TVA EMPLOYEE CONCERNS SPECIAL PROGRAM

REPORT NUMBER: 23000

REPORT TYPE: SUBCATEGORY REPORT FOR ENGINEERING

REVISION NUMBER: 3

TITLE: HVAC DESIGN

REASON FOR REVISION:

1. Revised to incorporate SRP and TAS comments.

2. Revised to incorporate SRP comments.

3. Revised to incorporate TAS comments and to add Attachment C (References).

PREPARATION

PREPARED BY:

Donner M. Blummer /OPD 10/19/87
SIGNATURE DATE

REVIEWS

~~PEER:~~ REVIEW COMMITTEE:

AW Jordon JB Violette, Parkinson 10/19/87
SIGNATURE DATE

TAS:

James E Worthy III 11/5/87
SIGNATURE DATE

CONCERNCES

8711240194 871117
PDR ADOCK 05000259
P PDR

SIGNATURE DATE

CEG-H: George R McNutt 11-4-87

SRP: Jimmie W Joyce* 11-10-87
SIGNATURE DATE

APPROVED BY:

WR Brown 11/5/87
ECSP MANAGER DATE

NA
MANAGER OF NUCLEAR POWER DATE
CONCURRENCE (FINAL REPORT ONLY)

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

EXECUTIVE SUMMARY

This subcategory report summarizes and evaluates the results of nine Employee Concerns Special Program (ECSP) element evaluations prepared under Engineering Subcategory 23000, HVAC Design. The element evaluations document the reviews of 30 issues related to TVA's four nuclear power plant sites - Sequoyah, Watts Bar, Browns Ferry, and Bellefonte. The issues were derived from a total of five employee concerns, which cited presumed deficiencies or inadequacies in the design of HVAC systems.

This subcategory contains concerns about testing of fire dampers, temperature control in computer and battery rooms, leak tightness of duct joints and weight of duct supports, heat buildup in the containment, and airborne contamination in the Condensate Demineralizer Waste Evaporator Building (CDWEB).

Of the 30 issues evaluated, 21 were found to require no corrective action. For the remainder, eight corrective actions were identified to remedy the nine negative findings. One of the corrective actions was initiated by TVA before the Employee Concerns Task Group evaluations, five are new actions required to resolve the issues, and two are actions required to resolve peripheral findings identified during the evaluations.

Causes for the negative findings are concentrated in the management effectiveness and design process effectiveness areas.

None of the corrective actions for this subcategory were judged to be significant from a nuclear safety standpoint.

Although the element evaluations for this subcategory did identify some valid concerns, the relatively small number of negative findings and the corrective actions already taken or initiated led to the conclusion that the HVAC design does not pose a major problem for the Sequoyah, Watts Bar, and Bellefonte nuclear power plant sites. However, the failure at Browns Ferry to respond in a timely fashion to the NRC-mandated 10 CFR 21 notice from the manufacturer regarding fire damper closure against airflow constitutes a breakdown in communication and tracking of an issue that was declared a condition adverse to quality for Watts Bar. This 10 CFR 21 notice did not result in an NRC IE Bulletin requiring mandatory action on TVA's part, and, therefore, no NRC reporting requirements were violated. The corrective action for Browns Ferry will evaluate or test all curtain-type fire dampers in fire barriers required by 10 CFR 50, Appendix R, criteria. Administrative procedures will be instituted for shutdown of airflow through fire dampers that may not close during a fire in the area. Surveillance procedures also will require periodic closure testing of fire dampers.

The reason Browns Ferry failed to examine the issue raised by the 10 CFR 21 notice could not be determined and is beyond the causes identified in this report for the finding of unassured damper closing. Underlying or root causes are identified in category evaluations. The Corporate Nuclear Performance Plan, in conjunction with plant-specific nuclear performance plans, describes the centralized Division of Nuclear Engineering, the Corporate Commitment Tracking System, and the Tracking and Recording of Open Items system. These steps will improve communications and timely resolution of open items, thus minimizing recurrence of the negative findings evaluated in this report.

The grouped evaluations of this subcategory report are being examined from a wider perspective in the Engineering category evaluation.

HISTORY OF REVISION

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

Preface

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

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

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

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

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

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

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

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

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

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

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

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

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

ECSP GLOSSARY OF REPORT TERMS*

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

Class A: Issue cannot be verified as factual

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

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

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

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

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

concern (see "employee concern")

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

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

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

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

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 23000, HVAC Design.

The evaluations of 30 issues related to TVA's four nuclear power plant sites - Sequoyah (SQN), Watts Bar (WBN), Browns Ferry (BFN), and Bellefonte (BLN) - are documented in this report. The issues were derived from five employee concerns that cited presumed design and testing deficiencies in various HVAC systems and components.

The employee concerns are evaluated and listed in Attachment A by element. The nuclear plant site where the concern was originally raised and the applicability to other nuclear plant sites, as determined by TVA, are also shown in Attachment A.

The balance of this report consists of the following sections:

- Section 2 -- summarizes, by element, the issues derived from the employee concerns and explains the rationale for generic applicability
- Section 3 -- outlines the process followed for the element and subcategory evaluations
- Section 4 -- summarizes, by element, the findings and identifies the negative findings that must be corrected
- Section 5 -- highlights the corrective actions required for resolution of the negative findings cited in Section 4 by element and shows their applicability to plant sites
- 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 this report, along with the plant site(s) to which it is applicable. The concern is quoted as received by TVA, and characterized by TVA as safety related (SR), not safety related (NO), or safety significant (SS).
- Attachment B -- contains a summary listing of issues, findings, and corrective actions by element. The concerns in Attachment A are linked by element number and plant site to Attachment B. The corrective action description in Attachment B is linked by the CATD number in parentheses to the causes and significance in Table 3.

The term "Peripheral finding" in the issue column refers to an issue that arose during the course of evaluating an employee concern, but was not directly derived from it. These issues are classified as "E" in Tables 1 and 2 of this report

- o Attachment C -- lists the references cited in this report

2. SUMMARY OF ISSUES/GENERIC APPLICABILITY

The employee concerns listed in Attachment A for each element and plant have been examined, and the potential problems raised by the five concerns have been identified as 30 issues. Results of the review of these issues are presented in the nine element evaluations.

A summary of the 30 issues evaluated under this subcategory, grouped by element, is listed below.

- o 230.1, Fire Damper Latching Test - Curtain-type fire dampers were not tested under actual operating conditions to assure their closure and latching. These issues are generic to Ruskin Manufacturing Company brand fire dampers, which are used at all four plants; consequently, the issues were evaluated for all four plants.

- o 230.2, Computer/Battery Room Temperature - The design, location, and operation of the environmental control system serving the computer and battery rooms are deficient. These issues were evaluated at the site of the concern (WBN). No other site evaluations were deemed to be necessary because the issues were determined to be component deficiencies typically found and corrected during plant commissioning and, therefore, specific to WBN.

- o 230.3, Leak Tightness of Duct Seals - Many HVAC duct systems do not meet the design requirements for leak tightness and use excessive amounts of sealing glue and excessively heavy supports. These issues were evaluated at the site of concern (WBN) and found to be partially factual. However, no adverse effects were identified due to this condition. The concern was determined not to be applicable to SQN and BLN because the issues were found not to be valid at WBN and because similar designs and design criteria were used at SQN and BLN. TVA's generic applicability statement indicates that the concern is not applicable to BFN. However, during the evaluation of a related concern at BFN, a potential duct leakage problem was identified. This BFN duct leakage and control room habitability concern was not evaluated as an employee concern. Instead, a corrective action plan (CAP 200 BFN 01, Ref. 141) was initiated, in which TVA committed to evaluating and correcting the problem outside the ECSP.

- <u>230.4, Heat Buildup in Containment Dome</u> - Excessive heat buildup in the upper reactor building and steam generator compartments limits personnel access. These issues were evaluated at the site of the concern (WBN) and found not to be valid because the concern was based on and erroneous presumption of the design basis for the containment temperature. No other site evaluations were deemed appropriate.

- <u>230.5, Airborne Radioactivity in CDWE Building</u> - Personnel could be exposed to radioactivity from the condensate demineralizer waste evaporator (CDWE) during an Auxiliary Building isolation (ABI) when noncondensibles back up from the closed building exhaust dampers. As this system and its separate building are unique to SQN and WBN, this concern was evaluated only at these two sites.

The issues summarized under the elements above deal with presumed deficiencies or inadequacies in the design of the HVAC systems. More specifically, four of the summarized issues are concerned with the adequacy of the design or the quality of components (elements 230.2, 230.3, 230.4, and 230.5) and one (230.1) is concerned with the adequacy of functional tests.

Three of the above summarized issues were found to be valid at the time TVA received the associated concern and required corrective action (elements 230.1, 230.2, and 230.5). Two of these (230.1 and 230.2) had all or part of the corrective action initiated before the ECTG evaluation. Two summarized issues required corrective action as a result of the ECTG evaluation (230.1 and 230.5).

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

3. EVALUATION PROCESS

This section defines the element and subcategory evaluation processes related to the issues summarized in Section 2.

3.1 Element Evaluation Process

The element evaluation process consisted of the following steps:

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

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

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

d. Reviewed applicable PSAR, FSAR, Safety Evaluation Report (SER), and SER Supplements 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, transcripts of interviews, procedures, test reports, evaluation reports, etc.

f. Interviewed TVA corporate and site personnel in person and by phone to develop understanding of problems noted.

g. Discussed component problems with supplier (vendor) representatives.

3.2 Subcategory Evaluation Process

h. Using the results from steps a through g above, evaluated the issues for each element.

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

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

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

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

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

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

4. FINDINGS

The findings from each of the nine element evaluations for this subcategory are contained in this section and summarized in Attachment B by element number and by plant. The references cited in this section are listed in Attachment C.

4.1 Fire Damper Latching Test - Element 230.1

The concerned individual (CI) referred to a summer 1982 time frame when Ruskin brand fire dampers failed to latch when tested at WBN.

Curtain-type fire dampers manufactured by Ruskin Manufacturing Company (Ruskin) have been subject to a variety of problems in the past, including improper installation and incomplete closure of the curtain. In a telephone conversation (Ref. 1), T. Arnold of Ruskin agreed that the type of fire damper release itself (fusible link, ETL, CO_2 or manual by string for testing only) does not affect the closing and latching operation. This concern is, therefore, discussed below as two separate issues: fusible link failure and damper closure failure.

In a later telephone conversation with TVA (Ref. 2) regarding the same issue for BFN, a knowledgeable individual disputed the sequence of events during fire damper testing shown in the concern for WBN. According to his account (Ref. 3), the damper curtains were first released by hand. Damper curtains that did not close were then reset and released by fusing a link. This sequence of events would have made evaluation of fusible link failures unnecessary; however, at the time of above telephone conversation, this issue had already been evaluated.

4.1.1 Release Mechanism (Fusible Link) Failure

Single purpose fire dampers are released by melting a fusible link under external heat (normally at 160°F). Dual purpose smoke control/fire dampers are released by melting an electrothermal link (ETL) either under external heat or by an electric current passed through it from a smoke control panel.

Nuclear Power Experience, Inc. reports for domestic and foreign nuclear power plants up to August 1986 (Ref. 4) do not indicate any generic fusible link or ETL failures of Ruskin or other brand fire dampers. A few release mechanism failures were attributed to mechanical interference of electrical conduits with ETLs, binding of curtain retaining cables, corrosion, and in one case, an unexplained melted fusible link. The latter resulted in inadvertent damper closure.

Watts Bar. A significant condition adverse to quality (CAQ) was identified at WBN by Nonconformance Report NCR W-210-P (Ref. 5), which reported failures of ETLs during initial performance of the fire detector panel tests per Surveillance Instruction SI-L601 (Ref. 6). Attachment A to NCR 210-P determined improper installation or concealed damage from handling as root causes of ETL failures. An evaluation showed that the smoke control function of dampers is not required for safe shutdown of the plant. Therefore, ETLs were replaced by fusible links on dampers in fire barriers, and dampers not required for fire compartmentalization were locked open. Surveillance Instruction SI-L601 was revised for dampers maintained as dual function smoke/fire control devices (for economic reasons), to include post-installation checking of the ETLs' electrical resistance, in lieu of firing them. Installation deficiencies, which resulted in impeded ETL release, were corrected per ECN 5523 (Ref. 8) and as described in a TVA memo (Ref. 9).

TVA General Design Guide for Fire Damper Application, Selection and Installation (Ref. 7) was revised to specify post-installation testing of fusible links' electrical resistance in order to avoid recurrence of failures.

Sequoyah. A TVA memo (Ref. 137) responded to MEB's request for a potential generic applicability evaluation (Ref. 10). This memo declared that the condition of NCR W-210-P did not exist at SQN.

Bellefonte. In response to a request for a potential generic condition evaluation (OE-EP1.52) (Ref. 10), BLN replied twice, by memo (Refs. 11 and 12), that an inspection of ETLs for the Control Building confirmed acceptable resistances. The memo from the BLN Project Manager to the Engineering Project Manager (Ref. 12) further committed to adding the ETLs to the Preventive Maintenance Quality Control Procedure (QCP) (Ref. 13) for checking after installation and before transfer to the Division of Nuclear Power (NUC PR). The preventive maintenance equipment list, Attachment B to the QCP (Ref. 13), has not yet been prepared. The ETL resistance check must also be included in the Technical Specification and Surveillance Instructions; the QCP only covers the time period from receipt until transfer of equipment to NUC PR.

Browns Ferry. In response to this same request for a potential generic condition evaluation (OE-EP1.52) (Ref. 14), BFN replied by memo (Ref. 15) that the condition does not exist. An evaluation (Ref. 16) revealed no ETLs in use at BFN.

4.1.2 Damper Closure Failure

Watts Bar. A TVA memo (Ref. 19) reported failure to completely close against air flow of curtain-type gravity-operated fire dampers from Ruskin Manufacturing Company. This was discovered during preoperational test of fire dampers per Instruction TVA-24 (Ref. 20). NCR WBN MEB8203, Rev. 0 (Ref. 21), was issued, which shows the addition of positive closure springs, deletion of some dampers, and modification of TVA standard specification for HVAC system dampers (Ref. 22) as corrective actions. Revision 1 of NCR WBN MEB8203 (Ref. 21) and the completion sheet show ECN 3761 (Ref.23) and the negator spring contract (Ref. 24) as closing out this NCR. Ruskin's Quality Assurance procedure for the positive closure spring kits (Ref. 25) stated that vertical model IBD 23 (1-1/2 hr rated) fire dampers will close against maximum 5,000 feet per minute air velocity or 10 inches water gauge static pressure when furnished with the specified negator springs.

Subsequent to implementation of the above corrective actions, NRC inspections at WBN and other nuclear power plants revealed improperly installed and rated fire dampers, which prompted issuance of NRC Information Notice IE 83-69 (Ref. 26). The ensuing spot check by TVA resulted in issuance of NCR 5036

(Ref. 27), which attributed the insufficient clearance between the dampers and embedded sleeves to lack of proper installation design documents. TVA ECNs 4297 and 5379 (Refs. 28 and 29) therefore requested revision of all fire damper installation drawings to reflect manufacturer's requirements and verification of actual installations. A TVA memo (Ref. 30) reported impending completion of these fire damper installation inspections and closure testing by fusible link removal. No specifics as to air flow velocity during these closure tests were given. This memo also reported requisitioning of replacements for dampers which were installed with less than manufacturer specified clearances or which failed the closure test. Per purchase documents (Ref. 31), new 3 hr fire rated model NIBD23 fire dampers were ordered with the same closure spring sizes as shown in the corrective action to the earlier NCR (Ref. 21) subject to confirmation of TVA's closure test findings by Ruskin tests.

In 1984, Ruskin found that its test methods for fire damper closure against air flow did not correspond with the actual installed configuration of most dampers at nuclear power plants. Ruskin's test configuration was essentially a wall mounting as showing in Air Movement and Control Association (AMCA) Standard 500 (Ref. 32) Figure 5.5 instead of duct installation per Figure 5.3 as stated in Ruskin's catalog. The wall-mounted configuration did not account for dynamic flow effects and resulted in higher allowable air velocities for closure. Since Ruskin dampers are installed in the majority of U.S. nuclear power plants, Ruskin then issued a 10 CFR 21 notice to the NRC and a corresponding letter (Ref. 33) to TVA. This letter recommended retesting of all fire dampers with closure springs under air flow, to verify proper operation. It also pointed out that Underwriters Laboratories (UL) Standard 555 (Ref. 34) does not require fire dampers to be tested with air flow; reduced air flow capability will not affect the fire rating.

A second Ruskin letter (Ref. 35) followed with new limiting fire damper air flow velocity test results for duct installation per AMCA standard 500-83, Figure 5.3.

On the basis of these two Ruskin letters, TVA issued NCR WBNMEB 8513 (Ref. 36) because the design basis for the dampers was not adequately changed as outlined in a TVA memo (Ref. 37) earlier.

NRC was informed of this inadequacy as shown on TVA Determination of Reportability Information Worksheet for 10 CFR 50.55(e) (Ref. 38).

A Quality Information Release (QIR) (Ref. 39) served as corrective action for NCR WBNMEB 8513 committing to change of the HVAC system descriptions for the Auxiliary, Control, and Fuel Buildings, and to institute administrative procedures for fan shutdowns, allowing the fire dampers to close.

A QIR (Ref. 40) shows the result of an analysis of WBN fire dampers versus the test data from Ruskin (Ref. 35). Seventy-six fire dampers were identified as requiring shutdown of the associated ventilation fans to assure complete closure.

TVA's administrative solution to the Ruskin damper closure problem was presented to the NRC in a meeting held on March 27, 1985, documented in an NRC letter (Ref. 41). The NRC's comments were confined to the degree of freedom to be given to the fire brigade leader in deciding whether or not to shut off the associated ventilation systems. A TVA letter (Ref. 42) to NRC clarified this concern by proposing mandatory shutdown of the fans for the areas where the 76 fire dampers may not close under air flow following receipt by the operator of two or more alarms.

The abnormal operating instructions for plant fires (Ref. 43) were then changed to include references to the system operating instructions (SOIs) for the fire detection system (Ref. 44). These SOIs list specific fan controls and impose the operating sequence as requested by NRC.

The General Design Guide for Fire Dampers (Ref. 7) has been revised to include the limitations of air flow velocities under which curtain-type fire dampers, even with negator springs, will close. The preoperational test instructions for the fire dampers (Ref. 20) were revised to define the "normal mode" for closure testing as being without airflow.

The concern is no longer valid for WBN because all curtain-type fire damper deficiencies have been corrected prior to the ECTG evaluation, by modification, replacement, or administrative procedures. The design documents were also corrected to clarify the limitation of airflow under which curtain-type fire dampers, even with negator springs, will close. The preoperational test procedure changes included a definition of normal mode for closing tests being without airflow.

Sequoyah. In response to the TVA memo (Ref. 19) noted above, NCR SQNMEB8207 (Ref. 45) was issued, following determination of generic applicability. This NCR resulted in the addition of Ruskin-supplied negator springs and positive blade latching mechanisms to 100 fire dampers, and replacement of 15 dampers which would not accept springs. Except for one damper, corrective modifications and full drop tests were completed in March 1984. Proper fire damper installation clearances were verified by the Division of Construction Quality Control inspector, as reported in a TVA memo (Ref. 18).

Workplan 10483 of ECN L5847 (Ref. 46) reports that one of the 15 replacement dampers did not fit the penetration sleeve, and a temporary alteration control form (TACF), 1-84-039-31, was issued for resizing the damper. This damper, 0-31C-1744, was never reinstalled, however. According to a telephone call on November 20, 1986 (Ref. 47), it may have been lost, but is on reorder. The originally installed damper was destroyed when removed. Past experience is quoted in workplan 10483 indicating that damper 0-31C-1744 and its companion (0-31C-1743) will fail the full flow drop test.

Workplan 10483 also records postmodification test completion of the SQN fire dampers with closure springs under full flow. No functional test procedure is referenced in the workplan, only a visual surveillance instruction (Ref. 136).

A TVA memo of April 30, 1985 (Ref. 48), lists the 12 dampers that either failed a full flow drop test or are expected to fail based on tests at WBN or engineering judgment. For nine of these 12 dampers, the proposed corrective action was to institute administrative operating procedures for ventilation flow shutdown to assure their closure. Two of the remaining three fire dampers were determined to be in systems operating less than 1,000 hours per year, and one damper is no longer required per 10 CFR 50, Appendix R, evaluation.

SQN System Operating Instruction (SOI) "Fire Interaction Manual" (Ref. 49) gives instructions for shutting area supply and exhaust fans, closing isolation dampers, or initiating Auxiliary Building isolation, in order to interrupt airflow to the nine fire dampers of concern. The appropriate action depends on the specific location of the damper. These instructions, however, do not specify a fire alarm or personal notification criteria for shutting off a specific airflow and do not designate the manual fan and damper controls and their locations for the fire brigade leader.

A meeting between TVA and NRC was held on March 27, 1985, to discuss the Ruskin fire damper concerns for WBN. Following this meeting, a TVA letter to the NRC (Ref. 42) clarified the administrative procedures proposed for shutting off the ventilation flow in areas where fire dampers may not close under air flow. For WBN, Abnormal Operating Instruction "Plant Fires" (Ref. 43) and System Operating Instruction "Fire Detection System" (Ref. 44) give detailed instructions for the sequence to be followed in shutting off the area fan(s), and specific locations of their controls. These instructions also incorporate the NRC's requirement for restricting the fire brigade leader's judgment in deciding if fans should be shut down. The fire brigade leader may, instead, request restart of fans after fire scene assessment.

The concern is not valid as to fire damper closure tests not representing actual operating conditions. Such tests have been performed since summer 1982, and administrative procedures have been issued for assuring closure of dampers that failed the tests. However, the System Operating Instructions for SQN (Ref. 49) are not as explicit as the ones for WBN.

TVA has submitted a corrective action plan (Ref. 119) that includes the following commitments:

a. to revise the Abnormal Operating Instructions (Ref. 73) so that, in case of fire, operators will take specific ventilating system actions necessary to assure fire damper closure; and

b. to install a new 0-31C-1744 damper after the next Unit 2 refueling outage.

The corrective action plan is satisfactory to the evaluation team.

Browns Ferry. In a TVA memo (Ref. 50), the Project Manager requested the Site Design Services Manager to review the above-mentioned Ruskin letters and to report possible fire damper closure problems at BFN. The Project Manager also offered to analyze the BFN fire damper installations versus Ruskin's new test data, in case onsite testing was not possible. This analysis would have been performed as part of BF-DCR 2949 (Ref. 51), which deals with fire damper rating verification. No response to the Project Manager's memo could be found, and DCR 2949 did not request a fire damper closure analysis.

In August 1985, a TVA memo (Ref. 52) reported on an Appendix R Compliance - Fire Damper Installation Walkdown and Inspection, stating that "this report does not address fire damper closure against airflow."

Note 15 on mechanical HVAC drawings (Ref. 53), issued in 1987 for BFN unit 2 Reactor Building only, specifies that "fire damper closure shall be verified with no airflow through the system by removing the fusible link(s) and allowing the damper curtain to cycle." No test procedure reference is given.

The Technical Specifications for BFN (Ref. 68) contain visual surveillance requirements for the fire barriers, including fire dampers. The requirements are partially complied with by Surveillance Instructions (SI) for Visual Inspection of Fire Dampers (Ref. 69), which, however, do not include functional closure tests under actual airflow. The SI also contain superseded damper lists and fire area compartmentation drawings, contradicting the fire area compartmentation and zone drawings (Ref. 70).

The BFN Fire Protection Plan (Ref. 71) on p. 97 instructs the shift engineer to ensure ventilation system operation during a fire emergency, because "ventilation will exhaust toxic gases and also smoke and thus provide improved visibility for fire fighters." However, operation of the ventilation system could spread fire if dampers do not close. The instruction contradicts the NRC's request, expressed in a meeting summary for WBN (Ref. 72), that the ventilation system be shut off immediately upon notification of a fire to assure fire damper closure.

The concern is valid for BFN. There are no full closure test procedures and reports and there is no evaluation of the vendor test results against the installed fire dampers at BFN. The surveillance instructions for the fire dampers do not contain periodic tests to demonstrate operability. Newly issued HVAC drawings only require closure tests without airflow and lack detailed instructions. No administrative procedures have been instituted for shutting off the airflow through the dampers in case of fire as an alternate measure to assure fire damper closure.

TVA has submitted a corrective action plan (Ref. 118) that includes the following commitments:

a. Review and verify all curtain-type fire damper installations in designated fire barriers (per 10 CFR 50, Appendix R evaluation) to determine which ones may not close against system airflow. This review is to consist of:

   o Determining duct velocities at fire damper locations and comparing them with manufacturer's test data. Identifying and documenting problem dampers.

   o Documenting any fire damper that is expected not to close against airflow on a Condition Adverse to Quality Report (CAQR).

   o Revising the BFN Fire Protection Plan to require periodic fire damper closure testing.

b. Resolve any problems noted by CAQRs in accordance with NEP 9.1. This step may consist of damper closure tests against airflow or issuance of administrative instructions to shut off the ventilation system in the fire-affected areas where fire dampers have been determined not to close against airflow.

c. Include revised fire compartmentation drawings in surveillance instructions. The Technical Specifications and Surveillance Instructions are revised during the modification as per existing procedures and are not issued until the modification is complete (full implementation of 10 CFR 50, Appendix R program).

The corrective action plan is satisfactory to the evaluation team.

Bellefonte. In response to an NRC IE Information Notice (Ref. 26), TVA issued NCR BLN MEB8403 (Ref. 54) in April 1984 covering fire damper installation deficiencies. This NCR also reported closure problems with fire dampers, first identified at WBN, but declared generic to all TVA nuclear plants.

The installation deficiencies were corrected per ECN 2945 (Ref. 55) by repairing or replacing the fire dampers that did not meet the manufacturer's UL-approved installation instructions, reflected in TVA drawings (Ref. 56) and a TVA quality control procedure (QCP) (Ref. 64).

The subject NCR (Ref. 54) attributed the assignable cause of the installation deficiencies to lack of proper and thorough understanding by TVA of the application, selection, and installation of fire dampers in meeting NFPA 90A and 90B standards (Ref. 57) and thus 10 CFR 50, Appendix R.

The planned corrective actions for damper closure failure were committed in "final report" (Ref. 58) to NRC for completion 6 months before fuel load of unit 1 and unit 2, respectively. The associated ECN (Ref. 55) initiated the following actions, which are tracked for completion by the Tracking of Open Items (TROI) system (Ref. 59).

- o Add negator springs to curtain-type fire dampers not already so equipped, to enhance closure against airflow.

  The affected dampers were listed in the fire damper installation guide (Ref. 56), and the closure springs were purchased from the original two damper suppliers, as shown by TVA purchase documents (Refs. 60 and 61).

- o Analyze the actual air velocities through multisectional curtain-type fire dampers at BLN and compare them with maximum allowable velocities per Ruskin's tests (Ref 35). The comparison will determine which air movers require shutdown in order to assure damper closure.

  An OE analysis (Ref. 62) of air velocities through fire dampers has been performed, and the subject air movers have been identified. Note that UL Standard 555 (Ref. 34) and the TVA specification for dampers (Ref. 63) did not require fire dampers to close under airflow.

- o Revise the mechanical design guide (Ref. 7) for fire damper application, selection, and installation and the OE standard specification (Ref. 22) for HVAC system dampers to prevent recurrence of the installation and closure problems.

  These documents have already been revised and a construction quality control procedure (QCP) (Ref. 64) provides guidance to assure installation in accordance with design drawings and damper manufacturer instructions.

- o Issue appropriate system descriptions and system operating instructions (fire protection, HVAC, environmental control), including fan shutdown procedures for assuring closure of dampers identified in the OE analysis (Ref. 62) as having "abnormal" airflow.

  The operating procedures must further comply with the sequence of fan shutdown required by NRC as stated in its meeting minutes on the same subject at WBN (Ref. 41).

General Construction Specifications for fire protection systems (Ref. 65) require formal documented preoperational tests for fire dampers. The subject preoperational test procedure, PT-VC-01, is also referred to in an ECN (Ref. 55) but has not yet been issued.

The technical specifications and surveillance instructions for fire dampers (ETL resistance and closure and latching test) have not yet been issued.

In March 1985, an NCR (Ref. 66) reported a fire damper (OVC-MDMP-368-N) failing to close when repeatedly actuated per Division of Construction QCP (Ref. 64), Section 6.5.5.1.3. This damper is in the Auxiliary Building at elevation 610 feet next to the elevator shaft and not the one referred to in the concern that originated at WBN. The QCP (Ref. 64) does not require testing under airflow and is, therefore, no substitute for a preoperational test. The cause of the damper closure failure could not be established, and replacement with a new damper was completed in 07/86. As part of the installation inspection, the closure test was then repeated and acceptance documented in Attachment D (Ref. 67) of the above-mentioned QCP.

The concern is no longer valid for BLN because the fire dampers have been modified, and test procedures and administrative measures to assure their closure have been committed to prior to fuel load.

4.2 Computer/Battery Room Temperatures - Element 230.2

This concern for Watts Bar asserts that the HVAC system design for the battery and computer rooms and the operation of components is deficient because the battery room temperature falls to 55°F while the system maintains the computer room at its required temperature of 55°F.

The electrical board room air conditioning system is part of the Control Building HVAC system. It serves the nonsafety-related 250 V and 48/24 V battery and battery board rooms and communications rooms at elevation 692 feet, and the computer and auxiliary instrumentation rooms at elevation 708 feet.

According to the WBNP FSAR (Ref. 95), the Control Building air conditioning systems are designed to maintain a temperature of approximately 75°F in all equipment and personnel areas during all modes of normal and accident operation.

The Control Building air supply is heated to a minimum of 60°F by means of an electric heater. This fresh air (approximately 8 percent of total) is mixed with exhaust air from the auxiliary instrument rooms, computer room, and mechanical equipment rooms for reconditioning (filtering and cooling) by the electrical board room air handling units (AHU). These AHUs supply the auxiliary instrument, battery board, communication and computer rooms. A 10 kW capacity thermostatically controlled electric supply duct heater maintains the computer room at approximately 70°F (Ref. 92). There is no requirement to keep the computer room at 55°F. The battery room air supply is through wall penetrations from the corridor which collects exhaust air primarily from the battery board rooms. The battery room supply air temperature will, therefore, be higher than the unheated computer room supply air temperature. Even if the battery rooms were maintained at 55°F, which is below the 60°F minimum for rated battery capacity, there would be minimal degradation of the batteries ability to perform the nonsafety-related function.

The WBN design documents reviewed (Refs. 74, 75, and 76) and comparisons made with the SQN design did not reveal unusual design or location of the HVAC system for the rooms of concern.

According to the notes from a HVAC equipment maintenance coordination meeting (Ref. 77), "overheating of the computer room" and "borderline temperature" in the battery board and communications rooms were some of the problems discussed, and a design study was requested (Ref. 78). This design study (Ref. 79) attributed the temperature deviations to fouled air handling unit cooling coils and the frequent breakdowns of the electric board room HVAC system to specific component design deficiencies. The corrective action recommended in a first phase consisted of cleaning the battery board room AHU cooling coils by a contractor (Ref. 80). The second phase of the design study (Ref. 81) suggested solutions to the HVAC system component problems (fan bearings, damper blades, filter supports, motor adjustments).

The concern is valid as to reliability of H&V system components. Corrective actions suggested in the DS have not been implemented yet because the component deficiencies constitute mainly maintenance inconvenience rather than public safety or operability hazards.

TVA's corrective action plan (Ref. 82) commits to follow up on the Phase I work DSR-21 by having the cooling coils of the air handling units cleaned by a contractor. This work will be scheduled by TVA's maintenance section.

In addition, the mechanical maintenance section has submitted a design change request (DSR-692) to the change control board to approve corrective action work per Phase II of the design study. The DCR includes corrective actions for all other equipment deficiencies identified as causing frequent maintenance outages of the electrical board room HVAC system. Because the Phase II items are modified for reduced maintenance rather than operability, these changes are scheduled for completion after fuel loading. The completed corrective actions by the maintenance section, as proposed by TVA DNE, will resolve the concern as perceived by this evaluation.

4.3 Leak Tightness of Duct Seals - Element 230.3

This concern raised three issues for Watts Bar: that HVAC ducting cannot be maintained 100 percent leak tight; that ductwork supports are excessively heavy; and that an excessive amount of glue has been required to achieve this degree of leak tightness.

4.3.1 Leak Tightness

Watts Bar. The WBN HVAC systems were designed in the early 1970s and employed then-current nuclear industry practice for ductwork design. These practices were documented in the Sheet Metal and Air Conditioning Contractors National Association (SMACNA) standard (Ref. 83), as modified by a portion of the Oak Ridge National Laboratories Report ORNL-NSIC-65 (Ref. 84). In the evaluation team's judgment, these practices are characterized as high-grade industrial practices, supplemented by careful consideration of operating conditions, especially external and internal pressures.

In the mid-1970s, through development of NRC Regulatory Guide 1.52 (Ref. 85) and its companion industry standard ANSI N509 (Ref. 86), substantial changes occurred in requirements for safety-related HVAC systems. Regulatory Guide 1.52 references ANSI N509 Section 4.12 for leak tightness and Section 5.10 for ductwork design, construction, and testing. ANSI N509 Section 4.12 imposes a 0.5 percent of flow leak tightness requirement for engineered safety feature (ESF) systems (0.1 percent of flow for control room HVAC). For non-ESF systems, the requirement is 1.0 percent of flow. ANSI N509 Section 5.10 allows gasketed transverse joints. SMACNA High Velocity Duct Construction Standards (Ref. 83) are acceptable for longitudinal seals. Neither Regulatory Guide 1.52 nor ANSI N509 have "100 percent leak tightness" requirements as outlined in the concern.

TVA Design Criteria WB-DC-40-36.1 (Ref. 87) was first issued early in 1975, well before Regulatory Guide 1.52, R2 in 1978. It incorporates the practices documented in the SMACNA standards and ORNL-NSIC-65 (Refs. 83 and 84), which were applied to all safety-related ductwork. Those systems that could contain highly radioactive air in post-accident conditions (e.g., the emergency gas treatment system) were subject to additional requirements. Specifically, duct sections were to be all-welded, although flanged joints with neoprene seals were allowed between duct sections. However, some of these systems were also required to use all-welded joints where operational conditions dictated application of such requirements (e.g., hydrogen collection headers). These systems are covered in Table 3.3-1 of the TVA design criteria (Ref. 87, notes 4 and 5).

Leak tightness requirements for HVAC systems were specified on construction drawings for the individual systems. As described in TVA General Construction Specification G-37 (Ref. 88), only those ducts defined as "low leakage" on the drawings, and ducts on the discharge side of fans, are required to be leak tested by pressurization as opposed to leak checked. Leak checking consists of locating leaks by feel or sound. Leak testing measures actual leakage rates to verify compliance with the maximum allowable 1 percent of the system flow at 25 percent above specified system design pressure (Ref. 88, Section 3.3.3).

TVA documented the safety-related ductwork practices from Construction Specification G-37 (Ref. 88) and Design Criteria WB-DC-40-31.8 (Ref. 87) in FSAR Table 3.2-6 (Ref. 95). Compliance with Regulatory Guide 1.52 (Ref. 85) for the emergency gas treatment system, Auxiliary Building gas treatment system, Reactor Building purge ventilation system, and main control room air cleanup system was documented in FSAR Tables 6.5-1, 6.5-2, 6.5-3, and 6.5-4, respectively. Exceptions to the leak tightness criteria were provided in the footnotes. These exceptions are summarized below:

- o The majority of the ductwork upstream of the fans was located within secondary containment or pressurized control room areas, so that any out-leakage from the systems would be contained and processed by the gas treatment system for that area, rather th[illegible] leaking directly to the atmosphere.

- The ductwork would be at a negative pressure relative to its surrounding area, and any leakage would be in-leakage rather than out-leakage.

The NRC, using Regulatory Guide 1.52 as a criterion, found WBN's ductwork practices acceptable on a system-by-system basis, as indicated in the Safety Evaluation Report (Ref. 89).

As part of a program to verify weld adequacy for all safety-related HVAC ductwork (Refs. 90 and 91), leak testing to 1 percent of total volume, not flow, was successfully conducted in 1981.

The control room HVAC system and the post-TMI habitability requirements evaluated in FSAR Section 6.4 could give the impression of using "100 percent tightness" as a design parameter. This is because duct leakage values of 0 (zero) CFM (FSAR Table 6.4-1) are used to evaluate the control room habitability. In this particular case, "duct leakage" refers to leakage of contaminated outside air into the control room HVAC system ductwork, not to leakage of "clean" room air into the ducts. Note 7 of FSAR Table 6.5-4 (Ref. 95) justifies the use of commercial grade ductwork for this application. The justification is that the main control room habitability system (MCRHS) includes the HVAC ducting and recirculation fans inside the pressurized control room volume. Any actual duct leakage would not be uncontrolled contaminated outside air but room air. Therefore, the actual quantity of duct leakage from the pressurized volume has no impact on MCRHS habitability and safety. The commercial grade leak tightness criterion identified in FSAR Table 6.5-4 was accepted by NRC in the SER. A further review of the Control Building ductwork failed to find any leakage paths not already evaluated.

Browns Ferry. Although no ECTG evaluation was conducted at BFN, a related potential problem was identified (Ref. 138) with leakage from pressurized ducts routing unfiltered outside air through the control room to other post-accident cooled rooms in the building. TVA has committed to conducting an evaluation (Ref. 139) of the control room HVAC system at BFN and to correcting all deficiencies discovered. Under the conditions stated in a letter (Ref. 140), the corrective action plan is acceptable to the ECTG.

4.3.2 HVAC Supports

The EC stated that some of the HVAC duct supports are "excessively heavy." Unless specific negative effects of the alleged excessively heavy supports are identified, an unsatisfactory condition for plant operation or for the public health and safety cannot be found. The use of "heavy" supports is common throughout the nuclear power industry. It results from a combination of conservative regulatory requirements, economic factors, and design standardization. The supports for ductwork are designed to account for at least the component load, a 250 lb additional load (e.g., a person walking on the duct), and the effects of seismic forces. A seismic load on a component usually imparts a frequency of vibration of less than 33 Hz (often in the 10 to 20 Hz range). If the structure has a natural frequency greater than 33 Hz, it is considered to be "rigid" and the seismic loads become nonadditive. A viable design technique is to build "rigid" supports with standard components. The resulting support design may then be excessively heavy for the ductwork dead load alone.

4.3.3 Excessive Sealing Glue

The issue of "excessive" use of RTV glue is subjective. The use of it as sealant is a most effective and common method of achieving the required leak tightness requirements with the existing ductwork. Sealant is generally used on the gasketed and mechanical joints to minimize leakage. As previously indicated, the finished ductwork complies with the commitments made in FSAR Tables 6.5-1 through 6.5-4 (Ref. 95). Glue is an acceptable sealant (Ref. 86) and does not result in unacceptable operating conditions. For newer HVAC systems, all-welded ducting systems are preferred for meeting the new leak tightness criteria.

This evaluation concluded that there is no basis to the concern that the HVAC duct systems are inadequately designed for the functions intended. The assertion concerning "excessive use of glue" and "excessively heavy supports" are subjective. The design may be overly conservative and, therefore, does not reduce the ability of the plant to protect the health and safety of the public.

4.4 Heat Buildup in Containment Dome - Element 230.4

This EC refers to high temperatures that occur at two locations inside the primary containment: the upper portion of the steam generator enclosure and the dome of the containment itself. As shown in WBN equipment location drawings (Refs. 93 and 94), the top slabs of the steam generator enclosures are part of the boundary between the upper and lower containment compartments, which is a feature of the ice condenser containment concept. The lower compartment contains all high energy piping, and directs blowdown flow from a postulated pipe break through the ice condenser.

The WBN containment ventilation system, described in WBN FSAR Section 9.4.7 (Ref. 95), is divided into two major subsystems to serve the upper and lower containment compartments discussed in the previous paragraph. The lower compartment air cooling system is designed to maintain a maximum air temperature of 120°F in the lower compartment spaces, including the steam generator enclosure, during normal plant operation. This temperature limit is based on equipment environmental qualifications. These lower compartment spaces are rarely accessed during normal operation, and many, including the steam generator enclosure, are inaccessible due to high radiation levels. The upper containment compartment air cooling system is designed to maintain a maximum temperature of 110°F in the containment dome during normal plant operation. Access to the containment dome is also limited during normal plant operation. Therefore, the design temperatures for the containment ventilation systems were not based on personnel access considerations. For both of these systems, temperature is controlled by throttling the cooling water flow (Ref. 96). Thus, even with relatively low heat loads, the upper portions of the steam generator enclosures and the containment dome are at an uncomfortable temperature when the system is in automatic control.

WBN FSAR Section 9.4.7.4 (Ref. 95) commits to preoperational testing of the HVAC system components, including the temperature controlling devices.

TVA Division of Nuclear Engineering (DNE) reviewed the EC and prepared a response containing the following statement (Ref. 97):

> "The concern correctly states that the design of the containment to some degree and the design of the steam generator enclosures to a large degree retain heat."

The remainder of the response dealt with the ventilation modifications suggested in the employee concern. It concluded with the following statement:

> "Because of the safety function performed by the primary containment and the steam generator enclosure and because of the existing plant ventilation systems, it is concluded that the addition of vents would result in an additional risk to the health and safety of the public, and therefore, cannot be justified."

The additional risk to the public with the concerned individual's suggested redesign stems mainly from the need for additional large penetrations in the containment and in the barrier separating the upper and lower containment compartments. Fast-closing isolation valves would be required for these penetrations. Such valves have a much higher failure probability than the existing passive containment and barrier structures. For a similar design condition involving other plants' containment purge lines, the NRC recognized the inherent compromise of containment reliability by requiring major design changes. This condition involved normally closed valves, which compromised the safety less than the normally open isolation valves required in the recommended design of the concerned individual.

This concern is not valid because equipment environmental qualifications and not personnel access is the basis for the containment HVAC system design temperature.

4.5 <u>Airborne Radioactivity in CDWE Building - Element 230.5</u>

This concern asserts that personnel in the Condensate Demineralizer Waste Evaporator Building (CDWEB) could be exposed to radioactivity during isolation of the Auxiliary Building.

4.5.1 System Description

With minor exceptions, the CDWE system, HVAC system, and CDWEB of Watts Bar and Sequoyah are identical as described in this section. The CDWE is located in a separate building adjacent to the northeast and southeast corner of the Auxiliary Building, for WBN and SQN, respectively. The 30-gpm-capacity evaporator package was provided by Horton Process Design (HPD) Inc. and is a forced-circulation, vertical tube heater type. It was primarily intended for concentrating the neutralized spent regenerating liquids from the condensate polishing demineralizer system (CPDS). The CPDS was designed for full-flow treatment of the secondary (turbine steam) loop condensate. The CDWE was also designed as backup to the 2-gpm-capacity waste evaporator and the 15-gpm-capacity auxiliary waste evaporator for processing floor and tritiated drain wastes.

Air induced by the 1200-cfm-capacity CDWEB supply fan through a duct from the Auxiliary Building is used for ventilation. This ventilation air is supplied to areas of low potential for radioactive contamination and migrates to areas of progressively higher potential for contamination. The 1400-cfm-capacity CDWEB exhaust fan returns air from the area with highest contamination potential through a duct to the fuel handling area exhaust system in the Auxiliary Building. Double isolation dampers in the ventilation ducts penetrating the CDWEB-to-Auxiliary Building boundary close when the Auxiliary Building stack monitor detects high radiation. This Auxiliary Building isolation (ABI) may occur as a result of fuel handling accidents or spills and leaks within the Auxiliary Building. A loss of coolant accident (LOCA) also results in an ABI as part of the secondary containment enclosure (SCE) isolation. The CDWE is not part of the SCE. The double isolation dampers have a manual override switch in the waste packaging area. Fire dampers are also installed in the CDWEB-to-Auxiliary Building wall penetrations. Two separate air conditioning systems are provided in the CDWEB for heat removal, one serving rooms of low potential for contamination, and one serving rooms of high potential for contamination. The CDWEB has a monitored door to the outside for emergency exit.

Per HPD piping and instrument diagrams 101 through 106 (Refs. 98 and 99), there are four equipment vent lines originating from the CDWE package: a 6-inch heater relief valve discharge line and a 2-inch blowdown tank line exhausting through the roof; one 2-inch vent line from the bottoms tank; and a 1-inch line from the vent gas cooler. The latter two were originally routed to the waste gas system (WGS) in the Auxiliary Building. A 4-inch blowdown tank rupture disc vents into the CDWEB atmosphere.

A TVA memo from D. R. Patterson to R. M. Pierce (Ref. 100), dated November 13, 1979, addressing SQN, initiated rerouting of the CDWE equipment vents at SQN and WBN through the CDWEB roof to the atmosphere. The reason for rerouting was that the vent gas cooler noncondensible mass flow (45 lb/hr) exceeded the WGS capacity. More importantly, the WGS processes hydrogen-rich gases from the chemical and volume control system (CVCS) holdup vessels, and gases containing oxygen are specifically excluded.

A letter from HPD to TVA (Ref. 101), dated October 23, 1986, corrected the noncondensible mass flow to 4.5 lb/hr, down from 45 lb/hr.

The recommendation of the above memo (Ref. 100) was incorporated into the design by ECN SQN 2744 (Ref. 102), reflected in Drawing 45M4 47W560-23 Rev. 3, Section G23 - G23 (Ref. 103) and by ECN WBN 2257 (Ref. 104), reflected in Drawing 85M 47W560-22, Rev. 9 (Ref. 105), respectively.

These changes created the potential for unmonitored releases.

A TVA memo from J. C. Standifer to G. Wadewitz (Ref. 106), dated December 22, 1983, replied to an earlier memo from G. Wadewitz to J. C. Standifer (Ref. 107), which quotes an HPD Inc. design representative expressing concern over a remote possibility of contaminants exhausting through the vent gas cooler vent line under abnormal evaporator operation. Standifer added that in view of the recent decision to use the CDWE for routinely concentrating effluent from newly added hyperfiltration units (HFU) as replacement for the radwaste evaporators, the vent gas cooler line should be rerouted again, this time into the CDWEB ventilation duct returning to the Auxiliary Building. The radwaste radioactivity is orders of magnitude higher than that of turbine steam condensate. The TVA memo (Ref. 106) further committed to issuing an ECN for routing the vent gas cooler vent line into the CDWE exhaust ventilation duct.

4.5.2 Watts Bar Evaluation

ECN 4598 (Ref. 108) incorporated the vent line rerouting in TVA drawings (Refs. 98 and 105). The blowdown tank vent line remained venting through the roof because of the possible high moisture contents. The blowdown tank is only used for containing steam condensate and vapor body relief valve discharge, which have minor potential for radioactivity. This routing was verified by a site inspection (Refs. 109 and 110). It minimized the potential for unmonitored release from the CDWEB, but created the potential for backup of radioactive containmants in the CDWEB during periods of an ABI.

Table 11.2.2-2 of the SNP FSAR (Ref. 111) shows the expected radionuclide discharge rates from the waste evaporator and auxiliary waste evaporator package vents (including iodines) under normal operation to be negligible. The equivalent table in the WBNP FSAR (Ref. 95) was deleted; however, the similarity of the two plants supports an assumption of similar radioactivity levels in the waste streams. These discharge rates correspond to the CDWE package vent rates when processing radwaste. Per telephone conversation with TVA (Ref. 112), new radionuclide release rates are being calculated for an ALARA study in progress for Sequoyah.

The waste evaporator areas in the Auxiliary Building are monitored for area radiation levels. Since the CDWE is now routinely processing radwaste, the same criteria for monitoring could apply to the CDWEB as well.

However Tables 12.3-4 and -5 of the WBNP FSAR (Ref. 95) show that no plant area or airborne particulate activity radiation monitors are located in the CDWEB.

TVA general design guidelines for radiation protection - ALARA (Ref. 113) specify four to ten air changes per hour in airborne radiation enclosures. The CDWEB ventilation system only affords one air change per hour for the entire building, or 3.5 air changes per hour for radiation zone II (less than 5 mr/hr) rooms.

Nuclear Operating Experience Inc. Reports 352 and 353 (Ref. 120) state that frequent ABIs occurred at SQN from January through April 1984 because of normal maintenance operations and spurious signals. Based on the similarity between SQN and WBN, similar frequency of ABIs is possible at WBN. ABI is a safety-related function; therefore, control room annunciation is provided.

The CDWE system operating instructions (SOI) (Ref. 114) require alignment of the dampers per checklist shown in the Auxiliary Building general supply and exhaust fan operating instructions (Ref. 117) as a prerequisite for CDWE operation. This checklist requires that the supply duct isolation dampers for the CDWEB be open prior to restarting the fans. However, the exhaust dampers are not shown in the damper alignment checklist. These dampers are listed in the system operating instructions for the fuel handling area exhaust fans (Ref. 125), but execution of these instructions was not made a prerequisite for CDWE operation.

The CDWE SOI (Ref. 114) and the SOI for recovery from an ABI (Ref. 115) do not instruct shutdown of the CDWE in case of an ABI and opening of the CDWEB ventilation dampers prior to restart. The equivalent SQN instructions (Ref. 116) impose a 15-minute limit on CDWE operation with the building ventilation exhaust dampers closed.

The CDWE SOI (Ref. 114) further refers to a deleted vent gas cooler vent valve in the valve checklist but do not include the blowdown tank valves. The blowdown tank is not described in the instructions.

The concern is valid for abnormal operation of the CDWE simultaneously with an ABI. During normal operation, the expected airborne radioactivity is negligible. A follow-up investigation further showed that the CDWE heating steam supply valves close upon an ABI (Ref. 121); thus, a limit on the time of operation during an ABI is not required. In a telephone conversation (Ref. 122), the CDWE manufacturer assured that gassing off noncondensibles will cease within seconds of heating steam interruption. The concern is further valid that no area or particulate air monitors are provided in the CDWEB.

TVA has committed (Ref. 123) to updating the SOIs for the CWDE per as-built condition, and to including implementation of SOIs for Auxiliary Building general supply and exhaust fans (Ref. 117) and fuel handling area exhaust fans (Ref. 125) as a condition for CDWE start.

TVA has committed (Ref. 124) to initiating an ALARA review of the CDWEB to establish the need for radiation monitoring devices (Ref. 126). This review is to be performed before fuel load in unit 1.

4.5.3 Sequoyah Evaluation

A TVA memo from H. J. Green to M. N. Sprouse (Ref. 127), dated November 9, 1983, transmitted a field-completed DCR (Ref. 128) that documented rerouting of the vent gas cooler and slurry tank vent lines to the ventilation duct. This change has not been incorporated into design drawings; however, it was verified by a site inspection (Ref. 129). This change removed the potential for unmonitored release from the CDWEB, but created the potential for backup of radioactive contaminants in the CDWEB during periods of an ABI.

Per Table 12.1.4-1 of the Updated SNP FSAR (Ref. 130), there is no area radiation monitor located in the CDWEB.

Table 11.2.2-2 of the original SNP FSAR (Ref. 111) shows the radionuclide discharge rates from the waste evaporator and auxiliary waste evaporator package vents (including iodines) under normal operation to be negligible. These rates correspond to the CDWE package vent rates when processing radwaste. Per telephone conversation with TVA (Ref. 134), a CDWE vent activity release rate study is presently in progress to confirm this.

The waste evaporator areas in the Auxiliary Building are monitored for area radiation levels. Since the CDWE is now routinely processing radwaste (Refs 106 and 132), the same criteria for monitoring could apply to the CDWEB as well.

Nuclear Operating Experience Inc. Reports 352 and 353 (Ref. 120) state that frequent ABIs occurred at Sequoyah from January through April 1984 because of normal maintenance operations and spurious signals. ABI is a safety-related function and control room annunciation is provided.

TVA System Operating Instruction SOI-77.1B3 (Ref. 131) requires shutting down the CDWE upon an ABI, and verifying isolation damper opening prior to restarting the CDWE. TVA System Operating Instruction SOI-30.5D (Ref. 116) requires that the Auxiliary Building isolation signal be reset within 15 minutes of an ABI or shutting down the CDWE.

The concern is not valid for normal operation of the CDWE simultaneously with an ABI. Besides the low expected activity, the SOIs reduce the potential for noncondensible back-up into the CDWEB. A follow-up evaluation further showed an identical supply steam valve control logic to the CDWE as for WBN (Ref. 133).

The concern is valid in that there are no area or particulate air monitors provided in the CDWEB to assure compliance with ALARA guidelines.

TVA has committed (Ref. 135) to revising the appropriate drawings per DCR (Ref. 128) and to evaluating and documenting ALARA concerns for the CDWEB.

4.6 Summary of Subcategory Findings

The classified findings are summarized in Table 1. Class A and B findings indicate there is no problem and that corrective action is not required. Class C, D, and E are termed "negative findings" requiring corrective action. The corrective action class, defined in the Glossary Supplement, is identified in the table by the numeral combined with the finding class. For example, the designation D2 in Table 1 indicates that the evaluated issue was found to be valid (finding Class D) and that a corrective action involving some type of procedure is required (corrective action Class 2).

Findings are summarized by classification in Table 2. Of the 30 findings identified by a classification in Table 2, 21 require no corrective action. Of the remaining nine, two had corrective actions initiated by TVA before the ECTG evaluation, six required corrective actions as a result of the ECTG evaluation of a concern, and one required corrective action as a result of a peripheral issue uncovered during the ECTG evaluation. Table 2 shows that at Watts Bar, where most of the issues were originated, only three out of a total of 15 issues were found to be valid and in need of corrective action, and one of these three issues had corrective action initiated before the ECTG evaluation.

5. CORRECTIVE ACTIONS

Table 2 identifies nine negative findings (Class C, D, and E) that require corrective action. Since one of the corrective actions applies to more than a single plant, only eight different actions are required or have already been initiated to remedy the nine negative findings. The detailed corrective action descriptions are contained in Attachment B. A condensation of this information by element, with the applicable plant identified in parentheses, follows:

- o <u>230.1, Fire Damper Latching Test</u> - As required by the NRC for WBN, abnormal operating instructions (AOI) need to be revised to include more specific action to take in case of fire (SQN). Installation of one new fire damper will be required after the unit 2, cycle 3, refueling outage to replace an oversized fire damper, which will jam in the penetration (SQN).

  Evaluation of the installed fire dampers against new damper manufacturer closure test data with system air flow will identify which dampers require actual tests or administrative instructions to shut the ventilation system down in fire affected areas (BFN).

The surveillance instructions for fire dampers require revision to include the latest fire compartmentation drawings in compliance with 10 CFR 50, Appendix R requirements (BFN).

- 230.2, Computer Room/Battery Room Temperatures - Cleaning of cooling coils and modification of HVAC system components is planned per design study request (DSR) recommendations (WBN).

- 230.5, Airborne Radioactivity in CDWE Building - Appropriate drawings require revision to reflect existing piping configuration per local DCR-L and the flowsheet requires revision in accordance with corrected vendor information (SQN). The system operating instructions require revision to minimize airborne radioactivity (WBN). The modified piping and process changes require evaluation for compliance with ALARA (WBN, SQN).

These corrective actions also appear in Table 3, along with their corresponding finding/corrective action classifications. The table shows the plant or plants for which a corrective action is still required in the Corrective Action Tracking Document (CATD) column.

The Finding/Corrective Action Classification column of Table 3 shows the eight corrective actions, of which two require hardware or plant modification, two involve additional evaluation, three require procedural changes, and one requires documentation remedy. In addition, the CATD column of Table 3 shows that, in most cases, a particular corrective action is applicable to only a single plant. The corrective action for element 230.5, which involves ALARA evaluations, is the only corrective action applicable to more than one plant. The element requiring the largest number of corrective actions is 230.1, Fire Damper Latching Test, which has four. In all cases, the evaluation team found the completed or planned corrective actions acceptable to resolve the negative findings.

6. CAUSES

Table 3 identifies one or more causes for each negative finding requiring corrective action. For each corrective action, the most important cause is identified; however, in many instances it was felt that the problem resulted from a combination of causes, each of which should be identified. In those cases, more than one cause is identified. Engineering judgment was used to establish the causes, and was based on the findings in Attachment B.

For the eight corrective actions described in Table 3, 13 causes have been identified. These are shown in the table and totalled at the end. The most frequent causes are "Inadequate Communication" and "Inadequate As-built Reconciliation." The latter cause is discussed more fully in Subcategory Report 20600.

"Inadequate Communication" reflects deficiencies in communication between departments within a project organization (e.g., engineering and operation) and between projects (e.g., SQN, WBN) that lead to inadequate or inconsistent operating instructions. The TVA general design guidelines clarifying the requirement for closure of fire dampers without airflow were issued after the purchase orders for Sequoyah, Watts Bar, and Browns Ferry fire dampers were issued. This situation led Operations personnel to issue fire protection instructions based on erroneous vendor catalog information on allowable airflows against which fire dampers close.

The Corporate Nuclear Performance Plan (CNPP), Revision 4, describes changes that will make a centralized Division of Nuclear Engineering (DNE) responsible for accuracy, adequacy, and control of drawings and technical documents, including validation of as-built drawings. The BFN Nuclear Performance Plan, Attachment IV-2, commitment item 81, issued in August 1986, shows detail review of all fire protection system surveillance instruction for technical adequacy and compliance with technical specifications ongoing and to be completed before restart.

"Untimely Resolution of Issues" is a contributing cause for the uncertainty of fire damper closure against ventilation flow at Browns Ferry. No action has been taken since the 10 CFR 21 notice from the vendor in November 1984.

The CNPP, Appendix 8, Commitments D18 and D21, describes a single Corporate Commitment Tracking System (CCTS) and a Tracking and Recording of Open Items (TROI) system for CAQs as a remedy for untimely corrective action and for identification of problems applicable to more than one plant.

The cause "Inadequate As-built Reconciliation" is closely related to the lack of communication.

Two causes fall into the technical adequacy area under "Vendor Errors." They include erroneous vendor catalog information on fire damper capabilities and poor detail design of standard air handling unit components.

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. The issues evaluated in this subcategory do not require significant corrective actions.

The HVAC designs for the Sequoyah, Watts Bar, and Bellefonte nuclear power plants do not indicate major problems because most issues raised by the concerns were corrected before the ECTG evaluations. However, the corrective actions required, especially for fire dampers at BFN, indicate a shortcoming in the timely resolution and communication of important issues, which are causes in the management effectiveness area.

The 10 CFR 21 notice from the fire damper manufacturer to most domestic nuclear power plants in November 1984 did not result in an NRC IE Bulletin requiring mandatory action on TVA's part. Also, UL standards for fire dampers do not require fire damper closure against airflow. Therefore, no NRC reporting requirements were violated by the failure of the Browns Ferry Site Design Services Manager to respond to a memo on this issue from TVA's BFEP Project Manager.

"Vendor Errors" in catalog information and detail design of standard manufactured equipment (fire dampers, air handling units) are normally not detectable by the purchaser's (TVA) customary review of the design documents.

The results of this subcategory evaluation are being combined with the other subcategory evaluations and reassessed for 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
230.1	Fire Damper-Latching Test	a	A	A	A	A
		b	A	A	A	A
		c	D2	A	D6	A
		d	E1	-	E2	-
230.2	Computer and Battery Room Temperatures	a	-	A	-	-
		b	-	A	-	-
		c	-	C1	-	-
230.3	Leak Tightness of Duct Seals	a	-	A	-	-
		b	-	B	-	-
		c	-	B	-	-
230.4	Heat Buildup in Containment Dome	a	-	A	-	-
		b	-	A	-	-
230.5	Airborne Radioactivity in CDWE Building	a	D3	B	-	-
		b	B	B	-	-
		c	B	D2	-	-
		d	D6	D6	-	-

*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 for each plant in Attachment B

TABLE 2

FINDINGS SUMMARY

	Classification of Findings	Plant SQN	Plant WBN	Plant BFN	Plant BLN	Total
A.	Issue not valid. No corrective action required.	2	8	2	3	15
B.	Issue valid but consequences acceptable. No corrective action required.	2	4	-	0	6
C.	Issue valid. Corrective action initiated before ECTG evaluation.	0	1	-	0	1
D.	Issue valid. Corrective action taken as a result of ECTG evaluation.	3	2	1	0	6
E.	Peripheral issue uncovered during ECTG evaluation. Corrective action required.	1	0	1	0	2
	Total	8	15	4	3	30

ELEM	FINDING/ CORRECTIVE ACTION CLASS.**	CORRECTIVE ACTION	CATD	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
230.5	D3	Revise the appropriate drawings to reflect existing piping configuration per local DCR-L and the flow sheet per corrected vendor information.	SQN 01										X								-	-	-
	D2	Revise system operating instructions to minimize airborne radioactivity.	WBN 01 R1					X					X								-	-	-
	D6	Evaluate the modified piping and process changes for compliance with ALARA.	SQN 02 WBN 02														X				-	-	-
			TOTALS					4	2				3	1			1			2			

* Defined in the Glossary Supplement.

** Defined in Table 1.

TABLE 3
MATRIX OF ELEMENTS, CORRECTIVE ACTIONS, AND CAUSES
SUBCATEGORY 23000

ELEM	FINDING/ CORRECTIVE ACTION CLASS.**	CORRECTIVE ACTION	CATD	CAUSES OF NEGATIVE FINDINGS * — MANAGEMENT EFFECTIVENESS: 1 Frag-mented Organ-iza-tion	2 Inade-quate Q-trng	3 Inade-quate Proce-dures	4 Proce-dures Not Fol-lowed	5 Inade-quate Com-muni-cation	6 Un-timely Res of Issues	7 Lack of Mgt Atten	DESIGN PROCESS EFFECTIVENESS: 8 Inade-quate Design Bases	9 Inade-quate Calcs	10 Inade-quate As-blt Recon-cil.	11 Lack of Design Detail	12 Engrg Judgmt not Docu-mented	13 Design Crit/ Commit Not Met	14 Insuf. Verif Docu-menta-tion	TECHNICAL ADEQUACY: 15 Stds Not Fol-lowed	16 Engrg Error	17 Vendor Error	Signifi-cance of Corrective Actions* L	M	H
230.1	D2	Revise Abnormal Operating Instructions (AOI) to include more specific action to take in case of fire, as required by NRC for WBN.	SQN 01 R1					X													-	-	-
	E1	Install one new fire damper after unit 2 cycle 3 refueling outage as replacement of oversized damper which will jam in penetration.	SQN 01 R1										X	X							-	-	-
	D6	Evaluate installed fire dampers against manufacturer's test data with system airflow. Perform closure tests and/or institute operating instructions to shut down ventilation flow where dampers may not close in fire affected areas.	BFN 01					X	X											X	-	-	-
	E2	Revise surveillance instructions for dampers to include latest fire compartmentation drawings in compliance with 10 CFR 50, Appendix R requirements.	BFN 01					X	X												-	-	-
230.2	C1	Complete cleaning of cooling coils and modifying HVAC system component per design study request (DSR) recommendations.	WBN 01																	X	-	-	-

* Defined in the Glossary Supplement.

** Defined in Table 1.

GLOSSARY SUPPLEMENT
FOR THE ENGINEERING CATEGORY

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

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

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

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

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

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

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

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

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

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

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

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

- 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.

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: