

TVA EMPLOYEE CONCERNS
SPECIAL PROGRAM

REPORT NUMBER: 22000

REPORT TYPE: SUBCATEGORY REPORT FOR
ENGINEERING

REVISION NUMBER: 3

TITLE: SUPPORT DESIGN GENERAL

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REASON FOR REVISION:

1. Revised to incorporate SRP and TAS comments.
2. Revised to incorporate Bellefonte corrective action plans and SRP comments.
3. Revised text and Attachment B to incorporate SRP and TAS comments and added Attachment C (References).

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EXECUTIVE SUMMARY

The concerns of Subcategory Report 22000, Support Design General, deal mainly with the design adequacy of pipe supports. Other related issues in this subcategory report include design change control, technical decisions made by Construction, and technical review by Engineering. The findings confirm that the only issue of major significance is the adequacy of pipe support design.

The evaluation team examined both the design criteria and individual pipe support calculations. The pipe support design criteria for all four plants were found to adequately address the necessary seismic design requirements, with the exception of one Browns Ferry criterion, which did not include the deflection/rigidity requirement. This requirement will be implemented in the individual pipe support calculations under the Browns Ferry calculation verification review program, and the criterion will be revised to include the requirement.

The pipe supports reviewed by the evaluation team for all four plants were found to be adequately designed based on applicable design criteria, with the exception of four (of 28 reviewed) Watts Bar pipe supports that did not meet code stress allowables. Some calculation documentation was found to be incomplete or irretrievable, or contained minor discrepancies and inadequate documentation of engineering judgment. The rest of the related issues were found to be either technically insignificant or invalid.

Significant technical or safety problems are not apparent from this evaluation for Sequoyah, Browns Ferry, or Bellefonte. However, TVA has identified the need for better documentation (of analysis, engineering judgment, test data, etc.) in the area of pipe support design, and has initiated corrective action to improve the documentation. In addition, an extensive effort is underway at Watts Bar, Browns Ferry, and Sequoyah to locate or reperform the pipe support calculations that were irretrievable.

The four Watts Bar supports that do not meet code allowables are of technical significance. However, Watts Bar has committed to reevaluate and, if necessary, modify these supports. All Watts Bar calculations for engineered pipe supports will be reevaluated under the Hanger and Analysis Update Program.

The corrective action plans provided by TVA are found to be acceptable by the evaluation team to resolve the negative findings.

The causes identified and other evaluation results are being examined from a wider perspective in the Engineering Category evaluation.

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

HISTORY OF REVISION

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

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.

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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)

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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

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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

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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
WBECSPP Watts Bar Employee Concern Special Program
WBN Watts Bar Nuclear Plant
WR Work Request or Work Rules
WP Workplans

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1. INTRODUCTION

This subcategory report summarizes and evaluates the results of the ECSP element evaluations prepared under Engineering Subcategory 22000, Support Design General. It deals mainly with the design adequacy of pipe supports. Other related issues include design change control, technical decisions made by construction, and technical review by engineering.

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 and their generic applicability
- o Section 3 -- outlines the process followed for the element and subcategory evaluations and cites documents reviewed
- 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'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, the concern is quoted as received by TVA, and is characterized as safety related, not safety related, or safety significant.
- o 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.

- o Attachment C -- contains the references cited in the text.

The employee concerns providing the basis for the element evaluations are listed by element number in Attachment A. The plant location where the concern was originally identified and the concern applicability are also identified.

2. SUMMARY OF ISSUES/GENERIC APPLICABILITY

The employee concerns listed in Attachment A have been examined for each element and the potential problems raised by the concerns have been identified as issues in Attachment B. Some of these issues were evaluated for more than one plant when deemed generically applicable in accordance to ECTG Program Manual M.1, Section 7.3. Investigation of these issues constitutes the element evaluations.

2.1 Summary of Issues

Summaries of the issues evaluated under this subcategory for each element are listed below.

- o 220.1, "'A' Series Hanger Drawings and 0-50 Notes" - The 47A050 series drawing notes are confusing, open to interpretation, and allow rejected hangers to be accepted. NRC wrote violations against the 47A050 notes because they did not satisfy inspection criteria.
- o 220.3, "Design of Pipe Supports" - Pipe supports are designed inadequately. Seismic pipe support criteria are nonexistent. Seismic pipe supports are too rigid.
- o 220.6, "Revisions to Hanger Designs" - Pipe support designs are inadequately controlled and have as many as 100 revisions.
- o 220.7, "Installation-related Technical Decisions" - Crafts assume too much responsibility for originating design. Engineering revises the drawings to reflect as-built condition without review and approval.
- o 220.9, "Oversizing of Pipe Support Steel and Slick Grinding of Welds" - Pipe supports are overdesigned. The former practice of slick grinding welds is unnecessary.
- o 220.10, "Replacement Hangers" - Installed pipe supports have often been modified or removed.

- o 220.11, "Temperature Variation Consideration" - Thermal expansion is not considered in the pipe support calculations.
- o 220.12, "Technical Review" - Technical review is not performed after the checker's review of a pipe support calculation.

The issues summarized above deal mainly with presumed deficiencies or inadequacies in the design of pipe supports. Other related issues deal with the quality and use of the support installation tolerance notes (220.1), technical decisions made by Construction (220.7), and technical review by Engineering (220.12).

A complete statement of each issue investigated in the element evaluation is provided in Attachment B. This attachment also lists findings and corrective actions, which will be discussed in Sections 4 and 5 of this report.

Three of the above summarized issues were found to be valid and require corrective action (elements 220.1, 220.3, 220.11). On the basis of the findings, only the issues of inadequately designed pipe supports (element 220.3) are technically significant with respect to design adequacy.

2.2 Generic Applicability of Employee Concerns

The generic applicability of the employee concerns was determined as follows:

- o 220.1, "'A' Series Hanger Drawings and O-50 Notes"
 - WBN - All eight concerns of this element are applicable.
 - SQN - Only Concern IN-85-024-001 was applied to SQN. Since all concerns for this element originated at WBN, many of them made direct or inferred references to WBN, making the concern plant-specific to WBN. Concerns IN-85-052-001, IN-85-932-001, and IN-85-445-013 contained specific references to WBN documents. Concern IN-85-010-002 inferred it was specific to WBN because of the reference to an NRC violation. In addition, Concerns IN-85-415-001 and IN-86-249-001 implied the notes were vaguely written; however, the notes at SQN (and BLN) were found to be clear and concise. Therefore, these concerns are also plant-specific to WBN. The last concern, PH-85-006-001, was found not to be valid at WBN. Since field change request procedures similar to WBN's exist at SQN (and BLN), no further evaluation is required.

- BFN - The element is not applicable because no such notes (or similar notes) exist at BFN.
- BLN - The original TVA determination was that the concern of this element was not applicable. However, through the evaluation of element 220.3 for BLN, it was found that notes similar to SQN/WBN 47A050 notes (Refs. 1 and 2) existed at BLN as 36A0059 notes (Ref. 3). The issue stemming from Concern IN-85-024-001 that the notes may be misinterpreted was applied to BLN. The concern also deals with "A" series hanger drawings; however, they, or similar drawings, do not exist at BLN.
- o 220.3, "Design of Pipe Supports" - The concerns of this element are applicable to all four plants.
- o 220.6, "Revisions to Hanger Designs"
 - WBN - The concern of this element is applicable and found not to be valid.
 - SQN, BFN, BLN - The representative sample of supports from various safety-related systems (Refs. 18, 20, and 21) reviewed in element 220.3 for these three plants does not indicate that pipe support drawings were excessively revised. Hence, this concern does not require further evaluation.
- o 220.7, "Installation - Related Technical Decisions"
 - WBN - The concern of this element is applicable and found not to be valid.
 - SQN, BFN, BLN - Changes required by construction are initiated through field change requests which are approved by Engineering before the physical change is made. Since document change procedures similar to WBN's also exist for these three plants, this concern does not require further evaluation.
- o 220.9, "Oversizing of Pipe Supports Steel and Slick Grinding of Welds"
 - WBN - The concern of this element is applicable and found not to be valid.

- SQN, BFN, BLN - The representative sample of pipe supports (Refs. 18, 20, and 21) reviewed in element 220.3 for these three plants does not indicate that the pipe supports were oversized. Slick grinding of welds is an unnecessary procedure and, when properly performed does not impact the technical adequacy of the supports. Hence, the concern does not require further evaluation.
- o 220.10, "Replacement Hangers"
 - WBN - The concern of this element is applicable and found not to be valid.
 - SQN, BFN, BLN - Changes in hanger type and location changes are common during the design/construction process. These changes are considered and documented in the piping and support analyses. Hence, the concern does not require further evaluation.
- o 220.11, "Temperature Variation Consideration" - The concern of this element is applicable to all four plants.
- o 220.12, "Technical Review"
 - WBN - The concern of this element is applicable and found not to be valid.
 - SQN, BFN, BLN - From the WBN evaluation, it was found that 10 CFR 50, Appendix B (Ref. 4) and ANSI N45.2.11-1974 (Ref. 5) specify that verification or checking shall be performed by any competent individual or groups other than those who performed the original design. No additional verification or checking is required after the competent individual (or group) has checked or reviewed the calculations. Since these documents also apply to these three plants, the concern does not require further evaluation.

3. EVALUATION PROCESS

This subcategory report is based on the information contained in the applicable element evaluations addressing the specific employee concerns related to the issues summarized in Section 2.

3.1 Element Evaluation Process

The evaluation process for each element is as given below.

3.1.1 "'A' Series Hanger Drawings and 0-50 Notes" - Element 220.1

Sequoyah.

- a. Reviewed the 47A050 notes (Ref. 1) to determine if these notes were contradictory to hanger drawings (Ref. 9) and other installation documents (Refs. 6 and 7).
- b. Reviewed the 47A050 notes to determine if they can be misinterpreted.
- c. Reviewed TVA's corrective action plan for CATD 220 01 SQN 01.

Watts Bar.

- a. Reviewed applicable NSRS investigation reports (Ref. 8).
- b. Reviewed the 47A050 notes to establish whether these notes were contradictory to "A" series hanger drawings (Ref. 10).
- c. Reviewed the 47A050 notes to determine whether they can be misinterpreted. interviewed site personnel to determine if interpretational conflicts exist (Ref. 11).
- d. Reviewed the 47A050 notes to determine whether revisions to the notes allow rejected supports to be accepted.
- e. Reviewed a sample of calculations (Ref. 12) for justification of specific notes.
- f. Reviewed TVA's corrective action plan for CATD 220 01 WBN 01.

3.1.2 "Design of Pipe Supports" - Element 220.3 (All Plants)

- a. Reviewed NSRS report (Ref. 13) to determine the scope of the employee concern.
- b. Reviewed applicable pipe support design criteria (Refs. 14, 15, 16, and 17) and a random sample of support calculations (Refs. 18, 19, 20, and 21) from various safety-related systems to verify seismic design adequacy (excluding the requirements for base plate and anchor bolts, as they are examined in Construction Subcategory Report 10400, Ref. 53).

- c. Reviewed seismic support criteria (Refs, 14, 15, 16, and 17) to determine rigidity requirements.
 - d. Reviewed sample of pipe support drawings (Refs. 22 and 23) for constructibility (for SQN, WBN only - based on the evaluations for SQN and WBN element 220.3, and evaluations for element 222.3 [all four plants]); this step was determined to be unnecessary for BFN and BLN).
 - e. Performed study calculations (Refs. 24 and 25) to support evaluations, made engineering judgments as necessary, and conducted site interviews (BLN only, Ref. 25).
 - f. It was determined that BLN had similar notes (3GA0059 series) to the SQN/WBN 47A050 notes.
 - g. Evaluation of the 3GA0059 series (Ref. 3) notes was performed under element 220.3 as an additional finding.
 - h. Reviewed 3GA0059 notes to determine if they can be misinterpreted.
 - i. Reviewed TVA's corrective action plans for CATDs 220 03 SQN 01, 220 03 WBN 01, 220 03 BFN 01, 220 03 BLN 01, and 220 03 NPS 01.
- 3.1.3 "Revisions to Hanger Design" - Element 220.6 (Watts Bar)
- a. Reviewed pipe support design manual (Ref. 26) to verify the method of numbering hanger drawing revisions.
 - b. Reviewed TVA procedures (Ref. 27) for revising vendor drawings.
 - c. Reviewed WBN hanger tracking program report (Ref. 28) to verify the maximum number of revisions for a hanger drawing.
- 3.1.4 "Installation-related Technical Decisions" - Element 220.7 (Watts Bar)
- a. Reviewed the applicable procedures (Ref. 29) to determine the extent to which TVA might permit the crafts to participate in the design process.
 - b. Reviewed these same procedures to ascertain the degree of control of the FCR process in preventing hangers from being redesigned and installed without documented engineering approval.

- 3.1.5 "Oversizing of Pipe Support Steel and Slick Grinding of Welds" - Element 220.9 (Watts Bar)
- a. Reviewed TVA IOM (Ref. 30) regarding Employee Concern IN-85-316-002.
 - b. Reviewed TVA's General Construction Specification G-29C, Rev. 9
 - c. Reviewed TVA's General Construction Specification G-43, Rev. 8.
 - d. Reviewed TVA's typical small pipe standard drawings and general notes for Category I supports (drawings 47A053-62, 47A053-62A through 62E, 47A053-63, 47A053-63A, and 47A050-1P) for braced and unbraced cantilevers.

- 3.1.6 "Replacement Hangers" - Element 220.10 (Watts Bar)
- a. Reviewed documents (Ref. 31) and procedures (Ref. 32) relating to practices adopted for modifying the pipe supports that have already been installed (including deletions).
 - b. Reviewed ten sets of piping analysis calculations (Ref. 33), including stress isometric drawings, and the respective engineering change notices (ECNs)/field change requests (FCRs) causing the pipe support modifications (including deletions).

- 3.1.7 "Temperature Variation Consideration" - Element 220.11

Sequoyah.

- a. Reviewed design criteria (Ref. 34) and applicable codes (Ref. 35) to verify if consideration of temperature variations is required in the design of structural members of pipe supports.
- b. Reviewed design criteria to verify if thermal expansion of piping is considered in the piping analysis and if loads imposed by this expansion are considered in the pipe support design.
- c. Determined if SQN adequately addressed the WBN problem identification report (Ref. 36) on this subject.
- d. Reviewed TVA's corrective action plan for CATD 220 11 SQN 01.

Watts Bar.

- a. Reviewed design criteria (Ref. 37) and applicable codes (Ref. 38) to verify if consideration of temperature variations is required in the design of structural members of pipe supports.

- c. Reviewed corrective action plan provided by PIR BLN CEB 8512 (Ref. 55).
- 3.1.8 "Technical Review" - Element 220.12 (Watts Bar)
- a. Reviewed licensing commitments (Refs. 4, 5, 45) and TVA procedures (Ref. 46) for design calculation verification.
 - b. Reviewed pipe support calculations (Ref. 47) to verify the compliance with licensing commitments and TVA procedures.
 - c. Reviewed documentation pertaining to pipe support technical audit reports (Ref. 48).

3.2 Subcategory Evaluation Process

The evaluation process for this subcategory report was as follows:

- a. Tabulated issues, findings, and corrective actions from the element evaluations in a plant-by-plant arrangement (see Attachment B).
- b. Prepared Tables 1, 2, and 3 to permit comparison and identification of common and unique issues, findings, and corrective actions among the four plants.
- c. Classified the findings and corrective actions from the element evaluations using the ECSP definitions.
- d. On the basis of ECSP guidelines, analyzed the collective significance and causes of the findings from the element evaluations.
- e. Evaluated defined corrective actions to determine if additional actions are required as a result of causes found in step d.
- f. Provided additional judgment or information that may not be apparent at the element level.

4. FINDINGS

The findings from each of the element evaluations for this subcategory are contained in Attachment B. They are listed by element number and by plant.

The findings for each element are summarized in the following paragraphs.

4.1 "'A' Series Hanger Drawings and 0-50 Notes" - Element 220.1

The purpose of the notes is to provide Construction with as much flexibility as possible for hanger installation, and to provide guidelines for unforeseen situations and generic installation difficulties. The notes allow a larger number of pipe supports to meet acceptance inspections that otherwise would have required field change requests (FCRs) or would have been rejected by inspection rejection notices (IRNs).

For Sequoyah, the 47A050 series drawing notes were found to be neither confusing nor open to interpretation. However, minor discrepancies were found between a construction specification and an operations maintenance instruction.

For Watts Bar, the 47A050 notes were, in some cases, found to be confusing and contained conflicting or unnecessary instructions; however, they were revised in September 1985 to resolve conflicts and for clarification. Evaluation team interviews with site personnel (Construction and Quality Control) revealed that there were interpretational differences. There are Watts Bar programs in place to resolve the differences, such as inspection rejection notice (IRN) trend analysis, Quality Assurance (QA) training, and DNE/DNC biweekly meeting (see Attachment B). No NRC violations against the 47A050 notes were identified. However, it was found in a Nuclear Safety Review Staff (NSRS) report I-85-157-WBN (Ref. 8) and by the evaluation team that changes made to the 47A050 notes did not always have complete documented justification.

In addition, although the concerns were specifically directed at the 47A050 notes, similar notes were found at Bellefonte during investigation for element 220.3. These notes, 3GA0059 series drawings, were found to be reasonable and clear. However, some 3GA0059 notes did not have complete documented justification. Browns Ferry does not have any notes similar to the 47A050 notes.

4.2 "Design of Pipe Supports"- Element 220.3

The pipe supports reviewed by the evaluation team were found to be adequately designed for Sequoyah, Browns Ferry, and Bellefonte, but the calculation documentation was incomplete, or contained minor discrepancies. For Watts Bar, the above remarks apply in general. In addition, four Watts Bar pipe supports (1-74-11, 47A060-3-23, 47A060-70-27, and 1-63-404) did not meet code stress allowables because incorrect loads or load combinations had been applied.

The Sequoyah calculations for nine supports (2-MSH-315, 2-MSH-348, 1-AFDH-328, 1-CVCH-100, 1-RCH-302, 1-UHIH-130, 2-SGBH-290, 2-RHR-449, 2-CSH-5) provided justification of changes to the supports, but no analysis was included for the

original designs. From a general review (based on support configuration and size, and design loads) of these nine supports, the evaluation team determined that eight were adequately designed for the specified loads (Ref. 24). The adequacy of the remaining support, 2-CSH-5, could not be easily verified because of the complexity of the structure, its relationship with common supports, and the magnitude of the load. Complete reanalysis would be required, which is covered in the corrective action plan (CAP) for CATD 220 03 SQN 01. Under this CAP the adequacy of support 2-CSH-5 would be established, and modifications would be provided if necessary.

With the exception of Browns Ferry's General Design Criteria for the Long-Term Torus Integrity Program (LTTIP) BFN-50-D706 (Ref. 16), the pipe support design criteria for Sequoyah, Watts Bar, Browns-Ferry, and Bellefonte were found to adequately address the necessary seismic design requirements. The criteria for the Browns Ferry plant-specific LTTIP lack deflection/rigidity requirements. Browns Ferry supports designed under these criteria are to be reevaluated under the Browns Ferry instruction for the calculation verification program (Ref. 49). Browns Ferry has not completed its commitment to issue criteria for box anchors and a pipe support handbook. In addition, the punching shear requirement for tube-to-tube connections was not included in the pipe support design criteria for the four plants, contrary to TVA policy memorandum PM 86-04 (Ref. 50).

Bellefonte design loads and allowable stresses were found to deviate from the ASME Section III-1974 NF code (Ref. 51); however, these deviations were reviewed and approved by the Nuclear Regulatory Commission. In addition, it was found that a section of the Bellefonte Final Safety Analysis Report (FSAR) (Ref. 52) was missing some provisions for one load condition due to an oversight by TVA. This load condition is included in the design criteria and considered in design. An additional finding was made concerning the lack of complete documented justification for some of the 3GA0059 series drawing notes. (See summarized findings for element 220.1.)

The findings for element 220.3 for all four plants do not include review of specific requirements for base plates and anchorage bolts (e.g., base plate flexibility, anchorage bolt safety factor, construction tolerance), as these requirements are addressed in Construction Subcategory Report 10400 (Ref. 53).

Rigidity is a major factor in determining the design loads. Since the rigidity of supports is considered in the analysis of seismic piping, and, therefore, reflected in the resulting support design loads, the supports are sufficiently designed to prevent them from breaking loose during a seismic event.

4.3 "Revision to Hanger Designs" - Element 220.6

Pipe support revisions are adequately controlled in accordance with applicable procedures. In the review of Watts Bar unit 1 pipe supports, the evaluation team observed only three support drawings (out of the listing of 11,300 supports from TVA's Hanger Tracking Program Report, Ref. 28) that were revised a maximum of 11 times. The average number of revisions of all supports was noted as four, which is reasonable.

4.4 "Installation-related Technical Decisions" - Element 220.7

There is no indication that the crafts or any other TVA Construction personnel assumed responsibilities beyond those called for in the applicable FCR procedure, or that Engineering revised design drawings without required analysis or evaluation.

4.5 "Oversizing of Pipe Support Steel and Slick Grinding of Welds" - Element 220.9

It is possible that a pipe support member may have appeared to be oversized for the load; however, there are other design requirements, such as deflection/rigidity, that need to be met. Although a properly performed slick-ground weld is not an undesirable condition, the practice of slick grinding is unnecessary and has been discontinued by TVA.

4.6 "Replacement Hangers" - Element 220.10

TVA has a quality control procedure (QCP) (Ref. 32) which requires verification that the pipe supports are installed within specified tolerances. Any changes (out of tolerance, replacement, or deletion) are evaluated and documented by field change requests (FCRs) and engineering change notices (ECNs).

4.7 "Temperature Variation Consideration" - Element 220.11

Additional loading due to the thermal expansion of structural members restrained between two rigid points was not considered at Sequoyah, Watts Bar, Browns Ferry, and Bellefonte because it was not a code requirement. However, if the temperature variation is considerable, a support configuration that is thermally restrained could experience considerable thermal loading. Watts Bar has since addressed this condition in its corrective action for Problem Identification Report (PIR) WBN CEB8536. There is no indication that this restraint condition exists at Browns Ferry. Bellefonte has addressed this thermal restraint condition in its corrective action for PIR BLN CEB8512.

Pipe expansion imposed loads on the supports are considered at Sequoyah, Watts Bar, Browns Ferry, and Bellefonte and are addressed in the applicable pipe stress analysis and support criteria.

4.8 "Technical Review" - Element 220.12

Technical review after the checker's review is not required by applicable TVA procedures. These procedures meet the licensing commitments for design calculation verification required by 10 CFR 50 (Ref. 4) and ANSI N45.2.11-1974 (Ref. 5). In addition, TVA (civil engineering branch chief) had conducted an independent review of WBN pipe support calculations to verify technical adequacy and compliance with pertinent controlling documents and procedures (Ref. 48).

4.9 Summary of 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, defined in the Glossary Supplement, is identified in the table by the numeral combined with the finding class. For element 220.3, some of the issues were found to be invalid, although corrective action was still required for the documentation and/or procedures. These findings requiring corrective action were classified as "E"; however, they cannot be genuinely classified as peripheral because of the integral relationship with the stated issue. In addition, for element 220.11, Issue "c" was classified as "B" because Browns Ferry took immediate corrective action after 1975 and no further action was required.

The summary of findings by classification is given in Table 2. Where more than one finding/corrective action classification is listed in Table 1 for a single issue/finding, Table 2 counts only the classification that has the greater impact on the Employee Concerns Program. Thus for element 220.3, the "D" classification would be chosen over the "C" and the "E" classification over the "A." Therefore, Table 2 identifies only one finding/corrective action classification for each issue evaluated.

For Table 2 it can be seen that the majority of issues were not valid. Approximately half of the issues requiring corrective action have corrective action plans that were initiated by TVA before the ECTG evaluation. This is an indication that TVA is responsive in acting to correct known deficiencies. The most important finding, that Watts Bar did not meet code stress allowables, resulted from the ECTG evaluation.

(-SOUTH-)ngs requiring corrective action resulting from peripheral issues occurring at Sequoyah, Browns Ferry, and Bellefonte dealt basically with design documentation. Although the supports were found to be adequately designed, the design calculation documentation was not always complete and/or contained minor discrepancies.

In addition, the subject of irretrievable calculations is addressed in Subcategory Reports 21200 and 22100. (This subcategory report [22000] deals mainly with technical, not documentation issues.)

5. CORRECTIVE ACTIONS

The corrective actions for Sequoyah, Watts Bar, Browns Ferry, and Bellefonte along with their finding/corrective action classifications, are summarized in Table 3. The corrective action descriptions in the table are a condensation of the more detailed corrective action information provided in Attachment B. The table 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. The corrective action plans are summarized in the following paragraphs.

5.1 "A" Series Hanger Drawings and 0-50 Notes" - Element 220.1

For Sequoyah, the differences between the construction specification and operations maintenance instruction will be reconciled. For Watts Bar, calculations for justification of the WBN 47A050 notes will be provided; and WBN Engineering (DNE) will reinform Construction (DNC) and Quality Control (DNQC) by memo of the programs in place to help resolve 47A050 note interpretational differences.

5.2 "Design of Pipe Supports" - Element 220.3

For Sequoyah, calculations will be performed for the nine pipe supports. For Watts Bar, code stress allowables will be met, and engineering judgment will be properly documented for all engineered pipe supports under its unit 1 Hanger and Analysis Update Program (Ref. 54) and a similar program for unit 2. The four Watts Bar pipe supports not meeting code stress allowables will be reevaluated. For Browns Ferry, the Box Anchor Criteria and Pipe Support Handbook are to be issued. The Long-Term Torus Integrity Program criteria are to be revised to include deflection/rigidity and punching shear requirements. The Browns Ferry pipe support calculation lacking analysis for the critical base plate is to be revised. For Bellefonte, FSAR Table 3.9.3-37 (Ref. 52) will be revised to include load and allowable stress for the upset (primary plus secondary) condition. The computer output for the eight identified Bellefonte calculations will be retrieved by ITT Grinnell.

Complete documented justification will be provided for the 3GA0059 series notes. Two-sided welds on tubing at Bellefonte will be evaluated and modified if required. The punching shear requirement will be incorporated into Civil Design Standard DS-C1.6.1 (Ref. 55), which covers all plants and applicable design criteria. Generic evaluations were performed on previously generated calculations for punching shear.

5.3 "Temperature Variation Consideration" - Element 220.11

For Sequoyah, steel supports with the identified condition that restrains thermal growth will be evaluated and modified as necessary. For Watts Bar, corrective action for this restraint condition is provided by PIR WBN CEB8536 (Ref. 36), which includes the activities as described for Sequoyah. For Browns Ferry, no corrective action is required. For Bellefonte, corrective action for this restraint condition is provided by PIR BLN CEB8512 (Ref. 56).

5.4 Summary of Subcategory Corrective Actions

From the Finding/Corrective Action Classification column of Table 3, it can be seen that all seven corrective actions identified require some type of documentation remedy. In addition, the CATD column of the table shows that, in most cases, a particular corrective action is applicable to only a single plant. The element requiring the most corrective actions is 220.3, Design of Pipe Supports. There is a potential for the corrective actions for the Element 220.3 to result in physical (hardware) modification of supports. Finally, with respect to corrective actions, Table 3 shows that, of the eight elements in this subcategory, five require no corrective action (namely, 220.6, 220.7, 220.9, 220.10, 220.12).

The corrective action plans provided by TVA are found to be acceptable by the evaluation team to resolve the negative findings.

6. CAUSES

Table 3 identifies one or more causes for each negative finding requiring corrective action. For each corrective action, the most important cause is identified; however, in many instances it was felt that the problem was the result of a combination of causes, each of which should be identified. In those cases, more than one cause is identified for some of the corrective actions.

The bases for identifying specific causes for each corrective action description in Table 3 and the linkage with the findings are described in the following paragraphs.

6.1 "'A' Series Hangers and O-50 Notes" - Element 220.1

- o The differences between Sequoyah M&AI-11 and General Construction Specification G-43 (applicable to all plants) are caused by lack of comparability between the two documents.
- o The subject Watts Bar calculation for the justification of the 47A050 notes is specified as an "Inadequate Calculation" in Table 3 because the necessary analysis was not performed, and engineering judgment, as well as test data and reference material, were not properly documented.
- o 47A050 note interpretational differences at Watts Bar are a result of "Inadequate Q-training" and "Inadequate Communication." Personnel are not fully aware of the programs in place to resolve these differences in interpretation.

6.2 "Design of Pipe Supports" - Element 220.3

- o The subject Sequoyah pipe supports calculations are "Inadequate Calculations" because procedures were not followed, engineering judgments were not properly documented, and there was an overall lack of completeness.
- o Calculations at Watts Bar are "Inadequate Calculations" because engineering judgments were not being properly documented and design procedures were not being followed.
- o The four Watts Bar pipe supports do not meet code stress allowables because design procedures were not being followed and engineering judgments were not properly documented.
- o The punching shear requirement for tube steel is not included in the design criteria of all four plants. The cause is specified (in Table 3) as "Inadequate Procedure" although the requirement is not a code commitment.
- o Browns Ferry is to complete its commitment to issue the Box Anchor Design Criteria and Pipe Support Handbook. In this case, it is normal handling of documentation. Browns Ferry will revise criteria BFN-50-D706 to include the deflection/rigidity requirement. These criteria were inconsistent with other Browns Ferry pipe support criteria (which included this requirement). However, on the basis of industry standards during plant construction, a deflection/rigidity evaluation was not a code requirement.

- o The calculation for Browns Ferry support RHR-159, unit 3, is an "Inadequate Calculation" because it lacked the analysis for critical base plates and assumptions on which engineering judgments are based.
- o The design load and allowable stress for the upset (primary plus secondary) condition were inadvertently left off Bellefonte FSAR Table 3.9.3-37 but were included in the design criteria.
- o The eight Bellefonte pipe support calculations, whose computer output is with ITT Grinnell, cannot be considered complete. Justification for some of the 3GA0059 notes may have been qualified by engineering judgments but not documented.
- o At Bellefonte, the shorter flat (installed) length of weld to tube steel is not considered in the design calculations. It is possible that designers were not aware of this site practice.

6.3 "Temperature Variation Consideration"- Element 220.11

- o The identified restrained thermal condition for pipe supports at all four plants was not considered because it was not a requirement specified in the design criteria. The cause is noted as "Inadequate Procedure" although this requirement is not a code commitment.

6.4 Summary of Subcategory Causes

In summary, considering the significance of the findings and corrective actions, it would appear that the most important cause would be "Inadequate Calculations." The "Inadequate Calculations" are also a result of procedures not being followed and failure to document engineering judgment. These causes point to an overall lack of attention paid to the adequate documentation of calculations required to demonstrate adherence to design commitments.

7. COLLECTIVE SIGNIFICANCE

The concerns expressed by TVA employees and covered in this subcategory resulted in approximately a third of the 42 findings (from Table 2) requiring corrective actions. Corrective action for approximately half of these findings had been initiated by TVA before the ECTG evaluation.

The findings for Sequoyah and Watts Bar 47A050 notes, and Bellefonte 3GA0059 notes and FSAR require only documentation corrective action. They do not directly impact the design of pipe supports, and, therefore, are of relatively minor significance.

Also of minor significance are the findings for punching shear and thermal considerations. Consideration of punching shear on support design has little effect on the overall member stresses because of the nature (configuration and size) of pipe supports. Thermal loads (due to environmental temperature) also have little impact on the overall member stresses provided that the configuration of the support structure is such that thermal stresses are self-relieving (i.e., structural members are allowed, to a degree, to thermally expand without restraint or undergo local yielding/distortion to relieve these stresses).

In the cases where the support structure is restrained from thermal expansion (e.g., member between two concrete walls), there is the possibility of member overstress. However, TVA has committed to evaluate and modify, if necessary, such cases. In addition, for Browns Ferry, although deflection/rigidity must be considered in the design of seismic pipe supports, this requirement in general is not the governing design factor.

The pipe supports reviewed by the evaluation team were adequately designed to applicable design criteria, with the exception of four Watts Bar pipe supports. The calculations were not always properly documented. Failure to document engineering judgment, analysis, or other related data (test data, memorandums, reports, etc.) was the most prevalent cause of the calculational deficiencies. It was observed that the items most frequently not documented were relatively minor and had little impact on the overall analysis of the supports. Therefore, pipe support design does not represent a significant technical or safety problem for Sequoyah, Browns Ferry, and Bellefonte. However, TVA is aware of the need for proper documentation in the area of pipe support design, and has initiated corrective action to improve the quality of the documentation.

Of technical significance are the four Watts Bar supports that do not meet code stress allowables. It was evident that design procedures were not properly followed, and thus design commitments were not met. However, Watts Bar had committed to reevaluating these support and providing hardware modifications if necessary. In addition, Watts Bar's commitment under its Hanger and Analysis Update Program (and similar program for unit 2) extends to all engineered pipe supports. Under this program, TVA will identify and correct document deficiencies, and if required, provide hardware modifications.

On the basis of these conclusions, the subject matter of this subcategory report does not require specific treatment in the TVA Nuclear Performance Plan. The results of this subcategory report are being combined with the other subcategory reports and reassessed in the Engineering category evaluation.

TABLE 1
CLASSIFICATION OF FINDINGS AND CORRECTIVE ACTIONS

Element	Issue/ Finding**	Finding/Corrective Action Class*			
		SQN	WBN	BFN	BLN
220.1 "A" Series Drawing and U-50 Notes	a	A	C3	-	-
	b	A	C2	-	-
	c	C2	A	-	-
	d	-	A	-	-
	e	-	A	-	-
	f	-	A	-	-
220.3 Design of Pipe Supports	a	A	C2	A	A
		E5	C3	E2	E2
		-	D5	-	E3
		-	-	-	E5
	b	A	A	A	A
		-	-	E2	-
	c	A	A	A	A
		-	-	E2	-
		-	-	E5	-
	d	A	A	A	A
e	-	-	-	E3	
220.6 Revisions to Hanger Designs	a	-	A	-	-
220.7 Installation-related Technical Decisions	a	-	A	-	-
	b	-	A	-	-
220.9 Oversizing of Pipe Support Steel and Slick Grinding of Welds	a	-	A	-	-
	b	-	B	-	-
220.10 Replacement Hangers	a	A	-	-	-

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

TABLE 1 (Continued)

<u>Element</u>	<u>Issue/ Finding**</u>	<u>Finding/Corrective Action Class*</u>			
		<u>SQN</u>	<u>WBN</u>	<u>BFN</u>	<u>BLN</u>
220.11 Temperature Variation Consideration	a	C5	C5	A	C5
	b	A	A	A	A
	c	-	-	B	-
220.12 Technical Review	<u>a</u>	-	A	-	-

*Classification of Findings and Corrective Actions

- | | |
|--|------------------|
| A. Issue not valid.
No corrective action required. | 1. Hardware |
| B. Issue valid but consequences acceptable.
No corrective action required. | 2. Procedure |
| C. Issue valid. Corrective action
initiated before ECTG evaluation. | 3. Documentation |
| D. Issue valid. Corrective action
taken as a result of ECTG evaluation. | 4. Training |
| E. Peripheral issue uncovered during ECTG
evaluation. Corrective action required. | 5. Analysis |
| | 6. Evaluation |
| | 7. Other |

**Defined for each plant in Attachment B.

TABLE 2
FINDINGS SUMMARY*

<u>Classification of Findings</u>	<u>Plant</u>				<u>Total</u>
	<u>SQN</u>	<u>WBN</u>	<u>BFN</u>	<u>BLN</u>	
A. Issue not valid. No corrective action required.	7	13	3	4	27
B. Issue valid but consequences acceptable. No corrective action required.	0	1	1	0	2
C. Issue valid. Corrective action initiated before ECTG evaluation.	2	3	0	1	6
D. Issue valid. Corrective action taken as a result of ECTG evaluation.	0	1	0	0	1
E. Peripheral issue uncovered during ECTG evaluation. Corrective action required.	1	0	3	2	6
Total	10	18	7	7	42

* Note: This table summarizes information extracted from Table 1.

TABLE 3
MATRIX OF ELEMENTS, CORRECTIVE ACTIONS, AND CAUSES
SUBCATEGORY 22000

ELEM	FINDING/ CORRECTIVE ACTION CLASS.**	CORRECTIVE ACTION	CATD	CAUSES OF NEGATIVE FINDINGS *																	Signifi- cance of Corrective Actions*		
				MANAGEMENT EFFECTIVENESS							DESIGN PROCESS EFFECTIVENESS							TECHNICAL ADEQUACY					
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17			
				Frag- ment- Organi- zation	Inade- quate Q- trng	Inade- quate Proce- dures	Proce- dure Not Fol- lowed	Inade- quate Com- muni- cation	Un- timely Res of Issues	Lack of Mgt Atten	Inade- quate Design Bases	Inade- quate Recon- cili.	As-blt of Detail	Lack of Docu- ment	Engrg Design Not Met	Crit/ Verif Docu- ment	Insuf- ficient Fol- lowed	Stds Not Engrg Error	Vendor Error				
			D	M	H																		
220.3	E2	BFN Box Anchor Design Criteria and Pipe Support Handbook will be issued 08/31/87. BFN-50-0706 will be revised to include deflection/rigidity requirements.	BFN 01																		A	P	P
	E5	Calculation for BFN support RHR-159 unit 3 will be revised to include analysis for critical base plates and assumptions used to qualify shear force on the anchor bolts.	BFN 01							X											A	-	-
	E2	BLN FSAR Table J.9.3-37 will be revised to include load and allowable stress for upset primary plus secondary condition.	BLN 01																		A	-	-
	E3	Computer output for the eight identified BLN supports will be retrieved from ITT Grinell. Adequately documented justification for the 3GA0059 Series notes will be provided in the corrective action for CAQR BLF 870126.	BLN 01							X											A	-	-
	E5	Two-sided welds on tubing at BLN will be evaluated and modified, if necessary, through corrective action for CAQR BLF 870098.	BLN 01								X										A	P	P

* 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:

- o 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.
- o 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.
- o 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.