TVA EMPLOYEE CONCERNS SPECIAL PROGRAM

REPORT NUMBER: 25000

REPORT TYPE: SUBCATEGORY REPORT FOR ENGINEERING

REVISION NUMBER: 2

TITLE: CIVIL/STRUCTURAL DESIGN (21500) AND PIPE WHIP RESTRAINT DESIGN (22700)

REASON FOR REVISION:

1. Revised to incorporate initial SRP and TAS comments and to add BFN and BLN Corrective Action Plans.

2. Revised to incorporate additional SRP and TAS comments and to add Attachment C (References).

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CONCURRENCE (FINAL REPORT ONLY)

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

EXECUTIVE SUMMARY

This subcategory report addresses 13 employee concerns about perceived deficiencies in civil/structural design and pipe whip restraint design. This report encompasses such diverse subjects as seismic criteria, cut rebar, roofing design, hanger loads, crane service, sleeve covers, and whip restraints. The 13 concerns were grouped in ten separate elements to deal with the concerns that constitute the element.

The evaluation team determined that the most significant subjects of the concerns were cut rebar and hanger supports, which were expressed in four concerns and determined to be generic to the four TVA nuclear plants. The remaining nine concerns dealt with isolated rather than generic issues, and were judged to be of relatively minor nature; eight of them were not substantiated. The evaluation substantiated that the individual and cumulative effects of cut rebar on the capacity of concrete elements and the increase in load because of continuous addition of hanger supports were not adequately documented in calculations and on drawings at all four plants, except for cut rebar control at Watts Bar, which was found to be adequate.

The evaluation team reviewed the corrective action plans for all four plants and found them acceptable to resolve the findings. Corrective action plans have been initiated to establish procedural and design controls to demonstrate compliance with the design limits. Conclusive significance of the findings encountered for the subjects of cut rebar and hanger supports depends on the outcome of the evaluations prescribed in the corrective action plans. However, on the basis of experience with other nuclear power plants, it is anticipated that the need for hardware modifications because of insufficient capacity of concrete walls and slabs is remote. Thus, it is expected to be strictly a documentation activity, although a major one. The present status of this activity is as follows. Sequoyah has recently completed this substantial task of corrective actions required for restart. Watts Bar plans to accomplish this mainly by comparison with Sequoyah. Browns Ferry and Bellefonte have a substantial task ahead because of the large number of cut rebar releases and hanger attachments that are based on undocumented engineering judgments.

The TVA design process addressed within the limited area of this subcategory was determined to be generally sound. But a definite need for improvement was identified, since the causes for the negative findings for these two subjects were judged to be a combination of partially effective communication and lack of supervisory attention to technical matters, especially on the part of the first and second lines of engineering supervision. The other contributing causes were identified as procedures deficient in establishing requirements, engineering judgment not documented, standards not followed, and incomplete as-built reconciliation.

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.

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 - effective and thorough design process - and has issued the necessary corrective action tracking documents.

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

CONTENTS

TABLES

1. INTRODUCTION

This subcategory report summarizes and integrates the results of the ECSP element evaluations dealing with civil/structural design and pipe whip restraint design. These element evaluations addressed a variety of topics, which covered seismic criteria, seismic analysis of radiation shielding, cut rebar control, hanger loads on structures, roofing design, crane service, sleeve covers, and whip restraints. Structural steel connection design (element 215.9), as evaluated for SQN and WBN, is assigned to Subcategory Report 25500. One concern (IN-85-529-002) could not be evaluated because of insufficient information.*

Fourteen employee concerns provide the basis for the element evaluations and are listed by element number in Attachment A. The plant location where each concern was originally identified and the applicability of the concern to other TVA nuclear plants are also shown. The evaluations are summarized in the balance of this report as follows:

- o Section 2 -- summarizes, by element, the issues stated or implied in the employee concerns
- o Section 3 -- outlines the process followed for the element and subcategory evaluations, cites documents reviewed, and addresses determination of generic applicability
- o Section 4 -- summarizes, by element, the findings and identifies the negative findings that must be resolved
- o 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
- o Section 6 -- identifies causes of the negative findings
- o Section 7 -- assesses the significance of the negative findings
- o Attachment A -- lists, by element, each employee concern evaluated in the subcategory. The concern 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, the concern is quoted as received by TVA and characterized as safety related, not safety related, or safety significant.

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* Element 215.8, Tank Foundation - On hold by TVA. This issue cannot be evaluated because of insufficient information in the NRC-expurgated interview files.

- 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 ~~an~~ 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 negative findings raised by the 13 concerns have been identified as 42 separate issues. These issues are evaluated as 17 elements.

A summary of the issues evaluated under this subcategory, grouped by element, is listed below:

- 215.1, Seismic Criteria - An earthquake fault extending from Chattanooga to Knoxville runs under SQN and WBN, and plant structures could fail in an earthquake.

- 215.2, Cut Rebar Control - Lack of procedural control and assessment of cut rebar raise questions about the structural integrity of concrete walls and slabs.

- 215.3, Radiation Shielding Seismic Analysis - The present case-by-case approach for seismic analysis of radiation shielding takes more time and money.

- 215.4, Turbine and Service Building Roofing - The Turbine and Service Building roofing design is improper and roofing is leaking.

- 215.6, Hanger Loads on Structures - Structural integrity of concrete walls and slabs is questionable because of the excessive number of hangers and lack of assessment calculations.

- o 215.7, Auxiliary Building Crane Service - DNE does not appreciate the role of field engineering to make the designs work. The Auxiliary Building 125-ton crane can set load on only two out of five floors, and hatch grating is rated only for 100 psf.

- o 215.10, Feedwater Heater Monorail Design - The structural integrity of hangers for the feedwater heater monorails is questionable.

- o 215.11, Floor Sleeve Covers - Metal covers need to be installed over floor sleeve foam seals.

- o 227.1, Pipe Whip Restraint Design - Pipe whip restraints in the unit 1 Reactor Building have problems as shown on drawing 41W1700 series.

- o 227.2, Pipe Whip Restraint Design - Whip restraints are needed on the decay heat removal pipe coming from the borated water storage tank.

The element summaries above deal with perceived deficiencies in the design of the civil/structural components. More specifically, four of the elements are concerned with the quality of the design (215.2, 215.3, 215.6, and 215.11), one deals with the adequacy of design criteria provided (215.1), and five suggest errors or oversights in the design (215.4, 215.7, 215.10, 227.1, and 227.2).

As the following sections show, four of the above 10 elements were found to have valid issues and require corrective action (215.2, 215.6, 215.11, and 227.2). Three of these involve design quality, and the remaining one involves documentation error. Thus, this subcategory contains some valid issues and these are quite diverse in nature.

3. EVALUATION PROCESS

This subcategory report is based on the information evaluated 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

As part of the evaluation process, the employee concerns, which originated for specific TVA nuclear plant sites, were evaluated for their generic applicability to other TVA nuclear plant sites. Applicability was determined with consideration of the concerns' plant-uniqueness and their effect on safety-related structures, systems, and components. The employee concerns were categorized by their impact on safety per ECTG determination criteria as identified in Attachment A. The generic applicability review is summarized for each element as follows.

- 215.1, Seismic Criteria - Both concerns under this element are safety-related and allude to an earthquake fault that runs under the Sequoyah and Watts Bar plant sites. Thus, these two concerns are site-specific and do not apply to other two plants.

- 215.2, Cut Rebar Control - Both concerns under this element originated at WBN and are safety-related. The evaluation team determined that they also applied to the other three plants.

- 215.3, Radiation Shielding Seismic Analysis - The concern under this element is not safety-related. It addresses cost-effective methods of performing seismic analysis of radiation shielding installation. The element evaluation for Watts Bar revealed - as discussed in detail in Section 4 - that TVA, to the degree practicable, was implementing appropriate analytical methods. In view of the foregoing, it was determined that this element is not generically applicable to the other TVA plants.

- 215.4, Turbine and Service Building Roofing - The concern under this element is not safety-related. It addresses leaking roof of Turbine and Service Buildings at Watts Bar. The evaluation established that TVA already had taken corrective measures to alleviate this obvious problem. Therefore, the evaluation team determined that the concern was plant-specific and not applicable to the other plants.

- 215.6, Hanger Loads on Structures - Both concerns under this element originated at WBN and are safety-related. The evaluation team determined that they also applied to the other three plants.

- 215.7, Auxiliary Building Crane Service - The concern under this element is not safety-related. It addresses design engineering/field engineering interface, crane access, and hatch grating capacity. The interface concern focused on the lack of appreciation of field engineering work by design engineers rather than a potential breakdown in communication or coordination. In addition, crane access as designed was deemed adequate at Watts Bar. The hatch grating identified was a temporary construction-period grating. On the basis of the foregoing, the evaluation team determined that the concern was site-specific and did not apply to the other TVA plants.

- o 215.10, Feedwater Heater Monorail Design - The concern under this element identifies monorails which were installed in the Sequoyah Turbine Building to facilitate replacement of its feedwater heaters for operational reasons. The concern is not safety-related and is plant-specific. Therefore, the evaluation team determined it not to be applicable to the other TVA plants.

- o 215.11, Floor Sleeve Covers - The concern under this element is not safety-related. It addresses foam in abandoned large sleeves at Watts Bar. The element evaluation revealed - as discussed in detail in Section 4 - that the concern was valid. Generic applicability was determined before the complete element evaluation was done for Watts Bar. At that time a determination was made that the element was site-specific and did not apply to the other plants. However, in light of the element findings at Watts Bar, it is plausible that similar abandoned sleeves may exist at the other TVA plants. This report does not address plants other than WBN for this element because the evaluation team has not evaluated the other plants. In addition, CATDs have not been issued for other plants to investigate generic applicability because the concern is not safety-related.

- o 227.1, Pipe Whip Restraint Design - The concern under this element is safety-related. It addresses specific welding notes for pipe whip restraints at Watts Bar. Meanwhile, TVA had performed the required inspection and prepared documentation to correct the problem. As a result, no additional corrective action was specified by the evaluation team. Thus, this concern was determined to be an isolated, plant-specific case.

- o 227.2, Pipe Whip Restraint Design - The concern under this element is safety-related. It addresses a need for a specific whip restraint at Bellefonte. Because the concern is specific for a pipe coming from the borated water storage tank, the evaluation team determined that it was plant-specific. Furthermore, the concern was subsequently found to be invalid, and a peripheral finding of a minor drafting error was identified. Therefore, it was determined that the concern did not apply to the other TVA plants.

3.2 General Evaluation Process

This subsection describes the general evaluation process that was used to evaluate the civil/structural elements identified under this subcategory. Additional specific evaluation processes are described in the following subsection by element as applicable.

a. Defined issues for each element from the employee concerns.

b. Determined generic applicability of elements on the basis of their plant-uniqueness and their effects on safety-related structures, systems, and components.

c. Reviewed applicable FSAR, Safety Evaluation Report (SER), and SER supplements to understand TVA's commitments related to the specific design issues.

d. Reviewed applicable industry codes and standards and current regulatory requirements and practices to understand related engineering design requirements.

e. Reviewed relevant TVA design criteria, specifications, procedures, drawings, and calculations to develop an understanding of the design basis.

f. Performed plant walkdowns, as appropriate, to develop a first-hand understanding of the issues.

g. Reviewed issue-related correspondence, test reports, and nonconforming condition reports (NCRs) to evaluate actions taken by TVA.

h. On the basis of this composite review, evaluated the issues for each element and described findings (see Section 4).

i. Reviewed and concurred with corrective action plans prepared by TVA for the issues requiring specific corrective actions.

j. Tabulated the issues, findings, and corrective actions arranged first by elements and then by plants (in Attachment B).

3.3 Specific Evaluation Process

In addition to the general evaluation, as described above, performed by the evaluation team for each element, specific documents also were reviewed for each plant based on their applicability to the issues. These documents and other unique information are identified below.

- 215.1, Seismic Criteria

  a. Reviewed Section 2.5 of both the FSAR and SER of Sequoyah and Watts Bar.

  b. Reviewed TVA NSRS Report I-86-110-SQN for Sequoyah.

- 215.2, Cut Rebar Control

  a. Sought programs to control jobsite rebar cutting, record cuts, and forward records to engineering for evaluation at all plants.

  b. Reviewed for all plants engineering process of recording and evaluating the effect of such cut rebars, both single cuts and cumulative effects, by selecting a sample of drawings and calculations.

- 215.3, Radiation Shielding Seismic Analysis

  Reviewed on-going TVA methodology used in the design of radiation shielding with cost-effectiveness considerations at Watts Bar.

- 215.4, Turbine and Service Building Roofing

  Reviewed roofing design and performance, and TVA actions taken to correct problems at Watts Bar.

- 215.6, Hanger Loads on Structures

  a. Sought procedures for systematic structural review of hangers attached to concrete walls and slabs.

  b. Reviewed live load evaluation for all plants based on as-built hanger installation.

  c. Determined whether structural review considered feedback from cut rebar considerations.

- 215.7, Auxiliary Building Crane Service

  a. Reviewed organizational responsibilities of design and construction engineering.

  b. Reviewed crane and hatch cover design bases.

- 215.10, Feedwater Heater Monorail Design

  a. Reviewed monorail drawings and calculations.

  b. Determined that monorails were load-tested and obtained related documentation.

215.11, Floor Sleeve Covers

a. Reviewed Dow Corning Corp.'s information about "silicone RTV foam."

b. Reviewed TVA CEB Report 82-2 covering silicone foam seal testing results.

227.1, Pipe Whip Restraint Design

a. Reviewed 48W1700 series drawings to determine nature of problem.

b. Reviewed NCRs 3001R and 2523R.

227.2, Pipe Whip Restraint Design

a. Reviewed BLN drawings for DHR piping coming from borated water storage tank.

b. Reviewed BLN calculations for pipe supports and nozzle design.

4. FINDINGS

The findings from each of the 17 element evaluations for this subcategory are contained in Attachment B, where they are listed 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 element follow.

4.1 Seismic Criteria - Element 215.1

4.1.1 Sequoyah and Watts Bar Plants

The Sequoyah and Watts Bar sites are located in the Valley and Ridge Physiographic Province of the Appalachian Highlands. This province is characterized by highly folded and faulted northeast-trending sedimentary rocks of Paleozoic era (250 to 580 million years old). Both sites are underlain by several thrust faults, one of which is the Kingston fault. It is a major, extensive fault which is exposed at ground surface approximately 1 mile northwest of both sites and underlies the sites at a depth of several thousand feet.

The evidence clearly shows that the Kingston fault and the other thrust faults of similar age and origin under the sites have for decades been considered to be inactive faults, and they are still considered to be inactive by geologists and seismologists. The evaluation team is not aware of any evidence, or even hypothesis, that the Kingston fault or the other thrust faults that developed near the end of the Paleozoic era are capable faults. On the contrary, the available evidence indicates they are not.

Historically, earthquakes in the Appalachians which have been accurately located as to their hypocentral depth, typically occur below a depth of 7 km (4.3 miles), which is several kilometers below the thrust faults and the decollement zone. Consequently these earthquakes do not furnish any evidence for the existence of "an earthquake fault that runs from around Chattanooga to north of Knoxville," and underlies both the Sequoyah and Watts Bar sites. As stated in the FSAR and the literature, thrust faults exist under the site but the evidence indicates that they are not capable faults, or "earthquake faults."

TVA addressed the geology, seismology, and geotechnical engineering conditions in FSAR Section 2.5, has thoroughly examined the subject (Ref. 6), and has concluded that the 0.18 g Safe Shutdown Earthquake (SSE) seismic response spectra are adequate as the basis for the seismic design of Sequoyah and Watts Bar to ensure a safe shutdown of the plants. In addition, TVA reviewed the existing design employing a 0.22 g site-specific seismic response spectra which uses the 84th percentile of 13 actual earthquake recordings. This review of both plants determined that all Category I structures are adequate for seismic loading associated with this site specific spectra.

4.1.2 Summarized Element Findings

The faults at SQN and WBN alluded to in the concerns are thrust faults which are not capable of producing significant earthquakes. As presented in its licensing documents, TVA assessed the seismic significance of these faults. The design of seismic Category I structures has been accepted and documented by NRC in supplements to Safety Evaluation Reports (SER) for SQN and WBN.

4.2 <u>Cut Rebar Control - Element 215.2</u>

4.2.1 Sequoyah Plant

The evaluation team's review of TVA procedure AI-17 found that it required engineering review for only electrical and mechanical disciplines; civil review was not required prior to concrete drilling and chipping. The review also found that AI-17 did not reference specification G-2 requirements (TVA specification G-2, Section 8.3 contains DNE requirements for cutting of rebar), did not require prior DNE approval for cutting rebar or caution against cutting without it, and did not reference a procedure or instruction addressing how such DNE approval is obtained (Ref. 7). NCRs 2975 and 2836 are examples of lack of Civil Engineering Branch (CEB) prior approval.

The NRC issued Deficiency Report D4.3-1 in 04/86 which indicated that there was no documented evidence of CEB evaluation in the structural calculations of cut rebar effect for ECNs L6495 and L5202 (Ref. 8). The evaluation team determined that the rebar cuts were reviewed and approved by engineering judgment by engineers familiar with the design. However, calculations were not made and drawings were not always updated.

4.2.2 Watts Bar Plant

TVA initiated a program for control of rebar cutting in the mid-1970s as required by Quality Control Procedure WBNP-QCP 1.7 (Ref. 9) wherein a written release is required prior to drilling or cutting permanent structures or components. Verbal or written approval is obtained from the Division of Nuclear Engineering (DNE) prior to work release as required by Specification G-3 . DNE engineers would generally record these approvals on their own set of structural prints to provide a base of cumulative assessments of rebar cutting on structural integrity. The cumultive effects from all these bar cuts were evaluated. Calculations for these bar cuts were made, and drawings were updated.

NRC conducted inspections which included the control process for rebar cuts and concluded that the design evaluation program as established is adequate to assure structural integrity (Ref. 10).

4.2.3 Browns Ferry Plant

In a letter to NRC (Ref. 11), TVA indicated that Deficiency D4.3-1 identified at SQN is also applicable to BFN. The stated corrective action in "Browns Ferry Applicability to D4.3-1" attached in the TVA's letter to NRC is that an evaluation will be performed to identify areas where unevaluated rebar cuts exist and determine if a loss of function or reduction in capability of the concrete resulted from cut rebar. The evaluation team found that the BFN cut rebar evaluation program had already been planned as a result of the NRC audit at SQN (Browns Ferry Applicability to Deficiency D4.3-1).

4.2.4 Bellefonte Plant

Discussions with cognizant TVA engineers and a review of drawings, procedures, and other documents disclosed that the following methods are being used by TVA to control cutting and damage of rebar. Drilling and chipping operations are controlled by notes on drawings and are enforced by BLN Quality Control

Procedure BNP-QCP-10.6, "Work Release," Section 6.2, which requires a written engineering release before drilling or chipping of permanent structures (Ref. 12). If drawings do not permit cutting rebar without engineering approval, then permission is obtained from TVA DNE, and a field change request (FCR) is issued to identify rebar to be cut.

NRC performed a special inspection of the BLN facilities in 04/82 (Ref. 13) and, among other subjects, reviewed design controls for evaluations of rebar cutting. The inspector examined the program for documentation and evaluation of cut rebar. His review disclosed that the locations of cut rebar are being shown on the drawings, but that the design evaluation may not be documented in accordance with the requirements of 10 CFR 50, Appendix B. Therefore, NRC identified these factors as Unresolved Items 438/82-10-01 and 439/82-10-01. TVA has not furnished evidence to the evaluation team that these items are closed.

The sample calculations reviewed by the evaluation team were found perfunctory and lacking in sufficient detail for complete assessment. Moreover, they do not address cumulative effects of multiple cuts. DNE has already identified the lack of documents for rebar cut evaluation and accpetability in BLN CAQR BLF 870073.

4.2.5 Summarized Element Findings

WBN has an effective program to control, document, and assess the effect of cut rebar, including cumulative effect, on concrete calculations. On the basis of its inspection, the NRC has concluded that the design evaluation program as established is adequate to ensure structural integrity. SQN and BFN do not have a documented procedure or program for processing, evaluating, and controlling cut rebar. BLN Division of Nuclear Construction (DNC) has an effective program to control and document rebar cuts in the field, but BLN Division of Nuclear Engineering (DNE) does not have an engineering procedure for processing, evaluating, and controlling the cumulative effects of cut rebar. Assessment calculations of Category I concrete elements for cut rebar are not complete at SQN, BFN, and BLN.

4.3 Radiation Shielding Seismic Analysis - Element 215.3

4.3.1 Watts Bar Plant

Major radiation shielding is provided in the plant layout and is based on conservative source term models. This layout generally consists of normal weight concrete walls and slabs. These permanent plant features are installed as a part of normal plant design completion which includes ALARA programs. These shielding provisions are verified, and modified as required, during the design, testing, startup, and plant operation phases of a nuclear plant's life.

As indicated in the concern, this is not a plant safety concern. This concern relates to cost-effectiveness of radiation shielding used during plant operation. It is not practicable to perform a generic seismic analysis as there are many locations with different physical geometry, radiation sources, and radiation levels that need to be evaluated. TVA is involved in improving the cost-effectiveness of its radiation shielding program. One approach being pursued by DNE and Plant Operations is the implementation of a computer program, Pb SHIELDING, and/or the implementation of a set of tables or nomographs defining acceptable loadings versus different pipe sizes or configurations (Ref. 14).

4.3.2 Summarized Element Finding

At WBN, generic seismic analysis of required radiation shielding during plant operation and maintenance is not practical. TVA is actively improving the cost-effectiveness of its existing case-by-case approach.

4.4 Turbine and Service Building Roofing - Element 215.4

4.4.1 Watts Bar Plant

The Turbine and Service Buildings are non-Category 1 structures. The original built-up roofing was installed in accordance with TVA Specification 2600 with minor substitutions. The TVA architectural roof plans and sections indicate walkway over both buildings.

There is an indication that the turbine building roofing had sustained some damage during the construction phase as evidenced by the TVA memo from Touchstone to Liakonis (Ref. 28) where the need for reroofing is stated as follows:

> "Apparently, due to poor workmanship and heavy construction traffic that occurred during construction, the membrane was punctured in many places thereby permitting water to enter the system, thus resulting in a short lifespan requiring the roof to be replaced."

Protective boards are provided in foot traffic areas as delineated in TVA drawings (Ref. 15). This design will mitigate leakage caused by foot traffic on walkways. Since construction in now complete and access to the roof is limited and controlled, further damage to the roofing is not anticipated.

4.4.2 Summarized Element Finding

At WBN, the leaking of the original roofing was not caused by improper design, but by poor workmanship and uncontrolled heavy foot traffic during construction. The roofing always had designed walkways in foot traffic areas.

4.5 Hanger Loads on Structures - Element 215.6

4.5.1 Sequoyah and Watts Bar Plants

SQN Design Criteria V-1.3.3.1 and WBN Design Criteria 20-1.1 state:

> "A review and reevaluation for loads estimated or assumed during the design and construction process shall be made. . . . The review/reevaluation shall be made after the total plant design and construction has progressed to a point where the actual loads can be determined with a reasonable degree of certainty. A live load to be used by the plant operating personnel shall be ascertained and documented on a drawing for use during the operating plant life." (Refs. 16 and 18)

There was an implicit recognition that some areas of the plant might have greater loads than originally assumed. However, reevaluation was not performed. NCR SQN CEB 8403 and NCR WBN WBP 8338 identified that, during a postulated seismic event, two 8-inch thick reinforced concrete partition walls were overstressed because of the attachment of conduits and fire protection piping supports. TVA's review of the NCR concluded that originally it had designed these walls for the weight of the walls only and had not considered any attachment loadings. As a result, the corrective action required additional steel braces to qualify the partition walls (Refs. 17 and 19).

TVA Engineering Procedure, EN DES-EP 4.04 entitled "Squadcheck Process," described how to submit drawings for the purpose of review and comment. The evaluation team determined that compliance with these procedures was not always achieved.

All elevated concrete floors in the Auxiliary Control Building and Reactor Building were originally designed using the working stress design method described in SQN and WBN FSARs. However, the current assessment is based on the ultimate strength design method permitted by SQN and WBN design criteria, and this method has resulted in higher floor load capacities. Furthermore, moments in slabs are redistributed using ACI 318-77 code instead of the 318-63 code stated in the FSAR.

4.5.2 Browns Ferry Plant

Generally, in early stages of structural design, principal loads for major equipment and structures are reasonably well defined; but other loads, including hanger loads, are conservatively estimated to allow for various components, e.g., process piping, electrical raceways, HVAC ducts, and small equipment. This approach is necessary since final locations and exact loads are unknown for these components until their detailed analyses are performed. The final loads are then compared with the estimated loads to assure adequate margins of safety. This iterative process is normally satisfactory unless significant design additions have been made. The additions can be particularly significant at plants such as BFN, since the concrete structures have been subjected to many additional new systems and components. TVA Engineering Procedure, EN DES-EP 4.04 entitled, "Squadcheck Process," described how to submit hanger drawings for the purpose of review and comments (Ref. 20). The evaluation team did not find evidence of compliance with these procedures at BFN.

The evaluation team reviewed BFN design drawings covering general notes for pipe supports. The drawings do not require coordination and transfer of hanger design information to concrete design engineers nor do BFN procedures require such coordination. Neither could the evaluation team identify any samples of informal coordination. Furthermore, BFN has design drawings specifying design floor live load in a note (Ref. 21). However, the evaluation team has not found any calculations to demonstrate that the stated allowable live load is still unimpaired after numerous component additions since the original design.

4.5.3 Bellefonte Plant

Section 3.10.5 of criterion N4-50-D702 states:

> "A review and reevaluation for loads estimated or assumed during the design and construction process shall be made. . . . The review/reevaluation shall be made prior to initial plant operation. Prior to commercial operation, a live load to be used by the plant operating personnel shall be ascertained and documented on a drawing for use during the operating plant life." (Ref. 22)

TVA stated that it has not performed the reevaluation based on walkdowns yet but is planning to do so before fuel load date. However, there is no documented evidence that TVA plans this to be a comprehensive review for the effects of accumulated loading based on the as-built conditions at BLN for Category I concrete structures.

The evaluation team reviewed BLN design drawings covering general notes for component supports. The drawings do not require coordination and transfer of hanger design information to concrete design engineers nor do BLN procedures require such coordination. Neither could the evaluation team identify any samples of informal coordination. Furthermore, BLN has design drawings specifying design floor live load. However, the calculations are not available to demonstrate that the stated allowable live load is still unimpaired after numerous component additions since the original design. The evaluation team observed that the civil engineering discipline neither has a formal procedure for nor a practice of evaluating cumulative effects of hanger loads.

4.5.4 Summarized Element Finding

TVA design calculations have not evaluated all individual and cumulative effects of as-built hangers on concrete walls and slabs of Category I structures to establish structural integrity for all four plants. At present, for SQN and WBN, there are differences between the FSARs and the final design bases for Category I concrete elements. TVA does not have formal programs to coordinate and evaluate the effects of cumulative loading from different commodities, or to consider feedback from cut rebar effects.

4.6 Auxiliary Building Crane Service - Element 215.7

4.6.1 Watts Bar Plant

A TVA memo from Cantrell and Bonine which received wide distribution throughout TVA's engineering and construction organizations, establishes policy to clearly define the role and responsibilities of the two organizations as follows:

> "It is the responsibility of the Office of Engineering (OE) to provide all requirements in the design output documents to ensure that the final product, when constructed in accordance with these requirements, will compy with and perform in accordance with the design criteria and specifications. . . . All of the requirements necessary for construction activities are not specified by the design output documents. In those areas where the necessary requirements to control the fabrication, installation, or testing are not defined, it is the responsibility of the Construction Engineering Organization (CEO) to provide the requirements." (Ref. 23)

The main hook of the 125-ton crane services floor elevations 729'-0" and 757'-0" with a hook reaching down to elevation 722'-0" for maneuvering the fuel cask in the cask loading area at elevation 709'-0". The auxiliary hook services floor elevations 676'-0", 692'-0", 713'-0", 737'-0", and 757'-0" with a hook reach down to elevation 677'-6". TVA drawings show the service areas of the auxiliary hook which is through hatch openings approximately 8'-0" by 10'-0". Materials are hoisted or lowered through this shaft to the desired elevation and then moved into position horizontally with come-alongs or similar devices.

The grating on the floor rated at 100 psf cited in the concern is the one located at elevation 692'-0". It is for temporary construction access. This grating is used during the construction stage for easy access to the lower floors. This grating will carry approximately 100 psf live load based on the 8-foot span. This grating will be replaced by the permanent plant grating with a design live load capacity of 200 psf.

4.6.2 Summarized Element Finding

The interface between engineering and construction organizations is properly coordinated through published documents. The TVA specifications and design requirements applicable to the 125-ton Auxiliary Building crane at WBN are satisfactory. The 3-1/2-inch-opening grating at elevation 692 feet is temporary. The final grating is specified on the applicable design drawing and will be installed according to the current plan.

4.7 <u>Feedwater Heater Monorail Design - Element 215.10</u>

4.7.1 Sequoyah Plant

TVA decided to replace a total of 12 out of 42 feedwater heaters in late 1984 on both of the SQN units because of mechanical problems encountered. The feedwater heater replacement involved moving large, heavy (89,000 lb) equipment over long distances through confined spaced. The replacement, therefore, required additional monorails at various locations in the turbine building to transport the heaters.

The SQN turbine building and monorail supports are not Category I structures. The AISC specification covers design, fabrication, and erection of structural steel. The evaluation team reviewed the feedwater heater drawings, and confirmed that the correct lifting weights were used in the design calculations. The design calculations and drawings were reviewed for assumptions, logic, analysis, code interpretations, member selections, connections, and clarity of presentations. The evaluation team found the design documents well organized, complete, and meeting the AISC requirements. The team also performed a field walkdown of the as-built installation including connections. The installation appeared satisfactory.

The SON site director had requested a monorail load test prior to lifting the heaters to ascertain the soundness of the system design. The test was considered successful by visual observations (Ref. 24). Following the test, the feedwater heaters were replaced successfully.

4.7.2 Summarized Element Finding

At SON, the hangers are structurally adequate for the rated load. Other reviews, the load test, and the successful heater replacement operation confirm adequate design.

4.8 Floor Sleeve Covers - Element 215.11

4.8.1 Watts Bar Plant

All mechanical floor sleeve seals in the Auxiliary Building are tabulated in drawing 47W472 series. A review of these drawings indicated that all spare sleeve penetration seals are Type III seal, made of Dow Corning 3-6548 silicon RTV foam with a minimum thickness of 8 inches. All Type III penetration seals are fire-barrier seals with no air-pressure requirement. The sleeves protrude 4 inches above the floor slab and are filled with silicon foam fire-proofing material. The top surfaces of the silicon foam are dished (concave) and appear as though someone has stepped on them. The outside surfaces of the sleeves are covered with yellow and black striped reflective tape which identifies a hazard.

The protruding spare sleeves may create a safety hazard if they are located along, across, or in aisles and passageways because workers may trip on the protruding sleeves. OSHA Standards require aisles and passageways to be kept clean and in good repair, with no obstruction across or in aisles that could create a hazard (Ref. 25). In addition to the tripping hazard, a larger abandoned floor sleeve may also create a hazard if the seal is accidentally stepped on and is unable to support the weight of a worker.

4.8.2 Summarized Element Finding

The potential safety hazard caused by protruding sleeves requires a worker safety evaluation for compliance with OSHA standards. (The documents are not available to ensure the adequacy of seal foam to support the weight of a person.)

4.9 Pipe Whip Restraint Design - Element 227.1

4.9.1 Watts Bar Plant

The concern indicates that the problems can be identified by examination of the drawing series 48W1700 and further indicates that this is a construction department concern. Therefore special emphasis was given to the changes required to complete construction of the pipe whip restraints. From a review of the drawings and documents, it is observed that the general engineering design requirements as issued for construction are similar to those used widely in the nuclear power industry.

Review of the original notes provided on these drawings indicates that adequate tolerance and flexibility were provided to construction in the area of welding by notes. However, a further review of documents such as ECNs, NCRs, and FCRs indicates that a deficiency existed in the area of weld inspection and documentation. This deficiency was discovered by TVA during the review of the turnover package for the pipe whip restraints after the transfer of site engineering and inspection responsibility to the Civil Engineering Design Unit. After the location and review of all existing documentation and a random inspection of the as-built pipe whip restraints, a nonconforming condition was determined to exist. Based on this, NCR-3001R was initiated by TVA to determine the full extent of the deficiency and to evaluate its impact on the safety of the plant. As a result of this evaluation, TVA reported that a significant deficiency existed which could have affected plant safety. Therefore, this information was reported to NRC.

Subsequently, a program was developed by TVA to review, evaluate, and correct any weld deficiency that might have existed for all affected pipe whip restraints.

NRC I&E Inspection Reports indicate that the NRC has reviewed documentation and inspection sheets for NCR 3001R and has found them and the corrective action to be acceptable (Ref. 26).

4.9.2 Summarized Element Finding

The concern is related to reconciliation of the as-built condition with the design requirements regarding the welding of pipe whip restraints. Construction Engineering Department used incorrect inspection procedures, which resulted in improper inspection and insufficient documentation. This condition was corrected. The NRC reviewed the applicable correction documents and found them and the corrective action to be acceptable.

4.10 Pipe Whip Restraint Design - Element 227.2

4.10.1 Bellefonte Plant

The stated concern indicates that whip restraints are needed on the 36-inch decay heat removal (DHR) piping coming from the borated water storage tank (BWST). Pipe whip restraints are structural protective devices that permit some pipe motion and rotation but limit or prevent unrestricted pipe whip. Pipe whip is the movement of a pipe caused by the jet thrust resulting from a pipe failure.

The postulated types of pipe failure and the criteria for corresponding applicable piping are (Ref. 27):

- o Circumferential ruptures and longitudinal splits, which necessitate pipe whip restraints in high energy lines
- o Through-wall leakage cracks, which do not require provision of pipe whip restraints, in moderate energy lines

The criteria for establishing high and moderate energy system classification are governed by the maximum operating temperatures and pressures in the system. According to BLN FSAR the DHR is a moderate energy system (Ref. 27).

In addition, the review indicated that there is no 36-inch DHR piping coming from the BWST. BLN design criteria diagram drawing shows that the DHR pipe coming from the BWST has a 36-inch diameter at the nozzle location with a reducer to 24-inch-diameter pipe. The detailed section at the nozzle in the drawing used for construction shows a 30-inch diameter nozzle.

4.10.2 Summarized Element Finding

The problem relates to the decay heat removal piping, which is a moderate energy line at BLN and therefore does not require whip restraints. In addition, a discrepancy was noted between the design documents and the FSAR regarding the nozzle size.

4.11 Summarized Subcategory Findings

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

The summary of findings by classification is given in Table 2. Where more than one corrective action is identified in Table 1 for a single finding (e.g., element 215.11, Finding "a"), Table 2 counts only a single classification. Thus, Table 2 identifies one finding for each issue evaluated. Of the 42 findings identified by a classification in Table 1, 16 require no corrective action. Of the remaining 26 that required corrective actions, eight resulted from peripheral issues uncovered during the ECTG evaluation.

Even though TVA had initiated some corrective actions before ECTG evaluation that relate to two findings each for BFN and BLN of element 215.2 addressing cut rebar, its original scope was very limited, requiring only a cursory review. Similarly, TVA was also conducting floor live load evaluations for SQN and WBN that relate to one finding each of element 215.6, which addresses hanger loads on structures. Again, TVA's initial scope was not comprehensive enough to address the findings. Therefore, for the purposes of Tables 1 and 2, complete corrective actions are considered taken as a result of the ECTG evaluation. From Table 2, the ratios of issues or findings requiring corrective action to the total number of issues evaluated, by plant, are as follows:

	WBN	SQN	BFN	BLN
Issues or findings requiring corrective action	5	7	6	8
Total number of issues evaluated	17	10	6	9

The apparent differences between the ratio for WBN and the ratios for the other plants are due to the sequence of evaluation and the utilization of the results obtained from WBN. The Employee Concern Special Program started at WBN and was then expanded to cover all other plants. Through the general approach review process, those issues that were site-specific, and not safety-related, were not evaluated at the other plants.

5. CORRECTIVE ACTIONS

The evaluation team reviewed the corrective action plans for all four plants and found them acceptable to resolve the findings. The corrective action plans are described in Attachment B.

The general areas of corrective action are described below for each element reviewed for this subcategory. Following this is a summary discussion of the information presented in Table 3.

5.1 Cut Rebar Control and Hanger Loads on Structures - Elements 215.2 and 215.6

TVA plans to combine the corrective actions for these two elements at SQN, BFN, and BLN, as follows:

- Perform document search and compile relevant information on drawings
- Supplement with field walkdowns and reconcile with drawings
- Select the most critical concrete elements for detailed evaluation to verify their adequacy to meet the design commitments
- Revise FSAR as needed to identify the design methods used in the evaluation
- Develop procedures to control construction and operation activities and to provide engineering direction for evaluation to address future plant modifications

TVA also plans to follow the corrective actions described above for element 215.6 at WBN.

5.2 Floor Sleeve Covers - Element 215.11

To comply with personnel safety requirements, TVA has committed to the following actions at WBN:

- Perform personnel safety inspection of the plant area to identify and eliminate tripping hazards
- Evaluate adequacy of floor sleeve seals by testing to determine if they can support anticipated loads

5.3 Pipe Whip Restraint Design - Element 227.2

TVA has committed to the following actions at BLN:

- Review all safety-related piping/tank interfaces for consistency between the design criteria diagrams and all other applicable design documents
- Identify all discrepancies among the documents and correct them as appropriate

5.4 Summary of Corrective Actions

Table 2 identifies 26 findings that require corrective action. Because some of the findings were combined and were common for more than one plant, there are eight corrective action descriptions in this subcategory. Table 3 shows these eight corrective action descriptions, along with finding/corrective action classifications. The corrective action descriptions are a condensation of the more detailed corrective action information provided in Attachment B. Table 3 indicates the plant or plants to which a corrective action 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 descriptions identified, three involve additional evaluation to determine if plant modifications are necessary, two require changes to procedures, and the remaining three require some type of documentation remedy. In addition, the CATD column of Table 3 shows that, in most cases, a particular corrective action description is applicable to more than a single plant. Finally, with respect to corrective actions, Table 3 shows that, of the ten elements in this subcategory, only four require corrective actions, and elements 215.2 and 215.6 require most of the corrective actions.

The "significance of corrective actions" column of Table 3 shows that the primary activity to be performed by TVA is documentation change as a result of the eight corrective action descriptions. This activity requires preparing new calculations, drawings, and procedures. Two of the eight corrective action descriptions will result in reductions in design margins and, as Table 3 shows, three of the eight could potentially require physical modifications of the plant. The necessary evaluations which have not been completed for all plants will determine the extent of physical modifications. However, on the basis of experience with other nuclear plants, this possibility seems remote.

5.5 Corrective Action Status

The following is the current (September 1987) status of the corrective actions for this subcategory:

- 215.2 and 215.6, Cut Rebar Control and Hanger Loads on Structures
  - The corrective actions necessary for SQN restart are complete, were reviewed by the evaluation team in June 1987, and were deemed acceptable (Ref. 29).

- As discussed in Section 4, WBN already had an acceptable cut rebar control program. And the corrective actions to assess cumulative effects of hanger attachments at WBN are based on comparison with SQN because WBN is a sister plant to SQN. The related work is essentially complete.

- BFN awarded a contract in the summer of 1987 to an architect/engineer company to verify the structural adequacy of its Class I concrete elements. The related work is in progress.

- BLN has initiated appropriate corrective actions for this substantial task because of the large number of cut rebar releases and hanger attachments that have undocumented engineering judgments (CAQR BLF 870073).

o <u>215.11, Floor Sleeve Covers (at WBN only) and 227.2, Pipe Whip Restraint Design (at BLN only)</u> - The required corrective actions for these two elements are not complete.

6. CAUSES

Table 3 identifies one or more main causes for each problem requiring corrective action. For each corrective action, the most important cause is identified; however, in many instances it was observed that the problem resulted from a combination of causes, each of which should be identified. Therefore, more than one cause is identified for those corrective actions.

The following discussion describes the causes identified in Table 3 and the associated element evaluations with negative findings identified in Section 4.

6.1 Cut Rebar Control - Element 215.2

The evaluation team found that assessment calculations of Category I concrete elements for cut rebar were either incomplete or unavailable at SQN, BFN, and BLN because engineering judgments were often made without performing detailed calculations. In addition, updated as-built cut rebar drawings were not available for an overall assessment of the concrete structures. This subject was not adequately addressed by Engineering because of lack of sufficient involvement in technical matters by responsible first-line and second-line engineering supervisors.

Also, SQN did not have documented procedures for monitoring and evaluating cut rebar. This deficiency occurred because practices then current within the industry were not followed. In addition, at all plants except WBN, communication/coordination was not adequate between Engineering, Construction, and Operations to assess the effects of cut rebar, resulting in a degree of compartmentalization for this subject.

At BLN, NRC 1982 inspection items have remained open. This lack of resolution of items occurred because of a lapse in communication between Engineering and Licensing.

6.2 Hanger Loads on Structures - Element 215.6

TVA did not evaluate cumulative effects of as-built hangers on Category I concrete walls and slabs and establish structural integrity for all four nuclear plants. This resulted from the practice of exercising engineering judgment by engineers designing hanger supports for various Category I components. Furthermore, complete as-built drawings showing all major hanger attachments were not available to facilitate overall assessment. The main cause for this practice continuing at all four plants was lack of sufficient leadership in technical matters by the first- and second-line engineering supervisors.

TVA does not have formal procedures requiring coordination and evaluation of cumulative effects of hanger attachments. This deficiency at all four plants resulted from inadequate interaction and communication among Engineering disciplines as well as among Engineering, Construction, and later, Operations. Also, prevailing nuclear industry practice was not followed in this regard.

For SQN and WBN, at present, there are differences between the governing building codes identified in the FSARs and the codes used in the final assessment calculations. The lack of timely resolution of differences resulted from inadequate training in the procedures established for design process control. This deficiency also resulted from lack of communication between the design engineers and their supervisors regarding technical matters.

6.3 Floor Sleeve Covers - Element 215.11

The evaluation team determined that abandoned protruding sleeves at WBN were not documented as to whether they created industrial safety hazards. Clearly, compliance to OSHA regulations was not evident. The abandoned sleeves resulted from inadequate coordination among the responsible mechanical, electrical, and civil engineers. In addition, the structural adequacy of seal foam within the sleeves was not documented as to whether it met physical separation requirements of a nuclear power plant. TVA DNE apparently had accepted the adequacy of sleeve foam based on engineering judgment but without documenting the logic and rationale.

6.4 Pipe Whip Restraint Design - Element 227.2

The tank nozzle size for the decay heat removal piping at BLN was found to be incorrect on a drawing. This discrepancy resulted from engineering error in transcribing the information on the BLN design criteria diagram.

6.5 Summary of Causes

The consideration of main cause showed that, for this subcategory, three major groups of causes were represented - management effectiveness, design process effectiveness, and technical adequacy. Using these groups, the unweighted totals from Table 3 show that 12 causes are in the management effectiveness category, five are in the design process category, and four are in the technical adequacy category. Thus, the management effectiveness category, covering supervisory effectiveness, dominates in evaluating the summation of main causes.

The following observations apply to all four nuclear plants. The extent to which supervision is engaged in design work was examined on the basis of the negative findings identified. The responsibility of first- and second-line engineering supervision usually includes the overall review of the design and document control, and establishing and maintaining procedures that ensure compliance with the FSAR commitments. However, the combination of unclear design bases, undocumented design judgments and practices, lack of design commitment compliance, and absence of design verification documentation contributed to uncertainty regarding the design control process in this area of review. The observation of insufficient technical design and document control, which was encountered in the findings related to the cut rebar and hanger supports, indicates there was insufficient involvement on the part of engineering supervision in the design and control process in these two areas. The errors that occurred for this subcategory are those of omission. Inadequate procedures and lack of supervisory attention led to oversight in both verifying the design and properly controlling and directing construction regarding installation and modification in these two areas.

However, evaluation of the other findings in this subcategory indicated that there were adequate procedures and acceptable supervisory control of the associated design process.

7. COLLECTIVE SIGNIFICANCE

Evaluation of the civil/structural design issues raised by 13 TVA employee concerns that were identified in this subcategory indicated that a generic problem that would affect design margins of concrete components existed because of lack of assessment and documentation of construction completion and design modification. Two common elements indicating this were the cut rebar control (element 215.2) and the hanger loads on structures (element 215.6). The construction completion and modification control methods and procedures for these elements were found to be insufficient to document the as-installed design margins. Issues raised in four of the 13 concerns addressed this problem.

Another concern dealt with a potential violation of standards and improper coordination (element 215.11) and was seen as an isolated instance. Moreover, a documentation error, which does not directly relate to the expressed concern and had no effect on the design margins, was identified (element 227.2). Issues raised in the other seven concerns were found by the evaluation team to be invalid, and therefore, no further corrective action was needed.

In investigating the specific reasons of the identified problems, the evaluation team found a broader issue of insufficient attention to detail and thoroughness in reviewing calculations. The design of nuclear power plants requires the consideration of many unique items not generally considered in nonnuclear applications. Therefore, it is essential that the first-line engineering supervision be cognizant with nuclear power plant design in order to anticipate and address all the design needs in a logical manner.

Corrective action plans for the four nuclear plants for this subcategory, as well as for a CAP closure program for the SQN restart were prepared by TVA and submitted to the evaluation team for concurrence. Generally, the team observed that the documents submitted initially by cognizant engineers of all four plants were incomplete and required several resubmittals before they were deemed acceptable. This activity is indicative of lack of appreciation by first-line supervisors for the documentation needs of nuclear power plants, and reinforces the need for more attention toward ensuring that programs required for an effective and thorough design process are established and implemented.

One observation of the first-line engineering supervisors is that their actions in this area appeared to be a continuation of past practices when documentation requirements for nuclear power plants were not as extensive. In light of the major events that have transformed the nuclear industry, TVA, to some degree, has demonstrated a failure to document the collective needs of a complex multidiscipline effort. Indeed, a compelling close relationship between commitments, engineered design, and constructed plant is essential for these discrepant issues.

To address the general broader issues of TVA's past difficulties in the nuclear area, the Corporate Nuclear Performance Plan (CNPP) was created (Ref. 5). 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 (BLN is broadly addressed in the CNPP).

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 focus of this report has been on related negative findings. However, it is important to emphasize that employee concerns in this subcategory identified only a fraction of the total technical scope of the TVA civil/structural design group. In addition, as discussed earlier in this section, out of a total of 13 employee concerns, five were found to be valid, and there is remote potential for plant modifications. The resulting corrective actions are mainly to compile and to prepare documentation. The TVA design process addressed within the limited area of this subcategory was determined to be generally sound with a few exceptions, as discussed, for cut rebar control and the cumulative effects of hanger loads.

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 necessary corrective actions tracking documents.

TABLE 1

CLASSIFICATION OF FINDINGS AND CORRECTIVE ACTIONS

	Element	Issue/ Finding**	Finding/Corrective Action Class* SQN	WBN	BFN	BLN
215.1	Seismic Criteria	a	A	A	-	-
		b	A	A	-	-
215.2	Cut Rebar Control	a	D6	A	D6	D6
		b	D6	A	D6	D6
		c	D2	A	D2	D2
		d	-	-	-	E3
215.3	Radiation Shielding Seismic Analysis	a	-	A	-	-
		b	-	A	-	-
215.4	Turbine and Service Building Roofing	a	-	A	-	-
215.6	Hanger Loads on Structures	a	D6	D6	D6	D6
		b	D6	D6	D6	D6
		c	E3	E3	E2	E2
		d	E2	E2	-	-
215.7	Auxiliary Building Service Crane	a	-	A	-	-
		b	-	A	-	-
		c	-	B	-	-
215.10	Feedwater Heater Monorail Design	a	A	-	-	-

* Explanation of classes is on the next page.
**Defined for each plant in Attachment B.

TABLE 1 (Cont'd)

	Element	Issue/ Finding**	Finding/Corrective Action Class* SQN	WBN	BFN	BLN
215.11	Floor Sleeve Covers	a	-	D6	-	-
			-	D7	-	-
227.1	Pipe Whip Restraint Design	a	-	A	-	-
227.2	Pipe Whip Restraint Design	a	-	-	-	A
		b	-	-	-	E3

*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 (Compliance with OSHA)

**Defined for each plant in Attachment B.

TABLE 2

FINDINGS SUMMARY

	Classification of Findings	Plant				Total
		SQN	WBN	BFN	BLN	
A.	Issue not valid. No corrective action required.	3	11	0	1	15
B.	Issue valid but consequences acceptable. No corrective action required.	0	1	0	0	1
C.	Issue valid. Corrective action initiated before ECTG evaluation.	0	0	0	0	0
D.	Issue valid. Corrective action taken as a result of ECTG evaluation.	5	3	5	5	18
E.	Peripheral issue uncovered during ECTG evaluation. Corrective action required.	2	2	1	3	8
	Total	10	17	6	9	42

TABLE 3
MATRIX OF ELEMENTS, CORRECTIVE ACTIONS, AND CAUSES
SUBCATEGORY 25000

				CAUSES OF NEGATIVE FINDINGS*																			
				MANAGEMENT EFFECTIVENESS							DESIGN PROCESS EFFECTIVENESS							TECHNICAL ADEQUACY			Significance of Corrective Actions*		
ELEM	FINDING/ CORRECTIVE ACTION CLASS.**	CORRECTIVE ACTION	CATD	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/ Commit Not Met	14 Insuf. Verif Documentation	15 Stds Not Followed	16 Engrg Error	17 Vendor Error	D	M	N
215.2	D6	Review, evaluate, and document cut rebar condition.	215 02 SQN 01 215 02 BFN 01 215 02 BLN 01							X			X		X						A	A	P
	D2	Develop/revise procedures to control rebar cuts.	215 02 SQN 01 & 02 215 02 BFN 01 215 02 BLN 01			X		X										X			A	-	
	E3	Address NRC 1982 open items.	215 02 BLN 01					X	X												A	-	-
215.6	D6	Review, evaluate, and document cumulative hanger load assessments.	215 06 SQN 01 215 06 WBN 01 215 06 BFN 01 215 06 BLN 01							X			X		X						A	A	P
	E2	Develop/revise procedures to control hanger attachments.	215 06 SQN 02 215 06 WBN 02 215 06 BFN 02 215 06 BLN 02			X		X										X			A	-	-
	E3	Revise FSAR to reflect design methods used.	215 06 SQN 03 215 06 WBN 03		X			X	X												A	-	-
215.11	D6	Perform worker safety evaluation of the protruding floor sleeves for compliance with OSHA standards, and design evaluation of the adequacy of sleeve foam seals.	215 11 WBN 01 215 11 WBN 02					X							X			X			A	-	P
227.2	E3	Revise a drawing and FSAR to reflect correct nozzle size.	227 02 BLN 01																X		A	-	-
		TOTALS		-	1	2	-	5	2	2	-	-	2	-	3	-	-	3	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 design and licensing 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 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 actions are judged to be significant if the resultant changes affect the overall quality, performance, or margin of a safety-related structure, system, or component.