

TVA EMPLOYEE CONCERNS
SPECIAL PROGRAM

REPORT NUMBER: 10600

REPORT TYPE: Subcategory - Construction

REVISION NUMBER: 4

TITLE: Bolting (Construction)

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REASON FOR REVISION:

- R1 Incorporate corrective actions and SRP comments
- R2 Incorporate additional CATDs corrective actions, TAS, and SRP comments
- R3 Incorporate additional response from line organization, and SRP comments
- R4 Incorporate additional SRP comments

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

HISTORY OF REVISION

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

Preface

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

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

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

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

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

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

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

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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 imposes on itself (see also "requirement").

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

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

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

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

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

K-form (see "employee concern")

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

root cause the underlying reason for a problem.

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

Acronyms

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

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

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L/R Labor Relations Staff

M&AI Modifications and Additions Instruction

MI Maintenance Instruction

MSPB Merit Systems Protection Board

MT Magnetic Particle Testing

NCR Nonconforming Condition Report

NDE Nondestructive Examination

NPP Nuclear Performance Plan

NPS Non-plant Specific or Nuclear Procedures System

NQAM Nuclear Quality Assurance Manual

NRC Nuclear Regulatory Commission

NSB Nuclear Services Branch

NSKS Nuclear Safety Review Staff

NU CON Division of Nuclear Construction (obsolete abbreviation, see DNC)

NUMARC Nuclear Utility Management and Resources Committee

OSHA Occupational Safety and Health Administration (or Act)

ONP Office of Nuclear Power

OWCP Office of Workers Compensation Program

PHR Personal History Record

PT Liquid Penetrant Testing

QA Quality Assurance

QAP Quality Assurance Procedures

QC Quality Control

QCI Quality Control Instruction

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

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CONSTRUCTION SUBCATEGORY REPORT 10600

BOLTING

EXECUTIVE SUMMARY

SUMMARY OF ISSUES

This report addresses three issues that were derived from five concerns dealing with bolting applications. Three Watts Bar Nuclear Plant (WBN) concerns were broad in scope and defined an issue that was considered generically applicable to Sequoyah Nuclear Plant (SQN) and Bellefonte Nuclear Plant (BLN). This issue dealt with the use of carbon steel bolts in stainless steel bolted connections. The remaining two issues were defined by one concern and limited in scope to the specific application and plant identified on the concerns. One WBN concern identified potential deficiencies in the holddown bolt assemblies used to install borated water tanks. The remaining concern which was identified at BLN expressed reservations about the adequacy of the support of a component cooling pipe spool piece.

MAJOR FINDINGS

Evaluation of the BLN concern revealed that the spool piece in question was being installed and temporarily supported at the time the concern was filed. An investigation conducted by the BLN safety engineer several weeks later found that the spool piece was adequately bolted in place as a result of normal on-going construction activities; consequently, the concern was considered factual but not a problem. Investigation of the borated water tank holddown bolt assemblies did not confirm the explicit concerns expressed, e.g. appropriate materials were used and installation tolerances were met. However, a related issue involving the lack of QC documentation on the holddown assembly installation process was identified. The issue alleging that carbon steel bolts were used in stainless steel bolted connections was found to be true at WBN, SQN and BLN. However, the actual use of carbon steel bolting in stainless steel bolted connections is an acceptable practice. Even in borated water systems, carbon steel bolting has been proven reliable unless joint leakage occurs. Operational nuclear plants have experienced significant carbon steel bolting degradation due to boric acid corrosive wastage. This degradation and wastage is caused by inadequate or improper joint assembly and not specifically from the use of carbon steel bolting. TVA has recognized this problem to a limited extent at WBN and SQN but additional corrective actions are required to ensure that the problem is adequately addressed. No corrective actions addressing this issue were taken at BLN prior to the ECTG investigation.

The boric acid wastage of carbon steel bolts was determined to be a reliability issue rather than a safety issue. This conclusion was based on the application of the leak-before-break design philosophy which assumes that if pressure boundary degradation occurs detectable leakage will occur before a catastrophic failure of the pressure boundary. With respect to the borated water tank holddown bolt assembly concern, no hardware deficiency was found

and no systemic QA/QC deficiency was identified; hence, the concern was not considered safety-related. Finally, the BLN concern was factual but not a problem. It was also determined to be not safety-related.

COLLECTIVE SIGNIFICANCE

No issues of collective significance were identified by the ECTG evaluation. The small number of concerns and the lack of a common element within the issues precluded the identification and verification of any issue of broad collective significance.

CAUSES

Given that no broad, programmatic problems were identified, only proximate causes were identified for the two problems documented in this report. The inadequate handling of the issue on boric acid wastage of carbon steel bolts was attributed to the failure of TVA to assign responsibility and sufficient authority to an organization or manager to resolve the issue for all plants and the failure of technical personnel in design, construction and operations to reach a consensus on corrective actions. The failure to generate adequate QC documentation on the borated water holddown bolt assembly installations was traced to the failure to ask the vendor to provide such documentation.

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CORRECTIVE ACTIONS

TVA will comprehensively review all bolted connections on the pressure boundary of borated water systems at WBN, SQN and BLN, determine those connections that require replacement of carbon steel bolts and replace them, and ensure that the design integrity of modified connections is not compromised. Carbon steel bolting will remain installed in those application's where it is either unnecessary or impractical to effect a bolting change out. TVA will also evaluate the borated water tank holddown bolts installation and ensure that they are adequate.

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Programmatically, TVA has consolidated the nuclear power organization under a single Manager of Nuclear Power. This fundamental change, coupled with other organizational changes, provides assurance that the necessary coordination and communication among nuclear organizations occurs. In addition, DNQA will review potentially generic QA problems on a case-by-case basis to determine the appropriate corrective action.

BOLTING

Executive Summary Table #1

ISSUES	SR	NS	FINDINGS	CAUSE	CORR. ACTION	SIGNIFICANCE	COLLECTIVE SIGN.
Material Compatibility		X	<p>WBN-Factual SQN-Factual BLN-Factual The use of carbon steel bolts in stainless steel bolted connections is an acceptable practice and is a problem only in bolted connections on a borated water system pressure boundary where joint leakage occurs. Leakage at the connection could lead to boric acid corrosive wastage of the bolts. However, application of the leak-before-break design philosophy led to the conclusion that this is a reliability problem rather than a safety problem.</p> <p>No evidence was found of a systematic evaluation of vendor supplied and qualified components. Corrective actions have been initiated on TVA designed bolted connections. Vendor designed bolted connections have been excluded.</p>	<p>Poor coordination between design, construction, and operations management personnel. Poor communications between design, construction, and operations technical personnel.</p>	<p>WBN-Replace- ment of carbon steel bolts in TVA designed bolted connections on borated water systems has begun. Vendor designed connections will be re- viewed and replaced as appropriate. Mechanical maintenance procedures will be revised in accordance with the recommendations of the ASME/ MPC/EPRI task force on critical bolt- ing appli- cations. SQN- TVA designed flanged connections have been evaluated and corrected. Vendor flanged connections will be evaluated. Mechanical</p>	None	None
							R4
							R4

BOLTING

Executive Summary Table #1

ISSUES	SR	NS	FINDINGS	CAUSE	CORR. ACTION	SIGNIFICANCE	COLLECTIVE SIGN.
Material Compatibility (Continued)					maintenance procedures will be revised in accordance with the recommendations of the ASME/MPC/EPRI task force. BLN-All affected TVA and vendor designed bolted closures will be reviewed and replaced as warranted. The recommendations of the ASME/MPC/EPRI task force will govern the bolt replacement program and revisions to mechanical maintenance procedures. Organizational changes and management initiatives specified in TVA's Nuclear Performance Plan address the identified cause of the finding.		

BOLTING

Executive Summary Table #1

ISSUES	ISR	INS	FINDINGS	CAUSE	CORR. ACTION	SIGNIFICANCE	COLLECTIVE SIGN.
Material Adequacy		X	Applicable only to WBN. No hardware deficiency was found. A related potential deficiency was identified in that no QC documentation was found on the borated water tank installation process.	TVA did not require the vendor to provide QC documentation.	Mechanical Maintenance will issue a maintenance request to verify the adequacy of the holddown bolt installation. TVA's Division of Nuclear Quality Assurance will review potential generic QA deficiencies to identify the appropriate programmatic corrective action.	None	None
Inadequately Supported Flange		X	ELN Factual but not a problem The concern addressed a temporarily supported spool piece. By the time the concern was investigated, the spool piece was adequately supported as a result of the normal construction process.	NA	None	None	None

CHARACTERIZATION OF ISSUES

1.1 Introduction

Five concerns, each involving bolting installation and/or usage, have been evaluated. These five concerns were addressed as three separate issues.

1.2 Description of Issues

1.2.1 Material Compatibility

IN-85-021-X04 (WBN)
IN-85-824-001
IN-86-183-001

Carbon steel bolting was installed in stainless steel flanged connections, to include stainless steel valves. Replacement of the carbon steel bolting was started in the valves but was halted before completion. This issue was determined to be generically applicable to SQN and BLN.

1.2.2 Material Adequacy

PH-85-042-001 (WBN)

The nuts used to bolt down the borated water tanks may be inadequate and there may be insufficient contact between the bracket and plates. Also, during tightening of the nuts, a bolt turned due to the nut being too tight.

1.2.3 Inadequately Supported Flange

BNP-QCP 10.35-8-22 (BLN)

A flanged connection on a component cooling (KC) pipe is inadequately supported with only two bolts.

2.0 SUMMARY

2.1 Summary of Issues

The cited concerns raised a variety of issues pertaining to the installation and/or application of bolting. The specific issues raised were the use of carbon steel bolts on stainless steel flanged connections, inappropriate nuts and conformance to installation tolerances on chemical volume and control system (CVCS) holdup tanks A and B, and an inadequately supported flange connection.

2.2 Summary of Evaluation Process

The concerns were evaluated by using several approaches: reviewing drawings, specifications, contracts, Tennessee Valley Authority (TVA) General Construction Specifications, Nuclear Safety Review Staff (NSRS) and WBN Project Manager's Office (WBN-PMO) investigation reports, and other applicable documentation/criteria; interviewing TVA and contractor personnel familiar with bolting code requirements, procedures, practices, and installations; and inspecting the subject bolting where appropriate.

2.3 Summary of Findings

2.3.1 Material Compatibility

The use of carbon steel bolts in stainless steel flange connections at WBN was confirmed. This was a standard practice that was not disallowed by the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section III and American National Standards Institute (ANSI) B31.1 and was therefore allowed under General Construction Specification G-29M, Process Specification 4.M.1.1, Paragraph 3.1.7.4, for all but TVA class A systems. A review of the mechanical bill of material drawing series 47BM, which governs the use of bolting materials at Watts Bar, confirmed that stainless steel bolting material has been required for all TVA class A systems. However, TVA has noted since 1979 a potential problem in using carbon steel bolts in borated water systems which also include TVA class B piping. TVA concluded the problem was a reliability problem rather than a safety problem, based on the "leak before break" design philosophy. The problem was one of potential degradation and wastage of carbon steel bolts by boric acid from leakage caused by inadequate or improper joint assembly and not specifically from the use of carbon steel bolting. Therefore, replacement of carbon steel bolts on borated systems class B and C piping was specified, but not immediately required, to improve reliability. Therefore, the concern was factual but not a safety problem.

2.3.2 Material Adequacy

The concern, as stated, involved inadequate hold-down bolting hardware and tightening techniques used on borated water tanks. The investigation determined that the CVCS holdup tanks A and B in unit 1 of the Auxiliary Building (AB) were the subject of the concern.

The hold-down bolting hardware and bolt tensioning were provided by the Holdup tank vendor, Chicago Bridge and Iron (CBI). The bolting hardware was found to be marked correctly and in conformance with the vendor's design and technical data provided to satisfy the vendor's contractual obligations. Therefore, this aspect of the stated concern was not factual.

With respect to the inadequate tightening aspect of the concern, two issues were investigated: insufficient contact between the plates and bracket and the turning of a bolt during tightening. A visual inspection of the holddown bolt assemblies revealed sufficient contact between all components where intimate contact was required within the assembly. Therefore, the allegation of insufficient contact was not factual.

The bolt turning issue could not be resolved by either inspection or a review of documentation.

Consequently, technically competent personnel were contacted to determine if bolt turning was possible and, if possible, what the consequences would be if the bolt did turn during the tightening process.

Although there was no consensus on this point, turning of the bolt during the tightening process was determined to be possible; however, a consensus was reached that, had turning occurred, such turning would not adversely affect the ability of the holddown bolt assembly to perform its intended function assuming that all bolts were properly tensioned.

Therefore, although bolt turning may have occurred during tightening, this would not be a condition adverse to quality (CAQ).

It should also be noted that a NSRS investigation conducted on this concern documented a related CAQ, (i.e., no vendor QA documentation was found on the tensioning process). A follow-up investigation determined that WBN nonconformance reports (NCRs) 3928R and 6596R1 were written to document missing mechanical equipment installation process Quality Assurance/Quality Control (QA/QC) documentation. However, the CVCS Holdup Tanks were specifically excluded from the corrective actions specified in the disposition of the NCRs.

2.3.3 Inadequately Supported Flange

The inadequately supported flange concern was determined to be a personnel safety concern only. The flanged connection identified in the concern was a temporary two bolt connection that had not received final inspection. The connection was upgraded by adding eight more bolts and the remaining nine bolts will be added during scheduled construction activities.

2.4 Summary of Collective Significance

No issues of collective significance were identified by the ECTG evaluation. The small number of concerns and the lack of a common element within the issues precluded the identification and verification of any issues of broad collective significance.

2.5 Summary of Causes

2.5.1 Material Compatibility

No safety related CAQ was identified with respect to the use of carbon steel bolting in stainless steel bolted connections. It was determined that coordination between design, construction and operations management personnel was poor in resolving the issue of boric acid wastage of carbon steel bolting on borated water systems. In addition, poor communication between technical personnel in design, construction and operations made reaching a consensus on this issue difficult. | R4

2.5.2 Material Adequacy

The concerns explicitly identified by the CI were unsubstantiated; consequently, no proximate or root cause analysis on those concerns was performed. However, a related problem concerning the absence of QC documentation on the holdown bolt installation was identified. The proximate cause of this deficiency was that, in accordance with the QA standards current of the time CBI's contract was issued, no requirement was included in CBI's contract to provide QC documentation on the installation process.

2.5.3 Inadequately Supported Flange

The concern was factual but not a problem; therefore, no cause analysis was required.

2.6 Summary of Corrective Actions

2.6.1 Material Compatibility

On September 14, 1982, TVA issued ECN 3522 to add bolt replacement criteria to the mechanical bill of materials for WBN. In addition, the mechanical maintenance section issued Mechanical Section Letter 3.1 which directs the replacement of carbon steel bolts on flanged connections in borated water service. However, these corrective actions are confined to TVA designed flanged connections. Vendor designed bolted connections are excluded.

A summary of the additional corrective actions specified by WBN management to address this issue follows.

A design review of borated water systems will be performed to identify vendor designed and qualified pressure retaining bolted connections in borated water service. Carbon steel bolts used on a borated water pressure boundary will be replaced where the aforementioned review determines replacement is appropriate and any affected vendor stress analysis and code data sheets will be revised as necessary. The WBN mechanical maintenance procedures will be revised to incorporate the design approved changes in vendor designed and qualified joints.

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The SQN corrective actions that address this issue were implemented to address Nuclear Regulatory Commission (NRC) Inspection and Enforcement Bulletin (IEB) 82-02. The SQN responses to IEB 82-02 indicate that a review of bolted connections in borated water service was conducted but the scope of the review was not clearly established. Since the scope of the review and corrective actions at WBN were limited to TVA designed bolted connections, the scope of review and corrective actions at SQN should be confirmed to be comprehensive.

A summary of the additional corrective actions specified by SQN management to address this issue follows.

A program will be developed to ensure that all critical bolted closures are identified and included in the bolting replacement program as appropriate. The program will incorporate the recommendations of the AIF/MPC bolting task force on the identification and maintenance of critical bolted closures.

A summary of the corrective actions specified by BLN management to address this issue follows.

A design review of all TVA and vendor designed bolted closures in borated water service will be performed to identify and prioritize the closures that use carbon steel. The AIF/MPC bolting task force guidelines for critical joint identification will be used to identify and rank the bolted closures. Bolt replacement or augmented in-service inspections will be specified for critical closures subject to boric acid wastage depending on closure priority ranking and utility operating experience. In addition, mechanical maintenance practices and procedures will be reviewed to ensure compliance with the bolting task force guidelines for critical joint identification, leak detection criteria, NDE guidelines, and training aids.

2.6.2 Material Adequacy

No corrective actions were required for the concerns explicitly identified in this issue. However, a CATD was issued to document the lack of QC documentation on the holddown bolt installation. In addition, TVA's Division of Nuclear Quality Assurance was requested to address the programmatic issue of the retrofit of QA requirements to qualify-related activities.

WBN management's response to the lack of QC documentation is summarized as follows:

Installation of the holddown bolts was documented by the vendor in accordance with the vendor's QA program. TVA's position is that the holddown bolt installation is therefore adequate and no corrective actions are required. However, the torque of the holddown bolts will be checked and evaluated.

2.6.3 Inadequately Supported Flange

No corrective actions were required to address this issue.

3.0 EVALUATION METHODOLOGY

3.1 General Methods of Evaluation

As noted in the summary, section 2.2, the concerns were evaluated by using several approaches: reviewing drawings, specifications, contracts, TVA construction specifications, NSRS and WBN PMO investigation reports and other applicable documentation/criteria; interviewing TVA and GBI personnel familiar with bolting code requirements, procedures, practices, and installations; and inspection of the subject bolting where applicable. In addition, the Division of Nuclear Engineering's (DNE's) trend analysis data base was used to assess the incidence of documented CAQs similar to the employee concerns. This data base has been maintained since 1976 and includes most CAQs generated since that time. The types of CAQ documents included are: engineering, construction, power, and supplier NCRs; significant condition reports (SCRs); problem identification reports (PIRs); engineering, vendor, and joint audit deficiencies (EAUDs, VAUDs and JAUDs); preoperations test deficiencies (PTDs); licensee event reports (LERs), and NSRS report deficiencies (NSRS). All entries are cataloged by the problem area identified on the CAQ and can be grouped by the resulting identifier code for evaluation. The evaluation strategy pertinent to each issue is discussed in the following sections.

3.2 Requirements or Criteria Established for Individual Issues

3.2.1 Material Competibility

In composite, the cited concerns allege a WBN design inadequacy in that carbon steel bolts were used in the installation of stainless steel valves and flanges throughout WBN. Specific systems and one specific location were cited as examples.

Previous investigation results documented in NSRS Investigation Report I-85-483-WBN were reviewed to determine if the scope of the investigation and the resolution of its findings were sufficient to resolve the concerns.

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Design basis documents were reviewed and design personnel consulted to determine the design requirements pertinent to the concerns. Design output documents including TVA General Construction Specification G-29M (G-29H), the mechanical bill of materials drawing series 47BM, engineering change notices (ECNs) 3522 dated September 13, 1982 and 6004, dated January 31, 1986 and approximately 20 ASME forms NPV-1, "Manufacturers' Data Report for Nuclear Pumps and Valves," were reviewed to determine if bolting material construction specifications were consistent with the design requirements. TVA NCRs BLN NCR-59 and NEB-8017, NRC Information Notice (IN) 80-27 dated June 11, 1980 and IEB 82-02, dated June 2, 1982 Institute of Nuclear Power Operations (INPO) Significant Operating Experience Report (SOER) 84-5 dated September 20, 1984 and the DNE trend analysis CAQ data base were reviewed to establish the history of reported problems relevant to the concern. Internal TVA memorandums NEB791030108, SWP791109047, NRB810521264, SWP810611048, NEB811223275, L26820205899, NEB820209019, NEB820315014, NEB820401276, NEB820813291, L44841625803, L33841025804, L29850131894, and B45860113268, which detail the deliberations between design, construction, and power representatives who were involved in the resolution of this issue, were reviewed to identify the magnitude, depth, and direction of the efforts undertaken to resolve the issue. (Note that the indicated memoranda references encode the date of issuance in the fourth through the ninth characters, e.g., NEB 791030108 indicates that the Nuclear Engineering Branch issued the memorandum on October 30, 1979). TVA's reports to the NRC on the use of threaded fasteners in boric acid water systems at SQN (A27820802028, A27830218011 and A27831121008) were reviewed for comparison to the WBN disposition. NRC Inspection Report 50-390, 391/85-08 dated March 29, 1985 for WBN was reviewed to determine the basis on which the NRC closed IEB 82-02 for WBN. Finally, knowledgeable construction personnel were consulted to determine the intent and extent of bolt replacement activities cited in concern IN-85-021-X04.

The following TVA personnel were interviewed during the course of the investigation and made a significant contribution to the conduct of the investigation.

Design Personnel

Supervisor, Nuclear Engineering Branch, Codes, Standards, Materials, Corrosion and Coatings Section: This individual is a member of the joint Atomic Industrial Forum (AIF) Metal Properties Council (MPC) Task Group on Bolting and was a coeditor of the paper, "Improved Technology for Critical Bolting Applications," presented at the 1986 Pressure Vessels and Piping Conference and Exhibition and published by ASME (Attachment B). The paper summarizes industry-wide bolting failure experiences, the AIF bolting program, the results of the work performed under the AIF program and the AIF program recommendations.

He provided a copy of the AIF report, as well as additional documentation, detailing research on boric acid wastage of carbon steel bolts.

Metallurgical Engineer, Nuclear Engineering Branch, Codes, Standards, Materials, Corrosion and Coatings Section: This individual was an expert in materials applications and the pertinent industry standards and codes. In addition, he was familiar with G-29M and its application at TVA nuclear plants and is responsible for interpreting G-29M for construction personnel. He also authored the design technical position memorandum on the bolt degradation issue.

Construction Personnel

Engineering Associate, Nuclear Licensing Unit: Assisted in the search for documents relevant to the subject concern.

Mechanical Engineer, Supervisor, Mechanical Engineering Unit at BLN: Provided background and documentation on BLN-NCR-59. Also provided status on proposed bolt replacement activities at BLN.

Mechanical Engineers, Mechanical Engineering Unit (WBN): Several members of this unit were interviewed to determine if a systematic carbon steel bolt replacement program had been initiated and if any valve body-to-bonnet studs were included in the replacement activities. They provided comments on the bill of material notes addressing bolt change out and assisted in the search for documentation to establish whether or not bolt replacements occurred on either TVA designed connections or vendor components.

Power Personnel

Mechanical Engineer, Design Services: Discussed bolt degradation in general and concurred with the NSRS findings.

Two Mechanical Engineers, Mechanical Maintenance Unit, WBN: Discussed DME technical position and impact on maintenance activities; also, discussed the scope of the problem at WBN and reviewed Westinghouse drawings relevant to the concern. Later discussions identified the procedures and tracking mechanisms used to implement the required corrective actions.

3.2.2 Material Adequacy

The subject concern questions the adequacy of both the bolting hardware and installation procedures used by the vendor, CBI, to mount CVCS holdup tanks A and B in unit 1 of the AB at WBN. The issue was determined to be limited in scope to the specified components and evaluated accordingly.

NSRS investigation report I-85-694-WBN was reviewed to determine if the concern was adequately addressed. The WBN-PMO response to the NSRS report was reviewed to determine if the recommendations for corrective action supported the the NSRS findings and for references to relevant documentation.

CBI documents including drawings 74-3743/4 F1, F2, and F3, received April 9, 1976; the contract file for contract

75K54-83115 issued in 1975; letters WBN 770127018, MEB770303119, and other pertinent correspondence were reviewed to determine the vendor's material specifications and installation instructions. WBN NCRs 3928R issued February 1, 1982, and 6596R1 issued March 27, 1986, document the lack of equipment installation QA records for several pieces of equipment including the subject tanks. These NCRs were reviewed to assess their impact on the resolution of the concern.

Numerous TVA personnel and a CBI representative were interviewed during the course of the investigation. The following personnel made a significant contribution to the conduct of the investigation:

Design Personnel

Civil Engineer, Civil Engineering Branch: Discussed the design requirements for concrete anchorages and the tensioning process.

Construction

Civil Engineer, Civil Engineering Unit: Assisted in the inspection of the subject bolts.

Power Operations

Two Mechanical Engineers, Nuclear Services Branch: Initiated NCR 6596 to generate QA documentation required for subject bolts. Referred evaluator to Modifications Unit for an explanation of the disposition of the NCR.

Two Mechanical Engineers, Modifications: Discussed disposition of NCR 6596 and explained why the subject tanks were excluded from the corrective actions taken to resolve the NCR.

Three Mechanical Engineers, Mechanical Maintenance: The unit supervisor and two engineers discussed the implications of a bolt turning during the tensioning process and the relative merits of retensioning the bolts.

CBI Personnel, Mechanical Engineer, Engineering Supervisor: Approved CBI drawings F1, F2, and F3 detailing the tensioning process. Discussed tensioning operations in theory and practice. Agreed to attempt to locate tensioning documentation in CBI archives.

The CBI contact was an engineering supervisor at the time of the tanks installation and was intimately involved in the technical administration of the contract and in particular, the tensioning of the subject holddown bolts. He approved the CBI drawings that detailed the holddown bolt tensioning procedure and was the signatory on letters from CBI to TVA providing revisions to the tensioning procedure based on experience gained from installing similar tanks. He brought considerable expertise on the subject of bolt tensioning in general and on the installation of WBN CVCS tanks in particular.

3.2.3 Inadequately Supported Flange

The concern expressed reservations about the adequacy of the support provided by only two bolts installed in a specific flanged connection in the BLN component cooling system. Informal memorandum^s sent between the BLN Assistant Quality Manager and the BLN Safety Engineer were reviewed to assess the management actions taken to address the issue. The BLN Assistant Steamfitter Superintendent was interviewed to determine if any unusual practices were evident in this concern and to facilitate examination of the subject flange.

4.0 FINDINGS

The findings and conclusions relevant to each of the three issues within the bolting subcategory are detailed below.

4.1 Material Compatibility

Based on the findings presented below, the concerns addressed in this issue were factual and a corrective action program was implemented on a "no delay to schedule basis." However, the issue was resolved to achieve increased reliability of the affected systems; the issue was not found to adversely affect the safety of the plant. It should also be noted that the use of carbon steel bolting in stainless steel bolted connections is an acceptable, reliable practice.

4.1.1 Generic Findings

The concerns cited were generic to WBN as stated by the concerned individuals (CIs). Furthermore, while a design deficiency was not explicitly identified in the concerns, a design deficiency was implied. Consequently, the objective of the investigation was to determine the applicable design requirements and then to ascertain whether they had been met.

During the investigation into the history of carbon steel corrosion problems, a review of the documentation associated with NRC Information Notice (IN) 80-27 was performed. IN 80-27 issued June 11, 1980 documents leakage of borated water from a reactor coolant pump which resulted in the corrosive boric acid wastage of carbon steel bolts. TVA's design personnel reviewed IN 80-27 and documented on an internal memorandum (NEB 810521264) dated May 21, 1981 that the problem was generic to SQN, WBN, and BLN.

TVA addressed the problem at SQN and reported the corrective actions to the NRC in a final report dated November 21, 1983 on IE Bulletin (IEB) 82-02 (A27831121008) since 82-02 addressed the same problem and required a response. WBN was also subsequently addressed and will be detailed in the following section. A review of the documentation on IN 80-27, IEB 82-02 and other documents did not identify any corrective actions undertaken for BLN nor were any individuals contacted aware of any proposed corrective actions.

4.1.2 Site Specific Findings

A detailed review of the NSRS Investigation Report (I-85-483-WBN) issued January 6, 1986 addressing these concerns for WBN revealed that it addressed directly the subject concerns with respect to TVA designed flanged connections and provided adequate documentation to verify the findings and conclusion.

A review of TVA General Construction Specification G-29H revealed that Process Specification 4.M.1.1, paragraph 3.1.7.4, addressed stainless steel flanges but did not directly apply to stainless steel valves. A review of BLN-NCR-59 issued June 28, 1977 revealed that it applied to an ASME Class III stainless steel drain tank cooler which had carbon steel bolting in closure connections. The disposition of the NCR was to "use-as-is" since the vendor had supplied the tank with the carbon steel bolting installed.

As stated in the NSRS Investigation Report, NRC-IE Bulletin 82-02 addressed a corrosion wastage problem with carbon steel bolting in systems where borated water was present. This subject was also addressed in NRC Information Notice 80-27. The correspondence referenced in section 3.2.1 applies directly to carbon steel bolting in stainless steel flanged piping, valve and pump flange connections.

The summary of this correspondence is that carbon steel bolt degradation was an identified/documented reliability problem in borated water systems. TVA based this determination on the extension of the "leak-before-break" design philosophy. TVA design engineers have participated in ad hoc industry task groups working on bolting problems reported at nuclear plants. Although the final report on these efforts have not yet been published, several papers reporting on the results of the program have been presented, most notably the paper "Improved Technology for Critical Bolting Applications" which was sponsored by the Metal Properties Council, Inc., the Electric Power Research Institute (EPRI), and the PVP Materials and Fabrication Committee, ASME. This paper was presented at the 1986 Pressure Vessels and Piping Conference and Exhibition, Chicago, Illinois, in July 1986.

The paper presented an overview of the EPRI "Generic Bolted Joint Integrity" project which identified outstanding bolting issues affecting nuclear power plants, one of which was general borated water corrosion. Some of the results currently available as a result of this program are: overall bolting failure and success rates, fracture mechanics (FM) assessment, generalized closure

integrity (leak-before-break) model, bolt up procedure guidelines, thread lubricants evaluation, and mechanical maintenance training tapes. One of the most significant of these contributions is the generalized joint integrity model which allows the accurate modeling of a bolted joint and incorporates the load shedding and redundancy inherent to bolted connections. The following excerpt from the reference paper details the basis upon which the application of the "leak-before-break" design philosophy has been extended to bolted joints.

"The philosophy behind the model is analogous with the leak-before-break philosophy used in FN evaluations of other pressure boundary components. The steps required to achieve the desired result, i.e., demonstrate that a degraded joint (due to wastage, cracking, etc.) has ample margin against catastrophic failure when the leakage from the joint reaches levels that have a very high probability of detection, to include: knowledge of the degree of load shedding to adjacent fasteners due to fastener degradation, knowledge of the joint opening profile accounting for gasket spring back and flange distortion, realistic calculation of leak rates through the degraded joints, margin demonstration in load carrying capability of degraded joint and margin definition."

The paper concludes that joint integrity, assuming adequate joint design, is a function of station maintenance activities. Specific recommendations including critical joint identification, leak detection criteria, and nondestructive examination (NDE) guidelines are being developed for industry use as well as training aids to enhance the transfer of technology developed by the project.

TVA has been involved in the EPRI program from its inception, and this experience is reflected in the design guidance included in the TVA internal memorandums listed in section 3.2.1.

As a result, corrective action has been initiated to replace on a "no delay to schedule basis" carbon steel bolting in TVA designed flanged connections during routine surveillance/repair/maintenance

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activities. To this end, ECN 3522 was written on September 14, 1982 to add bolt replacement criteria to the TVA mechanical bills of material (B/Ms). However, in memorandum B45 860113 268 issued January 13, 1986 it was noted that considerable confusion had resulted in the original B/W changes in accordance with ECN 3522, so another ECN (6004) was initiated on January 31, 1986 to clarify the wording and give more specific bolting substitution guidelines. It should be noted that in Class B and C systems, the SA 193 GR B7 carbon steel bolting was to be replaced with specific stainless steel bolting material. However, if the replacement bolting was not immediately available, the SA 193 GR B7 carbon steel bolting could be substituted. This substitution is also addressed in the aforementioned NSRS report.

A review of the 47 B/W series of drawings for various piping systems and components revealed the following:

1. For Class A systems, in all cases, SA 453 GR 660 bolting material is specified for stainless steel flanged connections.
2. For Class B systems, the note initiated per ECN 6004 allowed substitution of SA 193 GR B7 (carbon steel) for SA 564 Type 630 (stainless) if the latter was not readily available. The stainless bolting was to be installed on a "no delay to schedule basis" as a replacement when it became available.
3. For Class C systems, if SA 193 GR B7 was installed, it was to be replaced as detailed above also.

An Employee Concerns Task Group (ECTG) review of vendor valve drawings (Westinghouse) for Class A systems check, globe, and gate valves was conducted. Of 18 separate drawings reviewed at random, no Class A valves were found to be furnished with carbon steel bolting. Also a review of approximately 20 Class B check, gate and globe valve drawings was conducted with the same result - no carbon steel bolting was furnished for the flanged body-to-bonnet connection. In addition, a Westinghouse valve specialist located onsite corroborated the results of the drawing review.

However, the results of this review do not constitute a conclusive basis on which to say that no Class A, B, or C stainless steel valves used on borated water systems were supplied with carbon steel studs. In addition, other vendor supplied components such as flanged pump casings, manway closure studs and heat exchanger connections could also be affected. The ECTG review revealed no evidence of a systematic evaluation of vendor supplied and qualified components to determine if carbon steel studs were used in any components that are part of a borated water system pressure boundary. This could be a significant omission since the Literature Survey of Carbon and Alloy Steel Fastener Corrosion in PWR Plants compiled and issued by Combustion Engineering, Inc. (CE) in April, 1983 for the EPRI Research Project 2058-7 identified 28 boric acid corrosion events (out of 43 total events documented before 1983) that involved vendor supplied components.

In addition, one of the SQN responses to the NRC on IEB 82-02 issued August 2, 1982 (A27820802 028) which tabulated the results of a maintenance review of bolted closures identified boric acid crystallization on a reactor coolant pump flange and four isolation valves. Four bonnet studs were replaced on one valve (1-FCV-62-70). This indicates that vendor supplied components are potentially subject to boric acid corrosive wastage. Consequently, there is no apparent basis on which to exclude vendor supplied and qualified components from a bolt replacement program.

Cognizant personnel in CONST-MEU were interviewed. They had no knowledge of a scheduled bolt change out involving stainless steel valves. They indicated that had it been a construction activity, they would have initiated the applicable paperwork to document/control the work performed. A cognizant Nuclear Services Branch (NSB) supervisor who was interviewed also had no knowledge of a bolt change out in stainless valves.

The cognizant individual in Mechanical Maintenance Section was interviewed. He was not aware of a scheduled bolt change out, but indicated that it was possible for a bolt change to have taken place per DNE's carbon steel bolt replacement recommendations. He verified the findings of the aforementioned NSRS report and indicated that the scope of the memorandum B45 860113 268 issued January 13, 1986, was applicable to stainless flanged connections as addressed in the NSRS report and stainless steel valve connections.

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Follow-up interviews with Mechanical Maintenance Section (MMS) personnel determined that a section procedure, Maintenance Section Letter (MSL) 3.1, was issued addressing the bolt change out to be performed on TVA designed bolted closures during maintenance activities. However, it should be noted that MSL 3.1 specifically excludes vendor components from the bolt replacement program. To implement the bolt change out, MMS also has documented action items AILMM0201, AILMM0094, and AILMM0203 that will be entered on the Tracking and Reporting of Open Items (TROI) tracking system to revise the appropriate maintenance instructions and requests. The TROI system is utilized by the Office of Nuclear Power to document and track outstanding work items and the action items that must be completed to close the lead item. The file record for each item identifies the scheduled closure date for each item and the organization and the supervisor responsible for implementing the actions necessary to close the item. These actions were the basis on which the NRC closed IE Bulletin 82-02 for WBN in Inspection Report 50-390/85-03 and 50-391/85-C3 paragraph 13.c.

The cognizant DNE individual who was the author of memorandum B45860113268 was interviewed. He indicated that the DNE intent of the memorandum was to include the valve body-to-bonnet bolted connection with respect to carbon steel bolting replacement. Their interpretation of the valve body-to-bonnet connection was that it was also a flanged connection. He also provided (informally) documentation with respect to DNE's position on carbon steel bolting used in stainless steel flanges and valves.

The cognizant site Design Services representative was interviewed. He concurred with the statement by DNE that the valve body-to-bonnet connection was, in fact, a flanged connection and therefore, requires carbon steel bolting replacement. He also indicated that it was reasonable to assume that the bolt replacement addressed by the subject concern on stainless valves was a result of DNE's carbon steel bolting replacement recommendations.

In addition to the bolt replacement activities, memorandum NEB81052164 issued May 21, 1981 outlined additional actions that should be implemented to maintain the design integrity of the affected vendor qualified components if any valve studs are replaced. The memorandum indicated that vendors of affected equipment "shall be notified of the proposed change to permit reconciliation of the affected stress reports with the new material and its design stress intensity and allowable stress values. New calculations may be required, and recertification of stress or

design reports by registered PE's, and review of the changes by the owner or his designee are also required to preserve the code-assigned responsibilities. EN DES will prepare a list of equipment requiring material replacement and will proceed to secure vendor approval for the changes." However, the investigation revealed no evidence of valve body-to-bonnet stud replacement at WBN; consequently, these actions have not been required to date.

Conclusion:

In view of these findings the following conclusions are offered:

1. There is evidence to support the possibility that carbon steel bolting could have been replaced with stainless steel bolting in TVA designed flanged connections intended for borated water service, including bolted valve connections. It is conceivable that the CI witnessed valve bolt change-out in accordance with this criteria and it is also conceivable that the change-out was halted before completion because:
 - (a) All available replacement bolting material had been used - no more was readily available.
 - (b) Since the bolting replacement was on a "no delay to schedule basis," more critical work may have required completion and therefore, caused the bolt change-out to be halted for an indeterminate period of time.

2. A partial review of valve drawings and B/Ms revealed no Class A systems where valves were furnished with carbon steel bolting and in class B and C systems, the use of carbon steel SA 193 GR B7 bolting is acceptable and will only be replaced in borated water pressure boundary systems to increase system reliability. According to the revised notes in the B/M the SA 193 GR B7 carbon steel bolting is even considered an acceptable substitute for the replacement stainless bolting until the latter can be installed in the class B and C systems.

The statement by the CI may well be a true statement with respect to carbon steel bolting used to install stainless steel valves and they may also have witnessed a bolt change-out in the subject valves' connections. However, based on the findings of this evaluation, the concern has not identified a condition adverse to quality. As stated previously, the use of carbon steel bolting in stainless steel bolted connections is an acceptable practice. Even in borated water systems, carbon steel bolting has been proven reliable unless joint leakage occurs. Also, this evaluation is in agreement with the findings of the NSRS report I-85-483-WBN.

Nevertheless, it should be noted that the safety significance of this issue is mitigated by the application of the leak-before-break (LBB) design philosophy. The use of LBB is justified by reference to the work performed by the AIF Bolting Task Force which assumed a comprehensive preventative maintenance program. Identification of critical connections, including vendor qualified connections, is an essential component of that problem and TVA has failed to incorporate a systematic review of vendor qualified components into its corrective actions directed at this problem.

4.2 Material Adequacy

Based on the findings presented below, the concerns addressed in this issue were not factual. However, a related deficiency involving missing QA documentation was identified that will require resolution.

A paraphrase of the concern follows:

The nuts used to bolt down the CVCS tanks A and B may be inadequate and there may be insufficient contact between the bracket and plates. Also, during tightening of the nuts, a bolt turned due to the nut being too tight.

4.2.1 Generic Findings

No specific generic implications were evident in the stated concern beyond the holddown bolts and installation procedures used on the subject tanks. In addition, the procurement contract on which the tanks and installation services were purchased was limited in scope to the subject tanks. Consequently, the concern was determined to be limited in scope to the subject tank hold-down bolts.

4.2.2 Site Specific Findings

The cited concern was previously investigated by NSRS and their findings were documented in NSRS report I-85-694-WBN. The ECTG investigator reviewed the report and found that it had addressed the subject concern adequately. The report also determined the subject tanks to be the CVCS holdup tanks A and B in unit 1 of the AB. The NSRS report addressed the concern in two parts since the concern was expressed by the CI in two basic parts. Part one dealt with the adequacy of the holddown hardware and this was evaluated by performing an inspection of the bolting installed. This revealed proper vendor identification marking on the bolting hardware as described in the vendor records package. Part two addressed the tensioning/tightening of the holddown bolts and the NSRS report recommended retensioning because no documentation could be found that would verify proper tensioning of the holddown bolts by the vendor.

The WBN-PMO response to the NSRS recommendations provided references to documentation relevant to the tensioning procedure, NCR 3928R which was initiated to identify the lack of documentation on the vendor tensioning operation, and the current procedure for Inspection documentation. However, it did not provide sufficient justification for not retensioning the holddown bolts nor did it offer alternatives to a complete retensioning operation. It also provided assumptions rather than evidence with respect to site procedure compliance and the vendor QA program which would have governed proper application of the bolt tensioning procedure.

Mechanical drawings (47W555 series) were reviewed to determine if any information related to the bolt tensioning/holddown hardware was included, but none was found.

CBI vendor drawings (74-3743/74-3744 series) were reviewed, which contained information/criteria relevant to the tanks. Sheets F1 through F3 of the series detailed the holddown hardware and complete bolt tensioning procedure.

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A comprehensive search of TVA records was made for documented evidence of proper bolt tensioning performance by the vendor. Some relevant information was found in the correspondence initiated as a result of the TVA contract with CBI, to wit: Memorandum WBN 770121 018 dated January 21, 1977 referenced in WBN-PMO response addressed contract completion and Memorandum MEB 770303 119 dated March 3, 1977 from MEB to H. C. Loy, Purchasing Agent, documented all technical data requirements covering the CBI contract as having been met. In addition, TVA weekly Surveillance Report 26 filed May 12, 1976, on the CVCS holdup tank erection was located which documented the completion of "torquing (sic) activities" on the subject tanks. This document was generated in compliance with WBNP-QCP-4.11 and is essentially a checklist of activities performed by CBI during the week ending May 7, 1976. However, no quantitative acceptance criteria or holdpoints pertinent to the tensioning process were included. Therefore, it was determined that no QA documentation was readily available in TVA's archives which would clearly establish procedure compliance by CBI on the bolt tensioning process. At this point, other methodology was employed to answer the subject concern.

NCR 3928R was initiated in 1982 to document the fact that no inspection documentation existed for several pieces of mechanical equipment, including the CVCS Tanks. Reinspection documentation was generated according to the disposition of NCR 3928R but the documentation did not adequately reflect the equipment evaluation/reinspection. It was subsequently discovered that NCR 6596 revision 1 had been initiated by CONST-NSB and dispositioned by DNP-Modifications to satisfy the recommendations made in the NSRS investigation report with respect to the reinspection evaluation referenced in NCR 3928R. The disposition of NCR 6596 established a correction method which required retorquing/retightening of bolt studs on the aforementioned mechanical equipment. However, the CVCS Holdup Tanks were excluded from this action because the tensioning/torquing of the holddown bolts for the subject tanks was accomplished by CBI while the other mechanical equipment bolts were tightened by TVA personnel.

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A documented conversation however, between DNP-Mechanical Maintenance Engineering Supervisor and CBI Engineering Coordinator revealed that in their opinion no further action would be required on the holddown bolts for the subject tanks. It further revealed that the "turning of an anchor bolt" presented no problem with respect to the holddown bolts being properly tensioned. The informal documentation provided by the DNP-Mechanical Maintenance Engineering Supervisor corroborates the statements made by the vendor.

Interviewed cognizant personnel in CONST-NSB who provided comments that indicated their agreement with the content of NSRS Investigation Report I-85-694-WBN. Reference to NCR 6596 was made but NSB was not aware the CVCS tanks were excluded in the disposition.

Interviewed the individual responsible for disposition of NCR 6596 in DNP-Modifications who provided reasoning for exclusion of CVCS Tanks from the disposition of the NCR.

Interviewed responsible personnel in DNP-Mechanical Maintenance who indicated their willingness to contact the vendor in an attempt to obtain documentation concerning those parameters of the bolt tensioning process not addressed in the bolt tensioning procedure. Specific information was requested to establish whether the statement in the concern "the bolt turned while tightening because the nut was too tight" is, in fact, a condition that would render the tensioning process unacceptable. The responsible DNP-Mechanical Maintenance Engineering Supervisor telephoned CBI's Engineering Coordinator who indicated that the turning of the holddown bolts would not create a condition that would cause the tensioning procedure to be unacceptable. The final comment made was that "the CBI observation represented an acceptable condition."

Follow-up contacts with CBI resulted in the submission of a package of documents (B44861016500) from CBI's archives and a letter explaining the QA records requirements that CBI conformed to during the fabrication and erection of the CVCS holdup tanks. The documents submitted indicate that CBI did not require " a documentation sign-off that specifically covers the tensioning instructions on Drawing F-3." Calibration records of

the tensioning device used on the holddown bolts were included as well as ASME Code data package excerpts that include the signature of CBI QA auditors and Authorized Nuclear Inspectors certifying that the fabrication and erection of the tanks met all ASME code requirements.

Interviewed the Acting Supervisor, DNP-Mechanical Maintenance Engineering who indicated his complete agreement with the comments offered by the vendor. He explained that a bolt turning was not anticipated because of the double nut arrangement on the embedded end of the bolt assembly and the tensioning process did not require the bolt to be turned to accomplish the required preload. He further explained that the bolt assembly was, in fact, free to turn and could have turned prior to tensioning or during the torquing process but not during tensioning. His conclusion was that the tensioning process would not be affected by the turning of the holddown bolts.

Visual inspection of the subject tanks revealed sufficient contact between each nut and the tank rib or bracket. The statement by the CI that there was not sufficient contact between the "plates and bracket" was ambiguous since a plate to bracket installation does not exist. This inspection also revealed that the bolts adjacent to the manhole which were torqued instead of tensioned could not be suspect of turning because the location of the suspect bolts specified by the CI varied considerably from the location of the bolts torqued.

Consideration was given to selecting a random sample of a specific number of bolts on each tank for retensioning or, as a minimum, retorquing as detailed in the CBI procedure (drawing F-3) to verify the original tensioning/torquing process. However, conversation with site CQC personnel, Mechanical Maintenance and CBI personnel revealed:

- a. A certain degree of bolt relaxation would have occurred since the original tensioning/torquing process was performed. Therefore, retensioning/retorquing to the original values would not serve as evidence that the process was done correctly. The installed tension/torque values for each bolt today are considerably less than the installed tension/torque values applied in 1976 because of this relaxation of the bolts.

- b. The tensioning/torquing process required by CBI in the procedure detailed on drawing F-3, employs a sequence methodology.

To summarize, it is not possible to tension/torque only a certain number of bolts. When one bolt is retensioned all remaining bolts would require retensioning. Consequently, none of the holddown bolts have been tested to determine the preload on the bolts.

NCR 6596 was initiated to satisfy the recommendations made in the NSRS investigation report with respect to mechanical equipment having inadequate documentation and, therefore, requiring retightening/retorquing. The CVCS Holdup Tanks were excluded from the disposition of NCR 6596 because they were vendor fabricated, installed and inspected. While the readily available documentation is inadequate, as addressed in the NSRS report, it was not feasible for TVA personnel to adequately document a tensioning process performed by CBI ten years after completion. The correspondence reviewed shows that TVA accepted whatever technical data was offered by CBI upon completion of the work and the fact that the contract was subsequently closed is not without merit. This does not provide acceptable documentation for a nuclear construction process, but does infer that the process was performed in a manner acceptable to TVA.

The NSRS report sufficiently answered the subject concern with respect to adequate bolting being used, so it was determined that further evaluation was not required in this area. Visual inspection of the subject bolts revealed sufficient contact between each nut and the tank rib/bracket. The information obtained from the aforementioned vendor representative and the Mechanical Maintenance Supervisor revealed that the turning of a bolt(s) was not possible during the tensioning process but was possible prior to the tensioning or during the torquing process. At this point however, each individual stated that the turning of a bolt(s) did not affect the tensioning process or the preloading of the holddown bolts. No detailed evaluation was performed on those bolts torqued instead of tensioned because the location of the subject bolts given in the NSRS report precluded the bolts adjacent to the manhole as being those addressed by the CI.

4.3 Inadequately Supported Flange

Based on the findings presented below, the concern was factual, but was an industrial safety issue only. The concern was stated as follows: A-13 between R and S line. Flange has 2 bolts. Two bolts won't support flange.

4.3.1 Generic Finding

The stated concern had no generic implications.

4.3.2 Site Specific Finding

The subject of the concern was a 24-inch diameter component cooling (KC) spool piece located at 10 feet N (A12) and 3 feet W (S) on elevation 640. The spool piece had been temporarily positioned using temporary supports and 2 bolts installed in the flange. Shortly after this stage of the installation was reached, a reduction-in-force occurred at the site. The concern was identified in the same time period.

Division of Nuclear Construction (DNC) management evaluated the concern and referred it to the BLN safety engineer for evaluation on October 14, 1985.

When the safety engineer inspected the subject spool piece, eight additional bolts had been placed in the flange in the normal course of construction activities. The safety engineer concluded that no unsafe condition existed and no further action was required.

DNC management was informed of the safety engineer's conclusions, October 14, 1985, and the CI informed thereafter.

No further action was required.

5.0 COLLECTIVE SIGNIFICANCE

5.1 Significance of Each Issue

5.1.1 Material Compatibility

The concern was verified to be true. The significance of the issue was mitigated however, by the existence of a Watts Bar program dedicated to the replacement of carbon steel bolts in TVA designed flanged connections in borated water systems on a "no impact to schedule" basis. The priority given this program was based on an engineering evaluation of the safety significance of the corrosion of carbon steel bolts exposed to borated water sources. The result of this evaluation was that the "leak-before-break" philosophy accepted by NRC justified the replacement of the carbon steel bolts on a normal maintenance schedule. With the exception of this specified usage, carbon steel bolting is acceptable for use in stainless steel bolted connections. The potential for joint leakage, caused by improper or inadequate joint assembly, is the only factor which impacts the reliability of carbon steel bolting in borated water systems.

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The fact that it took almost six years to address this issue for WBN and SQN and has yet to be addressed for BLN indicates that management effectiveness in dealing with this issue leaves something to be desired. The failure to document a credible reason to exclude vendor qualified components from the bolt replacement program in light of design recommendations to the contrary also raises questions about management effectiveness.

5.1.2 Material Adequacy

Of the three problems expressed in this concern, two problems were found to be not factual. The nuts used on the holddown bolts conformed to the approved design specifications provided by the vendor and sufficient contact between bearing members was found on all holddown bolt assemblies. The third problem could not be conclusively addressed since the problem involved a transitory phenomena, e.g. the turning of a bolt during the tightening of a nut. Visual inspection of the holddown assemblies would yield no useful information. This problem required either QA documentation of an acceptable installation or retensioning to generate such documentation. Such documentation was not readily accessible; therefore, further evaluation and, possibly, corrective actions will be required.

Therefore, the unresolved questions associated with this concern have immediate significance with regard to the "as-constructed" adequacy of the subject tanks; additionally, the lack of readily available QA documentation may require evaluation of QA record generating and record keeping requirements and procedures. It should be noted however, that the activities in question were performed ten years ago which was very early in the life of the construction project. Since that time, both as a result of experience gained within TVA and in the industry in general, QA records requirements and practices have evolved far past the standard practices in force at that time. Therefore, the significance of this issue may be diminished in light of current practices.

5.1.3 Inadequately Supported Flange

The concern in question was limited to a single example of a questionably supported spool piece. The issue was determined to be an industrial safety issue that was ultimately addressed within the course of normal construction activities. Therefore, there was no significance to this issue.

5.2 Collective Significance of the Subcategory

5.2.1 Generic Significance

There is no discernable generic significance of the three issues in the bolting subcategory when they are considered collectively. The small number of issues involved and the lack of any common problems of significance are indicative of at least an acceptable level of quality in bolting applications at TVA's nuclear plants. This conclusion is further supported by the fact that no concerns in this subcategory were identified by SQN or BFN personnel. Consequently, the bolting subcategory does not have collective generic significance.

5.2.2 Site Specific

No site specific issues beyond those included in the individual concerns were identified. There were no bolting concerns identified at BFN or SQN and only one non-significant concern identified at BLN. The two WBN issues, contained no common elements. Therefore, site-specific collective significance could not be established.

6.0 CAUSE

6.1 Material Compatibility

Although no safety-related CAQ was identified in this issue, a few comments on the management effectiveness in dealing with this issue would seem to be warranted. First, the documents that form the historical record of the handling of this issue seem to reflect a division of management responsibility and authority between design, construction and operations organizations that does not promote cooperation among the parties involved. This situation may have lengthened the time required to evaluate and disposition the concern and the inconsistent implementation of the corrective actions. Second, there appears to be no convenient way for technically oriented personnel in different organizations to communicate on complex technical issues and reach a consensus on a solution both adequate and acceptable to all. (CATD 10603-NPS-01)

Since these problems are interdisciplinary and interdivisional in nature, the corporate ONP is the appropriate organization to address the issue.

The ONP corporate response to this finding is as follows:

The following excerpt from Section IV of the NPP Volume 1 addresses the problem description.

Conclusions

TVA has restructured its organization to consolidate all responsibility for its nuclear activities within a single organization headed by the Manager of Nuclear Power. TVA has also established functional nuclear divisions and staff departments which have the responsibility and authority for providing

technical direction for and assuring the technical adequacy of all TVA nuclear activities within the respective functions, including site activities. As a result, TVA has taken action which provides assurance that lines of responsibility and authority for nuclear activities are clear, that the necessary coordination and communication among nuclear organizations occurs, and that TVA's nuclear activities are subject to centralized management direction and control.

6.2 Material Adequacy

The material adequacy issue explicitly identified in the employee concern was not factual and therefore no proximate or root cause analysis was required. The missing holddown bolt installation documentation cited in the NSRS investigation report is a problem that will require further assessment and corrective actions. The proximate cause of this problem was that TVA did not specify in CBI's contract that CBI provide QA documentation on the installation process to TVA. Whether or not this currently represents a programmatic weakness is a question that should be evaluated and dispositioned by the Division of Nuclear Quality Assurance (DNQA). (CATD 10604-NPS-01)

DNQAs response to this finding is as follows:

Programmatically, DNQA will recommend, but not provide, a specific corrective action solution to a potential generic problem such as missing or unavailable documentatica. Evaluation must be performed on a case by case basis. The assessment of each situation should take into consideration such factors as the item or component's importance to safety and whether the documentation is required for system compliance.

To determine the effectiveness of TVA's current program relating to quality requirements for vendor services, the Nuclear Quality Assurance Manual (NQAM) and the Nuclear Engineering Procedures (NEP) were examined. The current program is described in the following manual sections and procedures.

- (1) NQAM, Part I, Section 2.4 Procurement Document Control
- (2) NEP-4.1 Procurement
- (3) NQAM, Part III, Section 2.1 Procurement of Materials, Spare Parts, and Services

NQAM, Part I, Section 2.4 indirectly implies that for design and construction, NEP-4.1 will apply and for operation phase activities, NQAM Part III, Section 2.1 will apply.

NQAM, Part III, Section 2.1, paragraph 4.3.2.8 addresses documentation requirements and part C of Appendix C provides a detailed checklist.

NEP-4.1, Attachment 9, paragraph 5-10, 8.1a, Attachment 11 and Attachment 12 address documentation requirements. However, DNE's program is not as clear and detailed as that of INQA's. To reduce the possibility of recurrence, NEP-4.1 should be evaluated regarding clarity and detail concerning documentation requirements.

6.3 Inadequately Supported Flange

This concern was factual but not a problem; therefore, no cause analysis was required.

7.0 CORRECTIVE ACTIONS

7.1 Material Compatibility

TVA has initiated a bolt replacement program for the replacement of carbon steel bolts on stainless steel flanges used on borated water systems at WBN and SQN. Inadequate or improper joint assembly can cause leakage which results in corrosive wastage of carbon steel bolting. Although this problem may also exist at BLN, no program exists as yet to change out carbon steel bolts used in a similar application at BLN. The existing programs at SQN and WBN should be evaluated to determine if vendor qualified components should be included in the program. The AIF bolting task force recommendations for improvements in bolted closure maintenance should be reviewed for incorporation into each affected plant's preventive maintenance program. Review of the ECTG findings on this issue resulted in the identification of additional corrective actions by various project organizations. The corrective actions specified by line organizations for each project are presented below.

SQN

Due to investigations associated with SQN Employee Concerns Task Group Element Report 106.03 SQN R1, it has been determined that a problem exists concerning the use of carbon steel bolting material in borated water systems flanged connections. The use of carbon or low alloy steel bolting material is a concern due to the potential of material susceptibility to corrosion wastage from leaking boric acid. SQN ECN L-5691 was written to address replacement of bolting material in borated water systems flanged connections, but specifically excluded flange bolting supplied by vendors on valves, pumps, and other equipment. This exclusion is contrary to DNE technical position memorandum B45 860113 268 and the documented scope of the AIF/MPC industry program on bolting wastage problems. Additionally, the SQN responses to IEB 82-02 did not indicate that

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all vendor qualified components in borated water service were reviewed to determine if carbon steel bolts were used in flanged connections, nor was there any evidence to suggest that SQN's maintenance program would be revised to incorporate the AIF/MPC bolting program recommendations.

Consequently, SQN will develop a program for implementation of the AIF/MPC bolting program recommendations. The program will include a review of vendor supplied bolted closures and flanged connections to ensure that all critical connections are identified and included in the bolting replacement program, as applicable (CATDs 10603-SQN-01,02).

WBN

Problem Identification Report (PIR) SQN NEB 8723 was initiated to address this concern at Sequoyah. This PIR was determined to be generically applicable to Watts Bar (WBN) and a potential generic condition evaluation has been initiated for WBN. The purpose of this PIR is to address the exclusion of vendor components from the bolt replacement program. A review of vendor designed and qualified pressure retaining bolted connections in borated water service (Class 1, 2, and 3) including those for valve body-to-bonnet flanges, will be performed by NEB-CSM to identify those connections. An evaluation will be performed to determine those connections where replacement of low alloy steel bolts is appropriate. An ECN will then be initiated to control the replacement of vendor supplied low alloy bolts, including review of the vendor stress analysis and revision of code data sheets, if needed. Approved changes on Unit 1 will be incorporated by the Mechanical Maintenance Section (MMS) into the WBN vendor bolt replacement program. MMS will maintain the status of vendor bolt replacements to ensure that all authorized changes to low alloy steel bolts in borated water service are replaced on a "no delay to schedule basis". Approved changes on Unit 2 will be incorporated by DNC for replacement of low alloy steel bolts on a "no delay to schedule basis" prior to system transfer. Any Unit 2 vendor bolts not replaced at the time of system transfer are to be tracked under the OWIL list, and added to the MMS bolt replacement program for tracking until replacement.

Maintenance Section Letter (MSL) 3.1 will be revised to include the approved changes in vendor designed and qualified components in the WBN bolt replacement program as ECNs are issued identifying vendor joints to be changed.

In addition, the ASME Paper "MPC-Vol.26", "Improved Technology for Critical Bolting Applications" will be jointly reviewed by DNE-OES and WBN Mechanical Maintenance for application to bolted, flanged, pressure boundary joints for TVA Piping Classes A, B, C, and D. This review will be completed by July 30, 1987. Any improvements identified by this joint review will be incorporated in the appropriate Maintenance Instructions or Plant Procedures by January 1, 1988. (CATDs 10603-WBN-01, 02)

BLN

BLN's proposed corrective action will be to systematically identify and prioritize all affected TVA designed and vendor supplied bolted closures (i.e., those with carbon steel bolting used in borated water systems). Guidelines for critical joint identification developed by AIF/MPC bolting task force will be used for the identification process and closure priority ranking. It is anticipated that criteria such as code class, size, function, etc., will establish the ranking procedure. Once the ranking process has been completed, DNE will recommend either material replacement or augmented in-service inspection procedure alternatives based on closure priority ranking and utility operating experience. DNE will either develop an inspection program based on the bolting task force guidelines and industry experience, or write an ECN for bolting material replacement, as applicable.

As recommendations become available from the AIF/MPC bolting task force, site mechanical maintenance procedures and practices will be reviewed to determine if deficiencies or inconsistencies exist between task force guidelines and plant policies. Task force recommendations should include criteria for critical joint identification, leak detection criteria, NDE guidelines, training aids, etc. Bolting task force guidelines identified as not included in present site maintenance policies should subsequently be incorporated into appropriate procedures. Training modules for maintenance/craft personnel, ISI and QA inspections, and engineering procurement and receipt inspection should be developed.

Also, experience gained by addressing this concern at SQN and WBN and related industry experience will be applied by BLN. (CATD 10603-BLN-01, 02)

7.2 Material Adequacy

The only outstanding question remaining on this concern is the lack of QA installation documentation on the holddown bolt tensioning process. The generation of NCR 6596 underscores the fact that this documentation is required for the Life of Plant (LOP) records. The disposition of NCR 6596 does not satisfactorily explain why the CVCS holdup tanks should be excluded from the requirement to produce such documentation; therefore, the lack of holddown bolt tensioning documentation should either be justified or the documentation produced. (CATD 10604-WBN-01)

Upon review of the ECTG findings, WBN QA managers concluded that no corrective actions are required. They reasoned that TVA's policy has been to accept items built and/or installed by vendors with approved QA programs. It has not been required that TVA personnel reverify items which fall under an approved vendor QA program. This is the reasoning behind the closing of NCR 6596 R1 even though the CVCS tanks were omitted. To resolve this concern, maintenance request (MR) 574906 was written to have the torque (tensioning) of the holddown bolts on the CVCS tanks checked and evaluated.

7.3 Inadequately Supported Flange

The concern was factual but not a problem; therefore, no corrective actions were required.

8.0 ATTACHMENTS

8.1 Attachment A, "Subcategory Summary Table and List of Concerns"

8.2 Attachment B, "Improved Technology for Critical Bolting Applications"

8.3 Attachment C, "List of Concerns by Issue"

ATTACHMENT A

REFERENCE - ECPS131J-ECPS131C
 FREQUENCY - REQUEST
 OWP - ISSS - RWH

TENNESSEE VALLEY AUTHORITY
 OFFICE OF NUCLEAR POWER
 EMPLOYEE CONCERN PROGRAM SYSTEM (ECPS)
 LIST OF EMPLOYEE CONCERN INFORMATION

PAGE - 1
 RUN TIME - 12:23:58
 RUN DATE - 10/21/86

CATEGORY: CO CONSTRUCTION-PROCESS SUBCATEGORY: 151 DAMAGE

CONCERN NUMBER	CAT	SUB CAT	PLT LOC	GENERIC			QTC/NSRS INVESTIGATION REPORT	P S R	CONCERN DESCRIPTION	REFERENCE SECTION # CATEGORY - CO SUBCATEGORY - 151
				B	B	S				
IN-85-021-X04 T50052	CO	106	WBN	N	Y	Y	Y	NO	WBNP UNIT #1, STAINLESS STEEL VALVES (CHECK, GLOBE AND GATE VALVES; DIFFERENT SIZES: 2"0 AND UP) HAVE STUD BOLTS & NUTS SHOULD BE STAINLESS STEEL. IN 1983 AND 1984, STEAMFITTERS STARTED TO CHANGE OUT THESE CARBON STEEL STUDS & NUTS, THE CHANGE OUT WAS STOPPED IN 1984 BEFORE ALL THE VALVES WERE COMPLETED. VALVES WITH CARBON STEEL STUDS & NUTS ARE NOW INSULATED. LOCATION: REACTOR BUILDING, (ACCUMULATOR ROOMS) AND AUX. BUILDING UNIT 1. CI COULD NOT RECALL SYSTEM OR VALVE NUMBERS.	3.2.1, 4.1.1, 4.1.2
IN-85-824-001 T50071	CO	106	WBN	N	Y	Y	Y	NO	UNIT 1, "ALL OVER" - STAINLESS STEEL VALVES INSTALLED WITH CARBON STEEL STUDS THAT HAVE SINCE BEEN COVERED OVER WITH INSULATION. NO ADDITIONAL INFORMATION AVAILABLE.	3.2.1, 4.1.1, 4.1.2

CONCERNS ARE GROUPED BY FIRST 3 DIGITS OF SUBCATEGORY NUMBER.

1946T

ATTACHMENT A

REFERENCE - ECPS131J-ECPS131C
 FREQUENCY - REQUEST
 OWP - ISSS - RWM

TENNESSEE VALLEY AUTHORITY
 OFFICE OF NUCLEAR POWER
 EMPLOYEE CONCERN PROGRAM SYSTEM (ECPS)
 LIST OF EMPLOYEE CONCERN INFORMATION

PAGE - 2
 RUN TIME - 12:23:58
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CATEGORY: CO CONSTRUCTION-PROCESS SUBCATEGORY: 151 DAMAGE

CONCERN NUMBER	CAT	SUB CAT	PLT LOC	GENERIC			QTC/NSRS INVESTIGATION REPORT	P S R	CONCERN DESCRIPTION	REFERENCE SECTION # CATEGORY - CO SUBCATEGORY - 151
				B	S	W				
IN-86-183-001 T50129	CO	106	WBN	N	Y	Y	I-85-483-WBN	NO	CARBON STEEL BOLTS ARE INSTALLED IN STAINLESS STEEL FLANGED CONNECTIONS. AN EXAMPLE OF THIS CAN BE FOUND IN UNIT 2 IN THE AUX. BUILDING ELEVATION 713' NEAR 13 & 14 AND U. GO ABOUT 10' TO THE NORTH DOWN HALL TO A ROOM ON THE LEFT. AN EXAMPLE IS ABOUT 3' OFF THE FLOOR ON SOME 6" PIPE. IT EXISTS ALL OVER THE PLANT. CI HAS NO ADDITIONAL INFORMATION. CONST. DEPT CONCERN.	3.2.1, 4.1.1, 4.1.2
PH-85-042-001 T50165	CO	106	WBN	N	N	N	I-85-694-WBN	NO	C/I HAS A CONCERN THAT THE NUTS USED TO BOLT DOWN THE BORATED WATER TANKS MAY BE INADEQUATE AND THERE MAY NOT BE A SUFFICIENT CONTACT BETWEEN THE PLATES AND BRACKET. ALSO, WHILE TIGHTENING THESE NUTS, A BOLT TURNED, BECAUSE THE NUT WAS TOO TIGHT. CONST. DEPT. CONCERN. C/I HAS NO FURTHER INFORMATION.	3.2.2, 4.2.1, 4.2.2
QCP10.35-8-22	CO	106	BLN	N	N	N		NO	A-13 BETWEEN R & S LINE. FLANGE HAS 2 BOLTS. 2 BOLTS WON'T SUPPORT FLANGE.	3.2.3, 4.3.1, 4.3.2

5 CONCERNS FOR CATEGORY CO SUBCATEGORY 106

CONCERNS ARE GROUPED BY FIRST 3 DIGITS OF SUBCATEGORY NUMBER.