# EMPLOYEE CONCERNS

## SPECIAL PROGRAM

VOLUME 2
ENGINEERING CATEGORY

SUBCATEGORY REPORT 23100
FIRE PROTECTION DESIGN

## UPDATED

TVA

NUCLEAR POWER

TVA EMPLOYEE CONCERNS SPECIAL PROGRAM

REPORT NUMBER: 23100

REPORT TYPE: SUBCATEGORY REPORT FOR ENGINEERING

REVISION NUMBER: 4

TITLE: FIRE PROTECTION DESIGN



REASON FOR REVISION:

1. Revised to incorporate SRP comments.

2. Revised to incorporate SRP and ECSP Operations and Construction Category review comments and to incorporate approved corrective action plans.

3. Revised to incorporate TAS comments; added Attachment C (References).

4. Revised to incorporate SRP and TAS comments.

PREPARATION

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TVA EMPLOYEE CONCERNS
SPECIAL PROGRAM

SUPPLEMENT TO: SUBCATEGORY REPORT FOR ENGINEERING

REPORT NUMBER 23100, REV. 4

TITLE: FIRE PROTECTION DESIGN

4 PAGES OF SUPPLEMENT SHEETS TO ADDRESS NRC SER COMMENTS ON SQN ELEMENT REPORTS 231.01, 231.04, AND 231.05

PREPARED BY: [signature] SIGNATURE 4/21/88 DATE

REVIEW COMMITTEE: [signature] SIGNATURE 4/27/88 DATE

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[signature] SIGNATURE 4/27/88 DATE

Page ES-1 of 2 - Revise the first bullet to read:

"o Improper pipe size, configuration and connection methods"

Page 6 of 54 - Add the following sentence to the first bullet entitled "231.1 undersized distribution headers":

"Welding of smaller diameter pipes to larger diameter pipes in the absence of proper connection fittings could cause flow restrictions."

Page 8 of 54 - After the first sentence of Section 3.1 entitled "Undersized Distribution Headers - Element 231.1" insert the following:

"In performing their SER evaluations on Element Report 231.01(B) for SQN the NRC raised an additional possible interpretation of concern BNP-QCP-10.35-8-16. The words "welding smaller diameter pipes to larger diameter pipes" read in conjunction with the words "...could restrict the flow of water" were taken to address connection methods of branch lines. This prompted a review of TVA piping and welding standards (Ref. 172) where the evaluators discovered a welding detail that allowed a header pipe to be drilled to the O.D. of a takeoff pipe to permit insertion of the takeoff line. The takeoff pipe could then be inserted and fillet welded to compete the coupling. Since this detail did not show any mechanism by which insertion length would be limited, the presumption was that it could be inserted to any depth. This arrangement would mean that the take-off pipe would adapt the configuration similar to a full penetration thermowell in the header pipe. In such a case, both header flow and takeoff flow would be restricted.

"To determine whether or not this was the case the fire protection drawings for each plant were reviewed (Ref. 177, 178, 179). Specific requirements for the installation detail in question were not evident. This was then supplemented by physical inspection of completed installations at SQN and BLN. (Refs. 173 and 174). These field surveys were to assess whether such installations actually existed through generic application of the welding detail in question. The surveys found none. In each plant, the take-offs in question employed either threaded fittings or used socket weld forged fittings (e.g., weldolets). Insertion of the nature alleged is impossible in either case. Threaded fittings will "bottom out" and the forged fittings have a machined shoulder that limits take-off pipe insertion lengths. Further, since both types of weld fit-ups are easier than the type suggested in the detail, there is little incentive to use it. On the basis of the drawing reviews for each plant, the SQN and BLN positive survey findings and the rationale that there is little incentive to use this particular detail, the evaluation team concluded that additional surveys at WBN and BFN were not necessary to close this interpretation of the concern. Assuming the . . ."

Page 20 of 54 - Add the following paragraph after the last paragraph on this page:

"In performing their SER evaluation of Element Report 231.04(B) for SQN, the NRC paired the subject of prompt reconciliation of design drawings with as-built conditions. Whether through FCR's or other change documents, these issues are treated in greater detail in Subcategory Report 206.00 and are not directly part of the Concern IN-86-305-022. No further review was therefore conducted."

Page 21 of 54 - Add the following paragraph as the first paragraph to Section 3.5.1, "Background":

"TVA's initial commitments on the general subject of enhanced fire protection were made in early 1977 (Ref. 175) and later revised (Ref. 176). The later revision more specifically addressed the Diesel Generators and Battery Room Ventilation Systems but does not mention hydrogen generation or overall design adequacy in detail.

"Irrespective of the full history of the subject, . . . "

Appendix B, Page 2 of 23 - Revise SQN issue "a" to read as follows:

"a. Change in pipe size and welding of smaller diameter pipes to larger diameter pipes could cause flow restrictions."

Appendix B, Page 2 of 23 - Add the following sentence to the end of SQN finding "a":

"No flow-limiting welded connections were found to exist in the SQN FPS."

Appendix B, Page 3 of 23 - Revise WBN issue "a" to read as follows:

"a. Change in pipe size and welding of smaller diameter pipes to larger diameter pipes could cause flow restrictions."

Appendix B, Page 3 of 23 - Add the following paragraph to the end of WBN finding "a":

"Based on review of drawing details for WBN and results of surveys conducted at SQN, a sister station to WBN, as well as BLN there is a strong presumption that no welded connections of the type that could restrict flow exist in the WBN FPS."

Appendix B, Page 4 of 23 - Revise BFN issue "a" to read as follows:

"a. Change in pipe size and welding of smaller diameter pipes to larger diameter pipes could cause flow restrictions."

Appendix B, Page 4 of 23 - Add the following sentence to the end of BFN finding "a":

"Based on the BFN drawing review and successful surveys at other TVA units, there is a strong presumption that welded connections which could restrict FPS flow were not not used at BFN."

Appendix B, Page 4 of 23 - Revise BLN issue "a" to read as follows:

"a. Change in pipe size and welding of smaller diameter pipes to larger diameter pipes could cause flow restrictions."

Appendix B, Page 4 of 23 - Add the following sentence to the end of BLN finding "a":

"No flow-limiting welded connections were found to exist in the BLN FPS."

Page C-12 of 12 - Add the following references:

172. TVA General Construction Specification G-29M, R21, Welding Standard M.2-10, R5, "Mechanical Weld Joint Detail Branch Connections," Detail BC-2 (07/11/85)

173. Bechtel Memo from S. Mable to L. Damon/K. Wiedner, "Fire Protection System Walkdown, SQN Units 1 and 2," (04/06/88)

174. Bechtel Memo from S. Mable to L. Damon/K. Wiedner, "Fire Protection System - BLN," (04/11/88)

175. TVA Letter to NRC, J. E. Gilleland to R. S. Boyd, "Sequoyah Units 1 & 2 Fire Protection/Prevention Program Reevaluation," (770128H0730), (01/24/77)

176. TVA Letter to NRC, J. E. Gilleland to S. A. Varga, "Response to ASB Fire Protection Review Questions," (790315H0198), (DES "790313 036), (03/08/79)

177. WBN Drawings:

47W490-1 thru 21, "Mechanical Service Water, Air & Fire Protection"
47W491-1 thru 104, "Mechanical Service Air, Water and Primary Water Makeup"
47W492-1 thru 16, "Mechanical Service Air, Demineralized & Primary Water and Fire Protection (HPFP)"

178. BFN Drawings:

47W490-1 thru 19, "Mechanical Service Water, Air & Fire Protection"
47W491-1 thru 45, "Mechanical Service Water, Air & Fire Protection"

179. BLN Drawings:

3CWO 449-RF-01 thru 13, "Mechanical High Pressure Fire Protection"

3RWO 450-RF-01 thru 11, "Mechanical High Pressure Fire Protection"

3BWO 471-00-01 thru 74 "Mechanical Service Water, Air and Fire Protection"

3DWO 598-00-02/10, "Mechanical Exposed Piping"

## EXECUTIVE SUMMARY

This subcategory report summarizes and evaluates the results of 16 Employee Concerns Special Program (ECSP) element evaluations prepared under Engineering Subcategory 23100, Fire Protection Design. Fire protection design has long been recognized as an industry-wide problem, not something specific to TVA. The long evolutionary process of developing existing criteria, and the vagueness of initial NRC guidance, have resulted in many changes in and modifications to all U.S. nuclear power plants. Many of these changes are tied to the licensing time frame of the particular plant in question. As such, issues presented by this subject matter do not provide a clear perspective from which one can examine the impact of TVA's general management effectiveness, etc. The TVA Revised Nuclear Performance Plan should, nevertheless, improve TVA responsiveness to evolving NRC criteria such as fire protection.

The element evaluations encompass the review of 41 fire protection design issues related to TVA's four nuclear power plants: Sequoyah, Watts Bar, Browns Ferry, and Bellefonte. The issues were derived from the 11 employee concerns that cited presumed deficiencies or inadequacies in the fire protection systems such as:

- o Improper pipe size and configuration
- o Improper use of water spray
- o Obstructions to water spray
- o Lack of fire dampers
- o Inadequate battery room ventilation
- o Incorrect application of quality assurance requirements

Of the 41 issues evaluated, 21 were found to require no corrective action. For eight issues, TVA had initiated corrective actions before the start of the ECSP. Seven findings require new corrective action. In addition, five peripheral findings were uncovered, which also require corrective action. A total of 11 different corrective actions were identified to remedy the 20 issues with negative findings.

The most probable antecedent conditions leading to the 11 corrective actions have been identified. Six of these are the consequence of the initial vagueness and evolving nature of NRC guidelines and criteria for nuclear power plant fire protection. Three represent a failure to apply design criteria for battery room ventilation consistently, one reflects fragmented authority, and one represents a failure to produce as-built documents in a timely manner. Three of the 11 corrective actions were judged to be significant. They involve actual or potential changes in hardware. They are:

- Complete program to upgrade fire protection systems to conform to NFPA 13 and NRC guidelines
- Complete sprinkler obstruction review program
- Investigate possible incorrect invalidation of nonconforming condition reports (NCRs)

All three of these corrective actions were initiated by TVA and respond to regulatory changes or actual deficiencies that were identified by TVA, all before the start of the ECSP. On the basis of the issues evaluated in this subcategory and the corrective actions completed or proposed, the fire protection systems do not now present a significant technical problem at Sequoyah, Watts Bar, Browns Ferry, or Bellefonte nuclear power plants. This finding of present conditions does not imply that at one time these systems may have presented a significant technical problem. The evolving nature of fire protection requirements, the different licensing time frames for each plant during this evolutionary process, and the limited evaluative scope of the employee concerns program preclude an assessment of TVA's compliance at any given time in the past.

The most reasonably derivative causes identified herein are being compared with other evaluation results and reexamined from a wider perspective in the Engineering category evaluation.

## 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 those investigations are communicated by four levels of ECSP reports: element, subcategory, category, and final.

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

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

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

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

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

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

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

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

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

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

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

## ECSP GLOSSARY OF REPORT TERMS*

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

Class A: Issue cannot be verified as factual

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

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

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

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

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

concern (see "employee concern")

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

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

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

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

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

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

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

K-form (see "employee concern")

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

root cause the underlying reason for a problem.

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

## Acronyms

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

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

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

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

CONTENTS



TABLES

## 1. INTRODUCTION

This subcategory report summarizes and evaluates the results of the ECSP element evaluations prepared under Engineering Subcategory 23100, Fire Protection Design. The elements evaluate presumed deficiencies and inadequacies in the fire protection systems, such as:

- Improper piping size and configuration
- Use of water spray on electrical panels
- Obstruction to sprinkler head water spray patterns
- Lack of fire dampers
- Inadequate provisions to prevent hydrogen accumulation in battery rooms
- Improper application of quality assurance requirements

Employee concerns provide the basis for the element evaluations. These concerns are listed by element number in Attachment A. The plant site where the concern was originally identified is also listed.

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

- Section 2 -- summarizes, by element, the issues stated or implied in the employee concerns and addresses the determination of generic applicability
- Section 3 -- outlines the process followed for the element and subcategory evaluations and cites documents reviewed
- Section 4 -- summarizes, by element, the findings and identifies the negative findings that must be resolved
- Section 5 -- highlights the corrective actions required for resolution of the negative findings cited in Section 4 and relates them to element and to plant site
- Section 6 -- identifies causes of the negative findings
- Section 7 -- assesses the significance of the negative findings

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

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

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

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

Related fire protection issues are found in subcategory reports: 17100, Mechanical; 24500, Incorporation of Requirements, Commitments, and Experience in Design; and 30600, Fire Protection.

## 2. SUMMARY OF ISSUES/GENERIC APPLICABILITY

The 11 employee concerns listed in Attachment A for each of the six elements and four plants have been examined, and the potential problems raised by the concerns have been identified as 41 separate issues. The issues, presented in Attachment B, were reviewed in 16 element evaluations. Some concerns raised multiple issues. In others, the issue was applicable to other plants, and was treated as a separate issue because any corrective action was initiated by a different organization.

2.1 Generic Applicability

The generic applicability of the six elements to each of the four plants is summarized below:

| | Element | Applicable To: SQN | WBN | BFN | BLN |
|---|---|---|---|---|---|
| 231.1 | Undersized Distribution Headers | Yes | Yes | Yes | Yes |
| 231.2 | Electrical Panels Not Protected from Sprinklers | No | Yes | No | No |
| 231.3 | Sprinkler Head Spray Pattern Interference | No | Yes | No | No |
| 231.4 | Lack of Fire Dampers in Additional Diesel Generator Building | Yes | Yes | No | No |
| 231.5 | Adequacy of Battery Room Ventilation System Design | Yes | Yes | Yes | Yes |
| 231.6 | Fire Protection QA Designation | Yes | Yes | Yes | Yes |

Elements 231.1, 231.5, and 231.6 were identified as being applicable to all four plants, and the concerns were evaluated accordingly.

Element 231.2 was determined to be applicable only to WBN because the concern identified specific WBN electrical panels that were not protected from sprinklers. The element was not made applicable to the other plants because the WBN concerns did not result in any corrective actions or findings of unacceptable designs.

Element 231.3 was also applicable only to WBN because of a reference to specific WBN sprinkler head locations. The element was not made applicable to the other three plants because it was found that the concern had already been addressed at WBN by an existing inspection program (Ref. 58) required by Technical Specification 4.7.11.2.C.3. It was assumed that similar technical specifications existed for the other plants. A TVA letter to NRC (Ref. 58) also identified that the sprinkler deficiency problems were "addressed by TVA and the NRC at Browns Ferry and Sequoyah Nuclear Plants during the plant licensing process." The letter also identified that "a program has been implemented at Bellefonte Nuclear Plant to address sprinkler deficiencies."

Element 231.4 was applicable to SQN and WBN because only these plant sites had the Additional Diesel Generator Building identified in the concern.

## 2.2 Summary of Issues

The 41 issues evaluated under this subcategory, organized by element, are summarized below:

- 231.1, Undersized Distribution Headers - Welding small pipes to large pipes could result in flow restrictions. Review of such piping by an independent authority is recommended (all plants). At Sequoyah and Watts Bar, high pressure fire protection system piping sizing and configuration are not in accordance with National Fire Protection Association (NFPA) requirements.

- 231.2, Electrical Panels Not Protected from Sprinklers - 6900-volt shutdown boards at Watts Bar are not protected from fire protection water spray and will fail if the water spray system is actuated. (Note that one concern identified the 6900-volt switchgear for the reactor coolant pumps [RCPs]. Because the RCP switchgear is in another location not subject to sprinklers, this issue was assumed to relate to the 6.9 kV shutdown boards.)

- 231.3, Sprinkler Heads Spray Pattern Interference - There are obstructions at Watts Bar which will compromise the effectiveness of the fire protection system water spray.

- 231.4, Lack of Fire Dampers in Additional Diesel Generator Building - There are no fire dampers in the Additional Diesel Generator Building between the engine room and the fan room at Sequoyah and Watts Bar; this situation could permit the spread of fire.

- 231.5, Adequacy of Battery Room Ventilation System Design - The design of the battery room heating and ventilating system is inadequate. Hydrogen could accumulate, especially if battery room fans failed. Electric heaters could ignite this hydrogen.

- 231.6, Fire Protection QA Designation - Requirements for limited QA (quality assurance) for fire protection systems were contradicted by engineering drawings. At Bellefonte, such requirements were improperly applied.

The first three elements for which the issues are summarized above (elements 231.1, 231.2, and 231.3) deal with presumed design deficiencies in the main power plant (Reactor Building, Auxiliary Building, and Control Building). Element 231.4 deals with similar presumed deficiencies in the Additional Diesel Generator Buildings. Element 231.5 relates to the battery rooms in both the main power plant and the Diesel Generator Buildings. Finally, element 231.6 deals with QA requirements.

Of the 41 issues identified, 38 were valid - that is, factual. Twenty of the 38 required corrective action. Of these 20, TVA had identified eight and initiated corrective actions before the start of the ECSP, and five were peripheral findings identified during the ECSP. Eighteen of the 38 issues that were valid required no corrective action; the existing conditions are acceptable. Only three of the 41 issues could not be verified as valid. Two of the three were the result of a TVA decision to evaluate a Watts Bar concern at Browns Ferry and Bellefonte. The third was the result of the concerned individual's lack of knowledge about a specific sprinkler system.

Each issue evaluated for each element is stated fully in Attachment B, which also lists the corresponding findings and corrective actions that are discussed in Sections 4 and 5 of this report.

## 3. EVALUATION PROCESS

This subcategory report is based on the information contained in the applicable element evaluations prepared to address the specific employee concerns related to the issues defined in Section 2. The evaluation process in general consisted of the following steps:

Element Evaluation

a. Defined issues for each element from the employee concerns, and reviewed the working and expurgated files relating to each employee concern.

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

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

d. Reviewed applicable PSARs, FSARs, and Safety Evaluation Reports (SERs) to understand scope and basis of NRC review, to determine regulatory compliance, and to identify any open issues or TVA commitments related to the design.

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

Subcategory Evaluation

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

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

h. Prepared Tables 1, 2, and 3 to permit comparison and identification of common and unique issues, findings, and corrective actions among the four plants.

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

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

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

The evaluation process for each element and issue, including specific references to relevant documents (see Appendix C), is detailed in the following sections.

3.1 Undersized Distribution Headers - Element 231.1

Concern BNP-QCP-10.35-8-16 was raised about BLN but also relates to the Fire Protection Suppression System (FPSS) flow capacity in small diameter piping take-offs from larger diameter headers for all four plants. Assuming the header (i.e., the "larger diameter pipes" referred to in the concern) is adequately sized, it presents essentially an infinite capacity to the branch (i.e., the "smaller diameter pipes") lines. Whether or not the branch lines have adequate capacity depends upon the number and size of sprinklers each branch line must serve. The National Fire Protection Association (NFPA) Code establishes pipe size/service design parameters to ensure that these conditions are met. This concern, therefore, becomes one of compliance with NFPA code pipe sizing requirements.

The sizing of sprinkler system distribution headers in accordance with NFPA code requirements may be accomplished by one of two methods: "Pipe Schedules Method" (NFPA 13. Section 3-4, Ref. 19 ) or the "Hydraulic Calculation Method" (NFPA, Chapter 7). The Pipe Schedule Method allows for conservative sizing on the basis of restrictive tables, limitations on orifice size (1/2-inch only), and sprinkler quantity to pipe size ratios. The inherent conservatism of the Pipe Schedule Method allows for acceptable sizing in the absence of documented calculations. Both SQN and WBN initially used the pipe schedule method.

With the advent of 10 CFR 50.48 (Ref. 14) and Appendix R (Ref. 16), TVA found it necessary to retrofit certain portions of the SQN and WBN FPSS protecting safety-related equipment to meet new separations criteria requirements. In the process of making these modifications, TVA employed the more accurate hydraulic calculation method to verify the previously used pipe schedule method. Therefore, in the process of making changes to the FPSS for separations purposes on each plant, TVA also brought the pipe sizing and its methodology into conformance. This process, which coincidentally also resolved the concern, was documented with the NRC and reviewed by an independent insurance company or reliable authority as indicated below.

3.1.1 SQN Evaluation

The SQN Fire Protection System was initially designed in accordance with NRC Branch Technical Position (BTP) APCSB 9.5-1 (Ref. 18) and sized using the NFPA-13 Pipe Schedule Method based on ordinary hazard occupancies. The NRC evaluated the SQN FPSS against NFPA-13 and NFPA-15 (Ref. 53), as well as BTP APSCB 9.5-1, and in the SER (Ref. 10) found that:

> "Fixed water spray systems and sprinkler systems are designed according to the requirements of NFPA Standard No. 13, 'Standard for Installation of Sprinkler Systems,' and NFPA Standard No. 15, 'Standard for Water Spray Fixed System.'"

The NRC further concluded that:

> "Our conclusion, given in Section VII, is that the Fire Protection Program at the Sequoyah plant was adequate and met General Design Criterion 3. However, to further ensure the ability of the plant to withstand the damaging effects of fires that could occur, we required and the applicant has committed to provide additional fire protection system improvements. These additional fire protection features have been completed for Unit 1 and will be completed for Unit 2 prior to Unit 2 fuel load."

In addition to the NRC evaluation, SQN has been inspected by specially trained personnel working for the insurance underwriters, American Nuclear Insurance of Farmington, Connecticut (Refs. 11 and 12). This independent review, called a "Candidate Inspection," includes a physical walkdown of the unit. A finding of general compliance with NFPA requirements is a prerequisite to obtaining property insurance. SQN was issued Policy Number 5001 based on such an inspection confirming compliance with NFPA. Part of the requirements for retaining such coverage is a reinspection every 6 months with a finding of general compliance and with adjustments/improvements made by TVA in any areas suggested. In an October 8, 1986, telephone conference with V. Dudley, TVA Nuclear Insurance Program Manager, the evaluator established that the insurance has never been cancelled and is in effect at this time.

In response to 10 CFR 50.48 and Appendix R, a retrofit effort, initiated by SQN-DCR-D-2133 (Ref. 1), necessitated a series of walkdowns on a phased basis as described in H. L. Abercrombie's memo of December 7, 1984 (Ref. 3). The first phase included compliance with NFPA-13 criteria where fire suppression capability was required to meet Appendix R separation requirements, while the second phase continued the effort to the remaining plant areas containing safety-related equipment. These remaining areas either do not contain Appendix R required equipment or Appendix R requirements were met by fire barriers without dependence upon suppression systems.

On December 19, 1984, TVA issued Special Report 84-08 (Ref. 4) to the NRC advising that portions of the FPSS ". . . do not comply with the literal requirements of NFPA Standard 13, as committed to in the Fire Protection Program submitted and the SER Supplement I." Following this report, ECN L6319 (Ref. 6) was issued in January 1985 to continue the compliance efforts. In his memo of February 14, 1985 (Ref. 7), J. P. Vineyard expanded and clarified these efforts to include the following activities:

"(1) The 'As Constructed' location of the modified or added heads will be located on drawings which currently show the 'As Designed' location of sprinkler heads.

(2) 'As Constructed' locations of sprinkler piping which is added or relocated will be included in calculation packages as sketches.

(3) Calculations will be performed to provide a design basis for the sprinkler heads being moved significantly, or added.

(4) Modifications to sprinkler piping 2 inches and larger will be shown on design drawings."

This memo was explicit in that only the "modified/added heads" would have their adequacy confirmed by hydraulic calculations and recommended that the scope of DCR 2133 be expanded to:

1) Perform hydraulic calculations to confirm the HPFPS adequacy using "as constructed" drawings and to

2) Provide Quality Assurance level documentation of such adequacy.

J. P. Vineyard followed this up with a memo on March 28, 1985, to H. B. Rankin (Ref. 8) in which he advised that, as a result of additional walkdowns and calculation work, ". . . the present piping cannot provide the required flow/pressure demands." This memo confirmed the need to perform the hydraulic calculations.

Revision 1 of SQN Special Report 84-08 to the NRC (Ref. 9) was filed shortly thereafter (May 17, 1985). This revised Special Report also ". . . determined that there were potential hydraulic deficiencies associated with the sprinkler system" and concluded with the commitment that ". . . roving fire watches will continue until the sprinkler systems are modified to correct hydraulic deficiencies or until TVA can justify that deficiencies do not exist under current system configuration and level of corrosion build up."

Phase 1 of the SQN separations/fire protection compliance program is complete. In the attachment to its August 12, 1986, letter on this subject (Ref. 15), the NRC concluded:

> "(Closed) Special Report 327 and 328/84-08, Sprinkler System Modifications. TVA's special reports, dated December 19, 1984 and May 17, 1985, identified a number of modifications required to bring the auxiliary building automatic sprinkler systems into compliance with the requirements of NFPA-13, Automatic Sprinkler Systems. These modifications required relocating approximately 418 sprinkler heads, removal of approximately 400 sprinkler heads and the installation of approximately 226 additional sprinkler heads. Also, the sprinkler systems for Units 1 and 2 elevations 734', 749' and 759' have been provided with additional flow paths to assure adequate pressure and flow are available to these areas. The system for each unit area, i.e., a system for each unit, is now supplied from the original four-inch feed main and a new six-inch feed main. The two feed mains to each system are provided with preaction valves. The two valves to each system are activated simultaneously by the smoke detector system within each area. All sprinkler system piping has been installed to meet TVA Class G piping support requirements for pressure retention following a seismic event. The inspector conducted a plant tour to review the new system installation and modifications. These modifications appear to bring the systems into compliance with NFPA-13 and the NRC guidelines. Therefore, this item is closed."

Phase 2 continues the NFPA-13 compliance activity into the remaining plant areas containing safety-related and other equipment is in progress. The plant restart effort has priority over the continuation of the program into remaining fire protection system areas. Internal TVA documentation indicates a concerted effort to close this issue out entirely. The NRC is also monitoring progress in the Phase 2 program.

Watts Bar Concerns IN-85-010-004, IN-85-534-001, and IN-85-534-002 cite specific cases of sprinkler system sizing unique to WBN, as well as the more generic issues of the NFPA code compliance. Two investigative reports (Refs. 21 and 22) relating to the WBN concerns found that the issues were not valid for several reasons specifically relating to WBN. These reasons were based on the "Hydraulic Method" pipe sizing used on WBN and would therefore apply to the generic NFPA sizing concern for SQN, since SQN also originally used the "Pipe Schedule" methods and then backfitted to the hydraulic method.

### 3.1.2 WBN Evaluation

The WBN high pressure fire protection system HPFPS was initially designed to comply with the requirements of the NRC Branch Technical Position (BTP) APCSB 9.5-1 and sized using the NFPA-13 "Pipe Schedule Method" based on ordinary hazard occupancies. The NRC evaluated the WBN HPFPS against BTP APSCB 9.5-1 and documented its conclusions in an SER (Ref. 28). The SER concluded that (1) the fire water supply system meets the applicable guidelines and is acceptable; and (2) the water suppression system, which includes sprinkler systems designed to the requirements of NFPA-13, meets the applicable guidelines for pipe sizing and is acceptable. The NRC did identify obstructions to providing proper sprinkler system coverage, which TVA agreed to resolve. However, this condition is not directly relevant to the employee concerns regarding the adequacy of pipe sizes.

In addition to NRC reviews and inspections (Refs. 29 and 30), WBN has also been periodically inspected by certified fire protection experts employed by M&M Protection Consultants (Refs. 23, 24, and 25). These inspections are in preparation for obtaining fire insurance which will, in turn, be preceded by additional inspections by the insurance underwriting company. Fire insurance will be in effect at fuel load. The inspections by fire protection consultants and insurance underwriters supply an additional level of review for compliance with NFPA standards and fire insurance company specifications.

TVA found it necessary to retrofit certain portions of the WBN HPFPS protecting safety-related equipment to meet the new requirements of 10 CFR 50, Appendix R. These modifications were implemented through ECN 5216 (Ref. 26) and ECN 3867 (Ref. 27). To support the ECN design changes, the HPFPS pipe sizes were based on the criteria contained in the "Hydraulic Calculation Method" of NFPA-13, and superseded the original "Pipe Schedule Method." This was verified by the NSRS reports (Refs. 21 and 22). System tests were required to verify that the flow rates and pressures were in conformance with applicable requirements. No confirmation of such tests was attempted by the ECTG team.

Employee Concerns IN-85-010-004, IN-85-534-001, and IN-85-534-002 cite specific cases of sprinkler system sizing unique to WBN, as well as the more generic issues of the NFPA code compliance. Two investigative reports (Refs. 21 and 22) concluded that Employee Concerns IN-85-534-001 and -002 were not valid, because either the example cited was not found or the use of the "hydraulic calculation method" justified conditions that would not meet the requirements of the "pipe schedule method." Employee Concern IN-85-010-004 also appears to address conditions that would not satisfy the "pipe schedule method" requirements, but would be justified by the use of the "hydraulic calculation method" criteria. Depending upon the actual implementation, the NSRS conclusions appeared to be valid to the ECTG evaluators.

3.1.3 BFN Evaluation

Previous evaluations of similar concerns at WBN and SQN were reviewed before assessment at BFN. The approach to addressing the concern on BFN deviates in two ways from that employed at WBN and SQN. First, only one of the four concerns addressed by the SQN report applies to BFN and it is not a question of system design criteria. Rather, it is simply an indication of a need for a confirmatory evaluation by an independent authority. It would, therefore, appear unnecessary to document the evolution of the present fire protection system design as was done for SQN. Second, the commitments made in the Browns Ferry Nuclear Performance Plan (BFNPP) which specifically relate to FPS installation adequacy are not evident in the SQN Nuclear Performance Plan.

The BFNPP was transmitted to the NRC on August 28, 1986 (Ref. 34). The purpose of this document is clearly stated in the introductory paragraph as follows:

> "This Browns Ferry Nuclear Performance Plan (BFNPP), Volume 3, in combination with the revised Corporate Nuclear Performance Plan (CNPP) describes specific actions to correct past problems at BFN. This report not only responds to NRC's specific request for information under 10 CFR 50.54(f) on TVA's specific activities but also presents an integrated plan for addressing NRC's general interest in the safe operation of the plant. The revised CNPP and the BFNPP provide a complete account of the actions which TVA is taking to improve its nuclear program for BFN. These plans serve as the basis for restart of BFN."

In the BFNPP, specific commitments are made regarding the review and justification for the design of the FPS. These commitments are concisely stated in a listing of all commitments in Attachment IV-2 of the BNFPP as follows:

- o <u>Commitment 81</u>: "A detailed review of all fire protection surveillance instructions to ensure they are technically accurate and verify compliance with Technical Specifications is ongoing and will be completed prior to restart of any unit."
- o <u>Commitment 82</u>: "All four of the evaluation reports which identify deviations from NFPA codes for fire protection equipment and systems will be completed prior to restart. The plan for implementation or justification for exceptions will be completed prior to restart of unit 2."
- o <u>Commitment 83</u>: "The BFN fire protection review, to be completed prior to restart, will address the program, procedures, facilities, and equipment at BFN related to fire protection."

Commitment 81 is being implemented by BFN site personnel (Ref. 39). The BFN Technical Specifications (Ref. 31) express the limiting condition for operation (paragraph 3.11.9) and require the FPS to be capable of supplying the hydraulic loads indicated in Table 3.11.A. The surveillance requirement for FPS hydraulic performance specifies that verification testing take place every 3 years to ensure compliance with the limiting conditions.

Commitment 82 describes an independent study of the BFN FPS by a qualified engineering consulting firm. The study is being documented in several reports, four of which apply to nuclear safety-related systems or areas. One report is related to all preaction sprinkler systems. The other three reports relate to the carbon dioxide, detection/alarm, and fire pumps. Exceptions to National Fire Protection Association (NFPA) standards are being identified and determinations made as to corrective actions necessary to enhance effectiveness and reliability of the fire protection systems. The study is being implemented by a qualified fire protection engineering consultant firm, Professional Loss Consultants, Oak Ridge, Tennessee, under contract TV-67414 A (Ref. 40). As indicated in the commitment, the program will implement modifications, or justify exceptions, to NFPA codes before unit 2 is restarted (unit 2 is scheduled to be the first of three to restart).

An additional FPS evaluation study is expressed in Commitment 83. This program is termed a "broader" effort which is intended to review the evaluation described in Commitment 82 (by 10 percent sample verification). The evaluation will also be extended to include a review of the FPS in nonsafety-related areas (Ref. 39).

### 3.1.4 BLN Evaluation

As with BFN, the only concern relevant to BLN relates to the need for a confirmatory evaluation by an independent authority. To confirm this, the BLN design and review process was evaluated.

Excessive flow restrictions due to changes in pipe size can be prevented by satisfying the NFPA design requirements. The BLN FSAR, Section 9.5.1 (Ref. 41), states that the fire protection sprinkler systems are designed in conformance with applicable requirements of NFPA 13.

System tests serve as a final check for unacceptable flow restrictions which may have resulted from the design and construction process. The preoperational test program ensures that systems important to safety perform in accordance with their design criteria. Section 14.2.1 of the BLN FSAR (Ref. 42) provides the commitment to perform a preoperational test of the fire protection system. The test objective includes ". . . verification of specified pressure and flow to designated suppression systems and hose stations." TVA Division of Engineering Design is committed to review the preoperational test instructions and approve the test results.

The BLN fire protection systems will be reviewed during the routine NRC licensing process required before an operating license is issued. Conformance to NRC Branch Technical Position 9.5-1 will be established. A nuclear insurance company review will be conducted independently and for a different purpose before an operating plant insurance policy is granted. (Ref. 171)

## 3.2 Electrical Panels Not Protected From Sprinklers - Element 231.2

The concerns in this element relate to protecting the 6900 V shutdown boards from the water sprays of the fire protection system.

The evaluation team reviewed the concerns from fire protection, seismic qualification, and failure analysis viewpoints.

3.2.1 Fire Protection System

The flow diagrams, Drawings 47W850-2, Rev. 32, and 47W850-5, Rev. 22 (Refs. 45 and 56), and the piping drawings, Drawings 47W491-82 and -83 (Refs. 46 and 47), describe the presence of the fire protection sprinkler system in rooms 757.0-A2 and 757.0-A24 (shutdown board rooms A and B, respectively). NSRS Report I-85-116-WBN (Ref. 43) confirms this presence:

> "A visual inspection of the . . . [6900-volt shutdown board room] area . . . determined that there are varying numbers of fire protection sprinkler heads located over the 6900-volt shutdown boards that would spray on the boards if activated."

The report then adds:

> "No spray shields were observed between the sprinkler heads and the 6900-volt shutdown boards; either horizontally providing direct protection from overhead spray or vertically providing adjacent sprinkler spray protection."

NSRS Report I-85-116-WBN states "the area fire protection system in question [is] of the preaction, air supervised, single head activation (fusible link) type." The flow diagrams (Refs. 45 and 46) and piping drawings (Refs. 46 and 47) confirm this. Normally, preaction fire protection system piping is not charged with water downstream of the preaction valve. The dry piping is pressurized with air to ensure the absence of leaks. Should a leak develop, a supervising alarm will be actuated by a loss in pressure (Ref. 48). To charge a preaction system with water, one or both preaction valves must be opened in one of two ways:

- o Automatically by a signal from two ionization-type smoke detectors
- o Manually by releasing the preaction valve hydraulic pilot pressure

Opening the preaction valve will supply water up to the sprinkler heads. The individual heads are temperature-activated and will open only if sufficient heat is present directly below the sprinkler head to melt the fusible link. NSRS Report I-85-116-WBN correctly recognizes this in stating:

> "If the sprinkler system [is] activated, it would be the result of a fire in the [shutdown] board directly below the activated sprinkler head and the board would be presumed as [already] operationally lost."

The NSRS report also indicated that the shutdown board rooms contained "little combustible material," thus adding to the assurance that any fire that activated a sprinkler head is probably in the shutdown board itself.

### 3.2.2 Seismic Qualification

The piping drawings (Refs. 46 and 47) show that the fire protection system piping in the 6900 V shutdown board rooms is classified as TVA Class G. This piping conforms to ANSI B31.1 and is designed for seismic loading (Ref. 49). This is confirmed by NSRS Report I-85-116-WBN, which notes that "the fire protection spray system piping [is] seismically qualified."

The sprinkler heads themselves are also seismically qualified. A TVA memorandum (Ref. 50) states that: "the sprinklers were allowed no leakage following 120 hours of 5 g, steady-state vibration at 35 Hertz." The memorandum stipulates this acceleration exceeds the seismic loading postulated for WBN and, therefore, "the sprinkler heads can be considered seismically qualified for the intended service."

### 3.2.3 Failure Analysis

NRC Branch Technical Position (BTP) CMEB 9.5-1 (Ref. 51) gives a qualified endorsement of the use of fixed water suppression systems for extinguishing electrical fires.

> "Experience with major electrical cable fires shows that water will promptly extinguish such fires. Since prompt extinguishing of the fire is vital to reactor safety, fire and water damage to safety systems is reduced by the more efficient application of water from fixed systems spraying directly on the fire rather than by manual application of fire hoses. . .
>
> This is not to say that fixed water systems should be installed everywhere. Equipment that may be damaged by water should be shielded or relocated away from the fire hazard and the water."

BTP CMEB 9.5-1 provides virtually no other relevant guidance. Section C.7.e does not mandate or prohibit fixed water suppression systems in switchgear rooms containing safety-related equipment. For fixed water extinguishing systems, Section C.6.c(3) merely refers to "appropriate standards such as NFPA 13, 'Standard for the Installation of Sprinkler Systems,' and NFPA 15, 'Standard for Water Fixed Systems'" (Refs. 19 and 53). However, these codes provide no guidance as to when electrical switchboards should be protected against water spray from sprinkler systems. The National Electrical Code (Ref. 54; Article 384) requires that only switchboards or panelboards in normally damp or wet locations or outside of a building be enclosed in a weatherproof enclosure or cabinet.

As described above, the fire suppression system in each 6900 V shutdown board room is a seismically supported, dry-pipe, preaction system with normally closed, sprinkler heads, which are opened only by heat from a fire in the affected room. Each room is served by a separate preaction, fire suppression system. Water is supplied to each system by either or both of two, normally closed, preaction valves, which in turn derive their water supply from separate fire mains (Refs. 46, 47, and 48).

The probability of an unintended discharge of the sprinkler system in a 6900 V switchboard room is very low. To charge a preaction system with water at least one preaction valve must be actuated either automatically or manually. Because automatic actuation of the preaction valve is controlled by a normally closed, energize-to-open, solenoid-operated, two-way valve, the preaction valve will not open inadvertently on loss of electrical power. If a preaction valve did actuate, water would be supplied up to the sprinkler heads. Opening of a preaction valve would result in a supervisory alarm, alerting the plant operators. The heads would open only if their fusible links melt. Thus, it is unlikely that a sprinkler head would be open at the same time that a preaction valve was inadvertently actuated.

It is also unlikely that water would be released from the fire protection system piping or sprinkler heads by a seismic event, because both the piping and the heads are seismically qualified.

Even if fire protection water should be inadvertently released, water spray from sprinkler discharge would occur in only one of the 6900 V shutdown board rooms. Assuming that water spray enters the shutdown boards, electrical faulting (i.e., shorts and grounds) would affect only one of the redundant Class 1E electrical system divisions. The consequences of water intrusion would be no more severe than a fire in a shutdown board room, i.e., total loss of the unit 1 and 2 boards and their connected loads. The redundant 6900 V shutdown boards in the unaffected room would remain available to supply power to the redundant safe shutdown equipment.

## 3.3 Sprinkler Heads Spray Pattern Interference - Element 231.3

Employee Concern I-85-534-004 was raised in the summer of 1985 and covers obstructions to fire protection system spray patterns. These obstructions were created by the presence of HVAC ductwork and walls either beside or below the fire protection system sprinkler heads. These ducts and walls, often erected after the fire protection system was installed, precluded satisfactory distribution of fire protection water from the sprinkler heads should the fire protection system be activated.

TVA recognized this problem at least 2 years before EC I-85-534-004 was raised. Nonconforming Condition Report (NCR) W-110-P (Ref. 57), issued on February 28, 1983, stated:

"Sprinkler systems are not installed in accordance with National Fire Protection Association Standard 13 [(NFPA 13)], as required by TVA commitments to the NRC. (See letter from J. E. Gilleland to R. S. Boyd, dated April 18, 1977.) . . . Spacing and clearance of sprinkler heads, inspector test pipes, and piping does not comply with NFPA 13."

The corrective actions taken are described in TVA's Final Report to the NRC on NCR W-110-P (Ref. 58):

"During the months of April and May 1983, an inspection team consisting of personnel from TVA's Divisions of Engineering Design (EN DES), Construction (CONST), and Nuclear Power (NUC PR) conducted a walk-down of the [WBN] sprinkler systems . . . Existing discrepancies . . . were identified and corrective actions were determined. These corrective actions include the relocation of sprinkler heads and piping, the addition of heat collectors and baffles, and replacing of damaged sprinkler heads. These actions are being implemented under engineering change notice (ECN) 3867.

"Subsequent to the system walk-down, additional sprinkler obstructions have been created by the installation of pipe and duct insulation, hangers, and missile barriers [walls]. To address these obstructions and any new obstructions resulting from the continuing construction process, the following actions are being taken:

"1. A second walk-down of the sprinkler system was conducted in October and November of 1983, by the same organizations involved in the first walk-down. All new deficiencies identified during the second walk-down are being corrected by Field Change Requests (FCRs).

"2. A drawing (47A491-1B) defining the acceptance criteria for sprinkler obstructions has been issued. This drawing will be used for field evaluation of potential obstructions. These evaluations will cover construction activities after the start of the second walk-down and will be made on a continuing basis as the construction process continues. Any deficiencies identified during the evaluations will be corrected immediately by FCRs.

"3. Notes defining the criteria for installing heat collectors and baffles have been added to the fire protection mechanical piping drawings (47W490-series, 47W491-series, 47W492-series). These criteria will be followed when relocating sprinkler heads under ECN 3867 and the FCRs for items 1 and 2."

ECN 3867 (Ref. 59) was issued on May 25, 1983, to "modify existing plant HPFP sprinkler piping [and] head locations to correct for NFPA 13 fire coverage violations outlined in NCR W-110-P." This ECN was closed January 13, 1984 (Ref. 60).

The applicability of NCR W-110-P to plants other than WBN was not addressed in the WBN element evaluation. As indicated in Section 2.1, an evaluation of the other plants was not conducted, because a TVA letter to NRC (Ref. 58) indicated that the other plants already have implemented programs to evaluate sprinkler deficiencies.

On March 26, 1984, TVA held a meeting to define responsibility for inspections and corrections of fire sprinkler systems until the completion of WBN unit 2. A TVA memorandum (Ref. 61) summarizes the results of the meeting:

> "During the meeting the following agreements were reached:
>
> "1. NUC PR will assume responsibility for outstanding Sprinkler Obstruction Notices (SONs) on unit 1 and common sprinkler systems. This responsibility will include evaluating each SON to determine if and when the sprinkler obstructions are to be corrected, implementing any modifications, and conducting follow-up testing if required.
>
> "2. EN DES and CONST will discontinue sprinkler surveillance inspections. NUC PR will conduct a final walkdown for the unit 1 and common sprinkler systems prior to unit 1 fuel loading and will be responsible for dispositioning any sprinkler obstructions identified.
>
> "3. At an appropriate time between fuel loadings for units 1 and 2, EN DES and CONST will conduct a walkdown of the unit 2 sprinkler systems. Any identified sprinkler obstructions will be the responsibility of EN DES and CONST to disposition. At the conclusion of this walkdown, a decision will be made jointly with NUC PR on the need for a continuing surveillance inspection effort on the unit 2 system."

Shortly after this meeting, NCR W-110-P was closed (Ref. 62).

Finally, requirements for continuing inspection of the fire sprinkler systems throughout the operating life of the plant are set forth in the Watts Bar Technical Specifications (Ref. 63). Section 4.7.11.2 states:

> "Each of the . . . required Spray and/or Sprinkler Systems shall be demonstrated OPERABLE . . . at least once per 18 months . . . by a visual inspection of each sprinkler head/spray nozzle area to verify the spray pattern is not obstructed."

These continuing inspections are tracked by the construction organization's Commitment Tracking Record.

3.4 Lack of Fire Dampers in the Additional Diesel Generator Building - Element 231.4

For both SQN and WBN the diesel generator (DG) designs (Refs. 64, 67, and 75) are essentially identical from a fire protection point of view. The evaluations of the concern resulted in identical findings.

At both plants, the building housing the DG sets 1 through 4 consists of four adjacent arrangements of rooms separated by fire walls. Each arrangement contains a DG room and associated rooms for the air intake, air exhaust, and electrical boards that make up one DG system. The building is compartmentalized for fire protection, and fire dampers are installed in ducts penetrating walls and in floor gratings from the DG rooms to the air intake and exhaust rooms. The rooms containing the DG sets and electrical boards 1 through 4 are equipped with $CO_2$ fire fighting systems and require fire dampers released by $CO_2$ pressure for maintaining the gas concentration, or by fusible link.

The "additional" or fifth DG building is a completely separate structure. It does not contain a $CO_2$ fire protection system. An aqueous film-forming foam (AFFF) fire suppression system is provided instead. The equipment in the air intake and air exhaust rooms above the fifth DG room is an integral part of the DG system in a single fire zone and must be operational with the DG. The failure of either the DG or the air equipment would cause the fifth DG system to fail. Fire dampers and compartmentalization between the DG and the fan room in the fifth DG building is, therefore, not required. A fire in the fifth DG building would not affect DG systems 1 through 4.

TVA General Design Criteria (GDC) (Ref. 65, 66, 76, and 77) paragraph 4.6 requires a fire protection system that prevents fire spreading from peripheral rooms to the fifth DG room. For WBN, the heating, ventilating, and air flow diagram (Ref. 79) and heating and ventilating (H&V) mechanical drawing (Ref. 80) show no fire dampers at the floor grating of the air intake and exhaust rooms to the fifth DG room. These drawings are, therefore, inconsistent with the TVA General Design Criteria. The HVAC design meets this criterion for rooms on the level of the DG set room, where fire dampers are installed at wall penetrations of ducts. However, there are no fire dampers at the floor gratings of the air intake and exhaust rooms.

For SQN, an H&V flow diagram (Ref. 70) shows fire dampers at the floor grating of the air intake and exhaust rooms to the fifth DG room. However, an H&V mechanical drawing (Ref. 71) reflects the present condition of the plant with deletion of the fire dampers per FCR 3532 (Ref. 72). There is a 22-month time period between the revisions of the two conflicting drawings. Per telephone confirmation of September 15, 1986, both drawings are the latest revision.

## 3.5 Adequacy of Battery Room Ventilation System Design - Element 231.5

### 3.5.1 Background

The TVA Nuclear Safety Review Staff (NSRS) Investigation Report I-85-993-NPS (Ref. 103) was initiated in December 1985, prompted by a letter from a concerned individual (CI). The CI referred to a May 1979 NRC resident inspector's identification of inadequate battery room ventilation, which, to CI's knowledge, had never been corrected. Neither the CI letter nor the NRC inspector's concern was identified in the NSRS report. This report traced the efforts to resolve the ventilation concern and the changes in design made since 1979. It further recommended a hydrogen survey in the battery rooms while equalizing the battery charges. This survey was subsequently performed for WBN in the battery rooms and confirmed the absence of hydrogen pockets (Ref. 91).

The element evaluations discussed below reviewed the past history and then undertook an independent review for all four plants. The reviews covered the following areas:

- Battery and electrical equipment locations, and the ventilation system design
- Hydrogen generation rates, and monitoring and inspection systems in use to track potential hydrogren generation
- Hydrogen pocketing and its preventive measures

It was found that the National Electrical Code Handbook (Ref. 100) Section 480.8 imposes no special requirements on the type of fixtures or other electrical equipment used in properly ventilated battery rooms. Proper ventilation of the rooms will prevent hydrogen ignition, assuring that the rooms are not hazardous locations subject to the National Electrical Code (NEC), Article 501 (Ref. 102). Electric resistance heaters are, therefore, acceptable in the battery rooms. This is also consistent with IEEE Standard 484 (Ref. 98). NRC's Regulatory Guide 1.128 limits hydrogen concentrations to less than 2 percent, an amount well below the lower flammability limit of 4 percent. Thus, the hydrogen will not be able to burn, regardless of the ignition sources.

### 3.5.2 SQN Evaluation

Battery Locations and Ventilation System Designs. Except for the DG batteries, all SQN batteries are located in dedicated rooms with redundant emergency powered class 1E exhaust fans sized for about five air changes per hour in the 250 V and 24/48 V battery rooms (Ref. 83). The Light Water Reactor Hydrogen Manual (Ref. 99) reports typically ten air changes per hour for battery rooms.

The exhaust ducts of vital battery rooms I through IV protrude approximately 1 foot from the ceiling in order to accommodate a motorized exhaust damper and a tornado damper (Ref. 90). Eight 3/4-inch-diameter holes are drilled in the exhaust damper frames near the ceiling for minimum ventilation in case of tornado or exhaust damper closure. These holes also scavenge potential hydrogen pockets near the ceiling during normal operation. The vital battery room V exhaust duct protrudes approximately 4 feet from the ceiling to accommodate two motorized dampers but has no scavenging holes. The exhaust ducts for the 250 V and 24/48 V battery rooms are routed horizontally on the ceiling with lateral inlet grilles (Ref. 95). Air flow interruption caused by failure of the common indoor fans for the 250 V and 24/48 V battery rooms is annunciated in the main control room, and automatic switchover to standby fans takes place.

The DG batteries I through IV are located under steel vent hoods, each exhausted by a 1,000 cfm indoor exhaust fan on emergency power (Ref. 96). A motorized fail-closed-design damper closes automatically upon fan shutdown. The fifth DG building does not have a dedicated hood and fan for the battery. The large DG bays have dual area ventilation systems that operate during DG operation or by manual initiation.

All batteries are of the sealed type with safety vents that prevent an outside spark or flame from igniting gases within the cells.

Hydrogen Generation. The rate of hydrogen generation depends upon the charging state of the battery and the current through the electrolyte. Per TVA EN DES calculation (Ref. 88), the highest 125 V vital battery hydrogen generation rate is based on the highest voltage that can be set at the charger and on the charging current capacity. This calculation method applies principles of Storage Batteries (Ref. 101). Application of the full 300 amperes charger nameplate current (Ref. 104) to a fully charged battery is unrealistic because of the charger/battery voltage/amperage limitations. Using the free room volume (4,252 cu ft) shown for vital battery rooms I through IV in the earlier TVA EN DES calculation (Ref. 93), it would take 68 hours to build up an average 2 percent hydrogen concentration. This is half of the 4 percent lower flammability limit in air and considered safe per IEEE Standard 484 (Ref. 98) and NRC Regulatory Guide 1.128 (Ref. 94). Complete loss of ventilation is further assumed for this analysis.

The free vital battery room V volume is about 35 percent larger than the free volume of rooms I through IV; the battery capacity is about 15 percent higher than that of the vital batteries I through IV (Refs. 93 and 95). The time required for buildup of an average 2 percent hydrogen concentration would therefore be longer than 68 hours.

The 250 V batteries are of comparable capacity to the vital batteries and are installed in rooms of about twice the free volume as the vital battery rooms (Ref. 93). Again, 68 hours time for a 2 percent average hydrogen buildup would be conservative.

The 24/48 V free battery room volume to total battery capacity ratio is approximately the same as for the vital batteries I through IV and, thus, the hydrogen buildup time comparable.

Per Balance of Plant Specifications (Ref. 105), Section E4.57.2, the battery voltage and charger voltage and amperage are checked every 12 hours. Any overcharging of batteries with associated hydrogen generation would be detected by this surveillance. This specification, however, does not give acceptance criteria for battery and charger parameters to prevent overcharging. Also, the specification is marked up to change the surveillance frequency to once every 7 days.

The technical specification for the vital battery systems (Ref. 107) Section 4.8.2.3.2, requires a 7-day battery and charger parameter surveillance interval. However, high voltage alarms for the 125 V vital battery chargers are provided, and the battery current and bus voltage are indicated in the main control room.

Average hydrogen concentration in the five very large DG bays is of no concern. Natural air circulation through the large ceiling grates would dilute the concentration even without fans operating.

Hydrogen Pocketing. While SQN is not committed to NRC Regulatory Guide 1.128 (Ref. 94), a TVA memo (Ref. 92) cites it as "good practice" to prevent buildup of hydrogen pockets in a battery room. This regulatory guide modifies IEEE Standard 484-75 to limit the hydrogen concentration to less than 2 percent by volume at any location within the battery area.

Attached to a TVA memo (Ref. 91) are the results of a WBN hydrogen survey for the two 250 V battery rooms and the 125 V vital battery room III at points of low air currents. This survey showed no detectable hydrogen after several days of battery charging. The mechanical HVAC drawings of the surveyed rooms for SQN (Refs. 90 and 95) and WBN (Ref. 106) show identical designs.

The locations of the fans for the 125 V vital battery room V at the two plants are not identical. At SQN the exhaust ducts protrude approximately 4 feet from the ceiling to accommodate two isolation dampers. Since no hydrogen survey has been conducted in the vital battery room V, there is no assurance of pocket prevention. There are no scavenging holes in the ducts near the ceiling, which is inconsistent with vital battery rooms I through IV.

Hydrogen could accumulate under the hoods of DG batteries I through IV if the damper is closed.

### 3.5.3 WBN Evaluation

Battery and Ventilation Systems. Except for the DG control power batteries, the other major WBN batteries are located in dedicated rooms with redundant emergency-powered class 1E exhaust fans. There are about five air changes per hour in the 250 V and 24/48 V battery rooms and a minimum of 12 air changes per hour in the vital battery rooms (Ref. 109). The Light Water Reactor Hydrogen Manual (Ref. 99) reports typically ten air changes per hour for battery rooms.

The exhaust ducts of vital battery rooms I through IV, in the Auxiliary Building at elevation 772 feet, protrude approximately 1 foot from the ceiling to accommodate a motorized exhaust damper and a tornado damper (Ref. 111). Eight 3/4-inch-diameter holes are drilled into the exhaust damper frames near the ceiling for minimum ventilation in case of tornado or exhaust damper closure. These holes also scavenge potential hydrogen pockets near the ceiling during normal operation. The vital battery room V exhaust ducts, in the Auxiliary Building at elevation 772 feet, are routed horizontally beneath the ceiling to accommodate the fans and motorized dampers. These ducts do not require scavenging holes, because no dead air space is created near the ceiling. The exhaust ducts for the 250 V and 24/48 V battery rooms in the Control Building, at elevation 692 feet, are routed horizontally on the ceiling with lateral inlet grilles (Ref. 114). Air flow interruption caused by failure of the roof-mounted fans for vital battery rooms I through IV, the vital battery room V indoor fans, or the common indoor fans for the 250 V and 24/48 V battery rooms is alarmed in the main control room, and automatic switchover to standby fans takes place.

The DG control power batteries I through IV are located under steel vent hoods, each exhausted by a 1,000 cfm indoor exhaust fan on emergency power (Ref. 115). A motorized fail-closed damper closes automatically upon fan shutdown. The fire damper in the hood exhaust duct is equipped with two redundant fusible links to minimize accidental closure. The fifth DG building does not have a dedicated hood and fan for the battery. The large DG bays have redundant ventilation systems that operate during DG operation or by manual initiation.

Batteries are of the sealed type with safety vents that prevent an outside spark or flame from igniting gases within the cells.

The vital, 250 V and DG control power battery system statuses are continuously monitored, and overvoltage and charger failures are alarmed in the main control room.

Hydrogen Evolution. The rate of hydrogen evolution depends upon the charging state of the battery and the current through the electrolyte. In accordance with the TVA EN DES calculation (Ref. 110), the highest 125 V vital battery hydrogen evolution rate is based on the highest voltage that can be set at the charger and on the charging current capacity. This calculation method applies principles of Storage Batteries (Ref. 101). Application of the full 200 amperes charger nameplate current (Ref. 109) to a fully charged battery is unrealistic because of the charger/battery voltage/amperage limitations. Using the free room volume (4,252 cubic feet) shown for the identically sized SQN vital battery rooms I through IV in the earlier TVA EN DES calculation (Ref. 112), and the battery capacity shown in a TVA contract (Ref. 116), it would take 64 hours to build up an average 2 percent hydrogen concentration. This concentration is half of the 4 percent lower flammability limit in air and is considered safe per IEEE Standard 484 (Ref. 98) and NRC Regulatory Guide 1.128 (Ref. 94). Complete loss of ventilation is further assumed for this analysis.

The free volume of vital battery room V is about 35 percent larger (Ref. 109) than the free volume of rooms I through IV; the battery capacity is the same as that of vital batteries I through IV (Refs. 112, 114, and 116). The time required for buildup of an average 2 percent hydrogen concentration would therefore be longer than 64 hours.

The 250 V batteries are of comparable capacity to the vital batteries (Ref. 118) and are installed in rooms of about twice the free volume as that of the vital battery rooms, as shown in the TVA analysis for the identically sized SQN battery rooms (Ref. 112). Again, 64 hours for a 2 percent average hydrogen buildup would be conservative.

According to the FSAR (Ref. 109) and contract documents (Ref. 118), the ratio of the 24/48 V free battery room volume to total battery capacity is approximately the same as that for vital batteries I through IV. Thus, the hydrogen buildup time is comparable.

Average hydrogen concentration from the DG control power batteries in the five very large DG bays is of no concern. Natural air circulation through the large ceiling grates would dilute the concentration, even if fans were not operating.

Hydrogen Accumulation. Although WBN is not committed to NRC Regulatory Guide 1.128 (Ref. 94), a TVA memo (Ref. 92) cites it as "good practice" to prevent buildup of hydrogen pockets in a battery room. This regulatory guide modifies IEEE Standard 484-75 (Ref. 98) to limit the hydrogen concentration to less than 2 percent by volume at any location within the battery area.

Attached to a TVA memo (Ref. 91) are the results of a hydrogen survey for the two 250 V battery rooms and the 125 V vital battery room III at points of low air currents. This survey showed no detectable hydrogen after several days of battery charging. The configuration of the ventilation systems in vital battery rooms I, II, and IV is identical to that of battery room III.

The horizontal orientation of the exhaust ducts and fans near the ceiling of the 125 V vital battery room V prevents hydrogen pockets from forming. Therefore, no scavenging holes in the ducts near the ceiling are required. However, hydrogen could accumulate under the hoods of DG control power batteries I through IV if the exhaust damper is closed.

### 3.5.4 BFN Evaluation

Description of Batteries. The batteries supplying power to engineered safety features (ESF), to their controls, or to important common plant loads are:

- Unit and plant batteries. Three 250 V unit batteries are located in the control bay of the Reactor Buildings at elevation 593.0 feet; the 250 V plant battery is in the unit 3 Turbine Building at elevation 586.0 feet.

- Shutdown board batteries. There are five 250 V batteries supplying control power to five of the eight 4,160 V shutdown boards. Two batteries each are located in Reactor Buildings 1 and 2, at elevation 621.25 feet, and the fifth battery is in the Diesel Generator Building for unit 3, at elevation 583.5 feet.

- DG batteries. The eight DG 125 V batteries are located in the associated DG set rooms under exhaust hoods.

Hydrogen Evolution Rates. According to battery vendor information (Ref. 112), the maximum hydrogen evolution rates at 120°F for fully charged batteries (2.33 volts per cell) in float service are as follows:

| Volts | Ampere-hours | Cubic Feet per Hour |
|---|---|---|
| 250 | 2,100 | 6.3 |
| 250 | 100 | 0.3 |
| 125 | 100 | 0.15 |

Per TVA specification for the shutdown board control power (Ref. 131), the battery chargers are provided with timers that reduce the equalizing current toward the end of the charge to the very low floating current. This floating current was used by the battery supplier to compute the hydrogen evolution rate. Overcurrent is annunciated in the main control room.

Battery Room H&V System. Per TVA electrical standard drawing (Ref. 121) and environmental data drawings (Ref. 129), the battery rooms are environmentally controlled to maintain an average annual temperature of about 77°F. The electrical standard drawing states that the battery rooms are not classified as hazardous areas, per National Electrical Code Article 500.

The National Electrical Code Handbook (Ref. 100), Section 480.8 imposes no special requirements on the type of fixtures or other electrical equipment used in properly ventilated battery rooms. There are no electric heaters in the unit and plant battery rooms. The shutdown board control power battery rooms are heated by electric duct heaters outside the rooms. Electric unit heaters are installed on the DG room ceilings. However, the DG rooms are large, and it is unlikely that significant amounts of hydrogen could escape from under the battery vent hoods to build up to a hazardous concentration. NRC Regulatory Guide 1.128 (Ref. 94) allows a maximum of 2 percent hydrogen concentration in the air as a safe limit.

Analysis of the individual battery room sizes and ventilation system configurations (Refs. 124 and 125) and flow rates (Ref. 123) showed a minimum of four air changes per hour in the unit battery rooms. This amount may be reduced to two air changes per hour in winter (Ref. 120). This would maintain hydrogen concentrations below 2 percent. The redundant fans in the battery rooms are supplied from the class 1E power bus and provided with lead-lag controls. Flow indicators or alarms are provided locally or in the main control room. No potential hydrogen pocketing locations due to duct placement were found.

The DG battery ventilation hood systems do not have redundant fans and flow alarms or indicators; however, there are no dampers in the exhaust ducts, thus allowing natural ventilation to keep the hydrogen concentration in the hoods below 2 percent should the fans fail. Standard Practice for Conduct of Operations (Ref. 130) requires that local control panels, meters, indicators, pressures, and motors be checked every shift (8 hours). This would include any ventilation and battery charging systems. The relevant main control room annunciators indicating abnormal operation of these systems and the operator action required are described in a TVA BFN Annunciator Response Procedure (Ref. 132).

### 3.5.5 BLN Evaluation

Vital Battery Systems. The eight 125V vital batteries deliver control power to engineered safety features (ESF) equipment. Four batteries are dedicated to each unit, and each battery is located in a separate room in the Auxiliary Building at elevation 686 feet.

According to TVA contract data (Ref. 127), the two-train A and two-train B vital battery rooms for each reactor unit are provided with A- and B-trained class 1E ventilation systems. Each system has two redundant 100 percent capacity supply and exhaust fans. In addition, each A and B ventilation system has an air-handling unit (AHU) for reconditioning vital battery room air and an electric 25 kW duct heater outside the two battery rooms it serves. The battery rooms have 3-hour rated fire walls with single fusible link released fire dampers in the wall penetrations. Supply and exhaust fan start-stop-controls are provided in the main control room, which also receives an alarm of low ventilation flow. The AHUs also are start-stop-controlled from the main control room. Temperature in the vital battery rooms is maintained at maximum 85°F. The fresh air change frequency is approximately six per hour. This frequency rate is customary and is sufficient to keep the average hydrogen concentration in the vital battery rooms below the 2 percent considered safe by NRC Regulatory Guide 1.128.

From TVA Mechanical Heating and Ventilation drawings (Ref. 134), it appears that the low elevation of the exhaust duct grilles in the vital battery rooms permits potential buildup of hydrogen at the ceilings. Such a buildup violates paragraph 4.3.4.1 of the General Design Criteria (GDC) for Auxiliary Building ESF Zone Environmental Control System (Ref. 136). According to TVA contract data (Ref. 140), the 200-ampere-capacity battery chargers have 24-hour equalize timers to limit overcharging of the batteries. Upon charger failure, the main control room receives an alarm.

Nonsafety-Related Batteries. The two 250 V plant batteries, one each for units 1 and 2, provide power for nonsafety-related loads, such as inverters, turbine auxiliaries, computers, switchyard control, and relaying equipment. The battery for each unit is located in a separate room in the Control Building at elevation 610 feet. According to the TVA contract data (Ref. 141), the batteries each have a 3-hour discharge rating of 572 amperes at 77°F. With reference to TVA contract (Ref. 142), the battery chargers for the 250V batteries have an output rating of up to 300 amperes with 72-hour equalize timer and failure alarm in the main control room. Battery state-of-charge is also annunciated in the main control room.

The 125V normal power battery supplies power to nonsafety-related equipment, such as the code alarm paging (CAP) system and protective relaying equipment of both units. The battery has a 3-hour discharge rating of 572 amperes at

77°F, as specified in the TVA contract (Ref. 141). The battery charger has an output of 300 amperes with 24-hour equalize timer to protect against overcharging, as specified in TVA contract (Ref. 143), and failure alarm in the main control room. In the Control Building, at elevation 610 feet, the 125V normal power battery is sharing a room with a 24V battery for the station microwave system and a 48V battery for the plant telephone system.

The 250V plant, 125V normal power, and 24/48V communication system battery rooms are served by the common HVAC system at elevation 610 feet. The fresh air supply to the three nonsafety-related battery rooms is through wall penetrations with fire dampers from a common corridor. Two redundant 100 percent capacity exhaust fans, common to the three rooms, provide approximately five fresh air changes per hour. This change rate is customary and is sufficient to keep the average hydrogen concentration in the nonsafety-related battery rooms below the 2 percent safe limit. Additional air is supplied to the battery rooms by two 100 percent redundant air-handling units. These units recirculate about 85 percent of electrical board room and mechanical room exhaust air via a corridor. The remainder of the air is from outside. There are no electric heaters in the battery rooms. Low exhaust air flow automatically initiates start of the standby fan and trips an alarm in the main control room. The design drawings (Ref. 135) show the battery room exhaust air grilles at the highest possible location in the room, so that hydrogen will not accumulate under the ceiling. This arrangement is required in accordance with paragraph 4.2.2.1 of TVA General Design Criteria for Control Building Environmental Control System (Ref. 137).

Hydrogen Gas Evolution Rates. According to battery vendor information (Ref. 122), the following table shows the calculated maximum hydrogen gas evolution rates at 120°F for fully charged batteries (2.33V per cell) in float service. The 8-hour discharge capacities are in accordance with TVA information (Ref. 167).

| Battery Voltage(V) | 8-hour Discharge Capacity (ampere-hour) | $H_2$ Gas Evolution per Battery ($ft^3$/hr) |
|---|---|---|
| 250 (plant) | 2,400 | 6.8 |
| 125 (vital) | 2,320 | 3.2 |
| 125 (normal) | 2,400 | 3.3 |

The time period required to reach an average concentration of 2 percent hydrogen in any battery room at the maximum evolution rate calculated, even without ventilation, is several 8-hour shifts long (29 to 65 hours). The control room alarms for the battery and ventilation systems therefore provide operators sufficient time for remedial action.

Ignition of Hydrogen by Electrical Equipment. The concern referred to ignition of hydrogen by electric resistance heaters. No electric heaters are installed inside any of the battery rooms. However, consideration to any spark or high-temperature-producing device must be given in rooms with localized hydrogen concentration above the 2 percent allowed by NRC Regulatory Guide 1.128 (Ref. 94). According to TVA's electrical standard drawing (Ref. 121), the battery rooms are not classified as hazardous areas as defined in the NEC (Ref. 102), Article 500. The National Electrical Code Handbook (Ref. 100), section 480.8, imposes no special requirements on the type of fixtures or other electrical equipment used in properly ventilated battery rooms. The battery rooms are adequately ventilated, except for the ceiling spaces above the vital battery room exhaust ducts, as discussed previously.

Administrative Procedures. The technical specifications for safety-related battery system and ventilation system inspections, surveillance instructions, and standard practices for plant operation for all battery and ventilation systems have not yet been issued. For other TVA nuclear power plants, these documents included requirements for panel, meter, indicator, pressure, and motor checks every shift to ensure that battery and ventilation systems are operating properly.

### 3.6 Fire Protection QA Designation - Element 231.6

Employee Concern BNP-QCP-10.35-1, raised on BLN, addresses TVA General Construction Specification G-73, "Inspection, Testing, and Documentation Requirements for Fire Protection Systems and Features" (hereinafter referred to as "G-73") (Ref. 152), which is applicable to all plants. As indicated in the following paragraphs, the wording of paragraphs 2.1, 3.1.2, and 3.2 of G-73, Rev. 1, was found to be somewhat confusing, thus leading to the concern. Non-plant-specific CAP 231.6-NPS-01 (Ref. 158) was generated to clarify the G-73 specification. The engineering treatment of the fire protection drawings was found to be acceptable for all four plants. No other related issues were found for SQN or WBN. Additional issues are discussed in 3.6.2 for BFN and 3.6.3 for BLN.

#### 3.6.1 Non-Plant-Specific Evaluation

Fire protection system (FPS) design and documentation requirements have been the subject of continuing development within the NRC. Lessons learned from the BFN fire on March 22, 1975, were incorporated into Appendix A to BTP APCSB 9.5-1, "Guidelines for Fire Protection of Nuclear Power Plants Docketed Prior to July 1, 1976" (Ref. 153). This document has subsequently been incorporated into NRC Branch Technical Position CMEB 9.5-1, "Guidelines for Fire Protection for Nuclear Power Plants" (Ref. 154). G-73 was issued on March 16, 1982, as part of the implementation of BTP CMEB 9.5-1, and was made applicable to all four TVA nuclear plants.

Regulatory Requirements. Current regulatory guidance does not classify fire protection as a "safety system," per se. No fire protection, suppression, or detection apparatus initiates any safety function (i.e., emergency core cooling system, containment isolation, etc.). However, certain portions of the FPS protect safety-related equipment and are thereby considered to be in sufficient association with a safety function to warrant closer controls than would be the case with more conventional NFPA fire protection systems. For this reason, certain elements of fire protection usually have some selected (limited) QA requirements applied.

Confusion as to QA requirements may be aggravated by the unique nature of fire protection systems. The traditional QA requirements, as outlined in 10 CFR 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants" (Ref. 155) are for systems and components that must act to fulfill a true "safety function," such as core cooling, containment of radioactive materials, and insertion of negative reactivity. This definition extends to systems and components that must also act to support the basic safety function. These systems are generally termed "safety-related."

Fire protection is not this kind of "active" safety-related system. Rather it is a passive system that ensures the availability of "active" systems; the physical systems equivalent of an insurance policy. While fire protection is essential, in terms of nuclear safety it is passive and, as such, does not warrant the full application of safety system QA. The limited QA requirements, specified in BTP CMEB 9.5-1, are appropriate for fire protection systems. G-73, a general construction specification prepared by Engineering Design to establish inspection, testing, and documentation requirements for fire protection systems and features, recognizes this as evidenced by its reference to the limited QA program of OEDC-QAI-6 (Ref. 156). It is not always understood that references to fire protection quality assurance include and apply these limited QA requirements.

Specification G-73.

G-73 QA Scope. The evaluator first reviewed G-73. This review was expected to establish the QA requirements to which the concerned individual (CI) was referring. Section 1.1 of G-73, "Scope," contains the following statement:

> "This general construction specification establishes minimum inspection, testing, and documentation requirements for fire protection systems and features for TVA nuclear power plants to assure compliance with quality assurance requirements set forth by the Nuclear Regulatory Commission (NRC)."

Specification G-73 further states that this scope applies to "all TVA nuclear plants." It should be noted that the G-73 scope statement contains no Engineering Design requirements; it contains only "inspection, testing, and documentation requirements." This is consistent with G-73 being identified as a "general construction specification."

G-73 Design Document Control. In spite of being a general construction specification, Section 2.1 of G-73, "Design and Procurement Document Control," does refer to control requirements for design documents. This "control," however, is to be distinguished from method of preparation or technical content of such documents. This distinction is not immediately apparent and may have led the CI to believe that G-73 has some jurisdiction over, in the CI's terms, "engineering treatment of fire protection drawings (as non-QA)."

Section 2.1 of G-73 should be compared to the BTP CMEB 9.5-1 QA requirements for the control of fire protection system design and procurement documents.

From G-73:

> "Measures should be established to ensure that the applicable NRC guidelines are included in fire protection design and procurement documents and that deviations from these documents are controlled."

From BTP CMEB 9.5-1:

> "Measures should be established to ensure that the guidelines of the regulatory position of this guide are included in design and procurement documents and that deviations therefrom are controlled."

TVA fire protection personnel pointed out that Section 2.1 of G-73 was intended to provide a general background to the necessity of such requirements and used the words of BTP CMEB 9.5-1 to accomplish this. They further pointed out that the intent was to establish a control over the Construction use of such documents and that the intent was not to establish Engineering Design requirements on the document's content. Specification G-73 applies to Construction and has no jurisdiction over Engineering Design; only Engineering Design standards, criteria, and procedures have that authority.

G-73 QA Requirements. G-73 Section 2.1 contains the phrase "applicable NRC guidelines." No clarification is made as to what they may be and no criteria are offered as to how applicability could be established. In Section 5 of G-73, "References," only the following NRC guidelines are listed:

"5.1 NRC Auxiliary Power Conversion Systems Branch (APCSB), Branch Technical Position (BTP) 9.5-1, 'Guidelines for Fire Protection for Nuclear Power Plants Docketed Prior to July 1, 1976.'

"5.2 Appendix A to APCSB BTP 9.5-1

"5.3 NRC Auxiliary Systems Branch (ASB) BTP 9.5-1 (R1)

"5.4 National Fire Protection Association National Fire Codes

"5.5 OEDC-QAI-6 'Establishment of Limited QA Program' (RO dated August 25, 1981) (QAM 810827 012)

"5.6 TVA General Construction Specification No. G-74, 'Application and Inspection Requirements for the Fireproofing of Structural Steel' (to be issued)"

References 5.1, 5.2, and 5.3 above contain QA requirements specifically tailored to fire protection systems. These requirements are outlined in Reference 5.5 above and, as explained previously, are appropriately different from those outlined in 10 CFR 50, Appendix B for nuclear safety systems.

There may be places where fire protection systems and nuclear safety systems interact. An example would be where fire protection piping would constitute a flooding or impact hazard to the very safety-related equipment it is intended to protect. In such instances, the seismic support of piping would need to conform to the requirements of 10 CFR 50, Appendix B, creating an overlap of and possible conflict between the 10 CFR 50, Appendix B, QA program and the G-73 limited QA program. This potential jurisdictional problem is handled in G-73 Section 3.1.2:

"Systems, components, or features described in section 3.1.1 which come under the requirements of 10 CFR 50, Appendix B are exempt from the requirements of this specification. The 10 CFR 50, Appendix B Quality Assurance Program applies instead of this construction specification." (Emphasis added.)

The "systems, components . . . [and] features described in G-73 Section 3.1.1" are:

"a. Mechanical fire suppression systems (including carbon dioxide and Halon);

"b. Fire detection systems including detectors, panels, central processing units, alarm stations, actuation circuits, and related wiring;

"c. Mechanical and electrical fire barrier penetration seals and fire stops;

"d. Heating, ventilating, and air-conditioning system fire and smoke dampers, fire and smoke damper controls, and duct fireproofing;

"e. Fire doors, frames, hardware, and related control circuits;

"f. Emergency lighting systems (eight-hour battery packs);

"g. Emergency communication systems (portable radios and fixed repeater systems); and

"h. Fire barriers and fire retardant cable coatings."

Since G-73 specifically defers jurisdiction where 10 CFR 50, Appendix B applies, it follows that G-73 applies only in limited Q and non-Q fire protection areas. However, G-73 does not establish the QA "designation of fire protection drawings" as stated in the concern. This position is further strengthened in Section 3.2 of G-73, "Fire Protection QA Boundaries," where identification of FPS QA boundaries is specifically deferred to the Engineering Design drawings:

"Fire protection QA boundaries shall be defined by EN DES on design drawings. All design drawings where this construction specification is applicable shall have a 'Q' or 'Q*' in the title block or Drawing Information System as required by EN DES-EP 4.25 and a note similar to that shown below which states the applicability of this specification and any exclusions thereto:

"All construction activities for the fire protection system and/or features shown on this series of drawings shall be conducted in accordance with TVA General Construction Specification No. G-73, 'Inspection, Testing, and Documentation Requirements for Fire Protection Systems and Features.' "

The use of the word "shall" in the above quotation gives the impression that this sentence is establishing an EN DES requirement in spite of the fact that specification G-73 has no jurisdiction over EN DES. The use of the explanatory term "will" (e.g., "QA boundaries will be defined by EN DES") in contrast to the mandatory term "shall" in appropriate places (e.g., "All construction activities . . . shall be conducted . . .") would probably have prevented the confusion that led the CI to believe that G-73 mandated the "designation of fire protection drawings (QA)." In fact, G-73 does not designate any QA requirements for "the engineering treatment of fire protection drawings." G-73 only covers Construction activities in this area, an issue separate and distinct from Engineering requirements. Since G-73 does not have jurisdiction in Engineering affairs, there can be no discrepancy between "the G-73 designation" and "the engineering treatment" as expressed in the concern. Minor wording changes in G-73 would make this clear.

3.6.2 SQN Evaluation

For the SQN FPS, the question remains as to where Engineering does express the QA requirements. Further investigation found two TVA Design Criteria covering SQN FPS. The first, originally dated September 26, 1972, and revised September 6, 1985, is SQN General Design Criteria SQN-DC-V-7.5 (Ref. 146). This document covers the high pressure, the $CO_2$, and the aqueous foam FPS. Section 4.0, "Quality Assurance," of this document carries the following instruction:

> "The fire protection systems are covered by a limited Quality Assurance Program when they provide protection for structures which contain safety-related systems or components. Refer to Quality Assurance (QA) List (Appendix A to Construction Specification N2G-877), System 26 (HPFP) and System 39 ($CO_2$) for components in the QA program.
>
> "NOTE: After completion of a trial period, Appendix A will be removed from Specification N2G-877 and a final QA list will be issued as design drawings."

The second design criteria document is SQN-DC-V-24.0 (Ref. 147) and is initially dated March 1, 1985, and revised July 2, 1985. These criteria cover the FPS for "Safe Shutdown Capability" and define where such fire protection must be located and to which systems Appendix R applies. SQN-DC-V-24.0 makes specific reference to Appendix R of 10 CFR 50. However, SQN-DC-V-24.0 does not contain any reference to the QA requirements of 10 CFR 50 Appendix B. Since Appendix R also makes no reference to Appendix B, SQN-DC-V-24.0 is consistent with the governing regulatory requirements.

This means that the most definitive source of FPS QA boundary identification and the QA requirements that apply thereto is the "final QA list . . . issued as design drawings" per the requirements of SQN-DC-V-7.5 as quoted above.

From this it is clear that:

a. G-73 defers jurisdiction to 10 CFR 50 Appendix B wherever they overlap

b. G-73 is exclusively a construction specification that defers to and depends upon the FPS QA boundaries to be defined by Engineering in other documents or drawings

c. Engineering establishes SQN FPS QA requirements in design criteria and identifies QA boundary requirements on design drawings

On these bases, therefore, there cannot be "Discrepancies between G-73 designations . . . and engineering treatment of" SQN FPS QA requirements as claimed in the concern.

3.6.3 WBN Evaluation

For the WBN FPS, the question remains as to where Engineering expresses the QA requirements. Mechanical Design Standard DS-M17.3.2, "Fire Protection System, Limited Quality Assurance Program" (hereinafter referred to as M17.3.2) (Ref. 159), was issued on July 1, 1985. Section 1.0, "General," of M17.3.2 states:

"This design standard defines the OE requirements and specifies implementing procedures for a limited quality assurance program covering fire protection systems and related features at TVA's nuclear power plants. The program implements NRC requirements in Branch Technical Position CMEB 9.5-1."

Section 2.0, "Applicability," states:

"The limited quality assurance program applies to the following fire protection systems and related features at TVA's Watts Bar . . . Nuclear Plant . . . when they provide protection for structures which contain safety-related systems or components.

- Water, foam, carbon dioxide, and halon fire suppression systems
- Fire detection systems
- Fire rated walls, floors, and ceilings
- Structural steel fireproofing
- Fire doors
- Fire and smoke dampers
- Mechanical and electrical fire barrier penetration seals
- Emergency lighting systems

- o Eight-hour, battery-powered emergency communication systems
- o Portable fire protection equipment. . . .

"Systems, components, or features . . . that fall under the requirements of 10CFR50, Appendix B are exempt from the requirements of this engineering procedure."

In paragraph 5.2.2.a, M17.3.2 essentially repeats G-73: "Fire protection limited quality assurance boundaries shall be defined by OE on construction and procurement drawings . . ." In M17.3.2, Attachment 2, acceptable methods for designating these boundaries, either by notes or by lines on the field of the drawing, are set forth.

From this it is clear that:

- o G-73 defers jurisdiction to 10 CFR 50, Appendix B wherever they overlap
- o G-73 is exclusively a construction specification that defers to and depends upon the FPS QA boundaries to be defined by Engineering in other documents or drawings
- o Engineering establishes WBN FPS QA requirements in M17.3.2 and identifies QA requirement boundaries on design drawings

On these bases, therefore, there cannot be "discrepancies between G-73 designations . . . and engineering treatment of" WBN FPS QA requirements as claimed in the concern.

3.6.4 BFN Evaluation

Section 1.2, "Applicability," of G-73 states:

"This construction specification applies to all TVA nuclear plants. This specification supersedes all previously issued directives as of the effective date of the original issue of this specification (or any subsequent revisions). Fire protection systems and features which are in operation, installed but not in service, or being assembled, or material or equipment received or on contract on the effective date of the original issue of this specification are exempt from strict compliance with this specification. The inspection and documentation criteria issued prior to the effective date of the original issue of this specification were established by memos between the Division of Engineering Design (EN DES) and the Division of Construction (CONST) for various nuclear plants on an individual basis. However, review by EN DES's Mechanical Engineering Branch (MEB) for compliance with the intent of this specification as of the commitment date for each plant shall be accomplished on a case-by-case basis by system and feature. This review and approval shall be documented. The commitment dates are as follows:

| Plant | Commitment Date |
|---|---|
| Browns Ferry | March 16, 1982 |
| Sequoyah | January 20, 1977 |
| Watts Bar | April 18, 1977 |
| Bellefonte | December 1, 1977 |

The commitment date for BFN was added at Rev. 1, dated March 14, 1984. This commitment date, March 16, 1982, is the original issue date of G-73, revision 0.

In discussion with the evaluation team, TVA personnel stated:

"1. G-73 was never adopted for use at BFN(P).

"2. [Quality assurance] (QA) requirements for fire protection systems [at BFN] are identified on the critical structures, systems, and components (CSSC) list. The CSSC list makes no distinction between the limited QA requirements associated with fire protection systems and full 10 CFR 50 Appendix B QA requirements. The CSSC list lists those components and systems which have any QA-requirements and a non-CSSC list identifies systems and components for which no QA requirements exist. Those items on the CSSC list are installed and maintained to full 10 CFR 50 Appendix B requirements. The CSSC List is in BFN Standard Practice 1.11.

"3. Currently TVA is in the process of removing fire protection generally from the CSSC list. Those items of the fire protection systems that require full Appendix B QA will remain on the CSSC list. The QA requirements for the remaining fire protection [system items] are spelled out in NQAM 1.3 and Attachment E to the Browns Ferry Fire Protection Plan" (Ref. 168).

Because, up to the present time, BFN practice has imposed more stringent requirements for the fire protection system QA than those imposed by G-73, the failure of BFN to adopt or commit to G-73 was not challenged by DNE. However, no subsequent revision of G-73 or separate controlled document of record could be established that withdrew or otherwise modified the G-73 statement of applicability. Therefore, the evaluation team concludes that G-73 is applicable to BFN, but there is no auditable record to establish why it was not used.

FPS Design Criteria for BFN. For the BFN FPS, the question remains as to where Engineering expresses the QA requirements. On two occasions (Refs. 162 and 163), TVA DNE personnel informed the evaluator that these requirements are expressed in Mechanical Design Standard DS-M17.3.2, "Fire Protection System, Limited Quality Assurance Program" (hereinafter referred to as M17.3.2) (Ref. 159). M17.3.2 states that it applies to WBN and BLN. However, Section 1.c of Attachment 2 to M17.3.2 exempts BFN from the requirement for "Q" or "Q*" designation on drawings, which suggests that the balance of M17.3.2 applies to BFN. Note also that TVA Engineering Procedure EN DES-EP 1.55 (Ref. 35), "Fire Protection Limited Quality Assurance Program," Rev. 0, 08/04/83, did apply to BFN. It appears that DS-M17-3.2 superseded EP 1.55 but also changed the plants to which it was applicable. So, as with G-73, it is not clear whether or not M17.3.2 applies to BFN even if it is now being used.

3.6.5 BLN Evaluation

As is the case with WBN (see Section 3.6.3), Design Standard M17.3.2 identifies where Engineering defines the QE requirements and implementing procedures covering fire protection systems for BLN. Thus, there is no conflict with Specification G-73.

The second part of Concern BNP-QCP-10.35-1 states that "NCR 2675 (fire protection cable deficiency) was invalidated based on verbal information received by telephone that contradicts design-approved document."

NCR 2675 was issued on December 20, 1983 (Ref. 164), and is specific to BLN. The "fire protection cable deficiency" referred to in the concern is described in Block 1A of the NCR:

> "The insulation on the shields of cables OGC-ECA2-52, OGC-ECA2-54, 1GC-ECA2-53, and 1GC-ECA2-66 is not taped. One wire touches the frame of 1GC-EMCP-1.
>
> "Apparent cause: The craft forgot to tape the spaghetti-type insulation."

This NCR was invalidated on December 23, 1985, three days after it was issued. The reasons for invalidation are stated in Block 3 of the NCR.

> "This is not a nonconformance. These are non-safety related cables. The QA description on the Cable Status Master Report is 'N'. The General Construction Specification, G-73, does not address cabling. It deals with device internal wiring only. This disposition has been coordinated with EN DES."

Presumably, this quote is a record of the "verbal information received by telephone" referred to in the NCR.

In evaluating the NCR 2675 issue, the evaluation team considered the following items:

- o Was there a deficiency?
- o Was the disposition of the NCR correct?

A walkdown was made on May 3, 1987, by Bechtel and TVA personnel. The "cables" and the "[control panel] frame" described in the NCR are parts of the fire detection system related to the carbon dioxide fire protection equipment in the Diesel Generator Building. This is a low voltage (48 V) system. The walkdown revealed that three of the four cables (OGC-ECA2-52, OGC-ECA2-54, and 1GC-ECA2-53) have been removed. Only one of the original four cables (1CG-ECA2-66) remains. However, a new cable (1CG-ECA2-52) had been added.

An insulated wire emerges from each cable and is connected to the control panel frame. These wires appear to be ground connections for the cable sheaths. At the point where the wire emerges from the cable, the insulation can be pulled back exposing bare wire. However, the wire is not normally exposed. The TVA walkdown personnel reviewed the construction criteria and could find no requirement for taping the insulation on the cable shield ground wire. Both Bechtel and TVA walkdown personnel believe that the condition described in the NCR does not constitute a deficiency and the cables should be used as-is.

The NCR was invalidated because the cables in question were listed as "N" in the Cable Status Master Report and because it was believed G-73 did not apply to cabling. However, Section 4.2 of G-73 defines "fire detection systems [as] including detectors, panels, central units, alarm stations, activation circuits, and related wiring." G-73 was reviewed by TVA DNE personnel, Bechtel and TVA walkdown personnel, and the evaluator. All are of the opinion G-73 applies to cabling; this is contrary to the opinion of those who dispositioned NCR 2675. Furthermore, since these are fire detection system cables in a seismic Category I building, all are of the opinion that limited quality assurance requirements apply to these cables; this is contrary to the opinion of those who prepared the Cable Status Master Report.

From discussions with TVA personnel (Refs. 169 and 170), it became clear to the evaluator that there was no provision in the Cable Status Master Report for identifying cables subject to the limited quality assurance requirements of G-73. The only designations used are "1E," for cables subject to full 10 CFR 50 Appendix B quality assurance, and "N," for cables not subject to quality assurance. This shortcoming may have mislead those who prepared the report into using an "N" designation for fire detection system cables.

## 4. FINDINGS

The findings from each of the 16 element evaluations for this subcategory are contained in Attachment B, listed by element number and by plant. They are summarized below by element.

### 4.1 Undersized Distribution Headers - Element 231.1

Fire protection system piping at Sequoyah, Watts Bar, and Browns Ferry was initially designed by the NFPA 13 Pipe Schedule Method. Subsequent increases in NRC fire protection system coverage requiring modifications to the system such that it no longer met the requirements of a schedule system necessitated recalculation of pipe distribution capabilities using the more definitive technique provided by NFPA 13 (Hydraulic Designed Method). TVA has used independent agencies to inspect and evaluate the fire protection systems to assure compliance with applicable requirements and standards. If necessary, these agencies recommend modification of the systems for continued conformance to NFPA and NRC requirements.

### 4.2 Electrical Panels Not Protected from Sprinklers - Element 231.2

The fire protection system in the area of the 6900-volt shutdown boards at Watts Bar is of the preaction dry-pipe type that has closed heads. The system is actuated by two crossed-zoned smoke detectors. The piping and sprinkler heads are seismically qualified. Consequently, the likelihood of inadvertent or spurious delivery of spray water is minimal. In the absence of a double failure, the sprinkler system will be actuated only if the boards are burning and, therefore, have already failed.

### 4.3 Sprinkler Heads Spray Pattern Interference - Element 231.3

At Watts Bar, the presence of obstructions to water spray patterns was recognized early and resulted in a nonconforming condition report (NCR). A consequent engineering change notice (ECN) corrected existing obstructions, and an ongoing program of inspection was initiated to assure early identification and subsequent correction of future obstructions.

### 4.4 Lack of Fire Dampers in the Additional Diesel Generator Building - Element 231.4

Fire dampers are not provided between the diesel room and the fan room in the Additional Diesel Generator Building because a fire in either room could disable the diesel generator. Since this diesel generator is located in a separate structure, however, a fire in this building would not spread to or affect the operability of another diesel generator. Fire dampers have been installed between the diesel rooms and the fan rooms for diesel generator rooms one through four, located in a common structure, because the spread of fire in one of these diesel rooms could affect the operability of another diesel generator. There is some inconsistency in the engineering design criteria documents for these buildings.

### 4.5 Adequacy of Battery Room Ventilation System Design - Element 231.5

Normal battery room ventilation will preclude hydrogen accumulation. Electric resistance heaters are permitted in properly ventilated battery rooms and are used at Sequoyah and Watts Bar. In all plants, most battery rooms include redundant fans with automatic switchover upon lead fan failure, and all battery room fans are supplied from the emergency power system. Consequently, the likelihood of fan failure is low, and such failure would be annunciated to the plant operator if it occurred. At Sequoyah and Bellefonte, some exhaust ducts are not properly configured for dispersion of hydrogen; at Sequoyah, not all duct configurations are covered by as-built drawings. At Watts Bar, tests demonstrated that damper leakage is sufficient to preclude hydrogen accumulation.

### 4.6 Fire Protection QA Designation - Element 231.6

At all plants, engineering drawings are the designated vehicle for identifying fire protection systems which are subject to limited QA. Since this is acknowledged in Specification G-73, there can be no discrepancy between the limited QA requirements of the drawings and Specification G-73. However, Specification G-73 includes ambiguities. At Browns Ferry, there are inconsistencies in engineering design standards which impose QA requirements on the fire protection systems. At Bellefonte, an NCR relating to fire detection system cabling was improperly invalidated.

### 4.7 Summarized Subcategory Findings

The findings are classified in Table 1. Class A and B findings are considered positive and indicate that a corrective action is not required. Class C, D, and E findings are considered negative and require corrective actions. The corrective action class, defined in the Glossary Supplement, is identified in the table by a numeral appended to the finding classification designation. For example, the designation C6 in Table 1 indicates that the finding was found to be valid and a corrective action was initiated before the ECTG evaluation (finding Class C) and that the corrective action involves evaluation (corrective action Class 6).

The summary of findings by classification is given in Table 2. Of the 41 findings identified by classification in Table 1, 21 require no corrective action. Of the remaining 20, eight had corrective actions initiated before the ECSP, seven had new corrective actions identified, and five resulted from peripheral findings uncovered during the ECSP. From this table it can be seen that at Watts Bar, where most of the issues originated, all but one out of a total of 14 issues were found to be valid; of the 13 valid issues, seven have acceptable consequences and require no corrective action, three had corrective actions initiated (and completed) before the ECSP, and three (including one resulting from a peripheral finding) require new corrective action. Table 2 also shows that for all plants there were eight valid issues that require new corrective action; in addition, five findings resulting from peripheral findings require corrective action.

## 5. CORRECTIVE ACTIONS

Table 2 identifies 20 negative findings, that is, findings that require corrective action. Because some of the corrective actions apply to more than one finding and because some apply to more than one plant, only 11 different corrective actions are required to remedy the 20 negative findings. The detailed corrective action descriptions are provided in Attachment B. A condensation of these descriptions by element, with the applicable plant(s) identified in parentheses, follows:

- 231.1, Undersized Distribution Headers
  - Complete program to upgrade fire protection sprinkler system (FPSS) to conform to applicable NFPA standards and NRC guidelines. The program includes inspection of existing systems verification of as-built drawings, hydraulic calculations per NFPA 13 based on as-built drawings to confirm pipe size and sprinkler coverage, and modification of systems, as necessary, so that such size and coverage conforms to all current requirements. (SQN and BFN; completed at WBN)

- 231.3, Sprinkler Heads Spray Pattern Interference
  - Sprinkler obstruction review program has been completed. The program included inspecting existing system to discover obstructions to sprinkler coverage, issuing ECNs to correct nonconformances, and instituting periodic inspections to identify and correct future nonconformances, if any. (WBN)

- 231.4, Lack of Fire Dampers in Additional Diesel Generator Building
  - Revise engineering design criteria documents to eliminate conflicting requirements for Additional Diesel Generator Building. (SQN, WBN)
- 231.5, Adequacy of Battery Room Ventilation System Design
  - Drill holes in six backdraft damper frames to preclude accumulation of hydrogen (SQN)
  - Raise vital battery room exhaust grilles to preclude accumulation of hydrogen (BLN)
  - Test dampers to establish presence of sufficient leakage to preclude accumulation of hydrogen (completed at WBN)
- 231.6, Fire Protection QA Designation
  - Edit G-73 to preclude future misinterpretation of QA jurisdiction for fire protection. (SQN, WBN, BFN, BLN)
  - Review possible incorrect invalidation of NCRs based on incorrect identification of QA requirements for fire protection system cables on Cable Status Master Report. (BLN completed prior to ECTG evaluation)
  - Resolve contradictions in the backfitting of generic limited QA requirements for fire protection systems to the existing BFN requirements. (BFN)
  - Revise cable listing procedures to include identification of limited QA (as well as full QA and no QA) for fire protection system cables. (completed at BLN)
  - Issue Engineering design standards for limited QA for fire protection systems. (BFN)

These corrective actions are summarized in Table 3, along with their corresponding finding/corrective action classifications. This table also indicates the plant or plants to which a corrective action is applicable and lists Corrective Action Tracking Document (CATD) number if applicable.

The Finding/Corrective Action Classification column of Table 3 shows that, of the 11 corrective actions identified, four require modification of a procedure; three involve programs of inspection, evaluation, and possible modification of hardware; two require hardware modification; and two involve documentation.

The CATD column of Table 3 shows that, of the 11 corrective actions identified, eight apply to a single plant, one applies both to Sequoyah and Watts Bar, one applies to Sequoyah, Watts Bar, and Browns Ferry, and one applies to all four plants.

One element, 231.2, requires no corrective action and, therefore, is not listed in Table 3.

In all cases, the evaluation team found the corrective action plans to be acceptable to resolve the findings.

## 6. CAUSES

Table 3 outlines a matrix relationship between causes and each corrective action. Only the primary or most logically derivable cause-effect association has been identified. Engineering judgment based on past experience was the major influence on establishing each entry.

The most frequent causal category (corresponding to 4 of 11 corrective actions) is "Inadequate Procedures." Of these, three are related to one element, 231.6, suggesting a weakness in the application of the NRC's requirements for fire protection quality assurance, or confusion resulting from the many changes in the requirements as they evolved. Issue "a" of element 231.6 (see issues referenced in Attachment B) resulted in a commitment to revise Specification G-73 to clarify jurisdiction for limited Q versus full Q requirements. In Issue "b," an NCR was invalidated incorrectly because the cable classification procedures did not adequately allow for the limited Q designation in additional to the Q and non-Q designation. In Issue "c," the procedures for designating the classification of cable on the cable list were deficient in not using the limited Q category. In Issue "a" of element 231.3, procedures to ensure compliance with NFPA-13 requirements were not implemented until NCR W-110-P identified the deficiency. While no single corrective action establishes a deficiency in TVA procedures, the accumulated weight of all suggest that similar problems may exist in parallel areas, and "Inadequate Procedures" was designated as the most appropriate cause.

"Design Criteria/Commitments Not Met" is the second most frequent cause (corresponding to three corrective actions). The three corrective actions in elements 231.5 for SQN, WBN, and BLN relate to battery room ventilation systems, where measures to preclude hydrogen accumulation were not applied consistently in all battery rooms in all plants. This suggests a weakness in design review in the particular area of battery room ventilation.

The third most frequent cause is "Inadequate Design Bases," with two occurrences. In element 231.1, two findings in each of three plants, SQN, WBN, and BFN, were condensed to a single finding. In all cases, the cause was chosen to be the "Inadequate Design Bases" to conform with the NFPA-13 and NRC guidelines. This reflects the failure of the plants' fire protection design bases to be maintained in a current status, consistent with the changing and evolving regulations. The second occurrence under "Inadequate Design Bases" is Issue "c" of BFN element 231.6. In this case, Mechanical Design Standard DS-M17.3.2 did not clearly address the QA requirements for fire protection systems for BFN, and no other document addressed this issue.

Of the remaining causes identified in Table 3, Issue "b" of BFN element 231.6 was assigned to "Fragmented Organization." This is the only cause that can explain the DNE G-73 requirements being backfitted to BFN while the BFN organization was implementing its own fire protection QA requirements.

The last entry, Issue "b" of SQN and WBN elements 231.4, was assigned to "Inadequate As-built Reconciliation" because the common fire zone concept employed for the fifth diesel, which was added at a later stage, was not addressed and updated in parts of the design criteria and drawings. The design criteria were originally written using separated fire zones for the fire protection of the other four diesels and were therefore deficient in accurately outlining current requirements.

The initial vagueness and evolving nature of NRC guidelines for fire protection in nuclear power plants are responsible for many of the corrective actions listed in Table 3, and manifest themselves primarily as "Inadequate Procedures" and "Inadequate Design Bases" causes, suggesting a failure to adjust procedures and design bases to changing requirements in a timely manner. Further discussion of the related problems of incorporation of requirements and commitments in design and experience feedback may be found in Subcategory Report 24500.

Using the three larger groups of causes identified by the headings in Table 3, five causes are in the management effectiveness group, six are in the design process effectiveness group. None are in the technical adequacy group. On the basis of this analysis, employee concerns for fire protection systems reflect more on management and design process concerns than on the technical adequacy of the fire protection system. These "larger scope" issues are the same as those being addressed by TVA's Revised Corporate Nuclear Performance Plan.

## 7. COLLECTIVE SIGNIFICANCE

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. As can be seen from these columns, only 3 of the 11 corrective actions for this subcategory are judged to be significant:

- Complete program to upgrade fire protection systems to conform to applicable NFPA and NRC guidelines
- Complete sprinkler obstruction program
- Investigate possible incorrect invalidation of NCRs

Completion of the program to upgrade the fire protection systems to conform to current requirements and completion of the sprinkler obstruction program were judged to be significant because the programs affect the performance of systems that protect safety-related structures. It must be recognized that these upgrade programs were initiated to bring the fire protection systems into compliance with modern NRC criteria. The corrective actions to accommodate valid issues raised by the various concerned employees were incidental to these NRC mandated changes. On the basis of the number of issues raised, their diverse nature, the time period during which they went unaddressed, and the level of disagreement as to the proper criteria, a general presumption can be made that they would have remained as latent defects.

However, the total number of issues in this subcategory does not provide a sufficiently large sample to justify drawing clean and unambiguous conclusions of collective significance. The relatively large number of valid issues that require no corrective action (18 out of 41) may suggest that employees expressing concerns are not aware of, do not understand, or lack confidence in the engineering decisions made during the design of the plant. This, in turn, may evidence poor communication within the TVA organization, but such a conclusion would be viable only if substantiated by a much larger sample. While a direct relationship between the issues presented in these concerns and TVA's Revised Corporate Nuclear Performance Plan is similarly difficult to draw, improvements made in the area of commitment tracking and management system and controls should result in more timely implementation of evolving criteria in a more uniform manner.

The results of this subcategory evaluation are being combined with the other subcategory evaluations and reassessed in the Engineering category in a single report.

TABLE 1

CLASSIFICATION OF FINDINGS AND CORRECTIVE ACTIONS

| | Element | Issue/ Finding** | Finding/Corrective Action Class* | | | |
|---|---|---|---|---|---|---|
| | | | SQN | WBN | BFN | BLN |
| 231.1 | Undersized Distribution Headers | a | B | B | C6 | B |
| | | b | B | B | C6 | B |
| | | c | C6 | C6 | - | - |
| | | d | C6 | C6 | - | - |
| 231.2 | Electrical Panels Not Protected from Sprinklers | a | - | B | - | - |
| | | b | - | A | - | - |
| 231.3 | Sprinkler Heads Spray Pattern Interference | a | - | C6 | - | - |
| 231.4 | Lack of Fire Dampers in Additional Diesel Generator Building | a | B | B | - | - |
| | | b | E3 | E3 | - | - |
| 231.5 | Adequacy of Battery Room Ventilation System Design | a | B | B | A | A |
| | | b | B | B | B | B |
| | | c | B | B | B | D1 |
| | | d | D1 | D6 | - | - |
| 231.6 | Fire Protection QA Designation | a | D2 | D2 | D2 | D2 |
| | | b | - | - | E2 | C6 |
| | | c | - | - | E3 | E2 |

*Classification of Findings and Corrective Actions

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

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

**Defined in Attachment B.

TABLE 2

FINDINGS SUMMARY

| | Classification of Findings | Plant SQN | WBN | BFN | BLN | Total |
|---|---|---|---|---|---|---|
| A. | Issue not valid. No corrective action required. | 0 | 1 | 1 | 1 | 3 |
| B. | Issue valid but consequences acceptable. No corrective action required. | 6 | 7 | 2 | 3 | 18 |
| C. | Issue valid. Corrective action initiated before ECTG evaluation. | 2 | 3 | 2 | 1 | 8 |
| D. | Issue valid. Corrective action taken as a result of ECTG evaluation. | 2 | 2 | 1 | 2 | 7 |
| E. | Peripheral issue uncovered during ECTG evaluation. Corrective action required. | 1 | 1 | 2 | 1 | 5 |
| | Total | 11 | 14 | 8 | 8 | 41 |

TABLE 3
MATRIX OF ELEMENTS, CORRECTIVE ACTIONS, AND CAUSES
SUBCATEGORY 23100

| 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 | Significance of Corrective Actions* D | M | H |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | CAUSES OF NEGATIVE FINDINGS * — MANAGEMENT EFFECTIVENESS (1–7) | | | | | | | DESIGN PROCESS EFFECTIVENESS (8–14) | | | | | | | TECHNICAL ADEQUACY (15–17) | | | | | |
| 231.1 | C6 | Complete program to upgrade FPSS to conform to NFPA 13 and NRC guidelines (completed at WBN). | SQN 01<br>(WBN)***<br>BFN 01 | | | | | | | | X | | | | | | | | | | A | - | A |
| 231.3 | C6 | Complete sprinkler obstruction review program; continuing review required by Technical Specifications (completed at WBN). | (WBN)*** | | | X | | | | | | | | | | | | | | | A | - | A |
| 231.4 | E3 | Revise flow diagrams (SQN only) and general design criteria to reflect as-built conditions. | SQN 01<br>WBN 01 | | | | | | | | | | X | | | | | | | | - | - | - |
| 231.5 | D1 | Drill holes to preclude accumulation of hydrogen. | SQN 01 | | | | | | | | | | | | | X | | | | | - | - | - |
| | D1 | Raise grilles to preclude accumulation of hydrogen. | BLN 01 | | | | | | | | | | | | | X | | | | | - | - | - |
| | D6 | Test dampers and establish existence of sufficient leakage to preclude accumulation of hydrogen. | WBN 01 | | | | | | | | | | | | | X | | | | | - | - | - |
| 231.6 | D2 | Revise G-73 to eliminate ambiguities. | SQN 01<br>NPS 01(WBN)<br>NPS 01(BFN)<br>NPS 01(BLN) | | | X | | | | | | | | | | | | | | | - | - | - |
| | C6 | Investigate incorrect invalidation of NCRs. | BLN 01 | | | X | | | | | | | | | | | | | | | A | - | - |

* Defined in the Glossary Supplement.
** Defined in Table 1.
*** Corrective action already completed, no CATD required.

TABLE 3
MATRIX OF ELEMENTS, CORRECTIVE ACTIONS, AND CAUSES
SUBCATEGORY 23100

| ELEM | FINDING/ CORRECTIVE ACTION CLASS.** | CORRECTIVE ACTION | CAID | CAUSES OF NEGATIVE FINDINGS * — MANAGEMENT EFFECTIVENESS: 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 | DESIGN PROCESS EFFECTIVENESS: 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 | TECHNICAL ADEQUACY: 15 Stds Not Followed | 16 Engrg Error | 17 Vendor Error | Significance of Corrective Actions* D | M | H |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 231.6 | E2 | Resolve contradiction in DNE's issuing a specification for a plant and the plant's not using the specification. | BFN 01 | X | | | | | | | | | | | | | | | | | - | - | - |
| | E2 | Devise a method to reflect limited QA requirements on cable lists. | BLN 01 | | | X | | | | | | | | | | | | | | | - | - | - |
| | E3 | Issue an Engineering document for limited QA for fire protection systems at BFN. | BFN 02 | | | | | | | | X | | | | | | | | | | - | - | - |
| | | | TOTALS | 1 | | 4 | | | | | 2 | | 1 | | | 3 | | | | | | | |

* Defined in the Glossary Supplement.
** Defined in Table 1.
*** Corrective action already completed, no CATD required.

## 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.

## ATTACHMENT A

## EMPLOYEE CONCERNS FOR SUBCATEGORY 23100

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

ATTACHMENT A

EMPLOYEE CONCERNS FOR SUBCATEGORY 23100



| ELEMENT | CONCERN NUMBER | PLANT LOCATION | APPLICABILITY SQN | WBN | BFN | BLN | CONCERN DESCRIPTION* |
|---|---|---|---|---|---|---|---|
| 231.1 | IN-85-010-004 | WBN | X | X | | | "Problem with fire protection piping design in Unit #1. CI gave this example: Unit 1, Aux. Bldg, Elev. 692', undersized fire protection piping for the amount of sprinklers being fed by line. EG: 5 sprinkler heads on a 1" line being fed by a 1-1/4" lines. CI feels that this design does not meet fire protection codes." (SR) |
| | IN-85-534-001 | WBN | X | X | | | "Fire protection system not installed per NFPA code requirements. Many lines have too many sprinkler heads for the pipe size (e.g. more than 10 heads on 2" pipe, or more than 5 heads on 1-1/2" pipe); Eg wrong pipe size in unit 2 Aux., 713' ele. 'go west toward reactor, run of 1" pipe at corner before wall with mezzanine over it.'" (SR) |
| | IN-85-534-002 | WBN | X | X | | | "Fire protection lines do not meet NFPA code, both units. Some supply lines are 1/2", which is too small. Example: Located in fresh air handling room aux. bldg Unit 1. 30' from air lock to reactor Bldg, on left, 713' Elevation." (SR) |
| | BNP-QCP-10.35-8-16 | BLN | X | X | X | X | "CI concerned that welding smaller diameter pipes to larger diameter pipes in FPS could restrict the flow of water. He would feel much better if he could see a document from an insurance company or some reliable authority stating that the system complied with specifications." (SR) |
| 231.2 | IN-85-064-001 | WBN | | X | | | "El. 757', 6900 V shutdown board rooms A & B are not protected from fire protection water." (SR) |
| | IN-85-470-001 | WBN | | X | | | "757' level, Reactor Building, units 1 & 2, contains 6.9 kV switchgear which controls the reactor coolant pumps. The switchgear is located under a fire control sprinkler system which, if activated, could cause failure of the switchgear and the pumps." (SR) |

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

ATTACHMENT A

EMPLOYEE CONCERNS FOR SUBCATEGORY 23100



| ELEMENT | CONCERN NUMBER | PLANT LOCATION | APPLICABILITY SQN | WBN | BFN | BLN | CONCERN DESCRIPTION* |
|---|---|---|---|---|---|---|---|
| 231.3 | IN-85-534-004 | WBN | | X | | | "Sprinkler heads in both units are installed adjacent to ducts and walls. This blocks their spray area. (Examples are generally around ducts larger than 1/2" across, also Aux. bldg., stairwells or Unit 2 side between 713' and 729' elev.) CI has no more information. Construction department concern." (SR) |
| 231.4 | IN-86-305-002 | WBN | X | X | | | "There are no fire dampers in diesel generator building #5 leading to the fan room. If a fire were to break out downstairs, the fans would pull the flames through the floor grating of the fan room." (SR) |
| 231.5 | TAK-85-006 | SQN | X | X | X | X | "Vital battery room resistance heaters could be a potential ignition source in the event an exhaust fan failure allows accumulation of combustible gases generated during charging." (SS) |
| | I-85-993-NPS | NPS | X | X | | | "The design of ventilation of battery rooms at SQN and WBN is not adequate." (SR) |
| 231.6 | BNP-QCP-10.35-1 | BLN | X | X | X | X | "Discrepancy between G-73 designation of fire protection drawings (QA) and engineering treatment of fire protection drawings (as non-QA).<br><br>"Also NCR 2675 (fire protection cable deficiency) was invalidated based on verbal information received by telephone that contradicts design approved documents." (SS) |

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

# ATTACHMENT B

## SUMMARY OF ISSUES, FINDINGS, AND CORRECTIVE ACTIONS FOR SUBCATEGORY 23100

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

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

| Issues | Findings | Corrective Actions |
|---|---|---|
| ****************** Element 231.1 - Undersized Distribution Headers ****************** | | |
| SQN | SQN | SQN |
| a. Change in pipe size could result in flow restriction. | a. SQN FPSS was initially designed to meet NRC BTP APCSB 9.5-1. The conservative NFPA-13 "Pipe Schedule Method" was used to size the FPSS piping. This method ensures that main headers have sufficient capacity to support branch lines and that branch lines are large enough to meet their service requirements. The NRC's SER found this design adequate and licensable. | a. No corrective action is required. |
| b. Fire insurance company review and documentation needed to confirm compliance with specifications. | b. Independent inspections by fire protection specialists were performed to obtain insurance. The insurance is in effect at this time. Independent reviews of SQN for NFPA compliance are conducted on a semi-annual bases by specially trained and certified personnel on contract to the fire insurance underwriter. | b. No corrective action is required. |
| c. The HPFPS piping is undersized for the amount of sprinklers. | c. The initial SQN FPSS must be upgraded to meet newer (10CFR50.48 and Appendix R) regulatory requirements. TVA has a two-phased program in place at Sequoyah to accomplish this. As part of this program, TVA is performing system walkdowns and identifying areas requiring modifications. As-built drawings reflecting the present system and any necessary modification are being generated. Hydraulic calculations based on these as-built drawings are being performed to confirm compliance with NFPA 13 header sizing and sprinkler density requirements. | c. CATD 230 01 SQN (Ref. 3) identifies the problem as follows:<br>"Bring SQN FPSS into pipe sizing compliance with NFPA-13."<br>The CAP for this CATD identifies the corrective action as:<br>"SQEP shall revise the FPSS drawings to reflect FCRs 4415, 4542, 4543, and 4551 under ECN L-6319." SQN shall complete phase 2 of the program by upgrading portions of the control building and auxiliary building areas to NFPA-13 requirements."<br>No CAQR was generated. The completion date is July 1988. |
| d. HPFPS pipe sizing is not in accordance with NFPA requirements. | d. Phase 1 of this program, which addresses portions of the FPSS necessary to meet Appendix R criteria is completed and has been accepted by the NRC. Additional piping has been installed to bring the pipe sizing into compliance with NFPA-13. Phase 2 will continue this effort to additional plant areas. Phase 2 is in progress. | d. See (c) above. |

| Issues | Findings | Corrective Actions |
| --- | --- | --- |
| Element 231.1 - WBN | WBN | WBN |
| a. Change in pipe size could result in flow restriction. | a. The WBN high pressure fire protection system (HPFPS) was designed to comply with the requirements of the NRC BTP 9.5-1, Appendix A, "Guidelines for Fire Protection for Nuclear Power Plants." The sprinkler systems are designed in accordance with the criteria established in the National Fire Protection Association (NFPA) Standard No. 13, "Standard for Installation of Sprinkler Systems." Originally, the design utilized the conservative tabular guidance of the "pipe schedule method." The HPFPS was later modified to accommodate the requirements of 10CFR50, Appendix R. The design was evaluated using the criteria for "hydraulically designed sprinkler systems" to eliminate unacceptable flow restrictions. These criteria are provided as an alternate method in NFPA-13. | a. No corrective action is required. |
| b. Fire insurance company review and documentation needed to confirm compliance with specifications. | b. Independent periodic inspections by certified fire protection experts are being performed prior to obtaining fire insurance. Though fire insurance will not be in effect until fuel load, the insurance company inspections provide an additional level of review for compliance with NFPA standards and fire insurance specifications. | b. No corrective action is required. |
| c. The HPFPS piping is undersized for the amount of sprinklers. | c. As a result of continued NRC inspections, WBN has gone through a phase of fire protection system review to comply with the requirements of 10CFR50, Appendix R. Design changes resulting from these reviews were evaluated by hydraulic analysis and by preoperational testing. Both the analysis and testing for ECNs 5216 and 3667 confirm that the fire protection system meets the NFPA sizing requirements to supply the required spray density to the prescribed area. | c. No further corrective action is required.<br><br>The previous revisions described under "Findings" were completed before the start of the ECSP. |
| d. HPFPS pipe sizing is not in accordance with NFPA requirements. | d. The HPFPS pipe sizing was evaluated by the hydraulic analysis method provided in NFPA-13, Section 7. The system was found acceptable by the fire insurance company inspectors. The HPFPS pipe sizing criteria were also reviewed by the NRC and found to be adequate as reported in its Safety Evaluation Report. | d. No further corrective action is required.<br><br>The previous revisions described under "Findings" were completed before the start of the ECSP. |

| Issues | Findings | Corrective Actions |
|---|---|---|
| **Element 231.1 - BFN** | **BFN** | **BFN** |
| a. Change in pipe size could result in flow restriction. | a. The BFN Technical Specifications Section 3/4.11 provide the minimum requirements for safe operation of the fire protection system. The Technical Specifications also require hydraulic performance testing every 3 years to assure that the system performance remains within the prescribed limitations. | a. CATD 231 01 BFN 01 (Ref. 38) identifies the problem as:<br><br>"The commitments made in the Browns Ferry Nuclear Performance Plan regarding the fire protection system (Nos. 81, 82 and 83) have not been completed to date."<br><br>The CAP for the CATD identifies the corrective action as:<br><br>"Commitments 81, 82 and 83 as stated in the BFNP Performance Plan Vol. III are currently in the process of being implemented. These commitments are scheduled to be completed prior to restart."<br><br>No CAQR was issued. |
| b. Fire insurance company or reliable authority review and documentation needed to confirm compliance with specifications. | b. The Browns Ferry Nuclear Performance Plan expresses commitments to provide additional independent evaluations of the FPS. These evaluations are being performed by a qualified engineering consultant. The evaluation will document any deviations from NFPA codes. A plan for implementation of modifications or justification of exceptions is required to be completed before restart of any BFN unit. | b. See (a) above. |
| **BLN** | **BLN** | **BLN** |
| a. Change in pipe size could result in flow restriction. | a. The BLN fire protection sprinkler systems are designed in conformance with NFPA 13. The BLN preoperational test program includes the fire protection system. The system test objective is to verify that specified pressures and flows are supplied to designated suppression systems and hose stations, which will establish conformance with the NFPA requirements, or require modifications to establish conformance. | a. No corrective action is required. |
| b. Fire insurance company or reliable authority review and documentation are needed to confirm compliance with specifications. | b. Independent NRC and nuclear insurance company reviews are planned, which are routine activities that occur prior to obtaining an operating license. These independent evaluations will confirm compliance with applicable specifications, or require modifications to establish compliance. | b. No corrective action is required. |

| Issues | Findings | Corrective Actions |
|---|---|---|
| ****************** Element 231.2 - Electrical Panels Not Protected from Sprinklers ****************** | | |
| SQN | SQN | SQN |
| (Not to be evaluated) | | |
| Element 231.2 - WBN | WBN | WBN |
| a. The 6900 V shutdown boards are not protected from fire protection water spray. | a. The flow diagrams (47W850-2 and -5) and the piping drawings (47W491-82 and -83) describe the presence of a fire protection sprinkler system in rooms 757.0-A24 and 757.0-A2 (6900 V shutdown panel rooms). Direct inspection of the area also confirms the existence of the high-pressure fire protection system (HPFPS). The 6900 V shutdown panel is not protected from the sprinkler spray (because such protection is not required). The location of the sprinkler heads above the shutdown panel and the absence of other major combustible materials provide reasonable assurance that any fire in the shutdown room that activates the sprinklers will be in the shutdown boards. The purpose of the sprinklers then is to prevent the fire from spreading, not to protect the panels from fire. | a. No corrective action is required. |
| b. The 6900 V shutdown boards will fail due to sprinkler actuation. (The concern identified "the 6.9 kV switchgear which controls the RCPs." In actual fact, the 6.9 kV switchgear identified are the 6.9 kV shutdown boards. The RCP switchgear is in weatherproof enclosures in a different location. The concern was interpreted to mean the 6.9 kV shutdown boards.) | b. The fire protection system installed in these areas is of a preaction design. The system piping is not charged with water downstream from a preaction valve. Actuation of this valve is provided by two cross-zoned (separate circuit) ionization smoke detectors. The dry system is also pressurized with air to ensure the absence of leaks. Therefore, the system is designed to preclude spurious actuation and is activated only by heat (probably from a fire in the shutdown boards) releasing the fusible link and by smoke detected by ionization smoke detectors to open the preaction valve. Thus, it is improbable that the sprinkler would be inadvertently activated. | b. No corrective action is required. |

| Issues | Findings | Corrective Actions |
|---|---|---|
| Element 231.2 - WBN (Continued) | | |
| | As indicated above, it is probable that activation of the sprinklers will be caused by a fire in the baords that has already damaged or inactivated the shutdown board. Note, however, that a second train of shutdown boards at another location is available and presumably operating. | |
| BFN | BFN | BFN |
| (Not to be evaluated) | | |
| BLN | BLN | BLN |
| (Not to be evaluated) | | |

******************
Element 231.3 - Sprinkler Heads Spray Pattern Interference
******************

| Issues | Findings | Corrective Actions |
|---|---|---|
| SQN | SQN | SQN |
| (Not to be evaluated) | | |

| Issues | Findings | Corrective Actions |
|---|---|---|
| Element 231.3 - WBN | WBN | WBN |
| a. Fire protection sprinklers are obstructed, which reduces the effectiveness of the spray pattern. | a. The concern regarding fire protection system sprinkler obstructions has been addressed in a nonconformance report, NCR W-110-P. In response to this NCR, WBN has established and implemented a program of walkdown and design review to ensure compliance with National Fire Protection Association Standard No. 13 (NFPA-13) requirements related to sprinkler spray coverage. This program has been reported to the NRC in the final report of NCR W-110-P. The NCR and the resulting ECN 3867 have been closed; however, the sprinkler inspection program is being tracked by the construction organization's Commitment Tracking Record (CTR). Continuing surveillance requirements are described in the Technical Specifications (4.7.11.2.C.3). This technical specification section requires that all safety-related areas be inspected for sprinkler obstructions every 18 months. | a. No further corrective action is required.<br><br>The corrective action described under "Findings" was completed before the start of the ECSP. |
| BFN | BFN | BFN |
| (Not to be evaluated) | | |
| BLN | BLN | BLN |
| (Not to be evaluated) | | |

******************
Element 231.4 - Lack of Fire Dampers in Additional Diesel Generator Building
******************

| Issues | Findings | Corrective Actions |
|---|---|---|
| SQN | SQN | SQN |
| a. Lack of fire dampers in the #5 diesel generator (DG) building between the diesel room and the fan room could cause spreading of fire. | a. The #5 DG system improves plant availability during testing, repair, and maintenance of the original four DG systems. | a. No corrective action is required. |

| Issues | Findings | Corrective Actions |
|---|---|---|
| Element 231.4 - SQN (Continued) | | |
| | The DG sets #1 through 4 are each in a separate fire zone and equipped with $CO_2$ fire fighting systems and fire dampers in the floor gratings. This arrangement prevents a fire in any DG or peripheral room from spreading to other DG systems in the same building, and thus complies with Appendix A, to Branch Technical Position, Auxiliary Power Conversion System Branch (APCSB).<br><br>The #5 DG room does not require fire dampers between the DG room and the intake and exhaust rooms because it is a single fire zone. | |
| b. Peripheral finding. | b. The design documents are inconsistent regarding the floor grating fire dampers in the #5 DG building. GDC SQN-DC-V-11.1.2 is not complied with. Drawing 47W866-14, R2, shows dampers; drawing 17W910-3, R8, does not. | b. CATD 231 04 SQN 01 (Ref. 73) identifies the problems as:<br><br>"Drawing 47W866-14 Rev. 2 and GDC SQN-DC-V-11.1.2 Rev. 1 do not agree with as-built condition and drawing 17W910-3 Rev. 8."<br><br>The CAP for this CATD identifies the corrective action as:<br><br>"SQN (DNE) shall revise flow diagram 47W866-14 Rev. 2 to delete fire dampers 0-30-647 and 0-30-638 at the floor grating of the air intake and exhaust rooms. DNE (NEB) shall revise general design criteria (GDC) SQN-DC-V-11.1.2 Rev. 1 paragraph 4.6 deleting the requirement for a fire protection system that prevents fire from spreading from peripheral rooms to the #5 D.G. Room"<br><br>No CAQR was issued.<br><br>Completion is scheduled for June 1987. |

| Issues | Findings | Corrective Actions |
|---|---|---|
| Element 231.4 - WBN | WBN | WBN |
| a. Lack of fire dampers in the fifth diesel generator building between the diesel room and the fan room could cause spreading of fire. | a. The DG sets 1 through 4 are each located in a separate fire zone within the same building and equipped with $CO_2$ fire fighting systems and fire dampers in the floor gratings. Fire dampers are installed in ventilation ducts penetrating fire walls of auxiliary rooms. This arrangement prevents a fire in any DG or peripheral room from spreading to other DG systems in the same building, and thus complies with Appendix A to NRC Branch Technical Position, Auxiliary Power Conversion System Branch (APCSB).<br><br>The fifth DG set is located in a separate building. It improves plant availability during testing, repairing, and maintenance of any one of the original four DG sets. The air intake and exhaust systems in the rooms above the DG bay are an integral part of and must be operational with the fifth DG set. It is true that "there are no fire dampers between the engine bay and the fan room above." As pointed out in the concern; nor are any required. No $CO_2$ fire protection system is installed which would require fire dampers, and the fifth DG building is not fire compartmentalized between the engine bay and the fan room. | a. No corrective action is required. |
| b. Peripheral finding. | b. TVA's General Design Criteria for Environmental Control in the fifth DG building specify that fire not be permitted to spread from peripheral rooms to the fifth DG room. However, drawings 47W866-14, R8, and 17W910-3, R13, do not show fire dampers between the DG room and the air handling rooms. | b. CATD 231 04 WBN 01 (Ref. 82) identifies the problem as:<br><br>"As built and [sic] drawings 47W866-14 Rev. 8 and 17W910-3, Rev. 13 do not agree with GDC No. WB-DC-40-28.2, Rev. 1, paragraph 4.6 regarding fire damper requirements."<br><br>The CAP for this CATD identifies the corrective action as:<br><br>"Issue a ECN (6827) to revise Watts Bar Nuclear Plant Design Criteria, WB-DC-40-28.2. (Additional Diesel Generator Building environmental control system), Section 4.6 (fire protection), to reflect actual compartmentation requirements for the additional diesel generator room. |

| Issues | Findings | Corrective Actions |
|---|---|---|
| Element 231.4 - WBN | WBN | |
| | | Note: The requirements imposed by this criteria (WB-DC-40-28.2), are not in accordance with criteria as stated in design criteria WB-DC-40-28.1 (additional diesel generator system class 1E), Section 3.13 (fire protection), which identifies TVA drawing series 47W240 as the governing document for the determination of fire protection compartmentation. Drawing 47W240-10 shows no compartmentation requirements for the additional diesel generator room."<br><br>The CAQ was to be investigated under PIR WBN WBP 8710. Completion is scheduled for before unit 1 fuel load. |
| BFN | BFN | BFN |
| (Not to be evaluated) | | |
| BLN | BLN | BLN |
| (Not to be evaluated) | | |

*******************
Element 231.5 - Adequacy of Battery Room Ventilation System Design
*******************

| Issues | Findings | Corrective Actions |
|---|---|---|
| SQN | SQN | SQN |
| a. Resistance heaters in SQN vital battery rooms could be ignition sources for hydrogen ($H_2$) generated during battery charging. | a. There is no violation of commitment to the NRC, TVA design criteria, or industrial code by installation of electric resistance heaters in properly ventilated battery rooms. There are no limitations on potential ignition sources because the ventilation system limits hydrogen buildup to less than 2 percent. Hydrogen cannot burn in air at less than 4 percent. | a. No corrective action is required. |
| b. Battery room exhaust fans fail. | b. Except for the DG battery I through IV hood exhaust systems, all battery room fans are provided with a backup and automatic switchover upon lead fan failure. There is no dedicated exhaust system for DG battery V. All battery system exhaust fans, including for DG batteries, are class 1E and supplied with emergency power. Malfunction of fans is annunciated in the main control room. Unnoticed complete failure of the ventilation system is, therefore, very unlikely. | b. No corrective action is required. |

Element 231.5 - SQN (Continued)

| Issues | Findings | Corrective Actions |
|---|---|---|
| c. Hydrogen accumulates in the vital battery rooms. | c. The normal ventilation flow in the battery rooms is sufficient to maintain the average hydrogen concentration below half of the lower flammability limit considered safe by NRC Regulatory Guide 1.128. The time required to build up to this concentration with complete ventilation failure is ample (usually more than 68 hours) for corrective action. Scheduled surveillance of battery and charger parameters would indicate overcharging of batteries and hence hydrogen generation before a hazardous concentration could be reached. | c. No corrective action is required. |
| d. The design of the ventilation systems for the 125 V vital battery rooms, 250 V battery rooms, 24/48 V battery rooms, and the diesel generator battery areas is not adequate. | d. A hydrogen survey confirmed that no pockets of higher concentration develop in the 250 V and 125 V vital battery rooms I through IV. No survey was conducted for the vital battery room V, which is more prone to pocket formation due to the location of the exhaust ducts several feet below the ceiling. The DG I through IV battery exhaust hood would accumulate hydrogen if the exhaust damper failed to close, followed by battery overcharging. | d. CATD 231 05 SQN 01 (Ref. 108) identifies the problem as:<br><br>"The fifth 125 V vital battery room has not been surveyed for hydrogen pocketing under actual conditions while and following equalizing of the battery. No scavenging holes are provided in the protruding exhaust duct. The DG battery I through IV exhaust hoods may accumulate hydrogen upon damper failing closed. BOP specification EJ/4.57.2 does not show criteria for acceptable battery charge parameters and surveillance interval (12 hours) is not confirmed."<br><br>The CAP for this CATD identifies the corrective action as:<br><br>"to prevent possible hydrogen buildup, SQEP M3 shall:<br><br>(1) Revise HVAC drawing 17W910-2, in the diesel generator battery rooms I through IV, to drill 3/4-inch holes in the motor operated damper located at the discharge of the battery hood exhaust fan. |

| Issues | Findings | Corrective Actions |
|---|---|---|
| Element 231.5 - SQN (Continued) | | |
| | | (2) Revise HVAC drawing 47W920-9, in the fifth 125 volt vital battery room, to include 3/4-inch holes in the exhaust damper frame near the ceiling.<br><br>The 125 volt vital battery rooms I through IV already have holes in the ducts near the ceiling."<br><br>No CAQR was issued. Completion was scheduled for 08/15/87. |
| WBN | WBN | WBN |
| a. Resistance heaters in WBN vital battery rooms could be ignition sources for hydrogen ($H_2$) generated during battery charging. | a. There is no violation of commitment to the NRC, TVA design criteria, or industrial code by installation of electric resistance heaters in properly ventilated battery rooms. The ventilation system limits hydrogen to less than 2 percent, which is well below the 4 percent flammability limit. | a. No corrective action is required. |
| b. Battery room exhaust fans fail. | b. Except for the diesel generator (DG) battery I through IV hood exhaust systems, all battery room fans are provided with a backup and automatic switchover upon lead fan failure. There is no dedicated exhaust system for DG battery V. All battery system exhaust fans, including those for DG batteries, are class 1E and supplied with emergency power. Malfunction of the battery room ventilation fans in the control and auxiliary buildings is annunciated in the main control room. Unnoticed complete failure of these ventilation system(s) is, therefore, very unlikely. | b. No corrective action is required. |
| c. Hydrogen accumulates in the vital battery rooms. | c. The normal ventilation flow in the battery rooms is sufficient to maintain the average hydrogen concentration below half of the lower flammability limit considered safe by NRC Regulatory Guide 1.128. The time required to build up to this concentration with complete ventilation failure is ample (29 to 65 hours) for corrective action. Scheduled surveillance of battery and charger parameters would indicate overcharging of batteries and hence hydrogen generation before a hazardous concentration could be reached. | c. No corrective action is required. |

| Issues | Findings | Corrective Actions |
|---|---|---|

**Element 231.5 - WBN (Continued)**

**Issues**

d. The design of the ventilation systems for the 125 V vital battery rooms, 250 V battery rooms, 24/48 V battery rooms, and the diesel generator battery areas is not adequate.

**Findings**

d. A hydrogen survey confirmed that no pockets of higher concentration develop in the 250 V and 125 V vital battery rooms I through IV. No survey was conducted for the vital battery room V or the 24/48 V battery rooms. However, the exhaust duct and fan configurations near the ceiling of battery room V and the 24/48 V battery rooms prevent hydrogen pocket formation.

The DG battery exhaust hoods in DG rooms I through IV would accumulate hydrogen if the exhaust damper downstream of the fan failed closed, followed by battery overcharging. The fire damper upstream of the DG battery exhaust hood fan is equipped with two fusible links in parallel. This minimizes unintentional fire damper closures.

**Corrective Actions**

d. CATD 231 05 WBN 01 (Ref. 119) identifies the problem as:

"The DG battery I through IV exhaust hoods and ducts may accumulate hydrogen upon damper failing closed."

The CAP for this CATD identifies the corrective action as:

"This concern is not a nuclear safety concern when evaluated from a single failure standpoint.

1. A mechanical failure of the DG battery exhaust fan would render the fan inoperable; however, the discharge damper would remain in open since power is still available. This situation leaves an open flowpath for hydrogen removal to the outside. This condition is documented in the Failure Modes and Effects Analysis, Section 9 of the FSAR. Failure of the fan due to a loss of power to the fan would be detected in sufficient time since the fan is inspected for operation every 8 hours (See OSIA-27 Attached).

2. A loss of power failure of a single train will cause the fan to shut down and its associated damper to close. Since the battery chargers are powered by the same train of that which is lost; there will be no hydrogen accumulation from battery overcharging.

| Issues | Findings | Corrective Actions |
|---|---|---|

Element 231.5 - WBN (Continued)

3. A mechanical failure of the exhaust damper to open or remain open during fan operation will not prevent hydrogen venting through damper leakage. During battery overcharging, assuming worst case conditions, the batteries are capable of producing 0.14 ft of hydrogen per hr. A damper leakage rate of just 1 ft/min is enough to vent the hydrogen with a safety factor of 428. A mechanical leakage test (attached [to the CAP]) was conducted and documented on 03/[illegible]/8[illegible] for each of the four battery exhaust dampers which were positioned in failure mode (closed). The results are as follows:

| Damper No. | [illegible] | CFM Leakage Data measured at Exhaust Hood, Fan Operating |
|---|---|---|
| 1-FCO-30-4[illegible]5A | 1A-A | 233 |
| 1-FCO-30-45[illegible]B' | 1B-B | 72 |
| 1-FCO-30-456A' | 2A-A | * |
| 1-FCO-30-[illegible]5[illegible]B | 2B-B | 205 |

* 1-FCO-30-456A is under Maintenance Request No. 537679 and, therefore, will not be able to test [sic] after maintenance work is complete. Expect same (or similar) results as the other three."

No CAQR was issued. No additional actions were necessary to complete the CAP.

THIS ITEM COMPLETED
DATE 2-24-88

| Issues | Findings | Corrective Actions |
| --- | --- | --- |
| Element 231.5 - BFN | BFN | BFN |
| a. Resistance heaters in the vital battery rooms could be ignition sources for hydrogen generated during battery charging. | a. There are no electrical heaters in the 250 V vital battery rooms. The DG control batteries are under vent hoods remote from the electrical unit heaters in the large DG rooms. There is no violation of commitment to the NRC, TVA design criteria, or industry code by installation of electric resistance heaters in properly ventilated battery rooms. The battery chargers are provided with monitoring instruments that annunciate overcurrent in the main control room. | a. No corrective action is required. |
| b. Battery room exhaust fans fail. | b. The battery room ventilation system has redundancy and is supplied from the class 1E power bus for keeping the hydrogen concentration at all times below the 2 percent considered safe by NRC regulations. Flow indicators or low alarms are provided locally or in the main control room. | b. No corrective action is required. |
| c. Hydrogen accumulates in the battery rooms. | c. Hydrogen evolution rates are low enough to prevent buildup to 2 percent average with no ventilation within the surveillance interval of the battery room and hood ventilation and charger systems. | c. No corrective action is required. |
| BLN | BLN | BLN |
| a. Resistance heaters in the vital battery rooms could be ignition sources for hydrogen generated during battery charging. | a. There are no electrical resistance heaters located inside the vital or nonsafety-related battery rooms. The NEC handbook imposes no special requirements as to the type of fixture or other electrical equipment used in properly ventilated battery rooms. | a. No corrective action is required. |
| b. Battery room exhaust fans fail. | b. The vital battery rooms are equipped with class 1E redundant 100 percent capacity supply and exhaust fans. The nonsafety-related battery rooms have redundant 100 percent capacity supply and exhaust fans. Low airflows in exhaust ducts trip alarms in the main control room. These and battery system trouble alarms give operators sufficient time for remedial action. The fresh air change frequencies in the battery rooms are sufficient to keep the average hydrogen concentrations below the 2 percent considered safe by NRC regulation. | b. No corrective action is required. |

| Issues | Findings | Corrective Actions |
|---|---|---|
| Element 231.5 - BFN | BFN | |
| c. Hydrogen accumulates in the battery rooms. | c. The equalizing charge, and thus the evolution of hydrogen, is limited by timers on the battery chargers. Even without ventilation, at the maximum calculated evolution rate, it would take several 8-hour shifts (29 to 65 hours) to build up an average hydrogen concentration of 2 percent in any battery room. However, the low elevation of the exhaust grilles in the vital battery rooms may allow hydrogen to accumulate at the ceilings. This is not in compliance with the TVA GDC for the Auxiliary Building ESF Zone Environmental Control System. The administrative procedures for surveillance and inspection of the battery and HVAC systems have not yet been issued. At other TVA plants these procedures provide for operational checks of the ventilation and battery systems every shift. | c. CATD 231 05 BLN 01 (Ref.145) identified the problem as:<br><br>"The elevation of the exhaust duct grilles in the vital battery rooms may allow accumulation of hydrogen at the ceiling. This may violate paragraph 4.3.4.1 of the General Design Criteria N4-VW-D740, Rev. 3, Auxiliary Building ESF Zone Environmental Control System."<br><br>The CAP for this CATD identified the corrective action as:<br><br>"Corrective Action Plan: Exhaust grilles for each vital battery room will be raised to the high point to prevent potential hydrogen accumulation at the ceiling. This engineering change will meet the requirements in design criteria N4-VW-D740, Auxiliary Building ESF Zone Environmental Control System, paragraph 4.3.4.1. ECNs 3591 and 3592 will be issued to implement this corrective action for units 1 and 2, respectively.<br><br>Generic implications: CATD did not indicate any similar items or instances involved on Bellefonte and other plants were reviewed by the task force for similar instances. Therefore additional actions and generic review are not required.<br><br>Based on review of other areas containing batteries, this appears to be an isolated case and should not reoccur since NEP 5.2, "Review," has been issued which provided assurance that design documents and drawings are given the necessary design verification and technical review to ensure that design requirements are met. |

| Issues | Findings | Corrective Actions |
|---|---|---|
| Element 231.5 - BFN | BFN | |
| | | A CAQR was issued under No. BLF 870113. The corrective action is scheduled for completion 1 year before fuel load for units 1 and 2. |

******************
Element 231.6 - Fire Protection QA Designation
******************

| Issues | Findings | Corrective Actions |
|---|---|---|
| SQN | SQN | SQN |
| a. Specification G-73 designates fire protection drawings at BLN as required to be QA, but they are treated as non-QA by engineering. | a. Engineering treatment of SQN FPS is a mix of both Q (including limited Q) and non-Q requirements. This is consistent with regulatory requirements for SQN FPS.<br><br>Specification G-73 does not designate fire protection QA requirements and specifically defers such jurisdiction to other documents. Specification G-73 also defers identification of QA boundaries to Engineering design drawings. Design Criteria SQN-DC-V-7.5 are the definitive present source of SQN FPS QA boundary identification and requirements. SQN FPS design drawings, in conformance with SQN-DC-V-7.5, establish QA boundaries and have clear jurisdiction over G-73. No "discrepancies," per se, can therefore exist between the two. | a. CATD 231 06 SQN 01 (Ref. 150) identified the problem as:<br><br>"Specification G-73 paragraph 3.1.2 defers QA jurisdiction to other documents. But after stipulating such deferral, goes on to make QA requirements in paragraph 3.2. This inconsistency should be resolved."<br><br>The CAP for this CATD identified the corrective ation as:<br><br>"Element report for Employee Concern 231.06 make it evident that a misinterpretation of general construction specification G-73 is possible. G-73 leads one to believe it has QA jurisdiction, but it does not. Engineering drawings have been designated by G-73 to define QA boundaries and they do. The next revision of G-73 will change paragraph 3.1.2 and/or 3.2 to avoid any potential misinterpretation."<br><br>No CAQ document was issued. Completion was scheduled for April 1988. |

| Issues | Findings | Corrective Actions |
|---|---|---|
| Element 231.6 - WBN | WBN | WBN |
| a. Specification G-73 designates fire protection drawings at BLN as required to be QA, but they are treated as non-QA by engineering. | a. The WBN Fire Protection System falls under a limited QA program described in Mechanical Design Standard DS M17.3.2. Specification G-73 is a general construction specification that does not intend to designate WBN fire protection QA requirements for engineering activities and specifically defers QA jurisdiction to other documents. Specification G-73 also defers identification of QA boundaries to Engineering design drawings. For these reasons the engineering design standards and drawings have clear jurisdiction in QA areas over G-73, and, therefore, "discrepancies," per se, cannot exist between the two.<br><br>To preclude future misinterpretation, a corrective action tracking document (CATD) accompanied SQN Element Report 231.6 to edit G-73 as necessary. For completeness and consistency, a similar CATD (231 06 NPS 01) was developed for this report.<br><br>Operations report 306.01 noted a conflict in DS M17.3.2 with the NQAM by implementing a limited program for safety related fire protection systems and issued CATD 30601-NPS-01 to resolve this issue. | a. CTD 231 06 WBN 01 (Ref. ) states that:<br><br>"general construction specification G-73 is subject to misinterpretation as to QA jurisdiction on fire protection."<br><br>TVA has submitted a corrective action plan (23106-NPS-01) (Ref. 158). This CAP states:<br><br>"General Construction Specification G-73 will be edited to preclude future misinterpretation of QA jurisdiction on fire protection. A paragraph will be added to differentiate the limited QA requirements (Q*) from the full QA requirements (Q)."<br><br>There is no CAQ. Completion was scheduled for June 1, 1987.<br><br>The corrective action is satisfactory to the evaluation team. |
| BFN | BFN | BFN |
| a. Specification G-73 designates fire protection drawings at BLN as required to be QA, but they are treated as non-QA by engineering. | a. Engineering treatment of BFN FPS is a mix of both Q (including limited Q) and non-Q requirements. This is consistent with regulatory requirements for BFN FPS.<br><br>Specification G-73 does not designate fire protection QA requirements and specifically defers such jurisdiction to other documents, such as design drawings. Specification G-73 also defers identification of QA boundaries to Engineering design drawings. BFN FPS design drawings establish QA boundaries and have clear jurisdiction over G-73. No "discrepancies," per se, can therefore exist between the two. | a. TVA has submitted a corrective action plan (in CATD 23106 NPS 01, Ref. 158) which includes a commitment to revise G-73 in a manner that will eliminate the confusion which led to the expression of this concern. No substantive changes to the BFN FPS QA program are required. The corrective action is satisfactory to the evaluation team. |

| Issues | Findings | Corrective Actions |
|---|---|---|
| Element 231.6 - BFN | BFN | |
| b. Peripheral finding. | b. DNE issued G-73 for use at all TVA nuclear plants, including BFN. BFN did not use G-73. There is no auditable record to establish why BFN did not use G-73. | b. CATD 231 06 BFN 01 (Ref.160) identified the problem as:<br><br>"There is a procedural defect which permits DNE to specify requirements for a plant while the plant has the option of not adopting or committing to the DNE specification."<br><br>The CAP for this CATD states:<br><br>"The Division of Nuclear Engineering (DNE) has initiated a Specification Improvement Program (SIP), in part, as a result of DNQA Audit Deviation QBF-A-85-0008-D10. In summary, the audit finding states that DNP/DNE has failed to coordinate and establish the applicable requirements of the general construction specifications that are applied to modification and non-routine maintenance activities at the operating nuclear plants.<br><br>The SIP will involve the development of master specifications and project-specific Engineering Requirements (ER) specifications from the existing general construction specifications. The ER specification will provide the engineering requirements for new construction, modification and non-routine maintenance on a given subject. A computerized tracking system will be developed that will identify all DNC, DNQA, and DNP site procedures that derive technical guidance from the master specification so that when an engineering specification is revised the corresponding procedures are identified for revision. |

| Issues | Findings | Corrective Actions |
|---|---|---|
| Element 231.6 - BFN | BFN | The SIP Program manual, which will identify the SIP scope and schedules, has been issued. The scope requires the generation of 67 master specifications and corresponding ER specifications for each site. Other master specifications will be generated as user needs are identified over time."<br><br>The corrective action is satisfactory to the evaluation team. No CAQ was generated. Completion is scheduled. |
| c. Peripheral finding. | c. There are inconsistencies in Design Standard M17.3.2 regarding its applicability to BFN. There is no other engineering document which specifies QA requirements for the fire protection system at BFN. | c. CATD 231 06 BFN 02 (Ref.161) states that:<br><br>"There is no engineering document which clearly establishes for BFN the QA requirements for fire protection systems."<br><br>TVA's submitted CAP CATD 231 06 BFN 02 states that:<br><br>"1. Identify commitments made to the NRC on Fire Protection QA.<br><br>2. Review design, construction, and operational procedures and related documents for implementation of item 1 commitments. Also review procedures and documents for consistency and clarity.<br><br>3. Incorporate any commitments that have not been addressed into existing or new procedures." |

| Issues | Findings | Corrective Actions |
|---|---|---|
| Element 231.6 - BFN | BFN | 4. Revise procedures to resolve conflicting or unclear requirements. This will include correction of discrepancies identified by this employee concern in the application and wording of General Construction specification G-73 and Mechanical Design Standard M17.3.2. It will also ensure that an engineering implementation level document clearly establishes the QA requirements for fire protection systems."<br><br>These functions are included in the existing CAQR BFT870329 due for completion by November 30, 1987.<br><br>The corrective action is satisfactory to the evaluation team. |
| BLN | BLN | BLN |
| a. Specification G-73 designates fire protection drawings at BLN as required to be QA, but they are treated as non-QA by engineering. | a. Specification G-73 does not designate fire protection QA requirements and specifically defers such jurisdiction to other documents, such as design drawings. Specification G-73 also defers identification of QA boundaries to Engineering design drawings. For these reasons, the engineering design standards and drawings have clear jurisdiction in QA areas over G-73, and therefore, "discrepancies," per se, cannot exist between the two. | a. TVA has submitted a corrective action plan (23106-NPS-01, Ref. 158) that states:<br><br>"General Construction Specification G-73 will be edited to preclude future misinterpretation of QA jurisdiction on fire protection. A paragraph will be added to differentiate the limited QA requirements (Q*) from the full QA requirements (Q)."<br><br>The corrective action is satisfactory to the evaluation team. |

| Issues | Findings | Corrective Actions |
|---|---|---|

Element 231.6 - BLN (Continued)

**Issues**

b. NCR 2675 was invalidated for reasons that contradict design approved documents.

**Findings**

b. The cables described in NCR 2675 are satisfactory and may be used as-is. These cables are subject to the limited quality assurance requirements of G-73. The cables were incorrectly identified as "N," or non-QA, in the Cable Master Status Report, and consequently NCR 2675 was incorrectly invalidated.

**Corrective Actions**

b. CATD 231 06 BLN 01 (Ref. 165) identified the problem as:

> "Condition adverse to quality may exist because cable tracking procedures had no provisions for identifying cables subject to limited QA requirements."

The CAP for this CATD identified the corrective action as:

> "The current method used at Bellefonte to identify the Quality Assurance (QA) Level of Cables, in the QA data field of the Cable Status Master Report is the computer assignment of a QA level of Y for trained cables and N for non-trained cables. Division of Nuclear Construction (DNC) system engineers manually update the QA data field for QA(L) Y cables.
>
> BNP-QCP-3.4, "Electrical Cable Preparation (Termination) 600 Volts or Less and Jumper Installation" and [sic] was revised December 5, 1984, to include section [illegible] which defines QA(L). BNP-QCP-3.34 "Electrical Cable Installation (Pulling)" was initiated at the same time and included sections 4.5 and 4.5.1, however, section 4.5.1 failed to list system QA as a QA(L) system. A revision request will be submitted to correct section 4.5.1 of BNP-QCP-3.34 so that it agrees with BNP-QCP-3.4.
>
> In order to insure that similar instances of mistaken invalidation of Nonconforming Condition Reports (NCRs) had not occurred, a review was conducted of invalidated NCRs up to December 5, 1984 (The time the cable

| Issues | Findings | Corrective Actions |
| --- | --- | --- |
| Element 231.6 - BLN (Continued) | | Procedures were revised to identify QA(L)s to determine if other NCRs had been invalidated for the same reason as NCR 2675. No similar cases were discovered, confirming that this instance was an isolated case.<br><br>BLN will review the QA data field in the Cable Status Master Report for the systems identified as having QA(L) cables to ensure that the cables currently in the program have the correct QA level assigned.<br><br>The situation that occurred when NCR 2675 was invalidated, was an isolated case and resulted from an incorrect QA designation in the QA data field. Steps have already been taken to revise procedures which identify systems that contain QA(L) cables. Taking additional steps as recommended above will ensure that the QA data field contains the correct QA designation in the future."<br><br>There is no CAQ, and completion was scheduled for January 15, 1988. |
| c. Peripheral finding. | c. There is no provision in the Cable Status Master Report for accurate identification of cables subject to the limited quality assurance requirements of G-73. | c. It is also noted that the Division of Nuclear Engineering has initiated a Specification Improvement Plan (SIP) as a result of DNQA Audit Deviation QBF-A-85-0008-D10. The SIP will identify and minimize inconsistencies between DNE and plant specific procedures, such as the problems identified above.<br><br>The corrective action is satisfactory to the evaluation team. |

THIS ITEM COMPLETED
DATE:

ATTACHMENT C

REFERENCES

1. TVA memo from Campbell to Vineyard, [SQP 840914 014], SQN - SQ-DCR D2133, (09/12/84)

2. Letter from TVA, Domer, to NRC, [L44 841109 806], (11/09/84)

3. TVA memo from Abercrombie to Those Listed, [S01 841203 910], SQN - Appendix R - "Fire Protection Suppression System Walkdown," (12/07/84)

4. Letter from TVA, Domer, to NRC, [L44 841218 800], "SQN Docket No.s 50-327 and 50-328," (12/18/84)

5. Letter from TVA, Domer, to NRC, [L44 841221 804], (12/24/84)

6. ECN L6319 [B25 851101 507]

7. TVA memo from Vineyard to Rankin, [SQP 850214 012], SQN - DCR 2133 - ECN 6319 - "Additions and Modifications to Sprinkler Systems," (02/14/85)

8. TVA memo from Vineyard to Rankin, [B25 850328 010], SQN - Appendix R - "High Pressure Fire Protection (HPFP) Design and Modification Work Under ECN-L-6319," (03/28/85)

9. Letter from TVA, Wallace, to NRC, [S53 850515 930], SQN - Docket Nos. 50-327 and 50-328 - "Facility Operating License DPR-77 and -79 - Special Report 84-08 Revision 1, Appendix R," (05/17/85)

10. SQN Safety Evaluation Report, Supplement 1, Section 9.5, "Fire Protection Systems," NUREG 0011 Supplement 1, (02/80)

11. American Nuclear Insurers, Insurance Inspection Report, TVA SQN 1 & 2, Property File No. N5-23, (02/17/82)

12. American Nuclear Insurers, Insurance Inspection Report, TVA SQN 1 & 2, Property File No. N-229, (03/25-27/86)

13. TCAB-016, Corrective Action Plan for Element Report 231.01, (11/26/86)

14. 10 CFR 50.48, "Fire Protection"

15. Letter from NRC, Zech, to TVA, White, "NRC Inspection Report Nos. 50-327/86-40 and 50-328/86-40," [L44 860815 067], (08/12/86)

16. 10 CFR 50 Appendix R, "Fire Protection Program for Nuclear Power Facilities Operating Prior to January 1, 1979"

17. NRC Branch Technical Position - Auxiliary Power Conversion System Branch BTP APCSB 9.5-1, "Guidelines for Fire Protection for Nuclear Power Plants," (05/76)

18. Appendix A to BTP APCSB 9.5-1, "Guidelines for Fire Protection of Nuclear Power Plants Docketed Prior to July 1, 1976," (08/76)

19. NFPA 13, Standard for the Installation of Sprinkler Systems

20. Telecon from L. Damon, Bechtel, to V. Dudley, TVA, IOM 514 (10/06/86)

21. NSRS Investigation Report I-85-396-WBN, Employee Concern IN-85-534-001, (report approved by M. A. Harrison 10/09/85)

22. NSRS Investigation Report I-85-454-WBN, Employee Concern IN-85-534-002, (report approved by M. A. Harrison 10/22/85)

23. Engineering Report, M&M Protection Consultants, covering inspections by T. V. Clark on 01/19, 20, and 21/83

24. Property Loss Prevention Report, M&M Protection Consultants, covering inspections by T. V. Clark on 08/12 and 13/86

25. Property Loss Prevention Report, M&M Protection Consultants, covering inspections by T. V. Clark on 11/04, 05, 06, and 07/86

26. ECN 5216, issued 10/31/84, closed 03/01/85, [B26 850301 544]

27. ECN 3867, issued 07/05/83, closed 01/13/84, [WBP 840113 536]

28. WBN Safety Evaluation Report, NUREG-0847, 06/82, Section 9.5, "Other Auxiliary Systems," updated through supplement 4, (03/85)

29. NRC Systematic Assessment of Licensee Performance Report, pgs. 63 through 65, [A02 830415 001], (for the period 07/81 through 12/82)

30. NRC Systematic Assessment of Licensee Performance Report, pgs. 16 and 17, [B45 850919 826], (for the period 01/85 through 05/85)

31. Appendix A to Facility Operating License DPR-33, Technical Specification and Bases for BFN Plant Unit 1, Limestone County, Alabama; Tennessee Valley Authority Docket No. 50-259

32. General Design Criterion BFN-50-747, BFN Fire Protection of Safe Shutdown Capability, (01/27/86)

33. BFN Final Safety Analysis Report

34. Browns Ferry Nuclear Performance Plan, TVA, (08/86)

35. Engineering Procedure EN DES-EP 1.55, ire Protection Limited Quality Assurance Program, (08/04/83)

36. TVA memorandum from White to Robertson, Office of Nuclear Power (ONP) Fire Protection Assessment and Improvement Plan, [L57 861014 867], (10/14/86)

37. TVA memorandum from Stapleton to Schlinger, BFN Fire Protection Report for 10 CFR 50, Appendix R, [B22 860516], (05/16/86)

38. TCAB 412, Corrective Action Plan for 231.1(c)-BFN-01, (06/22/87)

39. Telecon from Mahlman, Drouhard, Harkelroad, TVA, to J. Longworth, Bechtel, IOM 765, (03/12/87)

40. Telecon from D. Drouhard, TVA, to J. Longworth, Bechtel, IOM 790, (03/24/87)

41. BLN Final Safety Analysis Report, Section 9.5.1

42. BLN Final Safety Analysis Report, Section 14.2.1

43. Nuclear Safety Review Staff, Report I-85-116-WBN, "ERT Item No. IN-85-064-001, Milestone 3, Prior to 5 Percent Power," (06/28/85)

44. WBN, FSAR, Sections 8.0 and 9.0

45. TVA WBN Drawing 47W850-2, R32, "Flow Diagram, Fire Protection [and] Raw Service Water," (05/16/86)

46. TVA WBN Drawing 47W491-82, R2, "Fire Protection [Piping]," (10/31/85)

47. TVA WBN Drawing 47W491-83, R2, "Fire Protection [Piping]," (05/16/86)

48. TVA WBN Drawing 47W610-26-3, "Electrical Control Diagram, Hi[gh] Press[ure] Fire Protection Sys[tem]", R8, (08/22/86)

49. TVA WBN Drawing 47B21-1, R4, "Piping Systems Classification," (06/16/83)

50. TVA Memorandum, R. G. Domer to R. M. Pierce, "Sequoyah Nuclear Plant - Seismic Qualification of Automatic Temperature-Activated Sprinkler Heads," (07/13/77)

51. NRC Branch Technical Position CMEB 9.5-1, "Guidelines for Fire Protection for Nuclear Power Plants," R2, in NUREG-0800, "U.S. NRC Standard Review Plan," (07/81)

52. NFPA 13, "Installation of Sprinkler Systems"

53. NFPA 15, "Water Spray Fixed Systems for Fire Protection"

54. NFPA 70, "National Electrical Code"

55. TVA QIR MEB 85004, "Potential Damage to Redundant Shutdown Equipment by Sprinkler Discharge," [B44 850301 006], (02/26/85)

56. TVA WBN Drawing 47W850-5, R22, "Flow Diagram, Fire Protection," (05/16/86)

57. Nonconformance Condition Report (NCR) W-110-P, (02/28/83); Attachment A to TVA memo from J. C. Standifer to W. T. Cottle, "Watts Bar Nuclear Plant - Nonconformance [sic] Report (NCR) No. W-110-P," [MEB 830629 015], (830701T0222), (06/29/83)

58. Letter, TVA (L. M. Mills) to U.S. NRC, Attn: J. P. O'Reilly, "Watts Bar Nuclear Plant Units 1 and 2 - Spacing and Clearance of Sprinkler Heads in the HPFP System - WBRD-50-390/83-24, WBRD-50-391/83-23 - Final Report," [A27 831222 016], [MEB 831223 605], (12/22/83)

59. Engineering Change Notice (ECN) 3867, original issue, [WBP 830705 506], (05/25/83)

60. Engineering Change Notice (ECN) 3867, issue at closure, [WBP 840113 536], [840224C0052], (01/13/84)

61. TVA memo from J. C. Standifer to W. T. Cottle, "Watts Bar Nuclear Plant - Spacing and Clearance of Sprinkler Heads in the HPFP System - NCR W-110-P," [MEB 840406 019], (04/06/84)

62. TVA memo from W. T. Cottle to G. Wadewitz, "Watts Bar Nuclear Plant - Nonconforming Condition Report, W-110-P," [WBP 840418 076], (840424T0136), (04/18/84)

63. Final Draft Technical Specifications for Watts Bar Nuclear Plant Unit 1, Docket No. 50-390, (12/11/84)

64. Updated SNP FSAR Section 9.4.5 and Amendments 2 and 3

65. TVA General Design Criteria SQN-DC-V-11.1.1, R0, "Additional Diesel Generator System"

66. TVA General Design Criteria SQN-DC-V-11.1.2, R1, "Additional Diesel Generator Building Environmental Control System"

67. WBNP FSAR Sections 7.4.1.2.3, 8.1.2 and 9.4.5.2.2 up to Amendment 57 (Ref. 65 above, paragraph 3.1a. specifies a similar DG unit as at Watts Bar Nuclear Plant)

68. National Fire Code (NFC) 90A-85, "Installation of Air Conditioning and Ventilating Systems," Section 3-3.7

69. TVA NSRS Investigation Report I-85-693-WBN, (12/10/85)

70. Flow Diagram, Heating and Ventilating Air Flow, Additional DG Building 47W866-14 R2, (11/03/83)

71. Mechanical Drawing, Heating and Ventilating, Additional DG Building 17W910-3 R8, (08/30/85)

72. TVA Field Change Request (FCR) 3532, Deletion of fire dampers MK 47A381-597, (06/03/85)

73. TVA ECEP-SQN Restart Program - Corrective Action Plan (CAP) Transmittal TCAB 006 (11/07/86)

74. Not used.

75. WBN FSAR Sections 7.4.1.2.3, 8.1.2, and 9.4.5.2.2, Amendment 57

76. TVA General Design Criteria WB-DC-40-28.1, R0, "Additional Diesel Generator System Class 1E"

77. TVA General Design Criteria WB-DC-40-28.2, R1, "Additional Diesel Generator Building Environmental Control System"

78. TVA NSRS Investigation Report I-85-693-WBN, [no RIMS number, transmitted by TTB-15/4], (12/08/85)

79. Flow Diagram, Heating, Ventilating and Air Flow, Additional DG Building 85M 47W866-14 R8, (05/31/85)

80. Mechanical Drawing, Heating and Ventilating, Additional DG Building 85M 17W910-3 R13, (05/03/85)

81. TVA General Design Criteria WB-DC-40-36.1, R1, "The Classification of Heating, Ventilating, and Air Conditioning Systems," (11/15/83)

82. TVA letter TCAB-004-WBN transmitting corrective action plan (CAP), (2/12/87)

83. Updated SNP FSAR Sections 1.2, 8.3.2, and 9.4, and Amendments 2 and 3

84. TVA General Design Criteria SQN-DC-V-3.2, R1, "The Classification of HVAC Systems"

85. TVA General Design Criteria SQN-DC-V-7.5, R1, "Fire Protection Systems"

86. TVA General Design Criteria SQN-DC-V-11.2, R3, "125-V Vital Battery System"

87. TVA General Design Criteria SQN-DC-V-24.0, R1, "Fire Protection of Safe Shutdown Capability"

88. TVA EN DES Calculation DS-E3.1.1 (EEB 841226 926), (12/26/84)

89. TVA General Design Criteria SQN-DC-V-11.2.1, R2, "125-Volt Fifth Vital Battery System"

90. TVA Drawing 85M 47W920-9, R29, Auxiliary Building, Sheet Metal

91. TVA memo from E. R. Ennis to W. R. Lagergren (T07 860422 887), WBN Employee Concern Investigation Reports, Hydrogen Gas Survey Report, I-85-993-NPS, (4/22/86)

92. TVA memo from K. W. Whitt to H. L. Abercrombie (L12 860328 125), Corrective Action Response Evaluation Report I-85-993-NPS (SQN and WBN), (3/26/86)

93. TVA memo from W. E. Clift to Electrical Engineering Files (07/25/80), "SQN Design calculations for Hydrogen Evolution in Battery Rooms:"
2-HYDROGO-3, RO    250 V Batteries - EEB 800723 901
2-HYDROGO-2, RO    24V and 48V Batteries - EEB 800723 902
2-HYDROGO-1, RO    125V Vital Batteries - EEB 800723 903

94. U.S. NRC Reg. Guide 1.128, R1, "Installation Design and Installation of Large Lead Storage Batteries for Nuclear Power Plants"

95. TVA Drawings, Mechanical HVAC: 47W930-1, R40; 47W930-4, R35; and 47W930-5, R26: Control Building, SQN

96. TVA Drawings, Mechanical HVAC: 17W910-1, R16; and 17W910-2, R14: Diesel Generator Building, SQN

97. IEEE Standards 450-75 and 450-72, "Recommended Practice for Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Generating Stations and Substations"

98. IEEE Standard 484-75, "Recommended Practice for Installation Design and Installation of Large Lead Storage Batteries for Generating Stations and Substations"

99. NRC Light Water Reactor Hydrogen Manual, NUREG/CR-2726, SAND82-1137, R3

100. National Electrical Code Handbook, 18th edition by J. F. McPartland, McGraw-Hill

101. Storage Batteries, George Wood Vinal, Sc.D., fourth edition, John Wiley & Sons

102. National Electrical Code 1984

103. TVA NSRS Investigation Report I-85-993-NPS, (02/19/86)

104. TVA Transfer Requisition 835318 for fifth vital battery system, [MED 840321 502], (03/26/84)

105. SON Units 1 and 2, Balance of Plant Specifications E3/4.57.2, pages 57-4 and 5, [transmitted by TTB 147/3]

106. TVA Drawings, Mechanical HVAC: 47W930-1, R50; 47W930-4, R30; and 47W930-5, R16: Control Building, WBN

107. Technical Specification SNP Unit 1 R41; Unit 2, R29, Sections 3.8.2.3, 3.8.2.4, 4.8.2.3.2, and 4.8.2.4.2, [transmitted by TTB 165/3]

108. TVA ECEP - SQN Restart Program - Corrective Action Plan (CAP) Transmittal TCAB-047, (12/30/86)

109. WBNP FSAR Sections 1.2, 8.3, and 9.4 up to Amendment 57

110. TVA EN DES Calculation DS-E3.1.1, RO, [EEB 841226 926], (12/26/84)

111. TVA Drawings 85M47W920-9, R29; 85M47W920-10, R33; and 85M47W920-16, R16, "Auxiliary Building, Mechanical Heating, Ventilation, and Air Conditioning"

112. TVA memo from W. E. Clift to Electrical Engineering Files, "SQN Design Calculations for Hydrogen Evolution in Battery Rooms," [no RIMS number, transmitted by TTB 147/3], (07/25/80):

2-HYDROGO-3, 0, 250 V Batteries, [EEB 800723 901], (07/23/80)
2-HYDROGO-2, RO, 24V and 48V Batteries, [EEB 800723 902], (07/23/80)
2-HYDROGO-1, RO, 125 Vital Batteries, [EEB 800723 903], (07/23/80)

113. NRC Regulatory Guide 1.128 R1, "Installation Design and Installation of Large Lead Storage Batteries for Nuclear Power Plants," (10/78)

114. TVA drawings 85M47W930-1, R50; 85M47W930-4, R30; and 85M47W930-5, R16: Control Building - Mechanical Heating, Ventilating, and Air Conditioning

115. TVA Drawings 85M17W910-1, R1; and 85M17W910-2, R13: Diesel Generator Building - Mechanical Heating Ventilating and Air Conditioning

116. TVA Contract 84X 8-832101, 125 V Station Batteries - Class 1E, [MED 840125 504], (12/21/83), (5th Vital batteries for SQN and WBN)

117. TVA Contract 76K03-85763, 125 V Vital Batteries WBN [no RIMS number, transmitted by TTB 243/9], (01/15/76)

118. TVA Contract 75P8-85765, Non-Vital Battery and Rack [no RIMS number, transmitted by TTB 243/9], (07/01/74)

119. TVA letter to Bechtel TCAB-243, Corrective Action Plan (CAP), 03/06/87)

120. BFN FSAR Amendment 4, Sections 5.3.3.6, 8.1, 8.6, 10.12, Appendix F

121. TVA Electrical Standard Drawing SD-E3.2.1, Electrical Equipment Battery Room General Requirements, R1, (09/20/82), (original issue 08/27/79)

122. Field Letter 77-156 from C&D Batteries Division, Subject D-571, Hydrogen Gas Evolution, (09/15/77)

123. TVA Drawings: "Flow Diagrams HVAC"

67M 4 47W865-3, R14 Powerhouse Turbine Building Units 1, 2, and 3
67M 4 47W865-4, R29 Powerhouse Reactor Building Control Bay Units 1, 2, and 3
67M 4 47W865-8, R4 Diesel Generator Building Unit 3
67M 4 47W865-15, R2 Powerhouse Reactor Building Control Bay Units 1, 2, and 3

124. TVA Drawings: "DG Building Unit 3 mechanical HVAC"

67M 4 17W925-1, R8
67M 4 17W925-2, R8
67M 4 17W925-3, R6

125. TVA Drawings: "Mechanical H&V plans and sections"

67M 4 47W910-8, R11 Powerhouse Turbine Building Units 1, 2, and 3
67M 4 47W910-13, R12 Powerhouse Turbine Building Units 1, 2, and 3
67M 4 47W910-16, R6 Powerhouse Reactor Building Units 1, 2, and 3
67M 4 47W920-8, R22 Powerhouse Reactor Building Units 1, 2, and 3
67M 4 47W920-19, R4 Powerhouse Reactor Building Units 1 and 2
67M 4 47W930-1, R29 Powerhouse Reactor Building Control Bay Units 1, 2, and 3
67M 4 47W930-2, R29 Powerhouse Reactor Building Control Bay Units 1, 2, and 3

67M 4 47W930-3, R15 Powerhouse Reactor Building Control Bay Units 1, 2, and 3
67M 4 47W930-4, R15 Powerhouse Reactor Building Control Bay Units 1, 2, and 3
67M 4 47W930-6, R20 Powerhouse Reactor Building Control Bay Units 1, 2, and 3
67M 4 47W930-7, R20 Powerhouse Reactor Building Control Bay Units 1, 2, and 3
67M 4 47W930-11, R5 Powerhouse Reactor Building Control Bay Units 1, 2, and 3

126. TVA Drawing, Mechanical Control Diagram Ventilation System, Powerhouse Units 1 - 3, DG Battery Room 3EB Exhaust, 47W610-30-1, R0

127. TVA Drawing, Mechanical Logic Diagram Ventilation System, DG Building, Unit 3, 67M 47W611-30-1, R0

128. TVA Drawings: "Wiring Diagrams Shutdown Bds 250 V Bat & Chargers Single Line"

67E45N709-1, R1 Powerhouse Units 1 and 2, Sh-1
67E45N709-2, R1 DG Bldg Unit 3, Sh-2

129. TVA Drawings: "Environmental Data, Environment Mild"

67 M 47W225-00, R0 Environment Mild and Harsh, Drawing Series Index
67 M 47W225-1, R0 Reactor Building units 1-3, El. 621.25
67 M 47W225-10, R0 Control Bay Units 1-3, El. 593.0
67 M 47W225-16, R0 Diesel Generator Building Units 1-3, El. 565.5

130. Standard Practice, Conduct of Operation BF-12.24, R2

131. TVA Contract 73C8-84079, BFN 1-3, Shutdown Board Control Power 250-Volt Vital Battery Charger, (09/01/72)

132. TVA BFN Annunciator Response Procedure (ARP) for panels 9-8, 9-20, and 9-23, R0 (02/17/86)

133. BLNP-24 FSAR, Sections 1.2.3, 8.3.2, 9.4.1, and 9.4.5

134. TVA Drawings, Auxiliary Building Units 1 and 2, Mechanical, Heating, and Ventilation

88M 3 AW0910-00-22, R11
88M 3 AW0910-00-26, R10
88M 3 AW0910-00-28, R9
88M 3 AW0910-00-47, R5

135. TVA Drawings, Control Building Units 1 and 2, Mechanical, Heating, Ventilating, and Air Conditioning

88M 3 CW0930-00-01, R15
88M 3 CW0930-00-02, R7
88M 3 CW0930-00-04, R11
88M 3 CW0930-00-09, R9

136. TVA General Design Criteria N4-VW-D740, R3, Auxiliary Building ESF Zone Environmental Control System

137. TVA General Design Criteria N4-VK-D740, R3, Control Building Environmental Control System

138. TVA drawings, Auxiliary Buildings Units 1 and 2, Functional Control Logic Diagram Heating and Ventilation System

88E 2 GW0900-VA-1, R9

139. TVA Contract 78K4-823476, (02/17/78), 125-Volt Batteries (Vital) and Racks

140. TVA Contract 76K6-86843, (02/10/76), 125-Volt Vital Battery Charger

141. TVA Contract 77K7-821614, (02/03/77), Non-vital Battery and Rack

142. TVA Contract 76K5-86342-1, (08/08/75), 250-Volt Station and 26-Volt Turbomatic Battery Charger

143. TVA Contract 76K5-87259, (05/12/76), Battery Charger, 300 Amperes

144. TVA Electrical Standard Drawing SD-E3.2.1, R1, Electrical Equipment, Battery Room, General Requirements, (09/20/82)) (original issue 08/27/79)

145. TCAB 605 Corrective Action Plan 23105-BLN-01, (07/20/87)

146. TVA General Design Criteria SQN-DC-V-7.5, "Fire Protection Systems," R1, (09/06/85)

147. TVA General Design Criteria SQN-DC-V-24.0, "Fire Protection of Safe Shutdown Capability," (05/01/85)

148. SQN Safety Evaluation Report, Section 9.5, "Fire Protection Systems," NUREG-0011, Supplement 1, (02/80)

149. TVA OEDC-QAI-6, "Establishment of Limited QA Program," (08/25/81)

150. TCAB-064, Corrective Action Plan for Element Report 231.06, (S03 870116 801), (01/17/87)

151. NCR 2675, Nonconforming Condition Report, (12/20/83)

152. TVA General Construction Specification G-73, "Inspection, Testing and Documentation Requirements for Fire Protection System and Features," R1, (03/14/84)

153. Appendix A to NRC Branch Technical Position APCSB 9.5-1, "Guidelines for Fire Protection of Nuclear Power Plants Docketed Prior to July 1, 1976," (08/76)

154. NRC Branch Technical Position BTP CMEB 9.5-1, "Guidelines for Fire Protection for Nuclear Power Plants," R2, (07/81)

155. 10 CFR 50 Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants"

156. TVA OEDC-QAI-6, "Establishment of Limited QA Program," (08/25/81)

157. TVA Mechanical Design Standard DS-M17.3.2, "Fire Protection System, Limited Quality Assurance Program," (07/01/81)

158. TCAB-222, Corrective Action Plan 23106-NFS-01 (CAP), (03/22/87)

159. TVA Mechanical Design Standard DS-M17.3.2, "Fire Protection System, Limited Quality Assurance Program," R0 (07/01/85)

160. TCAB-487, Corrective Action Plan 231 06 BFN 01, (08/10/87)

161. TCAB-469, Corrective Action Plan 231 06 BFN 02, (07/29/87)

162. Telephone conference, B. D.Langtry, Bechtel, with D.Drouhard, TVA, IOM 1334, (06/25/87)

163. Telephone conference, B. D. Langtry, Bechtel, with J. Fender, TVA, IOM 1335, (06/25/87)

164. TVA Nonconforming Condition Report 2675-A, R0, (12/20/83)

165. NRC Branch Technical Position BTP CMEB 9.5-1, "Guidelines for Fire Protection for Nuclear Power Plants," R2, (07/81)

166. TCAB-646, Corrective Action Plan 231 06 BLN 01 (08/13/87)

167. C&D Power Systems Inc., LC, LA Batteries Specification and Letter from J. Hegyi, (05/14/87)

168. TVA memo, S. Cook to H. Mahlman, Re: "BFN Employee Concern 231.6(C) Preliminary," (04/29/87), TTB-450 Item 8

169. Telecon, B. D. Langtry, Bechtel, with H. Mahlman, J. Fender, and E. Massey, TVA, IOM 1340, (06/12/87)

170. Telecon, B. Langtry, Bechtel, with D. Drouhard and D. Evans, TVA, IOM 1341, (06/15/87)

171. Telecon, R. Bulchis, Bechtel, with J. Harkleroad, TVA, IOM 1149, (06/08/87)