EMPLOYEE CONCERNS

SPECIAL PROGRAM

VOLUME 2
ENGINEERING CATEGORY

SUBCATEGORY REPORT 22600
SEISMIC INTERACTION DESIGN

UPDATED

TVA

NUCLEAR POWER

TVA EMPLOYEE CONCERNS SPECIAL PROGRAM

REPORT NUMBER: 22600

REPORT TYPE: SUBCATEGORY REPORT FOR ENGINEERING

REVISION NUMBER: 3

TITLE: SEISMIC INTERACTION DESIGN

REASON FOR REVISION:

1. Revised to incorporate initial SRP and TAS comments and latest element evaluation status.
2. Revised to incorporate additional SRP comments and BFN and BLN CAPs.
3. Revised to incorporate additional SRP and TAS comments; added Attachment C (References).

PREPARATION

PREPARED BY:

SIGNATURE — DATE: 10-15-87

REVIEWS

~~DEER~~: REVIEW COMMITTEE:

SIGNATURE — DATE: 10-15-87

TAS:

SIGNATURE — DATE: 11/5/87

CONCURRENCES

		CEG-H: George RM Nutt	11-4-87
		SRP: Jimmie W Joyce	11-10-87
SIGNATURE	DATE	SIGNATURE*	DATE

APPROVED BY:

W S Brown	11/5/87	NA	
ECSP MANAGER	DATE	MANAGER OF NUCLEAR POWER CONCURRENCE (FINAL REPORT ONLY)	DATE

* SRP Secretary's signature denotes SRP concurrences are in files.

EXECUTIVE SUMMARY

This subcategory report summarizes and evaluates the results of four Employee Concerns Special Program element evaluations prepared under Engineering Subcategory 22600, Seismic Interaction Design. The perceived problem was that lighting fixtures could become free missiles or swinging missiles during a seismic event and could damage Category I equipment. The element evaluations document the evaluation of 20 issues related to TVA's four nuclear plants, Sequoyah, Watts Bar, Browns Ferry, and Bellefonte. The basic issues were derived from one employee concern filed for Watts Bar, which cited presumed deficiencies or inadequacies in the design of lighting fixtures. In addition, one concern specifically applies to Bellefonte, but its scope is enveloped by that of the Watts Bar concern.

The evaluation determined that the designs for Sequoyah, Watts Bar, and Bellefonte provide adequate vertical restraint to withstand seismic loads and prevent lighting fixtures from becoming free missiles; the Browns Ferry design does not substantiate such adequacy. When examining horizontal support, however, the evaluation team determined that the TVA design will not preclude pendant-mounted lighting fixtures becoming swinging missiles that might damage Category I (or Class I for Browns Ferry) components during a seismic event.

The issues evaluated resulted in negative findings which required corrective action. Eight corrective actions were developed to remedy the 20 negative findings. For three of the 20 negative findings, TVA had initiated corrective actions before the Employee Concerns Task Group evaluations, and three other negative findings required new actions to resolve the findings. The remaining 14 negative findings resulted from peripheral findings identified during the evaluations.

The causes for the negative findings were diverse, with causes stemming from design process ineffectiveness being dominant. All of the eight corrective action descriptions for this subcategory were judged to be individually significant from a licensing standpoint.

This design area may appear limited, but the cause implies broader significance in DNE management's lack of attention to selection, training, and supervision of first- and second-line engineering supervision assigned to this work.

TVA has developed corporate and plant-specific nuclear performance plans (NPPs). These plans identify corrective actions to remedy existing problems and to improve TVA's nuclear program.

Although the employee concerns and issues evaluated for this subcategory did identify some valid problems, the relatively small number of negative findings and the random nature of the causes do not lead to the conclusion that seismic interaction design constitutes a significant technical problem for the Sequoyah, Watts Bar, Browns Ferry, and Bellefonte nuclear power plants.

The findings of this subcategory are combined with those of other subcategory reports and reassessed in the Engineering category evaluation, which has assessed the broader issues identified and has issued the necessary corrective action tracking documents.

Preface, Glossary, and List of Acronyms
for ECTG Subcategory Reports

HISTORY OF REVISION

REV NUMBER	PAGES REVISED	REASON FOR CURRENT REVISION
3	i	To clarify that one or more attachments will help the reader find where a particular concern is evaluated

Preface

This subcategory report is one of a series of reports prepared for the Employee Concerns Special Program (ECSP) of the Tennessee Valley Authority (TVA). The ECSP and the organization which carried out the program, the Employee Concerns Task Group (ECTG), were established by TVA's Manager of Nuclear Power to evaluate and report on those Office of Nuclear Power (ONP) employee concerns filed before February 1, 1986. Concerns filed after that date are handled by the ongoing ONP Employee Concerns Program (ECP).

The ECSP addressed over 5800 employee concerns. Each of the concerns was a formal, written description of a circumstance or circumstances that an employee thought was unsafe, unjust, inefficient, or inappropriate. The mission of the Employee Concerns Special Program was to thoroughly investigate all issues presented in the concerns and to report the results of those investigations in a form accessible to ONP employees, the NRC, and the general public. The results of these investigations are communicated by four levels of ECSP reports: element, subcategory, category, and final.

Element reports, the lowest reporting level, will be published only for those concerns directly affecting the restart of Sequoyah Nuclear Plant's reactor unit 2. An element consists of one or more closely related issues. An issue is a potential problem identified by ECTG during the evaluation process as having been raised in one or more concerns. For efficient handling, what appeared to be similar concerns were grouped into elements early in the program, but issue definitions emerged from the evaluation process itself. Consequently, some elements did include only one issue, but often the ECTG evaluation found more than one issue per element.

Subcategory reports summarize the evaluation of a number of elements. However, the subcategory report does more than collect element level evaluations. The subcategory level overview of element findings leads to an integration of information that cannot take place at the element level. This integration of information reveals the extent to which problems overlap more than one element and will therefore require corrective action for underlying causes not fully apparent at the element level.

To make the subcategory reports easier to understand, three items have been placed at the front of each report: a preface, a glossary of the terminology unique to ECSP reports, and a list of acronyms.

Additionally, at the end of each subcategory report will be a Subcategory Summary Table that includes the concern numbers; identifies other subcategories that share a concern; designates nuclear safety-related, safety significant, or non-safety related concerns; designates generic applicability; and briefly states each concern.

Either the Subcategory Summary Table or another attachment or a combination of the two will enable the reader to find the report section or sections in which the issue raised by the concern is evaluated.

The subcategories are themselves summarized in a series of eight category reports. Each category report reviews the major findings and collective significance of the subcategory reports in one of the following areas:

- management and personnel relations
- industrial safety
- construction
- material control
- operations
- quality assurance/quality control
- welding
- engineering

A separate report on employee concerns dealing with specific contentions of intimidation, harassment, and wrongdoing will be released by the TVA Office of the Inspector General.

Just as the subcategory reports integrate the information collected at the element level, the category reports integrate the information assembled in all the subcategory reports within the category, addressing particularly the underlying causes of those problems that run across more than one subcategory.

A final report will integrate and assess the information collected by all of the lower level reports prepared for the ECSP, including the Inspector General's report.

For more detail on the methods by which ECTG employee concerns were evaluated and reported, consult the Tennessee Valley Authority Employee Concerns Task Group Program Manual. The Manual spells out the program's objectives, scope, organization, and responsibilities. It also specifies the procedures that were followed in the investigation, reporting, and closeout of the issues raised by employee concerns.

ECSP GLOSSARY OF REPORT TERMS*

classification of evaluated issues the evaluation of an issue leads to one of the following determinations:

Class A: Issue cannot be verified as factual

Class B: Issue is factually accurate, but what is described is not a problem (i.e., not a condition requiring corrective action)

Class C: Issue is factual and identifies a problem, but corrective action for the problem was initiated before the evaluation of the issue was undertaken

Class D: Issue is factual and presents a problem for which corrective action has been, or is being, taken as a result of an evaluation

Class E: A problem, requiring corrective action, which was not identified by an employee concern, but was revealed during the ECTG evaluation of an issue raised by an employee concern.

collective significance an analysis which determines the importance and consequences of the findings in a particular ECSP report by putting those findings in the proper perspective.

concern (see "employee concern")

corrective action steps taken to fix specific deficiencies or discrepancies revealed by a negative finding and, when necessary, to correct causes in order to prevent recurrence.

criterion (plural: criteria) a basis for defining a performance, behavior, or quality which ONP imposes on itself (see also "requirement").

element or element report an optional level of ECSP report, below the subcategory level, that deals with one or more issues.

employee concern a formal, written description of a circumstance or circumstances that an employee thinks unsafe, unjust, inefficient or inappropriate; usually documented on a K-form or a form equivalent to the K-form.

evaluator(s) the individual(s) assigned the responsibility to assess a specific grouping of employee concerns.

findings includes both statements of fact and the judgments made about those facts during the evaluation process; negative findings require corrective action.

issue a potential problem, as interpreted by the ECTG during the evaluation process, raised in one or more concerns.

K-form (see "employee concern")

requirement a standard of performance, behavior, or quality on which an evaluation judgment or decision may be based.

root cause the underlying reason for a problem.

*Terms essential to the program but which require detailed definition have been defined in the ECTG Procedure Manual (e.g., generic, specific, nuclear safety-related, unreviewed safety-significant question).

Acronyms

AI	Administrative Instruction
AISC	American Institute of Steel Construction
ALARA	As Low As Reasonably Achievable
ANS	American Nuclear Society
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
BFN	Browns Ferry Nuclear Plant
BLN	Bellefonte Nuclear Plant
CAQ	Condition Adverse to Quality
CAR	Corrective Action Report
CATD	Corrective Action Tracking Document
CCTS	Corporate Commitment Tracking System
CEG-H	Category Evaluation Group Head
CFR	Code of Federal Regulations
CI	Concerned Individual
CMTR	Certified Material Test Report
COC	Certificate of Conformance/Compliance
DCR	Design Change Request
DNC	Division of Nuclear Construction (see also NU CON)

DNE	Division of Nuclear Engineering
DNQA	Division of Nuclear Quality Assurance
DNT	Division of Nuclear Training
DOE	Department of Energy
DPO	Division Personnel Officer
DR	Discrepancy Report or Deviation Report
ECN	Engineering Change Notice
ECP	Employee Concerns Program
ECP-SR	Employee Concerns Program-Site Representative
ECSP	Employee Concerns Special Program
ECTG	Employee Concerns Task Group
EEOC	Equal Employment Opportunity Commission
EQ	Environmental Qualification
EMRT	Emergency Medical Response Team
EN DES	Engineering Design
ERT	Employee Response Team or Emergency Response Team
FCR	Field Change Request
FSAR	Final Safety Analysis Report
FY	Fiscal Year
GET	General Employee Training
HCI	Hazard Control Instruction
HVAC	Heating, Ventilating, Air Conditioning
II	Installation Instruction
INPO	Institute of Nuclear Power Operations
IRN	Inspection Rejection Notice

L/R	Labor Relations Staff
M&AI	Modifications and Additions Instruction
MI	Maintenance Instruction
MSPB	Merit Systems Protection Board
MT	Magnetic Particle Testing
NCR	Nonconforming Condition Report
NDE	Nondestructive Examination
NPP	Nuclear Performance Plan
NPS	Non-plant Specific or Nuclear Procedures System
NQAM	Nuclear Quality Assurance Manual
NRC	Nuclear Regulatory Commission
NSB	Nuclear Services Branch
NSRS	Nuclear Safety Review Staff
NU CON	Division of Nuclear Construction (obsolete abbreviation, see DNC)
NUMARC	Nuclear Utility Management and Resources Committee
OSHA	Occupational Safety and Health Administration (or Act)
ONP	Office of Nuclear Power
OWCP	Office of Workers Compensation Program
PHR	Personal History Record
PT	Liquid Penetrant Testing
QA	Quality Assurance
QAP	Quality Assurance Procedures
QC	Quality Control
QCI	Quality Control Instruction

QCP	Quality Control Procedure
QTC	Quality Technology Company
RIF	Reduction in Force
RT	Radiographic Testing
SQN	Sequoyah Nuclear Plant
SI	Surveillance Instruction
SOP	Standard Operating Procedure
SRP	Senior Review Panel
SWEC	Stone and Webster Engineering Corporation
TAS	Technical Assistance Staff
T&L	Trades and Labor
TVA	Tennessee Valley Authority
TVTLC	Tennessee Valley Trades and Labor Council
UT	Ultrasonic Testing
VT	Visual Testing
WBECSP	Watts Bar Employee Concern Special Program
WBN	Watts Bar Nuclear Plant
WR	Work Request or Work Rules
WP	Workplans

CONTENTS

TABLES

1. INTRODUCTION

This subcategory report summarizes and evaluates the results of the ECSP element evaluations prepared under Engineering Subcategory 22600, Seismic Interaction Design, which contains concerns about the design and installation of lighting fixture supports. The concerns cited the perceived problem of lighting fixtures becoming free missiles or swinging missiles during a seismic event and damaging Category I equipment.

Two employee concerns provide the basis for the element report evaluations and are listed by element number in Attachment A. The plant location where the concerns were originally identified and the concern applicability to other TVA nuclear plants are also identified.

The evaluations are summarized in the balance of this report as follows:

- Section 2 -- summarizes, by element, the issues stated or implied in the employee concerns
- Section 3 -- outlines the process followed for the element and subcategory evaluations and addresses the determination of generic applicability
- Section 4 -- summarizes, by element, the findings and identifies the negative findings that must be resolved
- Section 5 -- highlights the corrective actions required for resolution of the negative findings cited in Section 4 and relates them to element and to plant site
- Section 6 -- identifies causes of the negative findings
- Section 7 -- assesses the significance of the negative findings
- Attachment A -- lists, by element, each employee concern evaluated in the subcategory. The concern's number is given, along with notation of any other element or category with which the concern is shared; the plant sites to which it could be applicable are noted; and the concern is quoted as received by TVA, and characterized as safety related, not safety related, or safety significant.
- Attachment B -- contains a summary of the element-level evaluations. Each issue is listed, by element number and plant, opposite its corresponding findings and corrective actions. The reader may trace a concern from Attachment A to an issue in Attachment B by using the element number and applicable plant. The

reader may relate a corrective action description in Attachment B to causes and significance in Table 3 by using the CATD number which appears in Attachment B in parentheses at the end of the corrective action description.

The term "Peripheral finding" in the issue column refers to a finding that occurred during the course of evaluating a concern but did not stem directly from a employee concern. These are classified as "E" in Tables 1 and 2 of this report

- Attachment C -- lists the references cited in the text

2. SUMMARY OF ISSUES

The employee concerns listed in Attachment A for each element and plant have been examined, and the potential problems raised by the two concerns have been identified as two separate issues.

A summary of the issues evaluated under this subcategory for each element and each plant is listed below:

- 226.0, Design of Lighting Fixture Supports - Lighting fixtures are not properly designed to prevent them from damaging Category I equipment during a seismic event (SQN, WBN, BFN, and BLN).

  Safety cable is not adequate to seismically support lighting fixtures shown in drawings 4BA0893-X2-43, Rev. 1, and -44, Rev. 1 (BLN).

The issue summary above covers a presumed deficiency or inadequacy in the design of lighting fixtures and is associated with the quality of that design.

A statement describing the issues evaluated within the element reports is provided in Attachment B. This attachment also identifies findings and corrective actions, which will be discussed in Sections 4 and 5 of this report.

As the following sections show, the above issues were found to be valid and to require corrective action at each of the four plants.

3. GENERIC APPLICABILITY/EVALUATION PROCESS

This subcategory report is based on the information contained in the element reports prepared to address the specific employee concerns related to the issues broadly defined in Section 2. The evaluation process is described in the following subsections.

3.1 Generic Applicability Review

Two employee concerns provide the basis for the element evaluations and are listed by element number in Attachment A. The plant location where the concerns were originally identified and the concern applicability to other TVA nuclear plants are also identified. One concern was initiated at Watts Bar (WBN) and is sufficiently broad to generically apply to the three other TVA nuclear plants, as shown in the applicability column. The second concern specifically applies to Bellefonte and is enveloped by the scope of the Watts Bar concern.

3.2 General Evaluation Process

a. Developed issues from the employee concerns.

b. Reviewed current regulatory requirements, industry standards, and TVA criteria documents related to the issues to develop an understanding of the design basis.

c. Reviewed applicable design documents and conducted facility walkdowns, as appropriate, to develop design understanding and to verify implementation status.

d. Reviewed applicable FSAR, Safety Evaluation Report (SER), and SER Supplements to understand scope and basis of NRC review, determine regulatory compliance, and to identify any open issues and/or TVA commitments related to the design.

e. Reviewed any other documents applicable to the issues and determined to be needed for the evaluation such as correspondence, transcripts of interviews, procedures, test reports, nonconforming condition reports (NCRs), engineering change notices (ECNs), evaluation reports, etc.

f. Using the results from steps a through e above, evaluated the issues for each element and documented the findings in element reports.

g. Tabulated issues, findings, and corrective actions from the element reports in a plant-by-plant arrangement (see Attachment B).

h. Prepared other tables, as needed, to permit comparison and identification of common and/or unique issues, findings, and corrective actions among the four plants.

i. Classified the findings and corrective actions from the element reports using the ECSP definitions.

j. On the basis of ECSP guidelines, analyzed the causes and established the collective significance of the findings from the element reports.

k. Evaluated defined corrective actions to determine if additional actions are required as a result of causes found in step j.

l. Provided additional judgment or information that may not be apparent at the element report level.

3.3 Specific Evaluation Process

In addition to the general evaluation, as described above, performed by the evaluation team for each plant, specific documents were also reviewed on the basis of their applicability to the issues. These documents and other unique information are listed in Attachment C.

a. Evaluated program to assure that lighting fixtures do not become seismic interaction items. (SQN, WBN, BFN, and BLN)

b. Reviewed attachments to the two NRC letters from Youngblood to White (February 18, 1986, and June 23, 1986) for possible additional relevant information. (SQN, WBN, BFN, and BLN)

c. Obtained and reviewed design drawings for light fixtures. (SQN, WBN, BFN, and BLN)

d. Reviewed selected calculations of light fixture restraints. (SQN, WBN, BFN, and BLN)

e. Performed walkdown in Category I structures to view lighting fixture installations (all plants) and exit signs (BLN).

f. Reviewed program and results to date in resolving SCR SQN MEB 8610 and Gilbert/Commonwealth Technical Issue 11. (SQN)

g. Reviewed program and results to date in resolving SCR WBN CEB 8537 and TVA generic review of SCR SQN MEB 8610. (WBN and BFN)

h. Reviewed program and results to date in resolving and TVA generic review of SCR SQN MEB 8610, SCR WBN CEB 8537, SCR BFN MEB 8605, and PIR WBN CEB 8572. (BLN)

4. FINDINGS

The findings from each of the four element evaluations for this subcategory are listed in Attachment B by element number and by plant in a matrix form along with corresponding issues and corrective actions. The discussion and summarized element findings for each plant follow.

4.1 Design of Lighting Fixture Supports - Element 226.0

Individual lighting fixtures are typically lightweight, generally 50 pounds or less and rarely exceeding 100 pounds, and are adequately supported for Sequoyah, Watts Bar, and Bellefonte to withstand a seismic event and prevent the fixtures from becoming free-falling missiles that might damage seismic Category I components. However, the TVA design of pendant-mounted lighting fixtures does not, in general, provide adequate horizontal support during a seismic event to prevent them from becoming swinging missiles that might damage adjacent seismic Category I components.

4.2 Sequoyah

4.2.1 Detailed Findings for SQN

Light Fixture Support Criteria for SQN. NRC General Design Criterion 4 requires that Category I structures, systems, and components be appropriately protected against dynamic effects, including the effects of missiles, pipe whipping, and discharging fluids, that may result from equipment failures and from events and conditions outside the nuclear power unit. SQN commitment to comply with this criterion is contained in FSAR Section 3.2.

Position C-2 of Regulatory Guide 1.29, "Seismic Design Classification," states that those portions of structures, systems, or components that are non-Category I, i.e., I(L), but whose failure could reduce the functioning of a Category I item to an unacceptable safety level should be designed and constructed so that the Safe Shutdown Earthquake (SSE) would not cause such failure. SQN commitment to comply with this regulatory guide is contained in FSAR Section 3.2.1.

The design of SQN electrical system is based, in part, on Standard IEEE-308-1971 as stated in FSAR Section 8.1.5. This standard establishes and defines Class 1E as the classification of electrical equipment required to achieve safe shutdown. SQN was originally designed with three lighting systems:

- Normal Lighting - This system is powered from non-Class 1E power sources.

- Standby Lighting - This system is normally powered from non-Class 1E power sources and transfers to the onsite Class IE diesels upon failure of non-Class 1E sources.

- Emergency Lighting - This system is powered from the onsite Class 1E vital battery boards and is activated by failure of the offsite sources and operates until transfer from the normal to standby system is completed when the diesels are fully functional. This 125 Vdc system is designed for 2-hour operation.

The structural support of these three systems is described in SQN-DC-V-13.11 and shown on drawing series 47A057.

NCR SON MEB 8304, Rev. 2, indicates that TVA committed to the NRC on October 23, 1979, to provide a fixed self-contained second emergency lighting system consisting of fluorescent or sealed beam units with an individual 8-hour minimum battery power supply in areas that must be manned for safe cold shutdown and for access and egress routes to and from all fire areas.

This commitment was made in response to NRC review of FSAR for 10 CFR Part 50, Appendix R requirements. The structural support for this system is not included in SQN-DC-V-13.11, but is shown on drawing 47N1410-1, Rev. 18.

TVA design criteria for seismic support of original design lighting fixtures in Category I structures are contained in Civil Design Guide DG-C1.6.3, which states that a literature survey of damage due to earthquakes finds lighting fixtures highly susceptible to failure. This is particularly true for pendant-mounted fluorescent and incandescent fixtures. The criteria conclude that, with certain stated exceptions, the incorporation of an auxiliary support cable as an integral part of the light fixture is the most effective approach for ensuring an appropriate degree of seismic vertical restraint. This support is a 1/16-inch flexible corrosion-resistant cable (MIL-C-5424).

Additional requirements are imposed for the first emergency lighting system to maintain the electrical power supply to the fixture during or after a seismic event. This is accomplished by a three-way lateral cable support system which keeps the fixture in a plumb position.

Design Guide DG-C-1.6.3 further states that:

> "In the event of a lighting fixture failure due to seismic conditions, motion of the fixture in any direction will be limited to the length of free cable. Care must be taken to eliminate or otherwise protect any safety-related equipment within the range of motion afforded by the cable from impact by the fixture."

The evaluation team has reviewed these criteria in light of general engineering industry experience and determined that they are adequate.

The SQN design criteria for support of original lighting fixtures in Category I structures (which predate the civil design guide) are contained in SQN-DC-V-13.11, which forms the design commitment for SQN. The two sets of design criteria are very similar. With the exceptions noted later, after review of the 47A057 series lighting fixtures support drawing, the evaluation team determined that SQN-DC-V-13.11 criteria are adequate based on general engineering industry experience.

Criteria Application for SQN. The implementation of the SQN design criteria is contained in the notes and details shown on the 47A057 series lighting fixture support drawing which is invoked by lighting plan and detail drawings such as 45N1410-1, 55N416-1, and 55N416.2. Individual lighting fixtures in nuclear industry facilities are typically light weight, generally 50 pounds or less and rarely exceeding 100 pounds. These weights are confirmed by SQN-DC-V-13.11 Section 4.0, which indicates weights in the 20- to 35-pound range.

Smaller and lighter fixtures have one auxiliary cable support at the fixture stem while larger and heavier fixtures generally have more than one stem with auxiliary cable supports at each stem. The minimum breaking strength of the cable is specified to be 480 pounds. The cable is generally attached to a single expansion anchor either 1/4- or 3/8-inch in diameter. Specification G-32 indicates allowable tension working loads of 500 and 700 pounds and shear working loads of 300 and 500 pounds. Thus the evaluation team concludes that the light fixtures are properly designed with adequate vertical support to withstand a seismic event. The evaluation team has reviewed this drawing series and concludes that it is technically adequate, subject to one observation which is similar to that for Design Criteria SQN-DC-V-13.11. This observation is that Figure 5.0-1 of SQN-DC-V-13.11 and the principal detail for emergency lighting fixtures on 47A057-21, Rev. 3, correctly illustrate application of Section 5.0 criteria. However, the details in Figure 4.7-1 for the emergency light and the alternate detail shown on 47A057-21 and the emergency light detail shown on 47A057-6, Rev. 5, do not agree with the text of Section 5.0 and with Figure 5.0-1.

The evaluation team reviewed drawings 47N1410-1, Rev. 18, 55N416-1, Rev. 18, and 55N416-2, Rev. 19, and noted that they refer to a battery pack emergency light system that differs from the types described in either the SQN design criteria or drawing 47A057, as discussed earlier. This battery pack emergency lighting system is not required to withstand a SSE, as indicated by general note 5 of drawing 47N1410-1, but must be restrained from becoming a hazard to Category I systems during or following a SSE. These restraint details are

shown as detail A of drawing 47N1410-1 and the evaluation team deems them to be adequate for the purpose.

Seismic Interaction Program for SQN. The discussion below is not specifically about the support of lighting fixtures. It does, however, relate to the development of TVA's seismic interaction program and the subsequent addressing of lighting fixtures as a component of that program.

In early 1986, Gilbert/Commonwealth (G/C) conducted a technical review of the SQN main and auxiliary feedwater systems modifications between issue of operating license and June 1985. G/C Report 2614 (March 3, 1986) describes the approach, methodology, results, and conclusions of the technical review. Technical Issue 11 of that report is titled "Seismic Interactions" and describes a condition where a 2-inch O.D. Category I(L) primary makeup water supply piping system was located near tubing supplying air to the auxiliary feedwater bypass valve 2-LCV-3-148A. This piping is not seismically restrained to prevent lateral displacement and the striking of the air supply line. G/C found no documentation to demonstrate that this interaction would not impair the auxiliary feedwater system safety functions.

G/C also found that INPO Finding DC.3-2 (1985) for WBN identified a proximity issue regarding displacement of Category I(L) piping systems as a potentially generic concern. This INPO finding and the resultant SCR SQN CEB 8514 address the position retention (falldown) but not the displacement (swinging) of a Category I(L) system. The TVA action plan to resolve G/C Issue No. 11 resulted in the generation of SCR SQN MEB 8610.

From February 12 through March 14, 1986, the NRC staff conducted a special inspection to examine design control practices for SQN. The main focus of this inspection was on the findings of the G/C technical review and additional items. The inspection results are contained in NRC I&E Inspection Reports 50-327/86-27 and 50-328/86-27 transmitted by NRC letter from Taylor to White (April 22, 1986). The NRC concluded that the G/C review was thorough and appropriate in technical depth within the selected review scope and that the technical and generic issues identified appear to be valid.

G/C Technical Issue No. 11 indicated that a proximity issue was identified with regard to the displacement of Category I(L) piping as a potentially generic concern by INPO Finding DC.3-2 in 1985 for WBN. This finding resulted in SCR SQN CEB 8514 (December 24, 1985, and February 28, 1986). The INPO finding states:

> "An engineering evaluation has not been performed to justify the design criteria of seismically supported nonsafety (IL) [I(L)] systems. The present design criteria for IL [I(L)] rod hangers is not adhered to consistently. Some IL [I(L)] support designs do not consider all seismic loadings."

The INPO finding contained the following as supporting facts:

- Undocumented development of vertical load criteria for piping support rod hangers
- Inconsistent factors of safety not meeting design criteria for piping supports
- Undocumented development of flexibility criteria for HVAC duct rod hangers
- The potential for rod hanger supported pipe displacing and impacting other nearby components/systems is not addressed
- Rigid supports are interspersed with rod hangers in HVAC I(L) duct systems. Distribution of horizontal loads in a seismic event is not modeled consistently with actual structural behavior

Further Relevant Document Review for SQN. The evaluation team reviewed the attachments to NRC letters from Youngblood to White (February 18, 1986, and June 23, 1986) for issues or information, relevant to this report, that are not included in the concern statement itself. No such issue or information was found in the February 1986 letter; however, on pages 131-133 of the attachment to the June 1986 letter, it became apparent to the evaluation team that the term "caged" used in the concern relates to prevention of the light bulbs or tubes from falling out of the fixtures as a result of a seismic event. This associated issue does not appear to have been subjected to a documented review by TVA. However, the evaluation team's generic conclusion is that because light bulbs and tubes have brittle glass and light mass (usually one pound or less), they do not generally present a significant safety hazard that might compromise the function of adjacent Category I equipment, which is of greater ruggedness and mass. According to criteria developed by the evaluation team for other nuclear power plant facilities, the item being struck will not generally be adversely affected if the size or mass of the striking item is less than or equal to that of the item being struck.

Exceptions for this conclusion might be found in areas such as over the main control room semi-horizontal panels where plant operators or panel switches or buttons might be impacted. During the evaluation team walkdown during the week of June 24, 1986, for evaluation of Sequoyah Element Report 224.5, it was noted that there was a grate or grid for diffusing light between the tubes or bulbs and the control panels which will mitigate any falling tubes or bulbs. Thus the evaluation team considers this associated issue to be of no safety significance.

TVA Evaluation of SCR SQN MEB 8610. Inspection criteria for rod hung Category I(L) items are established in TVA memo from Handy to SQN Files (April 22, 1986). This memo, which has been checked, reviewed, and approved by TVA, establishes a maximum horizontal displacement of ± 6 inches for such pipes, conduits, HVAC ducts, and cable trays and a maximum horizontal displacement of ± 10 inches or ± 30 degrees swing angle, whichever is less, for pendant-mounted light fixtures.

Evaluation team discussion with TVA personnel indicated that there are no calculations or other documentation for these criteria which are based on informal studies of ground motion displacements at rock-based sites within the TVA service territory plus consideration of building movements during an SSE. TVA personnel agreed to provide such documentation in the corrective action plan.

On the basis of evaluation team discussions with TVA personnel, new engineering change notices will address seismic interaction concerns as a part of the seismic review process. These new evaluations will be similar to, and compatible with, those completed under SCR SQN MEB 8610. This seismic review process will be in accordance with CEB-DI-121.03, Rev. 1, "Seismic Design, Review and Control." The CEB seismic evaluation for seismic interaction will include the following elements:

- Ensure equipment and systems will not have unacceptable impact from existing rod hung Category I(L) items
- Ensure that new rod hung Category I(L) items will not impact existing Category I fragile items in an unacceptable manner

These two elements are currently expected to be based on design consultation and walkdown information and evaluation. As these elements are currently based on verbal instruction, TVA personnel understand that there is a need to formally document this instruction by revision of CEB-DI-121.03.

A walkdown of the Auxiliary Building was conducted (March 8 and 9, 1986, and documented by TVA memo from Estes to Brown, June 5, 1986) to identify possible interactions between Category I(L) supported components and safety-related components which could result in degrading a safety system.

This TVA walkdown of the Auxiliary Building identified 204 possible interactions of which 98 were reviewed by CEB. The remainder were justified by Electrical Engineering Branch (EEB) and MEB. Approximately 20 interactions involved lighting fixtures or stems. TVA concluded that 10 interactions - none involving lighting - required field work. TVA determined that one of

these ten interactions (one pipe potentially interacting with two separate air line solenoid valves) was due to seismic interaction considerations and that the remainder were due to other considerations.

A second walkdown of the Control Building, Diesel Generator Building, Additional Diesel Generator Building, emergency raw cooling water (ERCW) pumping station, and the annulus areas of both units 1 and 2 Reactor Buildings was conducted on April 26 and 27, 1986, as documented by TVA memo from Estes to Brown (June 11, 1986), for similar purposes and with similar methodology as the first walkdown.

This TVA walkdown identified 90 possible interactions of which 49 were reviewed by CEB. The remainder were justified by EEB and MEB. There were two interactions involving lighting fixtures and/or stems. TVA concluded that two interactions - none involving lighting - required field work for reasons other than seismic interactions.

The first walkdown was surveyed by the TVA Quality Surveillance Group (on April 18 through 22, 1986, and documented by TVA memo from Andrews to Wilson, May 14, 1986) to assess the adequacy of the walkdown procedures and walkdowns performed by Division of Nuclear Engineering (DNE) in the Auxiliary Building. The weaknesses listed by this memo appear to the evaluation team to have been satisfactorily resolved based on review of the walkdown package.

Technical Instruction TI-98, Rev. 0 (April 25, 1986) and a similar predecessor document were used to perform the walkdowns. This instruction was reviewed and approved by Plant Operations Review Committee (PORC) as documented by Unreviewed Safety Question Determination (USQD) for TI-98, Rev. 0 (April 25, 1986), in response to directions in a TVA memo from Andrews to Abercrombie (April 18, 1986) that walkdowns or surveys of safety-related matters must be performed by PORC-reviewed instructions pending an approval programmatic instruction. The evaluation team reviewed TI-98 and concluded that it was adequate for its stated scope.

During review of the walkdown instruction and resultant documentation the evaluation team noted that portions of the Auxiliary Building and the containment vessel portion of the Reactor Buildings were excluded from the scope of the walkdowns. TVA's Action Plan to resolve G/C technical Issue 11 (February 24, 1986) agreed to list, walkdown, and evaluate all Seismic I(L) systems for SQN as corrective action.

The evaluation team notes the lack of a document describing the complete program for controlling this seismic interaction activity. The technical instruction will effectively implement the walkdown activities of this program. The TVA memo from Handy to SQN files (April 22, 1986) contains

adequate threshold criteria for subsequent evaluations when its basis is adequately documented. The division of responsibilities between disciplines is defined in CEB-DI 121.03, Rev. 1. Such a program might include thresholds of fragility/ductility/flexibility to provide additional criteria for interaction resolution. The walkdowns and evaluations performed to date and those that are required to complete this effort will resolve near-term issues and furnish an adequate baseline for future evaluations as additional plant modifications are made. Recognition of this future need is alluded to in item c. of block 5e in SCR SQN MEB 8610, which states:

> "Corrective action will be readdressed to the 'post-modification walkdown phase' rather than to the 'design phase,' and will be included in the acceptance criteria of the post-modification walkdown."

TVA personnel will revise CEB-DI-12.1.03 to provide a complete program as a part of the corrective action plan.

The walkdown results are indicated on a marked set of plant drawings and a computerized listing attached to the two TVA memos from Estes to Brown. The documentation of the EEB and MEB evaluations appears to be principally the interaction resolution contained in the computerized listings while that for the CEB is calculation CEB CAS 214, Rev. 1.

The evaluation team reviewed both the computerized listings of potential seismic interactions and the calculations and noted the following:

- Many interactions are resolved by the notation that the nonrod-hung item is nondivisional, nontrained, etc. This is acceptable since neither item in the interaction is clearly required for safe plant operation or shutdown.

- The evaluation team reviewed a copy of the CEB calculation (CEB-CAS-214) for lighting fixtures and other items included within the scope of SCR SQN MEB 8610. The calculation was reviewed for its assumptions, collection of data, logic, analysis, and conclusions. This calculation is based on photographs of the interaction, the interaction description in the computerized listing, the design criteria in the TVA memo from Handy to SQN files (April 22, 1986) and other data gathered during the walkdowns. The evaluation team considers the calculation to be generally adequate; however, additional written justification is needed in some areas to permit another engineer who did not participate in the original walkdowns to arrive at the same conclusions. During the discussions with TVA personnel it became apparent that enhanced understanding may be obtained by viewing the original color photographs. During these

discussions TVA personnel agreed to have a supervisor re-review calculation CEB-CAS-214 in light of the above and any necessary changes to the calculations will be made at the time of additional walkdown evaluations. This action is a part of the corrective action plan.

The evaluation team considers the TVA action plan response to G/C Issue No. 11 and corrective action/action required to prevent recurrence portions of SCR SON MEB 8610 generally adequate in concept. However, some deficiencies and discrepancies exist in TVA evaluations and design documents regarding prevention of lighting fixtures from becoming swinging missiles (seismic interaction) and the application of the lighting design criteria. TVA personnel agreed to correct these deficiencies and discrepancies as part of their corrective action plans.

4.2.2 Summarized Findings for SQN

Overall, on Sequoyah, the basic structure of a program to control seismic interaction design was in place as a direct result of an early 1986 Gilbert/Commonwealth technical review of the Sequoyah main and auxiliary feedwater systems. However, portions of this basic structure were not cohesively integrated. There is no document which describes the complete program for controlling the seismic interaction design activity. A properly documented instruction has been issued to effectively implement the walkdown activities of this program when amended to address all plant areas. There is documentation that provides adequate threshold criteria but no technical basis for the criteria has been documented. The Civil Engineering Branch staff has formally revised a design interface document for seismic design, review and control, and the division of responsibilities between engineering disciplines after report preparation. This document contains generic instructions for seismic interaction design.

In addition, several inconsistencies were observed within and between both the design criteria and the construction drawings for the support of lighting fixtures. The Sequoyah project has agreed to resolve the inconsistencies as part of their corrective action plans.

At the time of evaluation team review, Sequoyah reviews were documented as being complete. The evaluation team noted that the Sequoyah action plan to resolve the Gilbert/Commonwealth issues committed to list, walk down, and evaluate all seismic interaction conditions at Sequoyah. The evaluation team found that the scope of the completed reviews for these mechanical, electrical, and civil interface reviews excluded portions of the Auxiliary Buildings and the containment portions of the Reactor Buildings. Sequoyah corrective action plan is to walk down and evaluate these areas. The evaluation team reviewed the calculation which supported the conclusions for

the completed efforts, and considers it to be generally adequate. However, additional written justification is lacking in some areas to permit another engineer who did not participate in the original walkdowns to arrive at the same conclusions as required by sound engineering practice and TVA management policy.

4.3 Watts Bar

4.3.1 Detailed Findings for WBN

Light Fixture Support Criteria for WBN. NRC General Design Criterion 4 requires that Category I structures, systems, and components be appropriately protected against dynamic effects, including the effects of missiles, pipe whipping; and discharging fluids, that may result from equipment failures and from events and conditions outside the nuclear power unit. WBN commitment to comply with this criterion is contained in WBN FSAR Section 3.1.

Position C-2 of Regulatory Guide 1.29, "Seismic Design Classification," states that those portions of structures, systems, or components that are non-Category I, i.e., I(L), but whose failure could reduce the functioning of a Category I item to an unacceptable safety level, should be designed and constructed so that the safe shutdown earthquake (SSE) would not cause such failure. WBN commitment to comply with this regulatory guide is contained in FSAR Section 3.2.1.

The design of the WBN electrical system is based, in part, on Standard IEEE-308-1971 as stated in FSAR Section 8.1.5. This standard establishes and defines class 1E as the classification of electrical equipment required to achieve safe shutdown. FSAR Section 9.5.3 and NCR WBN MEB 8305 indicate that WBN was originally designed with three lighting systems (hereinafter called "original lighting systems"):

- Normal Lighting - This system is powered from non-1E power sources.
- Standby Lighting - This system is normally powered from non-1E power sources and transfers to the onsite class IE diesels upon failure of non-1E sources.
- Emergency Lighting - This system (hereinafter called "first emergency lighting system") is powered from the onsite class 1E vital battery boards and is activated by failure of the offsite sources and operates until transfer from the normal to standby system is completed when the diesels are fully functional. This system is designed to operate for 2 hours.

The structural support of these three systems is described in Design Criteria WB-DC-40-31.11 and shown on drawing series 47A057 and drawing 45W1418-4.

NCR WBN MEB 8305 indicates that TVA committed to the NRC, on 09/09/80, to provide a fixed self-contained "second emergency lighting system." This system would consist of fluorescent or sealed beam units with an individual 8-hour minimum battery power supply in areas that must be staffed for safe cold shutdown and for access and egress routes to and from all fire areas.

This commitment was made in response to NRC review of FSAR for 10 CFR 50, Appendix R requirements. The structural support for this system is not included in Design Criteria WB-DC-40.31.11 but is shown on drawing 45W1410-1.

TVA design criteria for seismic support of "original lighting systems" in Category I structures are contained in Civil Design Guide DG-C1.6.3, which states that a literature survey of damage due to earthquakes finds lighting fixtures highly susceptible to failure. This is particularly true for pendant-mounted fluorescent and incandescent fixtures. The criteria conclude that, with certain stated exceptions, the incorporation of an auxiliary support cable as an integral part of the light fixture is the most effective approach for ensuring an appropriate degree of seismic vertical restraint. This support is a 1/16-inch corrosion-resistant cable (MIL-C-5424).

Additional requirements are imposed for the first emergency lighting system to maintain the electrical power supply to the fixture during or after a seismic event. This is accomplished by a three-way lateral cable support which keeps the fixture in a plumb position.

Design Guide DG-C-1.6.3 further states that:

> "In the event of a lighting fixture failure due to seismic conditions, motion of the fixture in any direction will be limited to the length of free cable. Care must be taken to eliminate or otherwise protect any safety-related equipment within the range of motion afforded by the cable from impact by the fixture."

The evaluation team has reviewed these criteria in light of general engineering industry experience and determined that they are adequate.

The WBN design criteria predates the criteria contained in the civil design guide. The design criteria for support of "original lighting systems" in Category I structures are contained in WB-DC-40-31.11, which forms the design commitment for WBN. The two sets of design criteria are very similar. With the exceptions noted later, after review of the design drawings the evaluation team determined that the WBN-DC-40-31.11 criteria are adequate based on general engineering industry experience.

Criteria Application for WBN. The implementation of the WBN design criteria is contained in the notes and details shown on the 47A057 series lighting fixture support drawing which is invoked by lighting plan and detail drawings such as 45W1410-1, 55W416-1, and 55W416-2. Individual lighting fixtures in nuclear industry facilities typically weigh 50 pounds or less and rarely exceed 100 pounds. These weights are confirmed by WBN-DC-40-31.11, Section 4.0, which indicates weights in the 20- to 35-pound range.

Smaller and lighter fixtures have one auxiliary cable support at the fixture stem while larger and heavier fixtures generally have more than one stem with auxiliary cable supports at each stem. The minimum breaking strength of the cable is specified to be 480 pounds. The cable is generally attached to a single expansion anchor either 1/4- or 3/8-inch in diameter. Specification G-32 indicates allowable loads of 500 and 700 pounds in tension and 300 and 500 pounds in shear for these expansion anchors. Thus the evaluation team concludes that the light fixtures are properly designed with adequate vertical support to withstand a seismic event. The evaluation team has reviewed this drawing series and concludes that it is technically adequate, subject to one observation which is similar to that for Design Criteria WBN-DC-40-31.11. This observation is that Figure 4.7-1 of WBN-DC-40-31.11 correctly illustrates application of Section 5.0 criteria. However, the details in Figure 4.7-1 for the emergency light and the emergency light detail shown on 47A057-6 do not agree with the text of Section 5.0 and with Figure 5.0-1. In addition, detail M of drawing 45W1418-4 shows a portion of the emergency light detail corresponding to Figure 5.0-1 of the design criteria with a reference to drawing 47A057 for remaining details. Drawing 47A057 contains no such details.

The evaluation team reviewed drawings 47W1410-1, 55W416-1, and 55W416-2 and noted that they refer to a "second emergency light system" that differs from the types described in either the WBN design criteria or drawing 47A057, as discussed earlier. This "second emergency lighting system" is not required to withstand a SSE, as indicated by general note 5 of drawing 47W1410-1, but must be restrained from becoming a hazard to Category I systems during or following a SSE. These restraint details are shown as detail A of drawing 47W1410-1, and the evaluation team deems them to be adequate for the purpose.

Seismic Interaction Program for WBN. The discussion below is not specifically about the support of lighting fixtures. It does, however, relate to the development of TVA's seismic interaction program and the subsequent addressing of lighting fixtures as a component of that program.

In early 1986, Gilbert/Commonwealth (G/C) conducted a technical review of the SQN main and auxiliary feedwater systems modifications made between issuance of the operating license (September 17, 1980) and June 1985. G/C Report 2614 (March 3, 1986) describes the approach, methodology, results, and conclusions

of the technical review. Technical Issue No. 11 of that report, titled "Seismic Interactions," describes a condition where a 2-inch-O.D. Category I(L) primary makeup water supply piping system was located near instrument tubing supplying air to the auxiliary feedwater bypass valve 2-LCV-3-148A. This piping is not laterally restrained to prevent it from striking the air supply line valves. G/C found no documentation to demonstrate that this interaction would not impair the auxiliary feedwater system safety functions.

G/C also found that INPO Finding DC.3-2 (1985) for WBN identified a proximity issue regarding displacement of Category I(L) piping systems as a potentially generic concern. This INPO finding and the resultant SCR WBN CEB 8537 address the position retention (falldown) but not the displacement (swinging) of a Category I(L) system. The INPO finding states:

> "An engineering evaluation has not been performed to justify the design criteria of seismically supported nonsafety (IL) [I(L)] systems. The present design criteria for IL [I(L)] rod hangers is not adhered to consistently. Some IL [I(L)] support designs do not consider all seismic loadings."

As a result of the G/C findings, SQN issued SCR SQN MEB 8610. The WBN generic evaluation was performed before the SQN extension of the scope of the SCR. Thus, DNE-WBN concluded that the SCR was not applicable to WBN. A documented re-review of this present SQN SCR would be appropriate.

TVA Evaluation of SCR SQN MEB 8610 for WBN. Inspection criteria for rod hung Category I(L) items are established in TVA memo from Handy to SQN Files (April 22, 1986). This memo, which has been checked, reviewed, and approved by TVA, establishes a maximum horizontal displacement of $\pm$ 6 inches for such pipes, conduits, HVAC ducts, and cable trays and a maximum horizontal displacement of $\pm$ 10 inches or $\pm$ 30 degrees swing angle, whichever is less, for pendant-mounted light fixtures.

Evaluation team discussion with TVA personnel indicated that there is no documentation for these criteria. They are based on informal studies of ground motion displacements at rock-based sites within the TVA service territory plus consideration of building movements during an SSE. TVA personnel agreed to providing such documentation in their corrective action plan.

On the basis of evaluation team discussions with TVA personnel, new engineering change notices will address seismic interaction concerns as a part of the seismic review process. These new evaluations will be similar to, and

compatible with, those completed under SCR SQN MEB 8610. This seismic review process will be in accordance with CEB-DI-121.03, "Seismic Design, Review and Control." The CEB seismic evaluation for seismic interaction will ensure that:

- o Equipment and systems will not have unacceptable impact from existing rod hung Category I(L) items, and
- o New rod hung Category I(L) items will not impact existing Category I fragile items in an unacceptable manner

These two elements are currently expected to be based on design consultation and walkdown information and evaluation. As these elements are currently based on verbal instruction, TVA personnel understand that there is a need to formally document this instruction by revision of CEB-DI-121.03.

The evaluation team notes the lack of a document describing the complete program for controlling this seismic interaction activity. The technical instruction will effectively implement the walkdown activities of this program. The TVA memo from Handy to SQN files (April 22, 1986) contains adequate threshold criteria for subsequent evaluations when its basis is adequately documented. The division of responsibilities between disciplines is defined in CEB-DI 121.03. Such a program might include thresholds of fragility/ductility/flexibility to provide additional criteria for interaction resolution. The walkdowns and evaluations performed to date and those that are required to complete this effort will resolve near-term issues and furnish an adequate baseline for future evaluations as additional plant modifications are made. Recognition of this future need is alluded to in item c. of block 5e in SCR SQN MEB 8610, which states:

> "Corrective action will be readdressed to the 'post-modification walkdown phase' rather than to the 'design phase,' and will be included in the acceptance criteria of the post-modification walkdown."

TVA personnel agreed to revise CEB-DI-12.1.03 to provide a complete program as a corrective action plan item.

The evaluation team considers the TVA action plan response to G/C Issue No. 11 and corrective action/action required to prevent recurrence portions of SCR SON MEB 8610 generally adequate in concept. However, some deficiencies and discrepancies exist in TVA evaluations and design documents regarding prevention of lighting fixtures from becoming swinging missiles (seismic interaction) and the application of the lighting design criteria.

Further Relevant Document Review for WBN. The evaluation team reviewed the attachments to NRC letters from Youngblood to White (February 18, 1986, and June 23, 1986) for their relevance to this report, that are not included in

the concern statement itself. No relevent information was found in the February 1986 letter; however, on pages 131-133 of the attachment to the June 1986 letter, it became apparent to the evaluation team that the term "caged" used in the concern relates to prevention of the light bulbs or tubes from falling out of the fixtures as a result of a seismic event. This associated issue does not appear to have been subjected to a documented review by TVA. However, the evaluation team's generic conclusion is that because light bulbs and tubes have brittle glass and light mass (usually one pound or less), they do not generally present a significant safety hazard that might compromise the function of adjacent Category I equipment, which is of greater ruggedness and mass. According to criteria developed by the evaluation team for other nuclear power plant facilities, the item being struck will not generally be adversely affected if the size or mass of the striking item is less than or equal to that of the item being struck.

The one likely exception for this conclusion would be over the main control room semi-horizontal panels where plant operators or panel switches or buttons might be impacted. During the evaluation team walkdown on January 30, 1987, for other element evaluations, it was noted that there was a grate or grid for diffusing light between the tubes or bulbs and the control panels which will mitigate any falling tubes or bulbs. Thus the evaluation team considers this associated issue to be of no safety significance.

4.3.2 Summarized Findings for WBN

Evaluation team discussions with Watts Bar personnel indicate that they are aware of the design oversights on the subject of seismic interaction, but they have not initiated activity in this design area as they are waiting for the completion of Sequoyah work to enable them to make maximum use of those efforts in developing an effective Watts Bar program. However, the tracking documentation indicates that the subject is closed since the design oversights were not noted during a generic design evaluation feedback from Sequoyah.

In addition, several inconsistencies were observed within and between both the design criteria and the construction drawings for the support of lighting fixtures. The Watts Bar corrective action plan is to resolve the inconsistencies.

4.4 Browns Ferry

4.4.1 Detailed Findings for BFN

Light Fixture Support Criteria for BFN. NRC General Design Criterion 4 (previously AEC General Design Criterion 2) requires Category I* (Class I for Browns Ferry) structures, systems, and components to be appropriately

* The term "Category I" is applicable for TVA other nuclear power plants

protected against dynamic effects, including the effects of missiles, pipe whipping, and discharging fluids, that may result from equipment failures and from events and conditions outside the nuclear power unit. The BFN commitment to comply with this criterion is contained in the Browns Ferry Final Safety Analysis Report (FSAR), Appendices A and C.

Position C-2 of Regulatory Guide 1.29, "Seismic Design Classification" (previously Safety Guide 29 issued June 7, 1972), states that those portions of structures, systems, or components that are non-Category I* (Class II for Browns Ferry), but whose failure could reduce the functioning of a Category I (Class I for Browns Ferry) item to an unacceptable safety level, should be designed and constructed so that the safe shutdown earthquake (SSE) would not cause such failure. BFN commitment to comply with this regulatory guide is contained in the BFN FSAR, Section 1.6.7 and Appendix C, Section C.2.1.

BFN FSAR Section 1.6.7 defines Class I and Class II items as follows:

- Class I

  "This class includes those structures, equipment, and components whose failure or malfunction might cause, or increase the severity of, an accident which would endanger the public health and safety. This category includes those structures, equipment, and components required for safe shutdown and isolation of the reactor."

- Class II

  "This class includes those structures, equipment, and components which are important to reactor operation, but are not essential for preventing an accident which would endanger the public health and safety, and are not essential for the mitigation of the consequences of these accidents. A Class-II-designated item shall not degrade the integrity of any item designated Class I."

NRC has initiated several unresolved safety issues (USIs) which affect the seismic design basis at Browns Ferry. This is indicated in the draft version of TVA BFN Seismic Design Basis Status Report. For example, the safety issue in USI A-17 (NUREG-0606) considers "system interactions" which include seismic interaction between Class I and Class II components. Part of the NRC Nuclear Reactor Regulation (NRR) plan to resolve A-17 is to assign the responsibility

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* These non-Category I items are designated as Category I(L) for TVA other nuclear power plants

for identifying seismically induced adverse system interactions to the USI A-46 program, "Seismic Qualification of Equipment in Operating Plants." This is indicated in Advisory Committee on Reactor Safeguards (ACRS) Full Committee meeting on the resolution of USI A-17 on May 8, 1986.

The safety issue in USI A-46 (NUREG-0606) is the concern that the margins of safety provided by equipment in operating nuclear power plants under seismically induced loads may vary considerably. These variations were due to the significant change in design criteria and methods for seismic qualification of equipment which have been adopted since these plants were reviewed for their operating license. NRC indicates that the seismic capability of equipment in operating plants should be reassessed to assure that the plant can be brought to a safe shutdown condition when subjected to a design basis seismic event. The NRC resolution of USI A-46 is contained in NUREG-1030 and NUREG-1211. Implementation of the requirements delineated in NUREG-1030 will have a duration of approximately 40 months (Table 4 of NUREG-1211).

The design of the BFN electrical system is stated in FSAR Section 8.0. This section together with FSAR Appendix C indicate class 1E as the classification of electrical equipment required to achieve safe shutdown. The BFN lighting system is addressed in FSAR Section 10.19. This section indicates that BFN is designed with normal lighting and emergency lighting systems: the normal lighting is supplied from nonclass 1E power sources, and the emergency lighting is generally battery powered from class 1E batteries. Standby lighting which is class 1E diesel-backed is also provided for fixtures in the main control room as stated in TVA BFN Design Criteria BFN-50-789.

TVA's new plan for compliance to 10 CFR 50, Appendix R, commits to upgrade BFN emergency lighting with at least an 8-hour battery power supply in all areas needed for operation of safe shutdown equipment and in access and egress routes to and from all fire areas. This new plan was attached in TVA's letter to NRC (January 31, 1986).

Based on evaluation team discussions with TVA on March 9, 1987, TVA indicated that BFN has no original design criteria for lighting fixture support. No original design criteria were implemented for design other than the National Electrical Code for the given year in which the design was issued. Civil Design Guide DG-C1.6.3, "Seismic Support of Lighting Fixture in Category I Structures," was issued in July 1978, and BFN has not implemented this design guide nor evaluated the adequacy of the previously installed lighting fixture supports against the criteria and/or the intent of the design guide. TVA stated that this design guide was not a BFN design commitment, and implementation would represent a plant back-fit. Typical drawings or specific drawings showing support details for lighting fixtures do not exist, other than drawings 48W1284-1, -2, and -3 of the main control room lighting

supports, which were initially issued in late 1982 for unit 2 and in 1983 for units 1 and 3. In a subsequent discussion at Browns Ferry during the week of March 2, 1987, TVA indicated that no calculations have been performed on BFN lighting fixture supports other than the recent calculation on supports for the main control room.

TVA BFN Design Criteria BFN-50-789 for lighting systems for the main control rooms were issued on January 9, 1984. Section 4.0 of the design criteria required lighting fixtures in the main control rooms to be mounted in accordance with Civil Design Guide DG-C1.6.3 or as approved by Civil Engineering Branch (CEB).

The evaluation team reviewed drawings 48W1284-1, -2, and -3 and noted that the drawings were initially issued for modifications to the control room lighting structure. Additional lateral bracing was added between the existing bracing, and end bracing members were added to the south wall on the existing braces. However, the evaluation team observed that there are no end bracing members in the east-west direction; the lighting fixture supports are different from those shown in Civil Design Guide DG-C1.6.3.

A review of TVA EN DES Calculation on "Miscellaneous Steel Main Control Room Lighting" revealed TVA CEB had reviewed and approved the main control room ceiling and lighting fixture supports shown on drawings 48W1284-1, -2, and -3. CEB review and approval for seismic adequacy of these drawings is indicated by TVA memoranda from Coleman and Huie to CEB files (December 22, 1982, and July 7, 1983). However, the evaluation team did not find any analytical data in the calculation or memoranda to demonstrate the adequacy of the control room lighting structure and lighting fixture support to withstand a seismic event.

Seismic Interaction Program for BFN. The discussion below is not specifically about the support of lighting fixtures. It does, however, relate to the current development of TVA's seismic interaction program and the subsequent addressing of lighting fixtures as a component of that program.

During late 1985 and early 1986, BFN generated several significant condition reports (SCRs). They indicated that an engineering evaluation was not performed which would ensure that various Class II features cannot degrade the integrity of Class I features as a result of forces caused by earthquake ground motions. This is generally referred to as evaluation of II over I (II/I) or seismic interaction between Class I and II components. In July 1986, the Mechanical Engineering Branch (MEB) of BFN issued SCR BFN MEB 8605 to serve as a single generic significant condition report to reduce, if not eliminate, the writing of additional SCRs on the subject of II/I.

Conditions Adverse to Quality (CAQ) Engineering Report for SCR BFN MEB 8605 stated that this SCR is intended to address all BFN Class II features and their components when they are located near Class I features. The Engineering

Report stated that the SCR is also intended to address potential damage to Class I features caused by impact from failure and excessive movement of Class II lighting fixtures. The report concluded that no documentation exists to assure that the integrity of Class I features has been considered in the design of Class II features; neither does documentation exist that would assure that the design of Class I features recognizes the presence of Class II features. Further, the potential exists that failure of Class II features could degrade the integrity of Class I features as a result of a seismic event.

The Engineering Report recommends that BFN develop a seismic II/I program or obtain the services of an engineering firm that has an acceptable II/I program developed to evaluate seismic interaction between Class I and Class II components.

TVA Division of Nuclear Engineering (DNE) is developing a program to evaluate seismic-induced effects of Class II items on Class I components. This was confirmed by the evaluation team discussion with TVA at Browns Ferry during the week of March 2, 1987. The program consists of two phases. Phase I establishes acceptance criteria, develops procedures, and defines work scope for evaluation of seismic-induced effects of Class II items on Class I components. Phase II implements the program. Phase I already has been awarded to two contractors. TVA, after reviewing the program, will select one contractor for Phase II. Phase II also will include development of a long-term program for the design of future modifications at Browns Ferry to prevent problems due to seismic interaction between Class I and Class II components. This plan is indicated in TVA's letter to EQE Inc., as well as in a letter from TVA to Sargent and Lundy (both dated November 24, 1986).

BFN has reviewed the applicability of Watts Bar SCR CEB 8537 which addressed the "position retention (falldown)" of a Category I(L) (class II for BFN) system as a result of INPO Finding DC.3-2 against WBN. BFN found the condition does exist and is being covered by SCR BFN CEB 8602 (indicated in a memo from Marshall to Barnett). SCR BFN CEB 8602 was later superseded by SCR BFN MEB 8605.

BFN has also reviewed the applicability of Sequoyah SCR MEB 8610, which addressed the horizontal movement (swinging) of seismic Category I(L) (Class II for BFN) supported items (including lighting fixtures) and their effect on adjacent seismic Category I (Class I for BFN) items. Sequoyah SCR MEB 8610 was generated as a result of G/C Technical Issue 11. BFN found the condition does exist and is being covered by SCRs BFN CEB 8602, CEB 8524, and NEB 8514. This was indicated in a memo from Crisler to Chandley (March 7, 1986). SCRs BFN CEB 8602 and CEB 8524 were later superseded by SCR BFN MEB 8605. For SCR BFN NEB 8514, portions related to seismic interaction are also covered by SCR BFN MEB 8605 as indicated in CAQ Engineering Report for SCR BFN MEB 8605.

Evaluation Team Walkdown of Lighting Fixture Supports for BFN. The evaluation team performed a plant walkdown during the week of March 2, 1987, to gain an understanding of how the lighting fixtures were supported. The specific areas included as a sample were the control room for units 1, 2, and 3, and various other areas of the unit 2 Reactor Building at elevations 593 feet and 621 feet. The following observations were made during the walkdown:

- The structural framing of the unit 3 control room lighting fixtures mainly consists of Unistrut P1000 channels and 1/2-inch diameter or smaller threaded rods. The Unistrut channels span the control room in the east-west direction and are interconnected with 1/2-inch-diameter rods spanning in the north-south direction. The horizontal framing structure has end bracings in the north-south direction but no end bracings in the east-west direction. The horizontal Unistrut P1000 is generally supported by a vertical 3/8-inch-diameter threaded rod anchored to the ceiling concrete slab. Two rows of fluorescent fixtures running parallel to each row of Unistrut P1000 are attached to each end of a mounting arm connected to the Unistrut channel at mid-length of the mounting arm.

- Safety cables are installed above the control room in unit 3 for emergency light fixtures.

- The suspended ceiling in the control room for units 1, 2, and 3 would protect control panels from falling light tubes or bulbs.

- In other areas of the Reactor Building, both fluorescent and incandescent fixtures have been used. Fixtures are typically supported from the ceiling with steel rod or conduit. For rooms with high ceilings and a heavy congestion of commodities routed below the ceiling, the fixtures are attached to the support of one of these commodities (e.g., HVAC duct or cable tray support). No safety cables were found. Wall-mounted battery pack, emergency light fixtures were observed in several locations. Each battery pack fixture was resting on a steel angle attached to the wall. A steel strap attached to the wall prevents the battery pack from sliding off the support angle.

Further Relevant Document Review for BFN. The evaluation team reviewed the attachments to NRC letters from Youngblood to White (February 18, 1986, and June 23, 1986) for issues or information relevant to this report, that are not included in the concern statement itself. No such issue or information was found in the February 1986 letter; however, on pages 131-133 of the attachment to the June 1986 letter, it became apparent to the evaluation team that the term "caged" used in the concern relates to prevention of the light bulbs or

tubes from falling out of the fixtures as a result of a seismic event. This associated issue does not appear to have been subjected to a documented review by TVA. However, the evaluation team's generic conclusion is that because light bulbs and tubes have brittle glass and light mass (usually one pound or less), they do not generally present a significant safety hazard that might compromise the function of adjacent Class I equipment, which is more rugged and has greater mass. According to criteria for other power plant facilities, the item being struck will not generally be adversely affected if the size or mass of the striking item is less than or equal to that of the item being struck.

Exceptions to this conclusion might be found in areas such as over the main control room inclined panels, where plant operators or panel switches or buttons might be impacted. During the same evaluation team walkdown for lighting fixture supports (week of March 2, 1987), it was noted that there was a grate or grid for diffusing light between the tubes or bulbs and the control panels that will mitigate the effect of any falling tubes or bulbs. Thus the evaluation team considers this associated issue to be of no safety significance.

4.4.2 Summarized Findings for BFN

The Browns Ferry design of light fixtures in general may not provide adequate vertical support to withstand a seismic event and to prevent the fixtures from becoming free missiles that might damage Class I equipment. Also, the Browns Ferry design of light fixtures does not provide adequate evaluation of horizontal support during and after a seismic event to prevent the fixtures from becoming swinging missiles that might damage adjacent Class I equipment. Both of these design items have been documented and are being addressed.

Browns Ferry DNE is developing a program to address seismic interaction between Class I and II components. The program consists of two phases: Phase I is the program development, which has been started, and Phase II is the implementation of the program. This program will also include development of a long-term program to preclude future II/I problems.

No calculations exist for lighting fixture supports, other than those for the main control room. No analytical data were provided in supporting calculations to demonstrate the adequacy of the control room lighting structure and fixture supports to withstand a seismic event. No end bracing members are shown in the east-west direction of the control room lighting structure on the construction drawings.

4.5 Bellefonte

4.5.1 Detailed Findings for BLN

Light Fixture Support Criteria for BLN. NRC General Design Criterion 4 requires Category I structures, systems, and components to be appropriately protected against dynamic effects, including the effects of missiles, pipe whipping, and discharging fluids, that may result from equipment failures and from events and conditions outside the nuclear power unit. The Bellefonte Nuclear Plant (BLN) commitment to comply with this criterion is contained in the Final Safety Analysis Report (FSAR), Section 3.1.

Position C-2 of Regulatory Guide 1.29, "Seismic Design Classification," states that those portions of structures, systems, or components that are non-Category I, i.e., Category I(L), but whose failure could reduce the functioning of a Category I item to an unacceptable safety level, should be designed and constructed so that the safe shutdown earthquake (SSE) would not cause such failure. BLN commitment to comply with this regulatory guide is contained in the BLN FSAR, Section 3.2.1.

BLN FSAR Section 3.2.1 describes Category I(L) items as follows:

> "Some safety-related components or systems perform a secondary safety function and are seismically designed to a limited extent because their locations create a potential for damaging features which perform a primary safety function. Those components or systems which must retain limited structural integrity because their failure could jeopardize to an unacceptable extent the achievement of a primary safety function are designated as Seismic Category I(L) (i.e., limited requirements). Those fluid containing elements which are included in Seismic Category I(L) are seismically qualified to meet Position C.2 and Position C.3 of NRC Regulatory Guide 1.29."

BLN is designed with three basic lighting systems:

- The Normal Lighting System is designed to economically provide the amount and quality of illumination to meet normal plant operations and maintenance requirements.

- The Standby Lighting System, upon loss of the Normal Lighting System, provides adequate illumination for the safe shutdown of the reactor and the evacuation of personnel from the plant if the need should occur. It forms an integral part of the normal lighting requirements and is fed from an independent class 1E source.

- The Emergency Lighting System is composed of two separate systems: (1) the 125V dc lighting system, which is designed to provide immediately the minimum illumination level in areas vital to the safe shutdown of the reactor for the 30-second period for diesel loading or for a two-hour period upon the loss of all ac auxiliary power; and (2) an individual eight-hour battery pack network, which is used to supplement the 125V dc emergency lighting, provide emergency lighting in areas that must be manned for safe shutdown, and to enable access and egress to and from all fire areas.

The supports for the components of these systems that are located in seismic Category I structures are to be seismically qualified to prevent failure that could impair the functioning of any safety-related plant feature. Details of the supports for the three systems (except for the emergency 8-hour battery pack network) are described in Design Criteria N4-50-D719. Details of the various support types are shown on drawing series 4BA0893-X2. Details of the 8-hour battery pack supports are shown on the various lighting plans, such as the 5AW0420-RW, 5CW0420-RW, 5DW0420-RW, and 5RW0420-RW series.

Additional requirements are imposed for the first emergency lighting system to maintain the electrical power supply to the fixture during or after a seismic event. This is accomplished by a three-way lateral cable support, which is intended to keep the fixture in a plumb position.

BLN also utilizes Design Guide DG-C-1.6.3 in accordance with the limitations described in the TVA policy statement. The design guide states that:

> "In the event of a lighting fixture failure due to seismic conditions, motion of the fixture in any direction will be limited to the length of free cable. Care must be taken to eliminate or otherwise protect any safety-related equipment within the range of motion afforded by the cable from impact by the fixture."

The evaluation team has reviewed the above requirements in light of general engineering industry experience and determined that they are adequate.

The BLN Design Criteria N4-50-D719 forms the design commitment for BLN. The criteria and General Design Guide DG-C-1.6.3 are similar. With the exceptions noted later, after review of 4BA0893-X2.lighting fixtures support drawing, the evaluation team determined that N4-50-D719 criteria are adequate for preventing lighting fixtures from becoming free-falling missiles, based on general engineering experience.

Criteria Application for BLN. To implement the BLN design criteria and FSAR commitments, notes and details are shown on drawing series 4BA0893-X2 except for the emergency eight-hour battery pack network, which is shown on the

various lighting plans. Individual lighting fixtures in nuclear industry facilities are typically lightweight, generally 50 pounds or less and rarely exceeding 100 pounds. These weights are confirmed by N4-50-D719 Section 4.0, which indicates weights in the 20 to 35 pound range. Small and lighter fixtures, including the emergency exit signs, have one 1/16-inch-diameter auxiliary cable support at the fixture stem, while longer and heavier fixtures generally have more than one stem with an auxiliary cable at each stem. The minimum breaking strength of the cable is 480 pounds. The cable is generally attached to a single expansion anchor either 1/4- or 3/8-inch in diameter. Specification G-32 indicates allowable loads of 500 and 700 pounds in tension and 300 and 500 pounds in shear for the two specified sizes of expansion anchors. Thus the evaluation team concludes that the light fixtures are properly designed with adequate vertical support to withstand a seismic event.

The evaluation team has reviewed the 4BA0893-X2 drawing series and concludes that it is technically adequate subject to the following observations:

- The requirements for conditions under which the three-way lateral cable support may be deleted is not consistent between drawing 4BA0893-X2-21 and Design Guide C1.6.3, Figure 18. Design Criteria N4-50-D719, Figure 5.0-2, is consistent with the drawing series. TVA did not furnish a calculation for BLN that supports Figure 5.0-2 of the criteria.

- Drawing 4BA0893-X2 series does not have a detail showing slack in the electrical cables at the emergency lighting fixture as required by Design Criteria N4-50-D719, Figure 5.0-3.

- Drawing 4BA0893-X2-32, Rev. 1, shows a 4 by 4 by 1/4 inch structural tube support up to 8 feet long, which may be used in lieu of the three-way lateral cable support. This detail was developed when Bellefonte construction personnel encountered difficulties in applying the 4BA0893-X2-21, Rev. 1, detail as described in TVA memos from Hodges to Barnettand Barnett to Hodges. Although the correspondence and the resultant calculation refer to the support as "rigid" and the evaluation team estimates the support frequency as in the 9 to 12 hertz range, for 20- to 50-pound fixtures, review of the calculation and project response spectra by the evaluation team indicates the design output is adequate. However, this change has not been reflected in the design criteria.

- The details in the design criteria Figure 4.7-1 for the emergency light and the emergency light detail shown on 4BA0893-X2-7, Rev. 1, do not agree with the text of Section 5.0 and with Figure 5.0-1.

Seismic Interaction Program for BLN. During a trip to Knoxville, the evaluation team determined that TVA did not have a complete seismic interaction program at BLN. This situation was expected because TVA's generic seismic design interface document, CEB-DI 121.03 did not address the control and coordination of an overall program.

Recently, TVA has revised this design interface document. Although, the details of the revision have not been completely reviewed by the evaluation team, it appears that TVA has adequately defined an overall umbrella program. To implement this program on BLN, a walkdown and evaluation will be performed at a time near fuel load. Specific details of the criteria to be used will need to be developed for BLN.

Evaluation Team Walkdown of Lighting Fixture Supports for BLN. During a trip to BLN, the evaluation team performed a walkdown of portions of the Category I structures with the intent of observing lighting fixture installations. The evaluation team observed the installation of safety cables for the lighting fixtures; however, installations were also observed where the rod hangers supporting lighting fixtures were in contact with other commodity supports.

No false ceiling was observed in the main control room. When information was requested by the evaluation team regarding any proposed false ceiling, TVA advised that there will be no false ceiling in the main control room. A properly designed false ceiling would mitigate the sway of the fixtures and prevent loosened bulbs from falling on operators or the semihorizontal control panels. For fluorescent light fixtures, the tubes appeared to be adequately restrained by the metal reflector bars that run perpendicular to the fixture. On the other hand, the incandescent fixtures do not have grilles or cages to retain the bulbs. The bulbs, however, are made of brittle glass and are light in mass (usually one pound or less). Therefore, although there is a remote possibility that the bulbs could become loose and fall during a seismic event, the evaluation team does not consider that this could have any significant impact on the safe operation or shutdown of the plant.

A separate walkdown was performed by the evaluation team specifically to view emergency exit signs in Category I structures. This walkdown revealed the following:

- Certain installations had safety cables and certain ones did not. No consistency was evident.
- Where safety cables were installed, they appeared to be adequate to prevent the fixture from becoming a free-falling object. Therefore, it appears the field has satisfied the design intent relative to proper location of safety cables for emergency exit lights.

- o As would be expected, most locations where exit signs have been installed are in corridors and other areas where the potential of impact with seismic Category I components is minimal.

Review of SCRs, PIRs, and NCRs for BLN. Numerous documents have been issued at various TVA plants identifying concerns or problems with seismic interactions between seismic Category I and non-Category I commodities. The following listing identifies the Conditions Adverse to Quality documents furnished by TVA to the evaluation team and BLN's resulting actions:

1. Initiating Document: SCR SQN MEB 8610

   BLN Document: None.

   Issue: Seismic Category I(L) piping supports will not prevent the piping from swaying and possibly damaging adjacent safety-related components during a seismic event.

   BLN Disposition: Although the concern for swinging pipes exists at BLN, it is stated in the Potential Generic Condition Evaluation that construction specification N4C-913 controls interferences.

   Discussion: A review of construction specification N4C-913 revealed that Construction was informed that, for piping, certain interactions during seismic events should be prevented. The specification indicates that where rigorous analysis is not performed, Construction should assume the Category I(L) pipe movement is 1 inch. According to discussions with TVA personnel, this 1-inch movement is believed to accommodate the worst pipe movement, but this assumption has not been validated. In addition, this does not preclude the possibility of safety-related commodities being installed after the Category I(L) piping is in place and violating the clearance requirements. Further, it does not take into account the possible lateral displacement of the safety-related components.

2. Initiating Document: SCR BFN MEB 8605

BLN Documents: SCR BLN MEB 8509 and NCR BLN EEB 8420

Issue: Non-seismic Category I HVAC piping and components may impact safety-related components in the vicinity during a seismic event.

BLN Disposition: BLN reviewed the plant arrangement and determined that one seismic Category I locally mounted instrument panel was susceptible to damage from non-seismic Category I HVAC equipment. Accordingly, the HVAC component supports in the vicinity were upgraded to seismic Category I(L).

Discussion: BLN disposition adequately addresses this particular seismic interaction issue.

3. Initiating Document: PIR WBN CEB 8572

BLN Document: PIR BLN CEB 8519

Issue: Design criteria for seismic Category I(L) rod hangers are not consistently adhered to (INPO Finding DC.3-2)

BLN Disposition: Piping supports that do not meet the requirements of Design Criteria N4-50-D725 will be redesigned and modified as required. Also the NRC has identified an unresolved safety issue, and ASME III is reviewing modified seismic analysis rules. Additional corrective actions are to be identified after 09/86.

Discussion: The referenced criteria (N4-50-D725) indicate the use of Design Criteria N4-50-D711 for the analysis of Category I(L) piping systems. These criteria limit the design consideration to failure of the piping system and do not address lateral displacements of Category I(L) components damaging adjacent Category I items. In addition, the NRC and ASME efforts have not been completed. Accordingly, no additional corrective actions have been identified.

4. Initiating Document: SCR WBN CEB 8537

BLN Document: None

Issue: Lateral loads on certain types of seismic Category I(L) supports could cause failure.

BLN Disposition: It was determined that the potential generic condition does not exist at BLN. This determination was based on the fact that Design Criteria N4-50-0725 require only dead load considerations and not lateral loads.

Discussion: To comply with NRC General Design Criterion 4 and the BLN FSAR, consideration of both vertical and lateral effects from seismic events is required.

5. Initiating Document: BLN NCR 2058

BLN Document: Same as above.

Issue: Lighting fixtures with glass or porcelain cannot be restrained with safety cables since the cables would damage the fixture.

BLN Disposition: Where attachments cannot be made to glass or porcelain lamp shades, safety cables must be attached to lamp housings.

Discussion: TVA disposition of this issue is reasonable based on current engineering practice.

Further Relevant Document Review for BLN. The evaluation team reviewed the attachments to NRC letters from Youngblood to White (February 18, 1986, and June 23, 1986) for issues or information relevant to this report, that are not included in the concern statement itself. No such issue or information was found in the February 1986 letter; however, on pages 131-133 of the attachment to the June 1986 letter, it became apparent to the evaluation team that the term "caged" used in the concern relates to prevention of the light bulbs or tubes from falling out of the fixtures as a result of a seismic event. This associated issue does not appear to have been subjected to a documented review by TVA. It has, however, been addressed by the evaluation team in the evaluation team walkdown of lighting fixture supports above.

4.5.2 Summarized Findings for BLN

Evaluation team discussions with Bellefonte personnel indicate that they are aware of the design oversights on the subject of seismic interaction, but they have not initiated activity in this design area because TVA experience indicates little benefit in developing a program for seismic interaction 4 years before unit 1 fuel load. However, the tracking documentation shows the subject closed since the design oversights were not noted during a generic design evaluation feedback from Sequoyah.

In addition, several inconsistencies were observed within and between both the design criteria and the construction drawings for the support of lighting fixtures.

4.6 Summarized Subcategory Findings

The classified findings are summarized in Table 1. Class A and B findings indicate that there is no problem and that corrective action is not required. Class C, D, and E findings require corrective actions. The corrective action class is identified in the table by the numeral combined with the finding class.

The findings are summarized by classification in Table 2, which identifies one finding for each issue evaluated. Of the 20 findings shown in Table 1, three had corrective actions initiated before the ECTG evaluations and three required new corrective actions to be identified. The remaining 14 had actions required to resolve peripheral findings noted during the ECTG evaluation.

5. CORRECTIVE ACTIONS

Since some of the corrective actions apply to more than a single plant and since some of the findings may be addressed by a single corrective action plan description for an individual plant, only eight different corrective action plan descriptions are required to remedy the 18 negative findings. The detailed corrective action plans are described in Attachment B. A condensation of this information, with the applicable plant identified in parentheses, follows:

226.0, Design of Lighting Fixture Supports

- Complete the resolution of plant-specific significant condition reports (SQN and BFN).
- Provide a complete program to describe and control the seismic interaction evaluations for current and future design activities (SQN, WBN, and BLN).

- Perform walkdown(s), evaluations, and calculations for plant areas previously excluded (SQN).
- Provide technical basis for inspection criteria (SQN).
- Review the adequacy of calculation CEB CAS 214 for written technical justification (SQN).
- Revise design documents to eliminate inconsistencies and evaluate any potential hardware impact (SQN, WBN, BFN, and BLN).
- Provide a generic review of current SCR SQN MEB 8610 (WBN and BLN).
- Finish development of a complete program to describe and control the seismic interaction evaluations for current and future design activities (BFN).

These corrective actions also appear in Table 3, along with their corresponding finding/corrective action classifications. The table indicates the plant or plants to which a corrective action plan description is applicable by the Corrective Action Tracking Document (CATD) column where the applicable plant is identified by the CATD number.

From the Finding/Corrective Action Classification column of Table 3, it can be seen that of the eight corrective action plan descriptions identified, none explicitly require hardware or plant modification, four involve additional analysis to validate the design and determine if plant modifications are necessary, and the remaining four require some type of documentation remedy.

The evaluation team found the corrective action plans for Sequoyah, Watts Bar, Browns Ferry, and Bellefonte to be acceptable to resolve the findings.

6. CAUSES

Table 3 identifies one or more causes for each problem requiring corrective action. For each corrective action description, the primary or most important cause is identified.

For the eight corrective action descriptions listed in Table 3, eight causes have been identified. These are shown in the table and totalled at the end. The two most frequent causes are "inadequate as-built reconciliation," column 10, and "engineering judgment not justified," column 12. These two causes, which reflect on the design process and, more particularly on design

documentation, combine to represent four of the ten causes identified. This indicates that weakness in the design documentation area have contributed to a number of problems and, therefore, improvement in this area appears warranted.

In addition, a number of the causes in Table 3, such as "Engineering Error," "Engineering Judgment Not Documented," and "Inadequate Design Bases," suggest a weakness in TVA's design review process. Besides improving the quality of the design, a stronger design review process would also be expected to resolve some of the weakness noted above in the design documentation area.

The bases for identifying specific causes for each corrective action description in Table 3 with the negative findings are as follows:

- Completion of resolution of plant-specific significant condition reports on Sequoyah and Browns Ferry requires walkdowns because the as-built plant conditions have not been reconciled with the design basis.

- Provision of a complete program to describe and control the seismic interaction evaluations for current and future design activities on Sequoyah, Watts Bar, and Bellefonte is required because the existing procedures are incomplete.

- Performance of walkdown(s), evaluations, and calculations for plant areas previously excluded is required for Sequoyah to rectify an engineering error that permitted exclusion of the Reactor Building and portions of the Auxiliary Building.

- Provision of a technical basis for Sequoyah inspection criteria is required because the current criteria are not based on documented engineering judgment.

- Review of the adequacy of calculation CEB CAS 214 for written technical justifications is necessary because the current revision is not based on adequately documented engineering judgment as required by TVA policy. This policy requires that the written basis be sufficiently clear to permit another engineer to understand the preparer's thought process.

- Revision of design documents to eliminate inconsistencies and to evaluate any potential hardware impact is required for the four plants because design bases are fragmented and incomplete.

- Provision of a generic Watts Bar and Bellefonte review of current SCR SQN MEB 8610 is required because the existing Watts Bar and Bellefonte generic reviews were performed before completion of Sequoyah scope definition. Thus, the procedures for such generic review were not completely followed.

- Development of a finished program on Browns Ferry is required to describe and control the seismic interaction evaluation for current and future design activities. The as-built conditions will be reconciled with a revised design basis conforming to NRC guidelines, neither of which has been issued.

7. COLLECTIVE SIGNIFICANCE

The evaluation team's judgment as to the significance of the corrective actions is indicated in the last three columns of Table 3. Significance is rated in accordance with the types of changes that may be expected to result from the corrrective action. All of the corrective action plan descriptions for this subcategory are judged to be individually significant from a licensing standpoint because there is a potential for degrading the functional capability of adjacent Category I or Class I equipment during a seismic event.

When all of the findings and corrective action descriptions for the four nuclear plants are viewed collectively, the following overall conclusions emerge:

- Because of the relatively low number of negative findings in this subcategory, the random nature of the causes, and the overall significance level of the corrective actions, it cannot be concluded that the seismic interaction design for the four nuclear plant sites investigated represents a significant technical problem.

- Although the design area of lighting may appear limited, the cause implies broader significance in DNE management's lack of attention to selection, training, and supervision of first- and second-line engineering supervision assigned to this work which represents a microcosm of activity that will be assessed in detail in the Engineering category evaluation.

To address the general broader issues of TVA's past difficulties in the nuclear area, a Corporate Nuclear Performance Plan (CNPP) was created. In addition, SQN, WBN, and BFN have generated plant-specific nuclear performance plans (NPPs) to further define the programmatic actions to be taken for their facilities.

In general, TVA senior management has identified the need for strengthening its Engineering organization in response to the requirements of nuclear plant design. The Engineering organization is responsible for the content and quality of the design documents and for ensuring that they conform to sound engineering principles, licensing commitments, and Quality Assurance program requirements. This need for strengthening is based, in part, on deficiencies in design process effectiveness, which are partially illustrated by the cause discussion in Section 6. This need is also partially based on past implementation of the TVA Quality Assurance program. Thus, the need for strengthening the Engineering organization, as indicated by the NPPs, is accomplished primarily through additional training of the DNE personnel to the requirements of that program and to basic management principles. DNE Nuclear Engineering Procedure NEP-5.2 and policy memo PM 87-35 clearly delineate the responsibility, authority, and accountability of the Project Engineers and Branch Chiefs. The Project Engineer is responsible for work scope, budget, and schedule, and for ensuring that project work is executed according to plan and in conformance with the technical direction of the Branch Chiefs and the requirements of the corporate QA program. The Branch Chiefs are responsible for staffing levels and qualifications of technical personnel on the projects, and for the technical adequacy of the engineering design. The Branch Chiefs are the final technical authority within DNE, and have the authority to stop work that does not conform to established requirements. In the past, Branch Chiefs' authority or resources to fully administer technical reviews was limited. Under the restructured organization, the Branch Chief provides engineers and technical direction for the Project Engineer; the Branch Chief also assesses the need for technical reviews, develops a document review and approval matrix, and schedules reviews as required. These programs have been started but have not, as of Revision 2 of this report, been fully implemented.

An independent audit on the effectiveness of the implementation of the total Quality Assurance program is instituted by Engineering management, as a management tool, to additionally ensure that management policy is being enforced. This audit function is provided by the Engineering Assurance (EA) organization.

The findings of this subcategory report are combined with those of other subcategory reports and reassessed in the Engineering category evaluation, which has assessed the broader issues identified and has issued the necessary corrective action tracking documents.

TABLE 1

CLASSIFICATION OF FINDINGS AND CORRECTIVE ACTIONS

	Element	Issue/ Finding**	Finding/Corrective Action Class* SQN	WBN	BFN	BLN
226.0	Seismic Interaction Design	a	C6	D6	C6	D6
		b	E6	E6	C6	D6
		c	E6	E6	E6	E6
		d	E6	-	E6	E3
		e	E3	-	E6	-
		f	E3	-	E6	-
		g	E6	-	-	-

*Classification of Findings and Corrective Actions

A. Issue not valid. No corrective action required.
B. Issue valid but consequences acceptable. No corrective action required.
C. Issue valid. Corrective action initiated before ECTG evaluation.
D. Issue valid. Corrective action taken as a result of ECTG evaluation.
E. Peripheral issue uncovered during ECTG evaluation. Corrective action required.

1. Hardware
2. Procedure
3. Documentation
4. Training
5. Analysis
6. Evaluation
7. Other

**Defined in Attachment B.

TABLE 2

FINDINGS SUMMARY

Classification of Findings	Plant SQN	WBN	BFN	BLN	Total
A. Issue not valid. No corrective action required.	0	0	0	0	0
B. Issue valid but consequences acceptable. No corrective action required.	0	0	0	0	0
C. Issue valid. Corrective action initiated before ECTG evaluation.	1	0	2	0	3
D. Issue valid. Corrective action taken as a result of ECTG evaluation.	0	1	0	2	3
E. Peripheral issue uncovered during ECTG evaluation. Corrective action required.	6	2	4	2	14
Total	7	3	6	4	20

TABLE 3
MATRIX OF ELEMENTS, CORRECTIVE ACTIONS, AND CAUSES
SUBCATEGORY 22600

ELEM	FINDING/ CORRECTIVE ACTION CLASS.**	CORRECTIVE ACTION	CATD	CAUSES OF NEGATIVE FINDINGS*																	Significance of Corrective Actions*		
				MANAGEMENT EFFECTIVENESS							DESIGN PROCESS EFFECTIVENESS							TECHNICAL ADEQUACY					
				1 Fragmented Organization	2 Inadequate Q-trng	3 Inadequate Procedures	4 Procedures Not Followed	5 Inadequate Communication	6 Untimely Res of Issues	7 Lack of Mgt Atten	8 Inadequate Design Bases	9 Inadequate Calcs	10 Inadequate As-blt Reconcil.	11 Lack of Design Detail	12 Engrg Judgmt not Documented	13 Design Crit/ Comalt Not Met	14 Insuf. Verif Documentation	15 Stds Not Followed	16 Engrg Error	17 Vendor Error	D	H	H
226.0	C6	Complete resolution of plant specific significant condition reports.	SQN 03 BFN 01										X								A	P	P
	E6	Provide a complete program to describe and control the seismic interaction evaluations for current and future design activities.	SQN 02 WBN 02 BLN 01			X															A	-	-
	E6	Perform walkdown(s), evaluations, and calculations for plant areas previously excluded.	SQN 03																X		A	P	P
	E6	Provide technical basis for inspection criteria.	SQN 02												X						A	-	-
	E3	Review adequacy of calculation CEB CAS 214 for written technical justification.	SQN 02												X						P	-	-
	E6	Revise design documents to eliminate inconsistencies and evaluate any potential hardware impact.	SQN 01 WBN 03 BFN 02 BLN 01								X										A	P	P
	D6	Provide a generic WBN and BLN review of current SCR SQN MEB 8610.	WBN 01 BLN 01				X														A	P	P
	C6	Finish development of a complete program to describe and control the seismic interaction evaluations for current and future design activities.	BFN 01										X								A	-	-
			TOTALS			1	1				1		2		2				1				

* Defined in the Glossary Supplement.
** Defined in Table 1.

GLOSSARY SUPPLEMENT
FOR THE ENGINEERING CATEGORY

Causes of Negative Findings - the causes for findings that require corrective action are categorized as follows:

1. Fragmented organization - Lines of authority, responsibility, and accountability were not clearly defined.

2. Inadequate quality (Q) training - Personnel were not fully trained in the procedures established for design process control and in the maintenance of design documents, including audits.

3. Inadequate procedures - Design and modification control methods and procedures were deficient in establishing requirements and did not ensure an effective design control program in some areas.

4. Procedures not followed - Existing procedures controlling the design process were not fully adhered to.

5. Inadequate communications - Communication, coordination, and cooperation were not fully effective in supplying needed information within plants, between plants and organizations (e.g., Engineering, Construction, Licensing, and Operations), and between interorganizational disciplines and departments.

6. Untimely resolution of issues - Problems were not resolved in a timely manner, and their resolution was not aggressively pursued.

7. Lack of management attention - There was a lack of management attention in ensuring that programs required for an effective design process were established and implemented.

8. Inadequate design bases - Design bases were lacking, vague, or incomplete for design execution and verification and for design change evaluation.

9. Inadequate calculations - Design calculations were incomplete, used incorrect input or assumptions, or otherwise failed to fully demonstrate compliance with design requirements or support design output documents.

10. Inadequate as-built reconciliation - Reconciliation of licensing or design documents with plant as-built condition was lacking or incomplete.

11. Lack of design detail - Detail in design output documents was insufficient to ensure compliance with design requirements.

12. Failure to document engineering judgments - Documentation justifying engineering judgments used in the design process was lacking or incomplete.

13. Design criteria/commitments not met - Design criteria or licensing commitments were not met.

14. Insufficient verification documentation - Documentation (Q) was insufficient to audit the adequacy of design and installation.

15. Standards not followed - Code or industry standards and practices were not complied with.

16. Engineering error - There were errors or oversights in the assumptions, methodology, or judgments used in the design process.

17. Vendor error - Vendor design or supplied items were deficient for the intended purpose.

Classification of Corrective Actions - corrective actions are classified as belonging to one or more of the following groups:

1. Hardware - physical plant changes

2. Procedure - changed or generated a procedure

3. Documentation - affected QA records

4. Training - required personnel education

5. Analysis - required design calculations, etc., to resolve

6. Evaluation - initial corrective action plan indicated a need to evaluate the issue before a definitive plan could be established. Therefore, all hardware, procedure, etc., changes are not yet known

7. Other - items not listed above

Peripheral Finding (Issue) - A negative finding that does not result directly from an employee concern but that was uncovered during the process of evaluating an employee concern. By definition, peripheral findings (issues) require corrective action.

Significance of Corrective Actions - The evaluation team's judgment as to the significance of the corrective actions listed in Table 3 is indicated in the last three columns of the table. Significance is rated in accordance with the type or types of changes that may be expected to result from the corrective action. Changes are categorized as:

- Documentation change (D) - This is a change to any design input or output document (e.g., drawing, specification, calculation, or procedure) that does not result in a significant reduction in design margin.

- Change in design margin (M) - This is a change in design interpretation (minimum requirement vs actual capability) that results in a significant (outside normal limits of expected accuracy) change in the design margin. All designs include margins to allow for error and unforeseeable events. Changes in design margins are a normal and acceptable part of the design and construction process as long as the final design margins satisfy regulatory requirements and applicable codes and standards.

- Change of hardware (H) - This is a physical change to an existing plant structure or component that results from a change in the design basis, or that is required to correct an initially inadequate design or design error.

If the change resulting from the corrective action plan descriptions is judged to be significant, either an "A" for actual or "P" for potential is entered into the appropriate column of Table 3. Actual is distinguished from potential because corrective actions are not complete and, consequently, the scope of required changes may not be known. Corrective action plan descriptions are judged to be significant if the resultant changes affect the overall quality, performance, or margin of a safety-related structure, system, or component.

ATTACHMENT A

EMPLOYEE CONCERNS
FOR SUBCATEGORY 22600

Attachment A -- lists, by element, each employee concern evaluated in the subcategory. The concern's number is given, along with notation of any other element or category with which the concern is shared; the plant sites to which it could be applicable are noted; and the concern is quoted as received by TVA, and characterized as safety related, not safety related, or safety significant.

ATTACHMENT A

EMPLOYEE CONCERNS FOR SUBCATEGORY 22600

ELEMENT	CONCERN NUMBER	PLANT LOCATION	APPLICABILITY SQN	WBN	BFN	BLN	CONCERN DESCRIPTION*
226.0	WI-85-100-023	WBN	X	X	X	X	"Lighting fixtures at WBNP are not properly restrained and caged to prevent them from becoming missiles or swinging missiles during seismic events. CI has no further information. Anonymous concern via letter." (SR)
	BNP-QCP-10.35-13	BLN				X	"Safety cable (shown on drawings 4BA0893-X2-43R1 and 44R1) does not provide the fixture its required seismic support." (SR)

* SR/NO/SS indicates safety related, not safety related, or safety significant per determination criteria in the ECTG Program manual and applied by TVA before evaluations.

ATTACHMENT B

SUMMARY OF ISSUES, FINDINGS, AND
CORRECTIVE ACTIONS FOR
SUBCATEGORY 22600

Attachment B -- contains a summary of the element-level evaluations. Each issue is listed, by element number and plant, opposite its corresponding findings and corrective actions. The reader may trace a concern from Attachment A to an issue in Attachment B by using the element number and applicable plant. The reader may relate a corrective action description in Attachment B to causes and significance in Table 3 by using the CATD number which appears in Attachment B in parentheses at the end of the corrective action description.

The term "Peripheral finding" in the issue column refers to a finding that occurred during the course of evaluating a concern but did not stem directly from a employee concern. These are classified as "E" in Tables 1 and 2 of this report

Issues	Findings	Corrective Actions
****************** Element 226.0 - Seismic Interaction Design ******************		
SQN	SQN	SQN
a. Lighting fixtures are not properly designed to prevent them from becoming: o Free missiles o Swinging missiles which might damage Category I equipment during a seismic event.	a. The TVA design of light fixtures provides for adequate vertical support to witnstand a seismic event and prevent their becoming free missiles that might damage Category I equipment. The TVA design of light fixtures, per se, does not, in general, provide adequate horizontal support during and after a seismic event to prevent their becoming swinging missiles that might damage adjacent Category I equipment. However, this design oversight has been documented on SCR SQN MEB 8610 (App. A, 5.v) and is being addressed.	a. A TVA transmittal submits a corrective action plan (CAP) which will eliminate the discrepancies between the various design drawings and design criteria; provide a complete program to describe and control the seismic interaction evaluations for current and future design activities; and provide a technical basis for the internal TVA memo from Handy to SQN files (04/22/86). In addition, this CAP will provide for an evaluation of areas of the plant previously excluded. This evaluation will use an appropriate tecnnical program followed by evaluation via calculation revision to CEB CAS 214, R1. This calculation revision will include a re-review for adequacy of written technical justification of the existing revision and as described in findings above, in IOM #399 (11/14/86) and IOM #410 (11/19/86). The evaluation team concludes that the stated CAP is an acceptable resolution of the concerns that should also preclude recurrence of findings. (CATD 226 00 SQN 01) (CATD 226 00 SQN 02) (CATD 226 00 SQN 03) ONLY THIS ITEM CLOSED DATE 7-14-88 THIS ITEM PARTIALLY COMPLETED 7-6-88

Issues	Findings	Corrective Actions
Element 226.0 - SQN (Continued)		
b. Peripheral Finding.	b. The evaluation team noted that there is no document which describes the complete program for controlling the seismic interaction design activity. Technical Instruction TI-98, R0 (App. A, 5.s) will effectively implement the walkdown activities of this program when amended to address all plant areas. The TVA memo from Handy to SQN files (04/22/86) (App. A, 5.k) provides adequate threshold criteria for subsequent evaluations. The division of responsibilities between disciplines is defined in CEB-DI 121.03, R1, (App. A, 6.f). In addition, the CEB seismic review process for future reviews is to be in accordance with a future revision of CEB-DI-121.03, R1 (App. A, 7.o) and includes an evaluation for adverse impact of rod hung items as indicated by IOM #326 (10/01/86) (App. A, 7.k). However, this evaluation is currently in the form of verbal instructions which TVA personnel have committed to properly document.	b. Refer to a. above.
c. Peripheral Finding.	c. Plant walkdowns and subsequent technical evaluations by TVA to resolve SCR SQN MEB 8610 (App. A, 5.v) excluded portions of the auxiliary building and the containment vessel portion of the reactor building which were contaminated or required dress-out. Evaluations of these areas are necessary to determine the need for any potential hardware fixes. TVA personnel committed to perform a walkdown and evaluation of these areas in IOM #416 (11/19/86) (App. A, 7.p).	c. Refer to a. above.
d. Peripheral Finding.	d. The technical basis for the inspection criteria established in TVA memo from Handy to SQN Files (04/22/86) has not been documented. TVA personnel committed to providing such documentation in IOM #326 (10/01/86) (App. A, 7.k).	d. Refer to a. above

Issues	Findings	Corrective Actions
Element 226.0 - SQN (Continued)		
e. Peripheral Finding.	e. The evaluation team considers calculation CEB-CAS-214, R1 generally adequate; however, additional written justification is needed in some areas to permit another engineer who did not participate in the original walkdowns to arrive at the same conclusions. TVA personnel committed to re-review the calculation based on the above and make any necessary changes (App. A, 7.p).	e. Refer to a. above.
f. Peripheral Finding.	f. Figure 5.0-1 of the design criteria SQN-DC-V-13.11 (App. A, 5.r) correctly illustrates the criteria application of Section 5.0; however, the details in Figure 4.7-1 for the emergency lighting do not agree with the text of Section 5.0.	f. Refer to a. above.
g. Peripheral Finding.	g. The principal detail for emergency lighting fixtures on 47A057-21, R3 (App. A, 5.u) correctly illustrates the application of design criteria SQN-DC-V-13.11, Section 5.0 (App. A, 5.r). However, the alternate detail shown on 47A057-21 and the emergency light detail shown on 47A057-6, R5 do not agree with the text of Section 5.0.	g. Refer to a. above.
WBN	WBN	WBN
a. Lighting fixtures are not properly designed to prevent them from becoming: o Free missiles o Swinging missiles During a seismic event, these missiles might damage Category I equipment.	a. The TVA design of light fixtures provides for adequate vertical support to withstand a seismic event and prevents the fixtures from becoming free missiles that might damage Category I equipment. The TVA design of light fixtures, per se, does not, in general, provide adequate horizontal support during and after a seismic event to prevent them from becoming swinging missiles that might damage adjacent Category I equipment. This design oversight for WBN has not been documented as a generic review of the present program on SQN as a result of SCR SQN MEB 8610. Also, no technical instruction was found to effectively implement plant walkdown activities of this program.	a. TVA transmittals TCAB 227-WBN through 229-WBN submit corrective action plans (CAPs) which will (a) eliminate the discrepancies between the various design drawings and design criteria, (b) provide a generic WBN review for SCR SQN MEB 8610, (c) provide a complete program to describe and control the seismic interaction evaluations for current and future design activities based on plant walkdown(s) generated information, and (d) provide a technical basis for the internal TVA memo from Handy to SQN files (04/22/86) and make it applicable to WBN. In addition, these CAPs will provide for an evaluation via required calculation. Further, these CAPS will result in a new drawing to provide

Issues	Findings	Corrective Actions
Element 226.0 - WBN (Continued)		
		emergency light details which will be forwarded to DNC for retroactive application via the ECN process; DNC will then review completed work to ensure installation in accordance with the drawing or obtain DNE approved variance on a case-by-case basis. The evaluation team concludes that the stated CAPs are an acceptable resolution of the concern that should also preclude recurrence of findings. (CATD 226 00 WBN 01) (CATD 226 00 WBN 02) (CATD 226 00 WBN 03)
b. Peripheral Finding.	b. The evaluation team noted that there is no document that describes the complete program for controlling the seismic interaction design activity. The TVA memo from Handy to SQN files (04/22/86) provides adequate threshold criteria for evaluations but does not document the technical basis for the inspection criteria (nor does any other document); the memo has not been made applicable to WBN. The division of responsibilities between disciplines is defined in CEB-DI 121.03, R1. In addition, the CEB seismic review process for future reviews is to follow revision 1 of CEB-DI-121.03 when it is issued. This review process includes an evaluation for adverse impact of rod hung items as indicated by IOM 326-(10/01/86). This evaluation is currently in the form of verbal instructions which TVA personnel have committed to properly document.	b. Refer to a. above.

Issues	Findings	Corrective Actions
Element 226.0 - WBN (Continued)		
c. Peripheral Finding.	c. Figure 5.0-1 of Design Criteria WB-DC-40-31.11 correctly illustrates the application of the criteria in Section 5.0; however, the details in Figure 4.7-1 and drawing 47A057-6 for the "original emergency lighting system" do not agree with the text of WB-DC-40-31.11 Section 5.0. Detail M of drawing 45W1418-4 shows a portion of the "second emergency lighting system" detail corresponding to Figure 5.0-1 of the design criteria with a reference to drawing 47A057 for remaining details. Drawing 47A057 contains no such details.	c. Refer to a. above.
BFN	BFN	BFN
a. Lighting fixtures are not properly designed to prevent them from becoming: o Free missiles o Swinging missiles During a seismic event, these missiles might damage Category I equipment.	a. The TVA design of light fixtures in general may not provide adequate vertical support to withstand a seismic event and to prevent the fixtures from becoming free missiles that might damage Class I equipment. Also, the TVA design of light fixtures does not provide adequate evaluation of horizontal support during and after a seismic event to prevent the fixtures from becoming swinging missiles that might damage adjacent Class I equipment. Both of these design issues have been documented on SCR BFN MEB 8605 and are being addressed. NRC has initiated several unresolved safety issues (USIs) that affect the seismic design basis at Browns Ferry. USI A-17 considers "systems interactions," which include seismic interaction between Class I and Class II components. Part of the NRC NRR plan to resolve A-17 is to assign the responsibility for identifying seismically induced adverse system interactions to the USI A-46 program, "Seismic Qualification of Equipment in Operating Plants." A-46 concerns margins of safety provided by equipment in operating power plants to resist seismically induced loads. The NRC resolution of A-46 is contained in NUREG-1030 and NUREG-1211. TVA's Browns Ferry Nuclear Plant is identified in NUREG-1211 as one of the operating plants to be reviewed to A-46 requirements.	a. Develop a seismic interaction program to evaluate seismic-induced effects of Class II items including lighting fixtures on Class I components. Perform a walkdown to identify II/I seismic interaction between as-built Class I and Class II components. Develop an evaluation methodology and provide fixes as required. Class II/I evaluation for seismic interaction between as-built Class I and Class II components will be performed under the Unresolved Safety Issue (USI) A-46 program as a post-restart activity. A procedure for controlling future II/I seismic interaction will be developed prior to completion of the baseline A-46 effort. This procedure will meet the more general requirements of design interface document CEB-DI-121.03. (CATD 226 00 BFN 01)

Issues	Findings	Corrective Actions
Element 226.0 - BFN (Continued)		
b. Peripheral Finding.	b. The evaluation team noted that there is no document that describes the complete program for controlling the seismic interaction design activity. TVA DNE is developing a program to address seismic interaction between Class I and II components. The program consists of two phases: Phase I is the program development, which has been started, and Phase II is the implementation of the program. This program will also include development of a long-term program to preclude future II/I problems.	b. Refer to a. above.
c. Peripheral Finding.	c. BFN has no original design criteria for lighting fixture support. No original design criteria were implemented for design other than the National Electrical Code for the year in which the design was issued. Civil Design Guide DG-C1.6.3 for seismic support of lighting fixtures was issued 07/78. BFN has not implemented this design guide as it was not a design commitment.	c. Watts Bar Design Criteria for lighting fixture supports WB-DC-40-31.11 will be used for the current design of BFN lighting fixture supports. A criteria will be developed for the future lighting fixture supports based on the A-46 resolution methodology or TVA design guide DG-C-1.6.3 or Watts Bar Design Criteria WB-DC-40-31.11 (including the future versions). (CATD 226 00 BFN 02)
d. Peripheral Finding.	d. BFN has no typical drawings or specific drawings showing support details for lighting fixtures other than drawings 48W1284-1, -2, and -3 of the main control room lighting supports. These drawings were initially issued for modifications to the control room lighting structure in late 1982 for unit 2 and in 1983 for units 1 and 3.	d. Existing lighting fixture support installations will be assessed for structural adequacy and documented under the seismic interaction program which is part of USI A-46 program and fixes will be provided as required. Provide drawings with support details or approved field change requests for new installations or rework of lighting fixture supports. Perform supporting calculations to document structural adequacy for these new or rework supports. (CATD 226 00 BFN 02)

Issues	Findings	Corrective Actions
Element 226.0 - BFN (Continued)		
e. Peripheral Finding.	e. No calculations were performed on lighting fixture supports other than those on the main control room lighting fixtures which were generated in 12/82.	e. Refer to d. above.
f. Peripheral Finding.	f. TVA EN DES calculation on "Miscellaneous Steel Main Control Room Lighting" documents the fact that TVA CEB reviewed and approved the main control room ceiling and lighting fixture supports shown on drawings 48W1284-1, -2, and -3. CEB review and approval for seismic adequacy of these drawings is indicated by TVA memoranda from Coleman and Hyie to CEB files. However, no analytical data are provided in the calculation or memoranda to demonstrate the adequacy of the control room lighting structure and lighting fixture support to withstand a seismic event. Also, drawings 48W1284-1, -2, and -3 do not show any end bracing members provided in the east-west direction of the control room lighting structure.	f. Adequacy of the main control room lighting structure and fixture supports to withstand a seismic event will be assessed under the A-46 seismic interaction program. This assessment will take into consideration that there were no end bracing members provided in the east-west direction of the control room lighting structures. (CATD 226 00 BFN 02)

Issues	Findings	Corrective Actions
Element 226.0 - BLN	BLN	BLN
a. Lighting fixtures are not properly designed to prevent them from becoming: o Free missiles o Swinging missiles During a seismic event, these missiles might damage Category I equipment.	a. The TVA design of light fixtures provides for adequate vertical support to withstand a seismic event and prevent the fixtures from becoming free-falling missiles that might damage seismic Category I components. However, the TVA design of pendant-mounted light fixtures does not, in general, provide adequate horizontal support during a seismic event to prevent them from becoming swinging missiles that might damage adjacent seismic Category I components. This design oversight for BLN was not addressed during any potential generic condition evaluations such as for SCR SQN MEB 8610.	a. Generate a CAQR to adequately document the BLN generic review of the present program on SQN as a result of SCR SQN MEB 8610. (CATD 226 00 BLN 01)
b. Safety cable is not adequate to seismically support lighting fixtures shown on drawings 4BA0893-X2-43R1 and 44R1.	b. Safety cables for emergency exit lights, where they have been installed, appear to be adequate to prevent the items from becoming free falling missiles. However, the requirement to have a safety cable on all emergency exit lights in seismic Category I structures has not been satisfied at this time. The evaluation team was not able to determine whether the installations observed without safety cables were work in progress or had already been accepted by Quality Control. It should be noted that most installations observed without safety cables were located in areas where the potential for unacceptable interaction with seismic Category I components was not likely. The assignment of responsibility to the field for locating safety cables is adequate.	b. Complete installation and inspection of lighting fixtures in accordance with project procedures and construction drawings. Approve any variations prior to final quality control acceptance. (CATD 226 00 BLN 01)
c. Peripheral Finding.	c. In addition, the evaluation team noted that there was no document provided by TVA that describes a complete and overall program for controlling seismic interaction design activities.	c. Prepare a complete procedure for performing a seismic interaction walkdown and evaluating its results to supplement the generic requirements of CEB DI 121.03. Revise the BLN Engineering Project Manual to require establishment of spacing criteria for seismic interaction and verification of existing spacing adequacy. Implement such walkdowns and evaluations before fuel load of each unit. (CATD 226 00 BLN 01)

Issues	Findings	Corrective Actions
Element 226.0 - BLN (Continued)		
d. Peripheral Finding.	d. In addition, the requirements for conditions under which the three-way lateral cable support may be deleted are not consistent between design guide G1.6.3, Figure 18, and design criteria N4-50-D719, Figure 5.0-2, and reconciliation is not available. Drawing 4BA0893-X2 series does not have detail showing slack in the electrical cables at the emergency lighting fixture as required by design criteria N4-50-D719, Figure 5.0-3. Drawing 4BA0893-X2, although technically adequate, does not agree with design criteria N4-50-D719. The details in Figure 4.7-1 of design criteria N4-50-D719 and drawing 4BA0893-X2-7 do not agree with the text of Section 5.0 and Figure 5.0-1 of design criteria N4-50-D719.	d. Revise design criteria, drawings, and calculations to remove inconsistencies. Evaluate any potential hardware impact resulting from these revisions and provide any necessary modifications. (CATD 226 00 BLN 01) |

ATTACHMENT C

REFERENCES

1. Sequoyah Element Report 226.0, "Seismic Interaction Design", Rev. 2 (12/18/86)

2. TVA Nuclear Performance Plans:

Revised Corporate Nuclear Performance Plan, Volume 1 (03/86)
Revised Sequoyah Nuclear Performance Plan, Volume 2 (03/87)
Browns Ferry Nuclear Performance Plan, Volume 3 (06/87)
Watts Bar Nuclear Performance Plan, Volume 4 (03/87)

3. Sequoyah Documents

a. Gilbert/Commonwealth's "Final Report Technical Review of SNP Modifications for TVA," G/C Report No. 2614, Technical Issue Data Sheet No. 11 (03/03/86)

b. Letter from J. M. Taylor, NRC, Director of Office of Inspection and Enforcement to S. A. White, TVA, Manager of Nuclear Power. Subject: "NRC Reports 50-327/86-27 and 50-328/86-27," [L44 860506 542], (04/22/86)

c. Letter from B. J. Youngblood, NRC, Director PWR Project Directorate #4, NRR to S. A. White, TVA, Manager of Nuclear Power, Subject: "Concerns Regarding TVA Nuclear Program," [L44 860226 001], (02/18/86)

d. Letter from B. J. Youngblood, NRC, Director PWR Project Directorate #4, NRR to S. A. White, TVA, Manager of Nuclear Power, Subject: "Transcript of Interview ...," [none], (06/23/86)

e. TVA SQN memo from J. P. Vineyard, Project Manager to H. B. Rankin, Manager Design Services. Subject: "Routing of Safety Related Conduits, Cable Trays, Piping and Instrument Lines in Nonseismic Designated Areas in Category I Structures," [B25 851205 004], (12/05/85)

f. TVA SQN memo from H. B. Rankin, Manger Design Services to J. P. Vineyard, Project Manager. Subject: "SCR SQN NEB 8516 Rev. 0," [S01 860102 805], (01/03/86)

g. TVA SQN Memo from J. P. Vineyard, Project Manager to H. B. Rankin, Manager Design Services. Subject: "SCR SQN NEB 8516 R0," [B25 860107 011], (01/07/86)

h. TVA SQN memo from J. C. Key, Mechanical Lead Engineer to C. N. Johnson, Civil Lead Engineer. Subject: "SCR 8610 Walkdown Civil Involvement," [B25 860408 002], (04/08/86)

i. TVA SQN memo from W. E. Andrews to D. W. Wilson. Subject: "Walkdowns conducted by DNE," [S08 860502 814], (05/14/86)

j. TVA SQN memo from W. E. Andrews, Site Quality Manager to H. L. Abercrombie, Site Director. Subject: "Conduct of Plant Walkdowns and Surveys," [S08 860418 811], (04/18/86)

k. TVA SQN memo from K. D. Handy, Mechanical Engineer to SQN Files. Subject: "SCR SQN NEB 8515 - Rod Hung Category I(L) System Interaction Limits with Safety Related Targets - Quality Design Information," [B25 860422 008], (04/22/86)

l. TVA SQN memo from C. N. Johnson, Civil Lead Engineer to J. C. Key, Mechanical Lead Engineer. Subject: "SNP-SCR 8610 - Walkdown Civil Involvement," [B25 860516 021], (05/16/86)

m. TVA SQN memo from D. W. Wilson, Project Engineer to H. L. Abercrombie, Site Director. Subject: "SNP - Seismic Dead Load Supports Used for Class 1E Electrical Conduit Installation," [B25 860603 013], (06/03/86)

n. TVA SQN memo from W. E. Estes, Mechanical Engineer to W. H. Brown, Mechanical Engineer. Subject: "Report of Results of March 8-9, 1986 Walkdown of the Auxiliary Building for Interactions," [B25 860606 003], (06/05/86)

   - TVA SQN computerized "Walkdown Report for Seismic Safety Interfaces SQEP Mechanical Section No. 1" for the Auxiliary Building attached to [B25 860606 003], (04/17/86)

o. TVA SQN memo from W. E. Estes, Mechanical Engineer to W. H. Brown, Mechanical Engineer. Subject: "Report of Results of April 26-27, 1986 Walkdown of the U1 and U2 Annulus, Control and Diesel Generator Buildings, and the ERCW Intake Pumping Station," [B25 860610 001], (06/11/86)

   - TVA SQN computerized "Walkdown Report for Identifying Interactions in the Control and Diesel Generating Buildings, ERCW Pump Station and U1 and U2 Annulus," attached to [B25 860610 001], (04/26-27/86)

p. TVA SQN DIM from C. N. Johnson, Civil Lead Engineer to SQN CEB files. Subject: "Sequoyah Nuclear Plant - Design Input Memorandum for Location and Design of Piping and Supplemental Steel in Category I Structures - Design Criteria, SQN-DC-V-24.1," preliminary (10/03/86)

q. TVA Memo from J. C. Key, SQN Mechanical Lead Engineer to N. A. Liakonis. Subject: "Auxiliary Building Piping Interaction Walkdown," [B25 861014 015], (10/14/86)

r. TVA Design Criteria/Guides:

- o TVA Design Criteria SQN-DC-V-13.11, R1, "Support of Lighting Fixtures in Category I Structures," (03/23/73)
- o TVA General Design Information, DG-C1.6.3, "Seismic Support of Lighting Fixtures in Category I Structures," (06/05/81)

s. TVA Procedures:

- o TVA SQN Technical Instruction TI-98 R0, "Walkdown Procedure for Identifying Interactions in the Control and Diesel Generating Buildings, ERCW Pump Station and U1 and U2 Annulus," (04/25/86)
- o TVA SQN USQD for TI-98 R0, (04/25/86)

t. TVA Specification:

- o TVA General Construction Specification No. G-32, Rev. 11, "Bolt Anchors Set in Hardened Concrete," [B42 851216 500] (01/31/86)

u. TVA Drawings:

- o 47A057, R10, "Mechanical Seismic Supports - Lighting Fixtures"
- o 45N1410-1, R18, "Lighting - Plans and Details - Elev. 653.0"
- o 55N416-1, R18, "Lighting - Floor ELev. 732.0 - Plans and Details"
- o 55N416-2, R19, "Lighting - Floor Elev. 732.0 - Plans and Details"

v. TVA Conditions Adverse to Quality (CAQ):

- NCR SQN MEB 8304, R2, [B44 860404 007] (04/04/86)
- SCR SQN CEB 8514, R0, [B41 851231 021] and [B41 860228 017], (12/24/85) and (02/28/86)
- SCR SQN MEB 8610, R1, [B44 860611 047] (06/11/86)

w. TVA Calculation:

- CEB CAS 214, R1 "Evaluation of Walkdown Report for Seismic Safety Interferences," [B41 860516 004] (05/16/86)

x. TVA SQN ECN L6693, [B25 860617 527] (05/19/86)

y. TVA SQN work request nos. 107622, 107623 and 107627 dated 05/20/86, 03/09/86, and 03/09/86 respectively [Interactions TPW/734/003; HVG/734/003; HVG/734/004]

z. INPO WBN 1985 Audit Finding DC.3-2

aa. TVA ECEP-SQN Restart Program - Corrective Action Plan (CAP) for Element 226.0(B), TCAB-029 (12/12/86)

ab. SNP FSAR Update through Amendment 03
3.1 "Conformance with NRC General Design Criteria"
3.2 "Classification of Structures, Systems and Components"
3.0 "Electric Power"

ac. NRC Regulatory Guide 1.29 R1, "Seismic Design Classification," (8/73)

ad. TVA Design Criteria SQN-DC-V-13.11, R1, "Support of Lighting Fixtures in Category I Structures," (03/23/73)

ae. TVA General Design Information, DG-C1.6.3, "Seismic Support of Lighting Fixtures in Category I Structures," (06/05/81)

af. TVA Policy Memorandum PM86-04(DNE) from W. C. Drotleff, Director of Nuclear Engineering to Those Listed. Subject: "Engineering Judgment," [B20 860424 001], (04/25/86)

ag. TVA Design Interface Document CEB-DI 121.03, R1, "Seismic Design, Review, and Control," (05/16/86)

ah. IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations, IEE Std 308-1971

4. Watts Bar Document

a. Gilbert/Commonwealth, "Final Report Technical Review of SNP Modifications for TVA," G/C Report No. 2614, Technical Issue Data Sheet No. 11, (03/03/86)

b. Letter from J. M. Taylor, NRC, Director of Office of Inspection and Enforcement to S. A. White, TVA, Manager of Nuclear Power. Subject: "NRC Reports 50-327/86-27 and 50-328/86-27," [L44 860506 542], (04/22/86)

c. Letter from B. J. Youngblood, NRC, Director PWR Project Directorate #4, NRR to S. A. White, TVA, Manager of Nuclear Power, Subject: "Concerns Regarding TVA Nuclear Program," [L44 860226 001], (02/18/86)

d. Letter from B. J. Youngblood, NRC, Director PWR Project Directorate #4, NRR to S. A. White, TVA, Manager of Nuclear Power, Subject: "Transcript of Interview . . . ," [B45 860714 832], (06/23/86)

e. TVA SQN memo from K. D. Handy, Mechanical Engineer to SQN Files. Subject: "SCR SQN NEB 8515 - Rod Hung Category I(L) System Interaction Limits with Safety Related Targets - Quality Design Information," [B25 860422 008], (04/22/86)

f. TVA Design Criteria/Guides:

- o TVA Design Criteria WB-DC-40-30.11, R0, "Support of Lighting Fixtures in Category I Structures," (07/03/75)
- o TVA General Design Information, DG-C1.6.3, "Seismic Support of Lighting Fixtures in Category I Structures," (06/05/81)
- o Electrical Design Standard DS-E 17.1.1, R2, "Lighting and Heating - Lighting Design Standards and Practices," (06/15/83)

g. TVA Specification:

- o TVA General Construction Specification No. G-32, Rev. 11, "Bolt Anchors Set in Hardened Concrete," [B42 851216 500], (01/31/86)

h. TVA Drawings:

- o 47A057, (Revisions as of 01/24/87), "Mechanical Seismic Supports - Lighting Fixtures"
- o 45W1410-1, R21, "Lighting - Plans and Details - Elev. 676.0"
- o 45W1418-4, R10, "Lighting - Plans and Details"
- o 55W416-1, R15, "Lighting - Floor Elev. 755.0 - Plans and Details"
- o 55W416-2, R15, "Lighting - Floor Elev. 755.0 - Plans and Details"

i. TVA Conditions Adverse to Quality (CAQ):

- o NCR WBN MEB 8305, R2, [MEB 840111 018] (01/11/84)
- o SCR WBN CEB 8537, R0, [B41 861010 003] (10/10/86)
- o SCR SQN MEB 8610, R1, [B44 860611 047] (06/11/86)

j. INPO WBN 1985 Audit Finding DC.3-2

k. TVA memo from E. Chitwood to C. A. Chandley, Chief Mechanical Engineer, "Potential Generic Condition Evaluation (OEP-17)," [B43 860404 913], (04/04/86)

l. TVA memo from R. O. Barnett, Chief Civil Engineer, to C. A. Chandley, Chief Mechanical Engineer, "Potential Generic Condition Evaluation (OEP-17)," [B41 860311 006], (09/11/86)

m. WBN FSAR through Amendment 54

3.1 "Conformance with NRC General Design Criteria"
3.2 "Classification of Structures, Systems and Components"
8.0 "Electric Power"
9.5.3 "Lighting Systems"

n. NRC Regulatory Guide 1.29 R1, "Seismic Design Classification," (8/73)

o. TVA Design Criteria WB-DC-40-30.11, R0, "Support of Lighting Fixtures in Category I Structures," (07/03/75)

p. TVA General Design Information, DG-C1.6.3, "Seismic Support of Lighting Fixtures in Category I Structures," (06/05/81)

q. TVA Policy Memorandum PM86-04(DNE) from W. C. Drotleff, Director of Nuclear Engineering to Those Listed. Subject: "Engineering Judgment," [B20 860424 001], (04/25/86)

r. TVA Design Interface Document CEB-DI 121.03, R1, "Seismic Design, Review, and Control," (05/16/86)

s. IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations, IEEE Std 308-1971

5. Browns Ferry Documents

a. Gilbert/Commonwealth's "Final Report Technical Review of SNP Modifications for TVA," G/C Report No. 2614, Technical Issue Data Sheet No. 11 (03/03/86)

b. Letter from J. M. Taylor, NRC, Director of Office of Inspection and Enforcement to S. A. White, TVA, Manager of Nuclear Power. Subject: "NRC Reports 50-327/86-27 and 50-328/86-27," [L44 860506 542], (04/22/86)

c. Letter from B. J. Youngblood, NRC, Director PWR Project Directorate 4, NRR to S. A. White, TVA, Manager of Nuclear Power, Subject: "Concerns Regarding TVA Nuclear Program," [L44 860226 001], (02/18/86)

d. Letter from B. J. Youngblood, NRC, Director PWR Project Directorate 4, NRR to S. A. White, TVA, Manager of Nuclear Power, Subject: "Transcript of Interview ...," [B45 860714 832], (06/23/86)

e. TVA memo from J. P. Stapleton to H. P. Pomrehn. Subject: "Browns Ferry Nuclear Plant Unit 1, 2, 3 - Engineering report for CAQ Report No. SCR BFN MEB 8605, Rev. 0," [B22 86 0717 003], (07/17/86)

   o CAQ Engineering Report for SCR BFN MEB 8605, (07/14/86)

f. TVA memo from R. W. Cantrell to G. W. Painter. Subject: "Browns Ferry Nuclear Plant - Request for use of existing personal services contract," [no RIMS number], (01/26/87)

g. Letter from R. O. Barnett, TVA, to P. Yanez[v], EQE Inc., "Seismic Interaction (II/I Program)," [B41 861124 001], (11/24/86)

h. Letter from R. O. Barnett, TVA, to R. J. Pruski, Sargent and Lundy Engineers, "Seismic Interaction (II/I Program)," [B41 861124 002], (11/24/86)

i. Proposal 0197-33 from R. J. Pruski, Sargent and Lundy Engineers, to R. O. Barnett, TVA, "Seismic Interaction Between Class I and Class II Components," (12/16/86)

j. A Proposed Plan for Evaluation of Seismic Related Category II over Category I and Proximity Conditions at Browns Ferry Nuclear Plant Unit 2, (12/17/86)

k. TVA memo from J. M. Marshall to R. O. Barnett, "Applicability of Watts Bar SCR CEB 8537 to Browns Ferry," [B22 860107 004], (01/07/86)

l. TVA memo from H. E. Crisler to C. A. Chandley, "Applicability of Sequoyah SCR MEB 8610 to Browns Ferry," [B22 860307 008], (03/07/86)

m. TVA Drawings:

- o 48W1284-1, R1, "Miscellaneous Steel Main Control Room Lighting Supports"
- o 48W1284-2, R1, "Miscellaneous Steel Main Control Room Lighting Supports"
- o 48W1284-3, R0, "Miscellaneous Steel Main Control Room Lighting Supports"
- o 45N1408-3, R8, "Lighting Floor Elevation 617.0 Plan and Details - Sheet 3"
- o 45N2408-3, R6, "Lighting Floor Elevation 617.0 Plan and Details - Sheet 3"
- o 45N3408-3, R9, "Lighting Floor Elevation 617.0 Plan and Details - Sheet 3"

n. SCR BFN CEB 8602, R0, [B41 860109 014], [B41 860312 007] and [B41 861020 001]; (01/09/86), (03/12/86) and (10/20/86)

o. SCR BFN CEB 8603, R1, [B41 860428 006], (04/28/86)

p. SCR BFN CEB 8524, R0, [B41 851122 002], [B41 860203 006] and [B41 861020 015]; (11/21/85), (01/24/86) and (10/20/86)

q. SCR BFN NEB 8514, R0 [B45 851223 852] (12/23/85); R1, [no RIMS number], (01/14/87)

r. SCR BFN EEB 8543, R1, [B22 861117 034], (10/14/86)

s. SCR BFN MEB 8605 [B44 860703 007], (07/02/86)

t. TVA EN DES Calculation "Miscellaneous Steel Main Control Room Lighting," [BWP 830707 101], (07/07/83)

u. INPO WBN 1985 Audit Finding DC.3-2

v. Letter from R. Gridley, TVA, Manager of Licensing to D. R. Muller, NRC, BWR Project Directorate 2, "TVA's new plan for compliance to 10 CFR 50 Appendix R for BFN," [L44 860131 809], (01/31/86)

- o 10 CRF 50 [10 CFR 50] Appendix R Submittal Fire Protection and Safe Shutdown Systems Analyses Report for Browns Ferry Nuclear Plant TVA

w. Draft version of TVA-BFN "Seismic Design Basis Status Report," (03/86)

x. Service for Evaluating Regulatory Changes, MS-86-53, "ACRS Full Committee Meeting on the Resolution of Unresolved Safety Issue A-17, Systems Interactions in Nuclear Power Plants," (05/08/86)

y. TVA memo from F. H. Coleman to CEB Files, Subject: "Browns Ferry, Squadcheck TP-00103, Main Control Room Ceiling and Lighting Fixture Supports - ECN P0590," [CEB 821222 257], (12/22/82)

z. TVA memo from J. T. Huie to CEB Files, Subject: "Browns Ferry, Main Control Room Ceiling and Lighting Fixture Supports - ECN P0590," [CEB 830707 251], (07/07/83)

aa. BFN FSAR Update Through Amendment 4 dated 08/06/86

Section 1.6, "Plant Description"

Section 8.0, "Electrical Power Systems"

Section 10.19, "Lighting System"

Appendix A, "Conformance to AEC Proposed General Design Criteria"

Appendix C, "Structural Loading Criteria"

ab. NRC Regulatory Guide 1.29 R1, "Seismic Design Classification" (08/73)

ac. Atomic Energy Commission Safety Guide 29, "Seismic Design Classification," (06/07/72) (superseded by NRC Regulatory Guide 1.29)

ad. NRC NUREG-0606, "Unresolved Safety Issues Summary," USI-A17 and USI-A46 (08/16/85)

ae. NRC NUREG-1030, "Seismic Qualification of Equipment in Operating Nuclear Power Plants," Unresolved Safety Issue A-46, Draft Report for Comment (08/85) and Final Report (02/87)

af. TVA-BFN Design Criteria BFN-50-789 "Normal, Standby, and Emergency Lighting Systems for the Main Control Rooms," (01/09/84)

ag. TVA General Design Guide, DG-C1.6.3, "Seismic Support of Lighting Fixtures in Category I Structures," (06/05/81)

ah. TVA Design Interface Document CEB-DI 121.03, R1, "Seismic Design, Review and Control," (05/16/86)

ai. 10 CFR 50, Appendix R, "Fire Protection Program for Nuclear Facilities Operating Prior to January 1, 1979"

aj. NRC NUREG-1211, "Regulatory Analysis for Resolution of Unresolved Safety Issue A-46, Seismic Qualification of Equipment in Operating Plants," (02/87)

6. Bellefonte Documents

a. Gilbert/Commonwealth's "Final Report Technical Review of SNP Modifications for TVA," G/C Report No. 2614, Technical Issue Data Sheet No. 11 (03/03/86)

b. Letter from J. M. Taylor, NRC, Director of Office of Inspection and Enforcement to S. A. White, TVA, Manager of Nuclear Power. Subject: "NRC Reports 50-327/86-27 and 50-328/86-27," [L44 860506 542], (04/22/86)

c. Letter from B. J. Youngblood, NRC, Director PWR Project Directorate 4, NRR to S. A. White, TVA, Manager of Nuclear Power, Subject: "Concerns Regarding TVA Nuclear Program," [L44 860226 001], (02/18/86)

d. Letter from B. J. Youngblood, NRC, Director PWR Project Directorate 4, NRR to S. A. White, TVA, Manager of Nuclear Power, Subject: "Transcript of Interview ...," [B45 860714 832], (06/23/86)

e. INPO WBN 1985 Audit Finding DC.3-2

f. TVA Design Criteria/Guides:

- o TVA Detailed Design Criteria N4-50-D719, R1, "Seismic Support of Lighting Fixtures in Category I Structures," [ESB 840717 204], (07/09/84)
- o TVA General Design Criteria N4-50-D725, R1, "Assignment of Responsibility for Analysis, Support, and Fabrication of Piping Systems," [ESB 831115 217], (11/09/83)
- o TVA General Design Criteria N4-50-D711, R3, "Detailed Analysis and Seismic Qualification of Category I and I(L) Piping Systems," [B42 851112 524], (10/17/85)
- o TVA General Design Information, Civil Design Guide DG-C1.6.3, R1, "Seismic Support of Lighting Fixtures in Category I Structures," [ESS 810608 229], (06/05/81)

g. TVA Specifications:

- o TVA Construction Specification No. N4C-913, R4, "Support and Installation of Piping Systems in Category I Structures," [B05 86027 501], (06/18/86)
- o TVA General Construction Specification No. G-32, R11, "Bolt Anchors Set in Hardened Concrete," [B42 851216 500], (01/31/86)

h. TVA Drawings:

- o 4BA0893-X2 Series, (latest revisions as of 06/87), "Seismic Supports Lighting Fixtures"
- o 5AW0420-RW Series, (latest revisions as of 06/87), Auxiliary Building Lighting Floor Plans and Details
- o 5CW0420-RW Series, (latest revisions as of 06/87), Control Building Lighting Plans, Sections and Details

- o 5DW0416-RW Series, (latest revisions as of 06/87), Diesel Generator Building Lighting Plans and Details
- o 5RW0416-RW Series, (latest revisions as of 06/87), Reactor Building Lighting Plans and Details

i. TVA calculation 4B893-01, R9, "Seismic Lighting Fixture Support," [B21 860423 401], (01/29/87)

j. TVA Conditions Adverse to Quality (CAQ):

- o SCR SQN MEB 8610, R1, [B44 860611 047], (06/11/86)
- o SCR BFN MEB 8605, R0, [B44 860703 007], (07/02/86)
- o SCR BLN MEB 8509, R0, [B44 851219 009], (12/18/85)
- o NCR BLN EEB 8420, R0, [EEB 841231 912], (12/31/84)
- o PIR WBN CEB 8572, R0, [B41 851212 014], (12/12/85)
- o PIR BLN CEB 8519, R0, [B41 860303 002], (03/03/86)
- o SCR WBN CEB 8537, R0, [B41 861010 003], (10/10/86)
- o BLN NCR 2058, R0, [BLN 830503 709], (04/27/83)

k. TVA memo from H. N. Benninghoff to C. A. Chandley, "Potential Generic Condition Evaluation (OEP-17), [B21 860715 003], (07/15/86)

l. TVA memo from J. P. Wooten to R. O. Barnett, "Potential Generic Condition Evaluation (OEP-17)," [B21 851126 010], (11/26/85)

m. TVA memo from R. M. Hodges to R. O. Barnett, "BLN - Emergency Lighting Fixture Supports," [BLP 820517 008], (05/14/82)

n. TVA memo from R. O. Barnett to R. M. Hodges, "BLN - Emergency Lighting Fixture Supports," [CEB 820614 013], (06/14/82)

o. TVA Report CEB 80-33, "Bellefonte Nuclear Plant, Dynamic Earthquake Analysis of the Auxiliary-Control Building and Response Spectra for Attached Equipment," R4, [CEB 841015 017], (10/15/84)

p. BLN FSAR through Amendment 27

3.1 "Conformance with NRC General Design Criteria"

3.2 "Classification of Structures, Systems and Components"

8.0 "Electric Power"

9.5.3 "Lighting Systems"

q. NRC Regulatory Guide 1.29, R1, "Seismic Design Classification" (08/73)

r. TVA Design Interface Document CEB-DI 121.03, R1, "Seismic Design, Review, and Control," [B05 860516 500], (05/16/86)

s. TVA Design Interface Document CEB-DI 121.03, R2, "Seismic Design, Review, and Control," [B41 870702 002], (07/02/87)