

In the instrumentation and control systems inspection, the IDI team focused on certain ERCW functional aspects, design issues, and design features important to safety. The attributes that were emphasized in the inspection are discussed below:

The implementation of licensing commitments in the detailed design was reviewed by the team. This included a selective review of component/circuit classification, automatic operation and interlocks, safety-significant alarms, circuit independence, instrument installation, ERCW leak/break detection and mitigation, and instrument specifications. Other attributes reviewed were: provisions for safe shutdown from outside the control room during a design basis fire, including a review of functional requirements and schematic diagrams; proper application of TVA's environmental and seismic qualification program to ERCW instrumentation and control equipment, and design considerations for extreme natural environmental conditions; and the demonstrated accuracy calculation program as applied to the ERCW system. Individual accuracy calculations were not reviewed in depth, but the methodology and scope of these calculations was reviewed. The team also reviewed application and design considerations for ERCW liquid radiation monitors and design control issues such as implementation of multiple discipline requirements and engineering change controls.

The emphasis during the review was on compliance with NRC Regulations, the FSAR and other TVA commitments/requirements, as well as assurance that the systems and equipment would function as required under design basis conditions. Where findings were reported in the ERCW system, the team identified any applicable generic design concerns that might extend beyond the ERCW system scope. The inspection considered both the technical adequacy of items under immediate review as well as any implications of flaws in the design process, such as inadequate communication of discipline interface requirements.

The selected documentation reviewed and discussed with TVA included: FSAR and regulatory commitments and requirements; TVA design criteria; engineering procedures; flow, logic, and schematic diagrams; instrument installation details; instrument specifications and procurement documents; demonstrated accuracy calculations; engineering change notices, work packages, nonconformance reports, and various other technical documents and correspondence.

At the beginning of the inspection, the IDI team performed a cursory walkdown of the ERCW system; this included the ERCW pumping station, main control room, auxiliary control room, cable spread room, and portions of the auxiliary building. A more comprehensive walkdown was performed during the ERCW As-Built Verification Inspection, and is reported separately in NRC Report Nos. 50-327/87-52 and 50-328/87-52.

5.2 ERCW INSTRUMENTATION AND CONTROL SYSTEMS DESIGN

5.2.1 Circuit Component Classification and Identification

Safety classification and train assignment of individual Class 1E and non-1E components and circuits appeared to be correct, thorough, and consistent in the ERCW documentation that was reviewed by the team. However, an inconsistency in ERCW safety classifications in FSAR Table 3.2.1-2 was noted as a deficiency by the team (Deficiency D5.2-1). This FSAR inconsistency did not appear to cause improper classification of any instrumentation or control devices in the current design, and the TVA cognizant instrumentation and control personnel seemed to have a good understanding of safety significance of individual components and circuits. There were some past incorrect classifications of traveling screen drive motors and instruments, but these deficiencies in classification were detected by TVA in 1981 (per NCR SQNNEB8126) and have since been corrected. It is possible that the FSAR deficiency noted could have contributed to this past error in classification.

During the walkdown, the team observed a deficiency in tagging the rear portion of certain control board switch modules (Deficiency D5.2-2). In several cases, the unit prefix identifier (i.e., 0, 1, or 2) was missing. This is a violation of TVA control panel specification and instrument tabulation requirements, and could increase the potential for maintenance errors. The front of the panel did not exhibit this deficiency; not only the tag numbers but also the safety trains were clearly and uniquely identified on the front of the panel.

5.2.2 Automatic Operation and Interlocks

The team selected a sample of control circuits for review to determine if mechanical and electrical systems' functional requirements had been satisfied and that circuit operability would be assured. Included in this sample were the ERCW pumps, ERCW traveling screen drives and screen backwash pumps, and ERCW containment isolation valves. Relevant aspects of the diesel load sequence logic circuits were also reviewed. From the logic and schematic diagrams and discussions with cognizant TVA personnel, the team concluded that the circuits reviewed would perform as required. In addition, the team selected for review revisions in the mechanical and electrical systems interlock requirements affecting the lower compartment coolers served by the ERCW system; the team concluded that the revision of the mechanical and electrical systems requirements had been correctly and thoroughly implemented in the circuit design. Discussions with TVA indicated that further assurance of correct interlock implementation is provided for safety-related control circuits by preoperational functional testing of control circuits.

The team also noted that the TVA instrumentation and control personnel had a good understanding of the circuit requirements, particularly considering that many of the design elements reviewed were developed nearly ten years ago.

5.2.3 Safety Significant Alarms

During the walkdown, the team observed an excessive number of apparently invalid alarms on the ERCW control room panel. The team considers an alarm to be invalid if the alarm is actuated but no operator action is required. Unlike many plant systems, the ERCW system should not exhibit a large number of alarms during shutdown because the system is still operating. The team concluded that there are an excessive number of nuisance or invalid alarms for a safety system and that this is a deficiency in the alarm system design which may occur for other safety systems as well (Deficiency D5.2-3). In addition, the team questioned the feasibility of using an alarm to initiate timely operator action to isolate a break in the nonseismic ERCW piping, due to instances of false alarms from the flow instrumentation used to detect the break. This is discussed further in Section 5.2.6.

The team recognizes that TVA has committed to correcting alarm system deficiencies as a result of findings from their control room design review program and expects this finding to be addressed in corrective actions resulting from that program.

5.2.4 Single Failure Criteria and Circuit/Channel Independence

The team noted two deficiencies, two unresolved items, and one observation in this area of design.

In reviewing the schematics for the traveling screen drives, the team determined that fuses had been added to the circuit by TVA with the intent of providing isolation of the non-Class 1E speed switch. A previous NCR had identified the isolation deficiency which was to be corrected by this change. The team determined that no analysis had been performed by TVA that would assure that the additional isolating fuse would clear a fault before the control circuit branch fuse would actuate. An analysis performed by TVA during the inspection demonstrated there was not sufficient assurance that the isolating fuse could perform its function since the control power fuse and isolating fuse current-time characteristics were not properly coordinated. The team determined this to be a deficiency, since a short circuit of the non-Class 1E speed switch induced by a seismic or other common design basis event could render all traveling screen drives inoperable (Deficiency D5.2-4).

A deficiency in circuit independence was identified during the walkdown of the main control board. The team observed that, in several places, braided metallic sheaths of redundant divisions of internal panel wiring were touching, could migrate with time to touch, or could touch if disturbed by maintenance personnel. This is a violation of specific FSAR separation requirements. By reviewing the design documentation and procurement history with TVA, the team concluded that this appears to be a deficiency in the installation and not the design or design process. The installation of this field wiring did not conform to TVA design criteria, or FSAR commitments (Deficiency D5.2-5).

The team identified a potential problem regarding adequate independence of non-Class 1E status signal wiring from Class 1E switchgear control wiring. A plant modification, which added isolation devices to virtually all safety-related switchgear, motor control centers, and other panels, was implemented in such a way as to bundle the input and output wiring together within the switchgear enclosure. TVA must demonstrate that this does not defeat the purpose of the isolation device by allowing a non-Class 1E circuit failure to propagate into the Class 1E circuit (Unresolved Item U5.2-6).

The team identified a second potential problem regarding channel independence, whereby TVA has allowed situations where instrument tubing shares the same penetration. This condition is allowed by TVA criteria. The team concludes that TVA needs to identify the extent of this practice and justify any specific cases where penetrations or other common structures are shared by redundant instrument lines to assure that single failure criteria are met (Unresolved Item U5.2-7).

Similarly, the team observed that TVA instrument line separation criteria permit the use of common process connections. However, in this case, TVA stated that no redundant safety-related instrument lines within TVA design scope shared common process connections, even though their criteria would allow this practice. The team believes the TVA criteria are too permissive in this regard and that only in extreme cases, justifiable by other overriding safety concerns, should this practice be permitted for future modifications (Observation O5.2-8).

Except as noted in the findings herein, the team found the TVA separation criteria complied with FSAR criteria and provided appropriate, comprehensive, and useful design guidance. With the exception of the design findings noted, the team concluded that TVA's general approach to circuit separation appeared to be well conceived and implemented in the design. This very general impression was reinforced during the cursory walkdown, although the IDI instrumentation and controls team did not actually trace circuits end-to-end as a part of the inspection. The NRC's ERCW As-Built Verification Inspection Report (50-327, 50-328/87-52) presents findings resulting from electronic tracing of selected samples of circuits requiring separation.

5.2.5 Design Considerations for Instrument Installation

Requirements for instrument line separation, slope, low point drains, and high point vents were clearly stipulated in the construction specifications and shown on installation details. The team questioned the TVA practice of not considering the use of hydraulic dampeners for instrument lines experiencing pressure pulsations, and not accounting for the possible effects on instrument performance and life (Observation O5.2-9).

Typical instrument support details were developed by TVA CEB for supporting field run instrument lines. This practice is acceptable provided the support locations are approved by a qualified engineer, and that thermal considerations are adequately considered in the design. TVA personnel stated that these conditions are met.

5.2.6 ERCW Leak Break Detection and Mitigation

In the event of a pipe break in the nonseismic portion of the ERCW piping, operator action is required to isolate the break and prevent degradation of ERCW capability. Operator action is initiated by a high flow alarm and status light in the control room that monitors each ERCW header train that would supply water to the break. The team identified a deficiency involving six problems with this approach (Deficiency D5.2-10).

1. TVA could not retrieve a calculation justifying ERCW system functionality associated with the minimum required operator response time for a double ended break in the non-seismic ERCW piping.

2. The annunciator is not seismically qualified.

3. Even if the annunciator were seismically qualified, a seismic event would result in numerous alarms competing for the operator's attention.

4. The alarm had not been identified as high priority.

5. System operating instructions and available control room instrumentation do not assure specific and timely action can be taken in all cases.

6. There have been instances of false alarms.

5.2.7 Process Instrument Specifications

Instrument specifications and data sheets were reviewed for ERCW header pressure, pump discharge pressure, ERCW strainer differential pressure, ERCW screenwash pressure, and the ERCW high flow alarm instruments. Instrument ranges were consistent with the TVA ERCW design criteria. Seismic qualification requirements were properly included for safety-related instruments. Since none of the ERCW safety-related instruments are required to operate in a harsh accident environment, no harsh environmental qualification requirements were necessary.

The team identified an apparent documentation deficiency regarding design control of instrument specifications which is summarized in Section 5.8 of this report.

5.3 PROVISIONS FOR SAFE SHUTDOWN FROM OUTSIDE THE CONTROL ROOM

The team believes that TVA's overall approach to safe shutdown from outside the control room is well founded and appears generally acceptable; however, a problem was identified in the traveling screen drive and screenwash pump circuits. Indicating lights in the control room are directly connected to these control circuits that must remain operable after the fire; consequently, a design basis control room fire can render all of the ERCW traveling screens and screenwash pumps inoperable. TVA should review any similar indicating light circuits to verify that this deficiency is not generic (Deficiency D5.3-1).

Except for this deficiency, based on the documents reviewed it appeared that proper separation distances, fire barriers, fire detectors, and fire suppression systems were provided to meet the committed ERCW requirements to 10 CFR 50, Appendix R. Transfer switches were provided on auxiliary panels to permit the operators to enable the controls required for attaining and maintaining hot shutdown from outside the control room. Where permissible, some motor-operated valves have power administratively removed to meet Appendix R commitments.

A separate walkdown by the ERCW as-built verification inspection team confirmed reasonable agreement between ERCW alarms and select indications on both the main control board and auxiliary control panel.

5.4 ENVIRONMENTAL DESIGN AND SEISMIC QUALIFICATION

While no safety-related ERCW instruments are required to operate in a harsh accident environment, a deficiency was found concerning adequate consideration of natural environmental temperature extremes in the ERCW pumping station. The team determined that no heat tracing or qualified space heaters had been provided to prevent freezing of safety-related instrument lines below elevation 720 (i.e., within the ERCW structure) and that TVA had not performed an analysis adequately justifying the absence of qualified environmental control features. The team identified apparent freezing problems in the ERCW pumping station documented in 1983 by maintenance requests. The team concluded that there is insufficient assurance that 10 CFR 50 Appendix A Criterion 4 is met in the design (Deficiency D5.4-1).

While harsh accident environment was not a concern for safety-related ERCW instrumentation, the team spot-checked the TVA design process to assure that a change in accident environmental temperatures resulting from changes in the ERCW design for the emergency gas treatment room coolers was properly accounted for in the environmental qualification (EQ) of other safety-related equipment in the room. The team determined that TVA had properly recognized the impact on EQ during the design change process, and was taking action to assure qualification would be maintained after the change.

As discussed in Section 5.2.5, the team developed an observation regarding the consideration of the effects of recurrent pressure pulses on the performance and life of a component. It does not appear that TVA has accounted for cycling of safety-related instruments due to hydraulic pulsations in the design, and the possible effects on performance and life.

In the area of seismic qualification, the team identified one deficiency and one unresolved item. The team reviewed the seismic qualification of the ERCW panel and control switches and identified a deficiency in the qualification. TVA could not retrieve a calculation demonstrating that the maximum accelerations at all switch locations satisfy the FSAR criteria that the acceleration at the panel mounting location be less than 75 percent of the value of the SSE peak response acceleration as determined from the appropriate response spectra or less than 75 percent of the actual device test acceleration. This FSAR requirement was not evident in the procurement documentation nor was compliance with the criteria clearly demonstrated by test or analysis. This finding is applicable to all of the main control room panels (Deficiency D5.4-2).

A potential problem in the area of seismic qualification relates to TVA's extensive practice, reflected on design drawings, of field location and field procurement of devices to be mounted on safety-related panels. In reviewing an extensive modification involving addition of isolation devices to switchgear, motor control centers, and other panels, the notations "field to locate" and "field to procure" appeared on the drawings. The team is concerned that TVA may have had inadequate engineering controls on such field located components and that this practice could violate the seismic qualification bases of either the component or the panel in which it is mounted (Unresolved Item U5.4-3).

5.5 INSTRUMENT ACCURACY CALCULATIONS

The team reviewed TVA's calculation methodology and performed a cursory review of the calculations and their assumptions. Although a detailed review was not performed, the team believes the calculations were properly scoped for the ERCW system with regard to safety significance, appropriate methods were used, and the calculations and assumptions appeared to be well documented. However, the demonstrated accuracy calculation for the high flow alarm used for ERCW break detection had not been issued except in draft form late in the inspection, so it was not reviewed.

5.6 ERCW RADIATION MONITORS

The team reviewed the specifications and location of the ERCW discharge liquid radiation monitors and determined that the monitor background radiation had been incorrectly specified, since it did not account for post-accident radiation sources. The team determined that the existing monitors will probably not function during a design basis accident, since accident background levels will actuate the monitor and likely mask any measured level. The FSAR states that these monitors are required during an accident to detect and manually isolate leakage from the containment spray or component cooling water heat exchangers into the ERCW system (Deficiency D5.6-1).

The team identified another deficiency for these radiation monitors regarding specification of pressure and temperature ratings. The rated temperature and pressure of the ERCW system is significantly higher than the values specified by TVA for the monitors. However, TVA demonstrated from vendor specifications that the equipment furnished does meet the required service conditions even though the TVA specification is incorrect (Deficiency D5.6-2).

TVA should investigate the generic implications of these deficiencies for other radiation monitors.

5.7 APPLICATION OF CODES AND STANDARDS

An important design attribute reviewed during the IDI was the application of codes and standards in the design of Sequoyah. The attributes that the team assessed were: (1) whether or not the proper codes and standards were being used; (2) whether or not they were being interpreted correctly and (3) whether or not the codes and standards were being applied consistently. Although the team did find misapplications of codes and standards in the I&C discipline, our review indicated that TVA, in general, correctly and consistently applied the codes and standards committed to in the FSAR.

One of the areas noted during the inspection that was not adequately addressed by TVA related to operability and qualification of equipment to withstand extremes of natural ambient conditions as required by 10 CFR 50, Appendix A, General Design Criteria (GDC) 4, "Environmental and Missile Design Bases." For example, the team noted that inadequate freeze protection had been provided for instrumentation in the ERCW pumphouse. Examples of improper qualification were found by the IDI team's Mechanical Systems discipline, where certain components located in the ERCW pumphouse were not qualified to the extremes of temperature.

The team also noted non-compliances with IEEE Standard 279 - 1971, "Criteria for Protection Systems for Nuclear Generating Stations." One item of non-compliance involved the inadequate isolation of the non-Class 1E ERCW traveling screen speed switch and alarm circuit from the safety-related Class 1E power circuits supplying the traveling screen drive motors. A second item of non-compliance related to the separation of wiring in the main control board and the fact that during the walkdown, the IDI team observed that redundant divisions of control cable, encased in braided metallic sheaths, were in contact with each other. The excessive number of nuisance or invalid alarms on ERCW panel OM-27 observed during the walkdown also represents an area of non-compliance with IEEE Standard 279-1971.

The team also found a non-compliance with 10 CFR 50, Appendix R, "Fire Protection Program for Nuclear Power Facilities Operating Prior to January 1, 1979." This was related to the operability of the traveling screens and screenwash pumps following a major control room fire. Since the indicating lights for these components are inside the control room and are directly connected to their control circuits, a control room fire could render these components inoperable.

5.8 DESIGN CONTROL

5.8.1 Discipline Interfaces

In the area of design control, the team believes that many of the findings described herein may have resulted from weaknesses in communicating FSAR and other engineering requirements across discipline lines and documenting requirements in a timely manner, so as to keep the design current and to keep all disciplines cognizant of the design bases and key safety issues. The team believes that the deficiencies identified for the break detection alarm, instrument line freeze protection, control board seismic qualification, ERCW alarms, radiation monitors, and perhaps the traveling screen deficiencies could be the result of failure to integrate multi-discipline systems requirements into the design.

The team notes that TVA's discipline interface review procedures improved greatly during the mid-1970's but that some additional effort may be required in improving TVA's systems integration capabilities.

5.8.2 Review of Change Documentation

Several of the deficiencies and unresolved items identified by the team involved TVA change documentation. Review of two ECNs and resolution of an NCR, each of which was related to diverse subjects, indicated failure to properly address key elements of safety significance and insufficient attention to detail in the design and/or the design documentation.

ECN L5637 was intended to provide proper isolation of the non-1E traveling screen speed switches, but as reported in Deficiency D5.2-4, the change failed to provide an engineering analysis demonstrating adequate fuse coordination. It was determined during the inspection that the isolation fuses were not properly coordinated when the change was implemented.

An NCR written in 1982 identified nonconformance with an LCO regarding operability of the ERCW liquid effluent monitors. The NCR noted that the monitor was inoperable because it had been disconnected to avoid nuisance alarms due to background levels apparently originating from a refueling water line. TVA corrective action consisted of raising the setpoint and moving the monitor. In doing so, TVA failed to recognize the post-accident safety significance of these monitors and failed to consider that the monitor would be exposed to much higher dose rates during an accident. As described in Deficiency D5.6-1, the monitor will not function during a design basis accident, as required by the FSAR.

One Deficiency and one Unresolved Item regarding engineering control of field location for devices on seismically qualified panels and wiring methods employed for isolation devices were identified by the team as a result of reviewing extensive modifications undertaken by TVA. TVA must demonstrate that adequate engineering controls and appropriate analyses assure that these modifications did not compromise the design bases for seismic qualification and circuit separation/independence (Deficiency D5.4-2, Unresolved Item U5.4-3).

Finally, a number of apparent documentation deficiencies were identified by the team in that discipline interface review responsibilities and actual review/approval signatures were not evident on several design documents reviewed. However, the team recognizes that TVA has improved its interface review procedures significantly since the time these apparently deficient documents were developed (Unresolved Item 5.8-1).

Regarding recent TVA practice, we were impressed with the completeness, clarity, and auditability of the design basis documents that TVA has assembled and the capabilities of technical personnel who have access to them. We encourage further use of this valuable tool for design control and systems integration.

6.0 ELECTRIC POWER

6.1 Scope of Inspection

In the electrical power discipline, the IDI team conducted an examination of the electrical power subsystems of the Sequoyah ERCW system, and their supporting electric power supply and control systems. Since the ERCW power supply is an integral part of the Sequoyah plant auxiliary power system, this inspection necessarily went beyond the bounds of the ERCW system.

The basic inspection strategy was to proceed "upstream" from the ERCW loads (e.g., the electric motors driving pumps, motor-operated valves, and control devices) through the conductors, switchgear, and transformers of the auxiliary and vital power distribution systems, back to the power sources. In addition to the 6900V and 480V ac auxiliary power systems (including the standby diesel generator sets), the team examined the 120V ac and 125V dc vital control power systems, which are critical to the operation of both the ERCW system and the plant auxiliary power systems supporting it. While the team concentrated on subsystems and equipment required for safe reactor shutdown, the team also considered nonsafety-related equipment to the extent that it can affect safety-related power supply functionality.

The team's evaluation addressed the following issues: (1) conformance of the electrical design with the applicable regulations and with TVA licensing commitments; (2) general adherence to sound nuclear-power-plant electrical engineering design principles; and (3) the effectiveness of TVA's electrical design process, i.e. design control and engineering quality assurance. Concerning conformance to licensing commitments, we evaluated the electrical design against the standards and other design criteria cited in the Sequoyah FSAR and other applicable documents incorporating TVA's commitments to NRC. Our evalution of the general soundness of the design involved such issues as the application of equipment within its ratings and other operating limits and the effectiveness of power system protection and separation among Class 1E divisions. Major design control and engineering QA issues included communication and coordination among the various organizations involved in electrical design, construction, procurement, and equipment vendors both within and outside TVA. The team also checked for the existence of and consistent adherence to appropriate internal design standards and procedures; and the effectiveness of design review and configuration control.

6.2 ELECTRICAL DESIGN OF AC AUXILIARY POWER SYSTEMS

6.2.1 Voltage and Loading Analysis

The objective of this portion of the inspection was to review the methods and results of studies used by TVA to determine the anticipated steady state and transient loading and voltage levels in the ac auxiliary electrical system during normal and emergency operation of the plant. The results were compared with the requirements of the ERCW system Class 1E electrical equipment and FSAR commitments. The various studies performed by TVA included an analysis of the preferred and standby power supplies.

The preferred power sources are the unit turbine generator during normal power operation, and the offsite power grid when the turbine generator is shut down. The voltage study for the 6900V auxiliary power system under preferred power conditions is based on a TVA developed computer program. The adequacy of this computer program was verified by TVA, using selected hand calculations. The worst case loading of the system was established by the study to be a loss-of-coolant-accident (LOCA) with Phase B containment isolation in Unit 2 and full-load rejection in Unit 1. The team concludes that the 6900V system voltage calculations demonstrate satisfactory voltages under the preferred power conditions.

The low-voltage power system voltage study was also based on an in-house computer program and checked by TVA using hand calculations. As in the medium voltage calculations the effects of motor feeder cables were considered. The worst case loading condition studied was a LOCA and Phase B containment isolation in Unit 2. However, contrary to the medium voltage study, Unit 1 was considered in cold shutdown. ERCW equipment (screen wash pumps, traveling screens and strainers) were shown to have motor terminal voltages of approximately 95% of nameplate rating (460V) or better during starting and 97% or better while running. The worst case for ERCW motor operated valves was shown to have motor terminal voltage of at least 85% during the seating portion of valve travel. The team found these calculations to be technically acceptable.

The four diesel generator sets in Units 1 and 2, plus their auxiliary equipment, constitute the standby ac power source for the plant. The team reviewed TVA's Calculation SQN-E3-002, "Diesel Generator Load Analysis," Rev. 5, that is intended to show that the worst case transient and steady state loading are within the capabilities of the diesel generator units and acceptable voltage and frequency limits are maintained. The study considers only Unit 2 in operation and those Unit 1 and common loads necessary to support Unit 2. Unit 1 is considered to be in cold shutdown. Thus, the worst case loading considered by TVA is a coincident loss of offsite power and a LOCA in Unit 2 requiring Phase B containment isolation. In contrast, FSAR Sections 8.1.2 and 8.3.1.1 and General Design Criteria 5 of 10 CFR 50, Appendix A, indicate that a loss of offsite power with a LOCA in one unit and hot shutdown of the other unit should be considered the worst case loading of a two-unit plant (Deficiency D6.2-1).

The automatic sequential loading of the diesel generators appears in FSAR Table 8.3.1-2 and also Attachment E of Calculation SQN-E3-002. These documents are in agreement regarding the sequential order and timing of load application on the diesel generators following a loss of offsite power coincident with a LOCA with Phase B containment isolation in one unit. The magnitudes of the sequentially applied loads also agrees with the above documents, except for the random and miscellaneous loads applied at the start of the sequence (t=0). The FSAR table indicates block loading of 1100 HP at t=0 while Attachment E assumes approximately 800 HP. Based on the team's review the latter appears more realistic and is acceptable. The team noted a second anomaly in the loading study wherein contrary to the FSAR and Attachment E tables, the containment spray pump motors are sequence-loaded at t=180 seconds rather than t=30 seconds. We were informed that TVA intends to correct the FSAR to make it consistent with the voltage and loading studies as part of their annual update as required by 10 CFR 50.71.

No identifiable calculation has been performed to evaluate voltage conditions at the various Class 1E motor terminals under the condition when power is supplied only from the diesel generators. While, as TVA contends, the high-speed voltage regulators and static exciters of the diesel generators probably provide voltage stability comparable to that of the preferred power system, further calculations are needed to confirm the adequacy of the motor voltages (Deficiency D6.2-2).

6.2.2 System Protection

The inspection team's evaluation of fault protection and protective device coordination involved examining: (1) the electrical schematic diagrams and the calculations containing the coordination studies of the ac auxiliary power systems to determine whether the protective relays, integral trip units of low-voltage circuit breakers, and fuses adequately protect the conductors and loads; and (2) whether the time-current characteristics of the various protective devices are coordinated so as to minimize the unnecessary interruption of unfaulted loads resulting from the isolation of a short circuit or overload.

With the exception of the absence of ground fault detection on low-voltage ac systems, which will be covered in Section 6.2.3, the protective subsystems of the ac auxiliary power system provide satisfactory protection for the conductors, containment penetrations and loads. Furthermore, the coordination among protective devices in the ac power systems is acceptable with the exception of the deficiency in coordination between several control power fuses intended to provide electrical isolation of non-Class 1E from 1E control circuits. This is discussed in Section 5.2.4.

The team evaluated the ERCW pumping station with respect to protection from lightning. Unlike several other safety-related structures at Sequoyah (e.g., the reactor containment and emergency diesel generator buildings) the ERCW pumping station lightning protection system has no air terminals (lightning rods). FSAR Section 8.1.5, "Design Criteria and Standards," commits TVA to compliance with NFPA 78 - 1971, "Lightning Protection Code." Part II, Section 204 states, "In case of buildings which are roofed, or roofed and clad, with metal, it may be possible to dispense with some air terminals..." Section 205 states, "Buildings with structural metal framing may be protected by the installation of air terminals..." The Sequoyah plant is located in an area which has a high frequency of thunderstorms, and the ERCW pumping station is an isolated building, remote from other buildings and structures, so it is more exposed to lightning strikes than other plant buildings. While the requirements of NFPA 78 are ambiguous and do not explicitly mandate the use of air terminals, the team recommends their installation (Observation 06.2-3).

6.2.3 System Grounding

We examined the effectiveness of system grounding in the 6900V and 480V ac auxiliary power systems with respect to its ability to perform its three basic functions: (1) suppressing transient overvoltages, (2) providing enough ground fault current to positively operate 6900V protective relays and 480V integral trip units during ground faults, and (3) limiting ground fault currents to the minimum levels consistent with (1) and (2).

When the 6900V system is supplied by either the unit or common station service transformers, i.e., during either normal power operation or shutdown operation with offsite power, the system neutral is grounded through one of the 1600 A neutral grounding resistors at the transformers, a condition which is satisfactory with respect to all three system grounding functions. During emergency operation on diesel generator power, the 6900V APS is high-resistance-grounded through neutral grounding systems which alarm on occurrence of a ground fault and limit ground fault current to about one ampere. This arrangement adequately suppresses transient overvoltages while allowing the standby power system to continue to operate with a single ground fault, which assures the maximum reliability of emergency ac power.

The electrical team also evaluated the system grounding design of the 480V auxiliary power systems at Sequoyah. The team found that the systems are entirely ungrounded. Furthermore, according to the SQN "as-built" drawings as confirmed by discussions with TVA/EEB personnel, and contrary to FSAR paragraph 8.3.1.1, the 480V power systems lack any form of ground fault detection. We consider this a serious deficiency. In addition to generally degrading the reliability of safety-related auxiliary power, the existing condition imposes a specific hazard to the plant's safety-shutdown capability because a ground fault can persist undetected indefinitely. This could lead to a scenario where a single subsequent detectable failure may disable redundant components in both trains of Class 1E equipment. This is a violation of IEEE Std 279 and NRC Regulatory Guide 1.6, both of which are committed to in the FSAR (Deficiency D6.2-4).

Resolution of this deficiency will require ground detection circuits to be installed at each 480V safety-related distribution substation. The team further strongly recommends that the ground detectors be designed to provide effective system neutral grounding, thereby suppressing transient overvoltages and reducing the risk of overvoltage-related failures of equipment and conductors.

6.2.4 Short Circuit Application

This part of the inspection concentrated on the ability of power switchgear and motor control devices to withstand and/or interrupt the currents which they could experience during short circuits in the ac auxiliary power systems. TVA has performed reasonably complete short circuit calculations on both 480V and 6900V ac systems, which the team audited and found satisfactory.

We compared the worst case short circuit currents calculated to be imposed on each circuit breaker in the 6900V unit board and shutdown board switchgear with the interrupting and momentary ratings of the breakers. The interrupting duties imposed on several of the load feeder breakers at both the unit boards and the shutdown boards are marginally greater than their nominal interrupting ratings, which normally implies a serious risk of catastrophic breaker failure and consequent unavailability of the associated switchgear bus. However, the team does not regard this condition as a significant deficiency in view of the switchgear manufacturer's test results showing that the breakers will successfully interrupt considerably more current than their nominal rating on a one-time basis, and the conservatism of the short circuit calculations. We nevertheless recommend that TVA take steps to reduce 6900V system short circuit levels at the earliest convenient opportunity (Observation 06.2-5).

The electrical inspection team similarly compared the short circuit ratings of the 480V distribution switchgear and motor controllers with the calculated short circuit currents to which they could be exposed. We found that the imposed duties were within the applicable equipment ratings in all cases.

6.2.5 Automatic Bus Transfer

At Sequoyah, a number of 6900V busses are automatically transferred from the normal power source, the unit turbine-generator, to offsite power from the common station service transformer upon loss of normal-source voltage. The team evaluated the design of these automatic transfer arrangements with respect to continuity of supply to critical loads, logic design of the transfer schemes, selection of the degraded-voltage setpoints which initiate the transfers, and protection of the transferred loads from damage due to reclosing torque transients. We found the design of the automatic bus transfer schemes to be acceptable, with some reservations about the possibility of potential long-term risk to the large auxiliary motors and driven loads (Observation 06.2-6). This is discussed further in Section 6.6.1.

6.3 ELECTRICAL DESIGN OF LOW-VOLTAGE VITAL POWER SYSTEMS

6.3.1 Voltage and Loading Analysis

The team reviewed the ac and dc vital power loading calculations in order to evaluate the ability of normal and standby vital power sources to supply their loads. These systems appear to have adequate capacity for all present and reasonably forseeable future loads.

The 125V dc control power system voltage drop studies reviewed by the team are intended to demonstrate that the voltages present at the terminals of the 6900 and 480V Class 1E switchgear control devices, solenoid valves, and ac vital power inverters under normal and anticipated off-normal conditions are within the equipment manufacturers' specifications. TVA's dc voltage study uncovered a number of problem circuits, which have been identified for correction through a Significant Condition Report. The team found several areas of deficiency, of which the most important are a failure to consistently consider the worst case battery terminal voltage (105V) identified in the FSAR and an unverified critical assumption about the minimum operating voltage of control relays (Deficiency D6.3-1).

The 120V ac control power system voltage drop studies we reviewed considered representative samples of Class 1E circuits. The studies calculated the voltages available at the various equipment and component terminals and compared the results with the minimum operating voltages specified by the manufacturers. The supply voltage level considered was 117.6 volts which is the specified minimum output of the inverters (i.e., 120V, minus 2%). The worst case voltage level on an instrument power panel board was determined as 115.4V. Similar to the dc voltage analysis, the ac study performed by TVA indicated several problem circuits, which have been identified for corrective action by a Significant Condition Report. Upon completion of these corrections, it is the inspection team's assessment that the design of the ac vital power voltage will be acceptable. However, the team has some concern about the apparent delay in implementing the SCRs resulting from the ac and dc voltage studies, some of which were performed as early as 1986.

In addition to the studies for the Class 1E 120V ac control power circuits served by the instrument bus inverters, the team reviewed TVA's Class 1E control circuit study for motor control centers. TVA analyzed these circuits using a Sargent & Lundy controlled and documented program which considers control transformer, cable and load characteristics. The worst case considered was a LOCA with Phase B containment isolation. The study disclosed undervoltage conditions on some circuits which will delay operation of those circuits during a voltage transient condition for 10 seconds following the incident. The analysis states that the delay will not affect any required safety-related system. This calculation appears satisfactory.

6.3.2 System Protection

In the absence of a detailed overall vital power system coordination study, we evaluated the quality of protection and protective device (circuit breaker and fuse) coordination in the ac and dc vital power systems on the basis of breaker and fuse ratings marked on "as-constructed" electrical drawings. Within the limits of this evaluation approach, protection and coordination appear to be satisfactory in all cases.

6.3.3 System Grounding

The 120V ac and 125V dc vital power systems are ungrounded, thereby incurring an increased risk of insulation damage from transient overvoltages, but both systems appear to have ground detection devices on the inverters and battery chargers respectively. Thus, the undetectable ground fault situation prevailing on the 480V system, discussed in Section 6.2.3, does not apply here.

6.3.4 Short Circuit Application

The electrical team inspected TVA's vital power system short circuit calculations for proper methodology, accuracy, etc., and found them satisfactory. We based our assessment of short circuit application of circuit breakers and fuses in the ac and dc vital power systems on the minimum standard ratings for the voltage and continuous current ratings shown on the electrical schematics. All of the equipment appears to be applied within its ratings.

6.4 POWER CABLE APPLICATION

The electrical inspection team evaluated the application of cables with respect to voltage rating, ampacity, and environmental qualification, based on electrical and environmental drawings, calculations justifying TVA's ampacity calculation and evaluation methodology, and a representative sample of approximately a dozen ampacity calculations for individual 6900V and 480V power cable runs. Our evaluation disclosed that all of the power cable is properly applied except as discussed below. The IDI team did not review the currently open questions regarding the installed cables with silicone-rubber insulation. This issue is being addressed by NRC's Office of Special Projects.

As discussed in Section 6.2.3, ungrounded electrical power systems are unusually susceptible to potentially damaging overvoltages caused by intermittent line-to-ground short circuits. Recognizing this, NEMA Standard WC5, an FSAR commitment, requires a cable insulation rating of 173% of the nominal system voltage in ungrounded systems which lack ground fault detecting features capable of assuring that ground faults will be discovered and removed within one hour of their occurrence. Since the 480V ac systems at Sequoyah are ungrounded and entirely lack ground fault detection, this standard requires a minimum cable insulation rating of 830V, well above the 600V rating of most, if not all, of the 480V power cable. The team does not consider this condition a separate deficiency because it will be corrected when ground fault detection is installed.

6.5 SYSTEM SEPARATION AND ISOLATION

The objective of this portion of the inspection was to review the electrical systems design for compliance to commitments for separation and isolation of redundant Class 1E power systems. The inspection team's electrical discipline placed its primary emphasis on the review of the power systems and equipment which serves the ERCW system, and collaborated closely with the IDI team's Instrumentation and Control discipline regarding control circuitry separation and isolation. See Section 5.2.4 for a discussion of the latter.

The team noted that TVA's commitments for separation include the criteria identified in IEEE 308-1971, Regulatory Guide 1.6, Rev. 0, and 10 CFR 50, Appendix R. There has been no commitment to Regulatory Guide 1.75. TVA's detailed design criteria document SQN-DC-V-12.2, Rev. 6 (dated 9/30/75) "Separation of Electrical Equipment and Wiring," together with several documented modifications (temporary design inputs) define the design requirements for separation of circuitry and equipment. Based on the team's review, TVA's separation design criteria are consistent with the standards cited in the FSAR.

6.5.1 AC Auxiliary Power System

Under the TVA separation criteria, the transformers, switchgear, and motor control centers associated with the two redundant safety-related power trains are to be separated by concrete block walls. Generally, raceways associated with the two trains are to be physically separated by a minimum of 3 feet horizontally and 5 feet vertically where no physical barrier exists. If either the 5-foot or 3-foot separation is not obtainable, then a fire-resistant barrier is to be provided. Our review of a representative sample of "as-constructed" electrical layout drawings and discussions with TVA personnel indicate that the separation design complies satisfactorily with both the licensing commitments and internal design criteria.

6.5.2 Vital Power Systems

The Class 1E 125V dc and 120V ac vital power systems are divided into four redundant divisions or channels designated I, II, III and IV. Four 125V batteries and battery boards shared by Units 1 and 2 are separated by concrete block walls. Each unit has four 120V ac inverters, one per channel. Channel I and II inverters are separated from channel III and IV inverters by a concrete block wall. Within channels I and II, and within channels III and IV, the inverters are separated by a minimum distance of 60 feet. Raceway separation criteria for the four redundant channels follow that discussed for the redundant power trains. According to TVA/EEB, the vital power system circuits are routed in conduit rather than cable trays. The team concluded that this design is consistent with the TVA separation design criteria on the basis of our inspection of vital power system layout drawings.

6.5.3 Separation and Isolation of Non-Class E Power Circuits

The separation commitments and TVA criteria allow non-Class 1E circuits to be fed by and routed with Class 1E power circuits. These non-Class 1E circuits ("associated circuits") are not permitted to be subsequently routed with circuits of a redundant Class 1E train or channel. Isolation of non-Class 1E power circuits from Class 1E buses is provided by circuit breakers or fuses. The associated circuits have been analyzed to assure that failures will not degrade the Class 1E circuits. The portions of the power systems inspected by the team appear to comply with the separation and isolation criteria.

6.5.4 Appendix R Considerations

To comply with 10 CFR 50 Appendix R, TVA has prepared design criteria document SQN-DC-V-24.0, Rev. 1 (dated 7/2/86), "Fire Protection of Safe Shutdown Capability," which specifies separation of circuits essential to safe shutdown by one of the following: (1) a fire barrier having a 3-hour rating, (2) a horizontal distance of more than 20 feet free of intervening combustibles and with fire detectors and automatic fire suppression system in the fire zone, or (3) a fire barrier having a 1-hour rating and with fire detectors and automatic fire suppression system in the fire zone. TVA has performed an extensive analysis to identify critical circuits and confirm adequate separation. Our review indicates that the design and installation of the electrical power system conforms to the design criteria.

6.6 ERCW MOTOR APPLICATION

The objective of this portion of the inspection was to review the application of the various ERCW system motors, including those for the ERCW pumps, screenwash pumps, traveling screens, strainers and valve operators. The team reviewed the various procurement documents issued by TVA to identify the technical requirements specified for the various motors, and compared these requirements with documented criteria and results of electrical system studies.

6.6.1 6.6kV Motors

The 6.6kV, 700 HP, Class 1E ERCW pump motors were specified to have sufficient torque to start their driven pumps at shutoff head with a terminal voltage of 85% of the nameplate voltage, and to accelerate the load to rated speed in five seconds with 90% voltage. (The 5-second accelerating requirement with 90% terminal voltage is based on the standby diesel generating loading sequence.) TVA's ac system voltage analysis shows that the 85% starting voltage requirement is satisfied when the 6.9kV shutdown boards are served from the station service transformers. However, TVA has not performed the calculations necessary to confirm that either of these voltage limits are satisfied when only the diesel generators are in service as discussed in Section 6.2.

The 6.6kV motors at SQN are subjected to fast bus transfer to offsite power upon failure of the normal power source (the unit turbine-generator). This creates a potential for loss of service life and possibly catastrophic motor, shaft, or pump failure because abnormally high transient torques can occur when the alternate source circuit breaker closes. The capability to withstand fast bus transfer is considered in Calculation SQN-APS-005, "Fast Bus Transfer Analysis," which demonstrates compliance with the fast transfer criteria in ANSI Standard C50.41. However, this standard was not specified for the ERCW motors. (In fact, the version of ANSI C50.41 in effect when the ERCW motors were purchased did not address fast transfer.) Section 22d of Specification 2261 used for the procurement of the pumps and motors identifies only a requirement for time delay transfer. There are no FSAR commitments or other NRC guidelines addressing this design consideration. Therefore, the team does not consider the existing condition a deficiency. Also, there are other circumstances, e.g., the redundancy of the ERCW pumps and the excellent service record of fast bus transfer, which is almost universally used in the electric power and other process industries, that indicate the failure of redundant ERCW pumps would be improbable. Nevertheless, we recommend that TVA investigate ways to limit the potential torque transients as discussed in Section 6.2.

With respect to environmental qualification, the purchase specification for the ERCW pumps and motors contained a seismic qualification procedure based on IEEE 344-1971, in compliance with FSAR Section 8.1.5. Since the motors are located in a mild environment, the team does not consider any additional environmental qualification specifications to be necessary.

6.6.2 <u>460 Volt Motors</u>

The team reviewed the application of the 460V, Class 1E ERCW motors, which includes the 40 HP screen-wash pump motors, the 7.5 HP traveling screen motors, and the 3 HP strainer motors. The review compared the performance specifications in the applicable procurement packages with the operational conditions determined by various TVA commitments, design criteria, and calculations. With the reservation discussed below, our review shows that the specifications are consistent with the expected operating conditions, and we conclude that the motors are properly applied.

The purchase specifications of the traveling screen and strainer motors lack any explicit requirement for starting at degraded voltage. TVA's auxiliary power system voltage analysis demonstrates that at least 85% of rated terminal voltage is available at all of the 460V ERCW motors when power is supplied from either the unit turbine generator or the off-site grid. This calculation concludes that the ERCW motor voltages are adequate on the basis of an assumption that the minimum acceptable motor starting voltage is 85% of nameplate voltage when specific vendor information is not available. TVA's justification for this assumption may not apply to the screen and strainer drives, both of which start under load and probably require substantial breakaway torque. Additional calculations or tests are needed to demonstrate that these motors can start and accelerate their loads under coincident worst case terminal voltage and load torque conditions.

In addition, as noted in Section 6.6.1, TVA has not performed the calculations necessary to confirm that ac load voltages will be adequate when the auxiliary power system is supplied by the standby diesel generators.

6.6.3 <u>Valve Operator Motors</u>

The various motor operated valves used in the ERCW system are considered safety-related and their motor operators are Class 1E. Many of these valves have been replaced in recent years. The team reviewed the procurement documentation for these to determine whether the specified motor characteristics conform to design criteria and calculated operational requirements. Many of the procurement documents reviewed failed to clearly state the desired motor characteristics, especially with regard to degraded-voltage starting performance. However, the specifications of most of the motors did cite TVA specifications 3321 and MEB-SS-10.10, both calling for sufficient torque to open and close their valves with a terminal voltage of 75% of rated voltage. TVA's ac system voltage and loading analysis shows that, with a few exceptions, the anticipated terminal voltages of the ERCW system valve motor operators are above 75% of rated voltage when auxiliary power is provided from the unit turbine generators or the station service transformers. The exceptions are exclusively "Appendix R" valves for which power connections have been removed. However, as noted above, the anticipated terminal voltages have not been determined by TVA studies based on power supply from the emergency generators.

6.7 ENVIRONMENTAL AND SEISMIC QUALIFICATION

The electrical team evaluated the environmental and seismic qualification of the electrical equipment associated with the ERCW system and supporting electrical supply systems on the basis of electrical and environmental drawings, equipment qualification packages, and procurement specifications. Equipment whose qualification was audited was the following: (1) 6900V and 480V Class 1E power switchgear; (2) Class 1E power transformers; (3) standby diesel generators and associated equipment; (4) vital power batteries, battery chargers, and inverters; (5) and the 460V pump, strainer, screen, and motor-operated-valve motors at the ERCW pumping station. Our inspection revealed that the qualification of the equipment inspected is satisfactory, except as noted by the Instrumentation and Control discipline in Section 5.4.

6.8 APPLICATION OF CODES AND STANDARDS

Paragraph 8.1.5 of the Sequoyah FSAR commits TVA to conformance with a variety of IEEE, NEMA, ICEA, and NFPA codes and standards as well as NRC regulatory guides and other criteria in the electrical design area. We found that the appropriate standards have been applied and that TVA has conformed quite consistently to their applicable requirements. Notably, Paragraph 8.1.5 states adherence to at least the intent of a number of standards which were not published when the plant was designed. From the sample of the design process we reviewed, this statement appears to be justified.

6.9 DESIGN CONTROL

In this part of the inspection the electrical team evaluated the quality of design control, i.e., TVA's management of the engineering design process. The team inspected samples of a variety of documentation including about 25 electrical calculations, 10 engineering change notice (ECN) packages, 10 purchase specifications, 15 nonconformance reports of various kinds, and several dozen one-line records of maintenance orders, all dealing with electrical power systems and equipment, to assess how well TVA has handled the design control function. The team's documentation sample encompassed the period from original (pre-OL) design in the early 1970s to the mid-1980s.

Successful execution of the design process required communication among a number of entities, both internal to TVA and external. TVA Electrical Engineering Branch must communicate with several other engineering branches, of which Mechanical Engineering Branch is by far the most important. The necessarily limited sample of documentation we examined indicated that all of the necessary information had been communicated in the electrical power area.

Similarly, the ECNs the team inspected showed that engineering changes were properly communicated to the plant and were apparently executed as designed. The team discovered no instances in the electrical power area where the plant made changes without engineering input which should have been engineered. However, the Instrumentation and Control discipline noted a related deficiency in the procedure allowing field-locating of components which apparently require seismic analysis, as discussed in Section 5.4.

As previously discussed, the team discovered several instances where procurement specifications did not reflect equipment requirements appearing in the FSAR, design calculations, or TVA's internal design criteria. This situation appears to be limited to the period in the early 1970s. We found no evidence of similar lack of specification content control in recent years.

The electrical power discipline evaluated independent review, engineering control of procurement specifications, and configuration control, within the limits of our scope of inspection. The team concluded that these areas are either currently satisfactory or being corrected where deficiencies have been uncovered in previous TVA and NRC reviews.

Insofar as the team could determine from our sample of procurement documents, TVA has consistently imposed appropriate QA requirements on vendors, either 10 CFR 50 Appendix B or their internal QA specifications before Appendix B was issued.

The nonconformance reports the team examined have consistently been addressed by a significant engineering evaluation effort, which in perhaps half of the cases in our sample resulted in issuance of an ECN and a hardware change. Where the conclusion of the evaluation was "Use-As-Is," this was sufficiently justified.

A general survey of ERCW-related maintenance orders, as described by one-line records in the SQN tracking system, revealed no particular failure trends which should have been addressed by engineering efforts. The team traced the outcome of one series of maintenance orders whose one-line descriptions suggested a systematic problem requiring engineering attention. The team found that the problem was promptly identified and corrected through the ECN process.

7.0 LIST OF PERSONNEL CONTACTED

7.1 CONTACT LIST - MECHANICAL SYSTEMS

Name	Title	Organization
R. E. Daniels	Acting Lead Mechanical Engineer	TVA MEB
F. P. Carr	Engineering Specialist	TVA MEB
G. Silver	Engineering Specialist	TVA MEB
D. Berch	Contract Employee	TVA MEB
M. Gardenhaire	Mechanical Engineer	TVA MEB
W. G. Askew	Mechanical Engineer	TVA MEB
R. A. Sulfridge	Nuclear Engineer	TVA MEB
H. G. O'Brian	Senior Engineering Specialist	TVA NEB
P. Baxter	Mechanical Engineer	TVA CEB
R. McKeehan	Principal Nuclear Engineer	TVA NEB
E. Steinhauser	Mechanical Group Leader	TVA MEB
P. Burnette	Mechanical Engineering Associate	TVA MEB
J. Hubble	Mechanical Engineer	TVA MEB
V. Chen	Mechanical Engineer	TVA MEB
J. Collins	Senior Electrical Engineer	TVA EEB
M. Cooper	Plant Operating Review Staff	TVA SQN
W. E. Rudacille	Nuclear Engineer	TVA NEB
R. Rosenfield	Mechanical Engineer	TVA MEB
M. R. Belew	Senior Electrical Engineer/ Supervisor I&C Section	TVA EEB
K. L. Mogg	Principal Mechanical Engineer	TVA CEB
D. C. Hatcher	Technical Supervisor, Civil Engineer	TVA CEB
M. Bressler	Senior Engineering Specialist	TVA WEB

M. Arroyo	Mechanical Engineer	Engineering Services
J. McClanahan	Mechanical Engineer	Engineering Services
L. Smith	Mechanical Engineer	TVA MEB

7.2 CONTACT LIST - MECHANICAL COMPONENTS

Name	Title	Organization
D. C. Hatcher	Technical Supervisor, Civil Engineer	TVA CEB
W. E. Roberts	Technical Supervisor, Civil Engineer	TVA CEB
J. A. Southers	Engineering Associate, Mechanical	TVA CEB
K. A. Brune	Senior Mechanical Engineer	TVA CEB
S. D. McMahan	Technical Supervisor, Mechanical Engineer	TVA CEB
K. Mogg	Principal Mechanical Engineer	TVA CEB
H. R. Threlkeld	Technical Specialist, Civil/ Geotechnical Engineer	TVA CEB
D. Lundy	Principal Civil Engineer	TVA CEB
R. Gish	Technical Supervisor, Mechanical Engineer	TVA CEB
D. Cox	Mechanical Engineer	TVA MEB
J. Rochelle	Senior Civil Engineer	TVA CEB
J. Maddox	Lead Engineer, Engineering Assurance	TVA EAB
M. Bressler	Staff Specialist, Nuclear Engineering	TVA NEB
E. D. Mysinger	Senior Engineering Specialist	TVA CEB
P. Guthrie	Senior Metallurgical Engineer	TVA NEB
K. Seidle	Assistant Chief Civil Engineer	TVA CEB
J. F. Edwards	Group Leader, Electrical Engineer	TVA EEB
R. E. Daniels	Lead Engineer, Mechanical Engineer	TVA MEB
F. P. Carr	Senior Mechanical Engineer	TVA MEB
S. Taylor	Technical Supervisor, Civil Engineer	TVA CEB

S. Doyle	Technical Supervisor, Civil Engineer	TVA CEB
R. T. Riner	Engineering Technician	G/C
G. Bushnell	Consultant - Supervisor Engineering Mechanics	SWEC
H. C. Cook	Technical Supervisor, Mechanical Engineer	TVA MEB

7.3 CONTACT LIST - CIVIL/STRUCTURAL

Name	Title	Organization
C. Johnson	Lead Civil Engineer	TVA - IDI team
S. Taylor	Civil Engineer - Structural	TVA/CEB
J. Peyton	Senior Civil Engineer	TVA/CEB
M. Bailey	Civil Engineer	TVA/CEB
J. Hoskins	Civil Engineer	TVA/CEB
K. Tockstein	Senior Civil Engineer	TVA/CEB
N. Foster	Civil Engineer	TVA/CEB
C. Morris	Civil Engineer	TVA/CEB
E. Stone	Senior Civil Engineer	TVA/CEB
S. Stone	Senior Geotechnical Engineer	TVA/CEB
R. Kroon	Civil Engineer	TVA/CEB
R. Hernandez	Assistant Chief Engineer	TVA/CEB
M. Shah	Structural Engineer	Stone & Webster
M. Cones	Senior Civil Engineer	TVA/CEB
M. Tormey	Chief Engineer - Engineering Service Division	Stone & Webster
M. Wilkinson	Design Engineering Associate	TVA/CEB
D. Denton	Senior Engineering Specialist	TVA/CEB
K. Handy	Civil Engineer	TVA/CEB
K. Mogg	Section Supervisor	TVA/CEB
H. Crotzer	Section Supervisor	TVA/Engineering Computer Methods Branch
J. Rochelle	Senior Civil Engineer	TVA/CEB
C. Seidle	Assistant Chief Engineer	TVA/CEB
D. Hatcher	Technical Supervisor	TVA/CEB

W. Pennell	Acting Chief Engineer	TVA/CEB
R. Day	Civil Engineer	TVA/CEB

7.4 CONTACT LIST - INSTRUMENTATION AND CONTROL REVIEW

Name	Title	Organization
M. R. Belew	Senior Electrical Engineer/ Supervisor, I&C Section	TVA/EEB
R. C. Williams	Lead Electrical Engineer/SQP	TVA/EEB
J. D. Collins	Senior Electrical Engineer	TVA/EEB
J. Edwards	Group Leader/SQP Knoxville	TVA/EEB
J. E. Staub	Engineer Specialist/I&C SQP	TVA/SQN
C. E. Brush	Engineer Specialist/I&C	TVA/EEB
E. L.Daugherty	Engineer Specialist/Mechancial Equipment	TVA/MEB
D. F. Cox	Mechanial Engineer/Mechanical Equipment	TVA/MEB
R. A. Sulfridge	Nuclear Engineer	TVA/MEB
J. Calvert	Operations	TVA/SQN
R. Gish	Technical Supervisor, Mechanical Engineer	TVA/CEB
D. C. Hatcher	Technical Supervisor, Civil Engineer	TVA/CEB
M. Cooper	Plant Operating Review Staff (Operations contact for IDI)	TVA/SQN

7.5 CONTACT LIST - ELECTRIC POWER

Name	Title	Organization
K. W. Brown	Senior Electrical Engineer	TVA/EEB
J. D. Collins	Lead Electrical Engineer	TVA/EEB
M. R. Belew	Senior Electrical Engineer	TVA/EEB
D. F. Cox	Mechanical Engineer	TVA/MEB
W. L. Elliott	Project Manager, Environmental Qualification Project	TVA/MEB
J. D. Hines	Electrical Engineer	TVA/EEB
S. Mazumbar	Electrical Engineering Specialist	TVA/EEB
G. L. Nicely	Senior Electrical Engineer	TVA/EEB
R. C. Williams	Lead Electrical Engineer	TVA/SQN

RESTART REQUIREMENT CRITERIA [1/]

The following criteria shall be used in evaluating whether a particular item must be resolved prior to restart of Unit 2 at Sequoyah.

1. The item identifies a specific deficiency which has significant probability of leading to the inoperability of a system required for restart or operation by the appropriate technical specifications.

2. The item identifies a programmatic deficiency which has a high probability of causing or has caused a specific deficiency which meets No. 1 above.

NOTE: To assist in the determination required for restart relative to technical specifications as in criteria No. 1 and No. 2 above, an affirmative answer to any of the following questions requires consideration of the item for restart based on technical specification requirements.

a. Does the item directly and adversely affect safety-related equipment function, performance, reliability, or response time?

b. Does the item indirectly and adversely affect safety-related equipment power supply, air supply, cooling, lubrication, or ventilation?

c. Does the item adversely affect primary containment integrity?

d. Does the item adversely affect secondary containment integrity?

e. Does the item adversely affect control room habitability?

f. Does the item adversely affect systems used to process radioactive waste?

g. Does the item adversely affect fire protection or fire loads?

h. Does the item adversely affect the ability of a system or component to meet its safety function during a design basis event by impacting the seismic analysis, single failure criteria, separation criteria, high energy line break assumptions, or equipment qualification?

1/ These criteria are reproduced directly from the Sequoyah Nuclear Performance Plan, Revision 1.

i. Are the programs such as Radiological Health, Security, Radiological Emergency Preparedness, or Quality Assurance which are necessary for safe conduct of operation of the plant adversely affected?

j. If not corrected prior to restart, could it lead to an uncontrolled release or spread of radioactive contamination beyond the regulated area?

3. The item identifies a specific deficiency that results in a failure to comply with NRC regulations and no variance has been approved by the NRC.

4. TVA has committed to the NRC to complete the item prior to restart.

5. The item identifies a specific deficiency which has a significant probability of leading to a personal injury during plant operation.

6. The item identifies a specific condition which has a forced outage risk (probability X outage length) during the next cycle in excess of the critical path time to correct the condition prior to restart.