TVA EMPLOYEE CONCERNS
SPECIAL PROGRAM

REPORT NUMBER: 17300

REPORT TYPE: Subcategory - Construction (Final Report)

REVISION NUMBER: 1

TITLE: Instrument Line Installation As Related To Construction

REASON FOR REVISION:
Incorporate line management responses to CATDs, make editorial changes, and finalize report

Revision 1

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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.

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.

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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)

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

Outline of Contents (cont'd.)

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EXECUTIVE SUMMARY

CONSTRUCTION CATEGORY

SUBCATEGORY REPORT 17300 INSTRUMENT LINE INSTALLATION

SUMMARY OF ISSUES

This subcategory report examined four areas of instrument line installation, e.g. (1) Slope, (2) Compression Fittings, (3) clamps, and (4) bending. All four issues are classified as being safety-related.

MAJOR FINDINGS

Three TVA power plants, Watts Bar Nuclear Plant (WBN), Sequoyah Nuclear Plant (SQN), and Browns Ferry Nuclear Plant (BFN) had instrument sensing lines installed which deviated from the minimum slope criteria as specified by the Division of Nuclear Engineering (DNE) design output documents. Programs in place and scheduled at the three projects to resolve this issue failed to consider the effects of Design Basis Accident (DBA) conditions on a sensing line's ability to function throughout all operational modes.

WBN, SQN, and BFN had installation and inspection procedures which were inadequate when implementing manufacturer's installation instructions for instrument line compression fittings. The evaluation and findings concluded the following: DNC installation procedures did not incorporate or reference manufacturer's installation instructions for compression fittings, craft training did not include manufacturer's instructions, and the QA organizations did not inspect the installed compression fittings to verify the integrity of the installed configurations.

Two projects, WBN and SQN, had instrument sensing line support clamps inadequately installed. The BFN project is in the process of implementing a sampling verification program to determine if this issue is applicable to that site.

COLLECTIVE SIGNIFICANCE OF MAJOR FINDINGS

Management in three divisions (DNE, DNC and DNQA), failed to ensure a quality design, installation and quality assurance program for instrument sensing line installation for safety-related systems. The craft personnel failed to perform their duties in a professional manner and created "Conditions Adverse to Quality" at the WBN, SQN and BFN projects.

CAUSES OF MAJOR FINDINGS

Management failed to research and develop documents controlling installation processes which would ensure quality installations at each site.

CORRECTIVE ACTION ON MAJOR FINDINGS

Corrective action varies between projects due to their respective phase of construction, operation or licensing. Basically, DNE will evaluate and correct deficiencies in the design criteria, DNC will evaluate, identify and correct the installation of instrument sensing lines according to the revised criteria established by DNE, craft will be trained to perform their duties in accordance with revised documents, Quality Control (QC) will inspect to these specified instructions, and Quality Assurance (QA) will monitor and audit the processes to ensure the quality of the program.

ISSUES	SR	NS	FINDINGS	CAUSE	CORRECTIVE ACTION	COLLECTIVE SIGN.
Instrument Line Slope (10 concerns) Seven of the ten concerns about instrument sensing line slope address specific instances where slope criteria were not met. Three concerns generically address slope criteria non-compliance. The issue raised in all concerns was that instrument sensing lines were not installed in accordance with the minimum slope criteria specified by design output documents.	X		This issue was substantiated at the WBN, Sequoyah Nuclear Power Plant (SQN), and Browns Ferry Nuclear Power Plant (BFN) projects with Bellefonte Nuclear Power Plant (BLN) being in compliance with DNE criteria. Programs in place or scheduled at the three projects to resolve this issue were adequate except that none of the programs took into consideration the effects of Design Basis Accident (DBA) conditions on a sensing lines ability to function during all modes of operation.	For those projects where this element was found to be generically applicable (WBN, SQN, and BFN) causes for the findings were: * Design output requirements from DNE are inadequate and inconsistent. * Installation practices were inadequate by DNC. * QC inspection techniques of instrument line slope were inadequate and, not adequately protected from a Construction environment which has resulted in damage.	* DNE evaluate as installed sensing line slope against design criteria. * Construction/modifications rework sensing lines as required. * Perform reviews of Maintenance/Work Requests (MR and WR) by Operations to identify instrument performance problems caused by inadequate sensing line slope. * DNE evaluate and revise slope design criteria to be consistent, complete, and correct. * DNE develop design and acceptance criteria for slope deviations which assures acceptance performance of instruments during and after a Design Basis Accident (DBA). * DNE evaluate the effects and acceptability of backfilling cold demineralized water back to a hot process nozzle. * Operations revise maintenance procedures to address backfilling restrictions and flow rates	The following is a summary of collective significance findings for the 4 elements comprising this subcategory (Slope, compression fittings, clamps, bending) MANAGEMENT EFFECTIVENESS. The findings for the 4 elements of this subcategory are collectively and primarily the result of ineffective management in the area of instrument lines. Management has failed to recognize problems, develop solutions, identify programmatic weakness and promote teamwork. Examples of these issues are:

ISSUES	SR	NS	FINDINGS	CAUSE	CORRECTIVE ACTION	COLLECTIVE SIGN.
Instrument Line Slope (Continued)	X					
					as required.	• Incomplete, incorrect and inconsistent Branch and Project Engineering design criteria.
Compression Fittings (11 concerns)	X					
Nine concerns were evaluated relative to the installation of compression fittings. Two additional concerns related to instrument drain lines were included in this evaluation. (See Attachment F, List of Concerns By Issue, paragraph 1.2.2) The issues evaluated were: • Compression fittings were not installed in accordance with the manufacturer's recommendations. Craft were not trained to install compression fittings. • The installation of compression			This issue was substantiated at the WBN, SQN, and BFN projects with BLN being in compliance with the manufacturers instructions. The evaluation also concluded that craft training and QA inspection programs did not adequately address compression fitting installation and inspection at the three projects where this condition was found. In addition to the concerns related to compression fittings, this element included three employee concerns involving inadequately tested instrument drain lines which were not substantiated and required no further evaluation.	For these projects where this element was found to be generically applicable, (WBN, SQN, and BFN) the causes for the findings were: • No design output document by DNE or DNC/Modifications procedure or instruction specified any requirements for compression fittings to be installed in accordance with manufacturers' instructions. • No site QC inspection program existed which would have verified compliance with the manufacturers' installation instructions. • No training had	• DNE initiated testing at Singleton Materials Laboratory to determine the acceptability of compression fittings not installed in accordance with manufacturers instructions. • Perform field disassembly and inspection of fittings on potentially radioactive drain lines to verify correct installation. • Revise construction, operation, and quality control procedures to specify installation and inspection requirements. • Train craft personnel on proper methods of installing compression fittings. • Compression fittings used on panels for safety-related instruments require verification of	• Lessons learned from one project are not incorporated into the other projects programs. • Quality inspection programs have not been effective because of a lack of adequate Branch and Project criteria and a lack of independence from constructing organizations. • Organizations are not effective in working together to meet a common

ISSUES	SR	NS	FINDINGS	CAUSE	CORRECTIVE ACTION	COLLECTIVE SIGN.
Compression Fittings (11 concerns) (con't)						
fittings was not adequately addressed by the Quality Assurance (QA) program. * Drain lines were not hydrotested. * Drain lines and fittings were not correctly installed.				been performed for craftsmen, foremen, construction engineers or QC inspectors on how to properly install and inspect compression fittings, and * The use of several fitting manufacturers' compression fittings by DNC substantially increased the chances of incorrect installations.	leak tightness during first heat up and pressurization of plants.	goal. Each group works to its own goals developing their own programs. Employee Effectiveness Within the guidelines established by Management utilizing the technical criteria available to them, TVA employees have done as good a job as can be expected. On the other hand, if employees are negligent in identifying problems or programmatic deficiencies to their line managers, they themselves are not fulfilling their responsibilities
Instrument Line Bending (6 concerns)	X					
Six concerns site-specific to the WBN Project related to instrument line bending were evaluated with issues involving: * Certification of bending equipment			This issue was substantiated at WBN and was subsequently resolved using the results of a field bending sampling program. This issue was not classified as generically applicable to TVA projects other than	This element was evaluated at WBN and was not considered generically applicable to other TVA projects. At WBN, the cause of the employee concern findings was	* Develop procedures which control bending process, bending tools and bending inspection which prevent recurrence of problem. * Perform sample evaluation to determine the adequacy of installed instrument line bend.	

ISSUES	SR	NS	FINDINGS	CAUSE	CORRECTIVE ACTION	COLLECTIVE SIGN.
Instrument Line Bending (con't) * Certification of bending personnel * Control of bending equipment Note: Related bending issues have also been evaluated under Construction Subcategory Report Number 10700, "Instrument Tubing."			WBN.	determined to be the inadequate DNC implementation of DNE requirements pertaining to production bending.	* Train installation and inspection personnel on the requirements of bending procedures.	to the TVA nuclear program. Maintaining effective communications between employees and management, with reacting to resolve issues when necessary, is extremely important. Technical Adequacy A common thread in the findings for each element of this subcategory is the inadequacy of technical criteria presented in design output documents and/or Construction/Modifications procedures and instructions. DNE Branch and Project Engineering design output documents need a major overhaul to address what has

ISSUES	SR	NS	FINDINGS	CAUSE	CORRECTIVE ACTION	COLLECTIVE SIGN.
Instrument Line Bending (con't)						to be done technically. Construction and Modifications programs should then follow suit to address how to do it. A great deal of what has to be done is currently left up to DNC and Modifications to develop without DNE input or concurrence.
Instrument Line Clamps (2 concerns)	X					
Two concerns related to instrument line clamp installation were evaluated which covered issues related to: • Improper installations • Damage after installation • Unacceptable clamp substitutions. • Missing clamps			This issue was substantiated at WBN and SQN with 100 percent field verification and correction programs in progress. The BFN project is currently preparing to implement a sampling verification program which will determine if this issue is applicable. This issue was substantiated at BLN, and no further action was required. For WBN and SQN, this	For those projects where this element was found to be generically applicable (WBN and SQN), the causes for the findings were: • Inadequate procedures were in existence which controlled clamp installations by DNC and ONP, • Clamp installation	• Perform sample inspection to determine extent of problem. • Perform 100 percent walkdown of clamps and correct deficiencies. • Revise installation and inspection procedures to assure proper future clamp installations.	SEE ABOVE

ISSUES	SR	NS	FINDINGS	CAUSE	CORRECTIVE ACTION	COLLECTIVE SIGN.
Instrument Line Clamps (con't) Note: Engineering Subcategory Report Number 223 "Instrument Support Design," evaluates the adequacy of design output requirements related to instrument line clamp installation.			evaluation also concluded that there were inadequate installation and inspection programs.	and Quality Control inspection practices were inadequate, • Management/supervisory control over the installation and inspection of clamps was inadequately trained. Note: If this element is found to be valid for BFN, the above listed causes would generally be applicable.		

1.0 CHARACTERIZATION OF ISSUES

1.1 Introduction

There are 29 concerns in the subcategory Instrument Line Installation. These concerns were grouped into the following four elements to aid in the evaluation effort.

- Instrument line slope
- Compression fittings
- Instrument line clamps
- Instrument line bending

Section 8, attachment A provides a listing of employee concerns for each of these four elements.

1.2 Description of Issues

1.2.1 Instrument Line Slope (10 concerns)

Seven of the ten concerns about instrument sensing line slope address specific instances where slope criteria were not met. Three concerns generically address slope criteria noncompliance. The issue raised in all concerns was that instrument sensing lines were not installed in accordance with the minimum slope criteria specified by design output documents. (See Attachment F, List of Concerns By Issue, paragraph 1.2.1)

1.2.2 Compression Fittings (11 concerns)

Nine concerns were evaluated relative to the installation of compression fittings. Two additional concerns related to instrument drain lines were included in this evaluation. (See Attachment F, List of Concerns By Issue, paragraph 1.2.2) The issues evaluated were:

- Compression fittings were not installed in accordance with the manufacturer's recommendations. Craft were not trained to install compression fittings.

- The installation of compression fittings was not adequately addressed by the Quality Assurance (QA) program.

- Drain lines were not hydro tested.
- Drain lines and fittings were not correctly installed.

1.2.3 Instrument Line Clamps (2 concerns)

Two concerns related to instrument line clamp installations were evaluated which covered issues related to:

- Improper installations
- Damage after installation
- Unacceptable clamp substitutions
- Missing clamps

Note: Engineering Subcategory Report No. 223 "Instrument Support Design," evaluates the adequacy of design output requirements related to instrument line clamp installation.

(See Attachment F, List of Concerns By Issue, paragraph 1.2.3)

1.2.4 Instrument Line Bending (6 concerns)

Six concerns site-specific to the WBN Project related to instrument line bending were evaluated with issues involving:

- Certification of bending equipment
- Certification of bending personnel
- Control of bending equipment

Note: Related bending issues have also been evaluated under Construction Subcategory Report No. 10700, "Instrument Tubing"

(See Attachment F, List of Concerns By Issue, paragraph 1.2.4)

2.0 SUMMARY

2.1 Summary of Issues

This subcategory report addresses four areas of employee concerns related to instrument line installation:

- Instrument Line Slope

- Compression Fittings
- Instrument Line Clamps
- Instrument Line Bending

2.2 Summary of Evaluation Process

The employee concerns related to the four areas were issued against a specific project. Each area was evaluated as a generic issue which examined entire programs in addition to the specific concerns. Employee concerns related to slope, compression fittings, and clamps were evaluated at all four TVA nuclear projects. Bending was evaluated only at Watts Bar Nuclear Plant (WBN), since it was characterized as not being generically applicable to the other three projects. The evaluation process varied slightly at each project because of the various stages of construction or operation of each project. Employee concerns for all four areas of concern can be basically summarized as a failure of the installing organization to follow design output or manufacturers installation instructions and an inadequate quality inspection program which should have identified the discrepancies. A lack of or inadequate design output criteria contributed to some of the discrepancies. In general, the evaluation process consisted of:

- The review of design output and manufacturers installation requirements.
- The review of Division of Nuclear Construction (DNC) and Office of Nuclear Power (ONP) procedures.
- The review of previous evaluation reports issued by Nuclear Safety Review Staff (NSRS), Division of Nuclear Engineering (DNE), and the WBN Instrument Project (IP).
- The review of Quality Inspection procedures and records,
- Plant walkdowns and inspections

- Interviews with cognizant DNC, ONP, and DNE personnel

2.3 Summary of Findings

The following is a summary of the findings and conclusions for each of the four instrument line installation issues enumerated in section 2.1 above.

2.3.1 Instrument Line Slope

The issue raised by this element is that instrument sensing lines were not installed in accordance with the minimum slope criteria specified by DNE design output documents. This issue was substantiated at WBN, Sequoyah Nuclear Power Plant (SQN), and Browns Ferry Nuclear Power Plant (BFN) projects with Bellefonte Nuclear Power Plant (BLN) being in compliance with DNE criteria. Programs in place or scheduled at the three projects to resolve this issue were adequate except that none of the programs took into consideration the effects of Design Basis Accident (DBA) conditions on a sensing line's ability to function during all modes of operation. |R1 |R1

2.3.2 Compression Fittings

The issue raised by this element is that instrument line compression fittings were not installed in accordance with the fitting manufacturer's instructions. This issue was substantiated at the WBN, SQN, and BFN projects with BLN being in compliance with the manufacturer's instructions. The evaluation also concluded that craft training and QA inspection programs did not adequately address compression fitting installation and inspection at the three projects where this condition was found. In addition to the concerns related to compression fittings, this element included three employee concerns involving inadequately tested instrument drain lines which were not substantiated and required no further evaluation. |R1 |R1

2.3.3 Instrument Line Clamps

The issue raised by this element is that clamps used to attach instrument sensing lines to supports are loose, missing and/or are not approved components. This issue was

factual at WBN and SQN with 100 percent field verification and correction programs in progress. The BFN project is currently preparing to implement a sampling verification program which will determine if this issue is applicable. |R1

This issue was not factual at BLN, and no further action was required. For WBN and SQN, this evaluation also concluded that there were inadequate installation and inspection programs. |R1

2.3.4 Instrument Line Bending

The issue raised by this element is that instrument sensing line bending tools were not certified or controlled adequately and that personnel performing bending were not adequately trained and certified. This issue was factual at WBN and was subsequently resolved using the results of a field bending sampling program. This issue was not classified as generically applicable to TVA projects other than WBN. (Construction subcategory report 10700, "Instrument Tubing", evaluated other instrument tube bending issues; some of which were generically applicable to other sites.) |R1 |R1 |

2.4 Summary of Collective Significance of Findings

2.4.1 Management Effectiveness

The subcategory findings reveal in the area of instrument lines, a general lack of management control over the issuance of adequate design output criteria, compliance with installation requirements and an adequate work control and quality inspection program. | |R1

2.4.2 Employee Effectiveness

The subcategory findings indicate, for some issues, a lack of employee understanding and execution of the technical requirements. Inadequate technical criteria, procedures, and training have contributed to this situation. |R1

2.4.3 Technical Adequacy

The findings for each element of this subcategory repeatedly indicate a lack of adequate technical criteria and procedures to control the work. Design and installation criteria issued by DNE and implementing procedures issued by DNC and ONP should be based on upper-tier criteria issued on a branch level which is currently inadequate or nonexistant.

2.5 Summary of Causes

The following is a summary of the causes of those findings which require corrective actions.

2.5.1 Instrument Line Slope

Instrument lines installed at less than the minimum slope value specified on DNE output documents are a result of the following causes:

- Inadequate/confusing requirements from design output documents
- Inadequate installation practices
- Inadequate inspection program
- Inadequate protection of sensing lines

2.5.2 Compression Fittings

Instrument line compression fittings were not installed in accordance with the fitting manufacturers' instructions. Causes for this finding are:

- Inadequate DNE criteria for DNC to follow manufacturers installation instructions |R1
- Inadequate DNC installation procedures |R1
- Inadequate inspection program
- Inadequate training for craft installation and Quality Control inspection personnel.

2.5.3 Instrument Line Clamps

The cause of the findings related to instrument line clamps was a combination of the following:

- Inadequate written instructions

- Inadequate installation and inspection practices

- Inadequate management/supervisory control

2.5.4 Instrument Line Bending

The cause of the findings related to instrument line bending at WBN was the inadequate implementation of DNE requirements pertaining to production bending.

2.6 Summary of Corrective Action

Corrective action (C/A) for each element of this subcategory varies between projects based on (1) where each project stands in construction, operation or licensing and (2) completed or in process C/A as a result of prior evaluation(s) of the issues. The following is a cumulative summary of C/A for all projects, listed by element. Site-specific C/A, when required, is detailed in section 7.0 of this report.

2.6.1 Instrument Line Slope

- DNE evaluate as installed sensing line slope against design criteria.

- Construction/modifications rework sensing lines as required

- Perform reviews of Maintenance/Work Requests (MR and WR) by Operations to identify instrument performance problems caused by inadequate sensing line slope.

- DNE evaluate and revise slope design criteria to be consistent, complete and correct.

- DNE develop design and acceptance criteria for slope deviations which assures acceptable performance of instruments during and after a Design Basis Accident (DBA).

- DNE evaluate the effects and acceptablity of backfilling cold demineralized water back to a hot process nozzle.

- Operations revise maintenance procedures to address backfilling restrictions and flow rates as required.

2.6.2 Instrument Line Compression Fittings

- DNE initiated testing at Singleton Materials Laboratory to determine the acceptability of compression fittings not installed in accordance with manufacturers instructions.
- Perform field disassembly and inspection of fittings on potentially radioactive drain lines to verify correct installation.
- Revise construction, operation and quality control procedures to specify installation and inspection requirements.
- Train craft personnel on proper methods of installing compression fittings.
- Compression fittings used on panels for safety-related instruments require verification of leak tightness during first heat up and pressurization of plants.

2.6.3 Instrument Line Clamps

- Perform sample inspection to determine extent of problem.
- Perform 100 percent walkdown of clamps and correct deficiencies.
- Revise installation and inspection procedures to assure proper future clamp installations.

2.6.4 Instrument Line Bending

- Develop procedures which control bending process, bending tools and bending inspection which prevent recurrence of problem.
- Perform sample evaluation to determine the adequacy of installed instrument line bends.
- Train installation and inspection personnel on the requirements of bending procedures.

3.0 EVALUATION PROCESS

3.1 General Methods of Evaluation

The employee concerns within this subcategory were investigated according to the Instrument Line Installation Initial Evaluation Plan. The following is a summary of the specific methodology utilized in the evaluation.

3.1.1 Instrument Line Slope

Instrument line slope employee concerns were evaluated at the four TVA Nuclear Projects: WBN, SQN, BFN, and BLN. Because of the various stages of construction, operation, and licensing, the evaluation methodology varied at each project. Action taken at each project prior to the employee concerns evaluation for this element also caused variation in the evaluation methodology. |R1

3.1.1.1 WBN - Instrument Line Slope

The employee concerns contained within this element were evaluated at WBN by reviewing the results of an evaluation performed by the WBN IP. The WBN IP was organized in October 1985 and chartered to evaluate and resolve all slope employee concerns (reference memorandum F01 851029 604, attachment B). The results of the WBN IP evaluation were published in memorandum F01 860620 602 (attachment C) and an action plan issued to resolve all discrepancies and deficiencies in memorandum F01 860115 603 (attachment D). This information forms the basis of the employee concern evaluation and established the detailed evaluation methodology utilized.

3.1.1.2 SQN - Instrument Line Slope

Employee concerns were evaluated for generic applicability at SQN utilizing the following methodology:

a. Interviews were conducted with six individuals from the WBN IP, the Sequoyah Engineering Project (SQEP) and the SQN Nuclear Power Instrument Maintenance Section concerning:

- Background and applicability to SQN based on WBN IP evaluation results

- Specific SQN evaluations and/or action taken to determine the applicability

- The existence of instrument performance, operating or maintenance problems which are the result of the condition outlined in the related employee concerns

b. Correspondence and previous evaluation reports issued by NSRS, SQEP and the SQN Generic Concerns Task Force (GCTF) were compiled and reviewed to determine exactly what the SQN projects position on slope is and if that position is technically acceptable.

c. Reviewed approximately 222 MRs and WRs from 3 systems to determine if performance, operational or maintenance problems have historically occurred as a result of instrument lines not being installed in accordance with minimum slope requirements.

d. Reviewed seven TVA Norris Test Laboratory reports related to air bubble migration in sensing lines and the effects of entrapped air on transmitter output signals.

e. Reviewed Regulation Guide 1.97 Revision 2 and 3 and "WBN Calculations Related to Post Accident Monitoring (PAM) Instruments," in order to determine the approximate number of instruments required to function following a Design Basis Accident (DBA) and which may require further engineering and design evaluation.

3.1.1.3 BFN - Instrument Line Slope

Employee concerns were evaluated for generic applicability at BFN utilizing the following methodology:

a. Interviews were conducted with four individuals from DNE site, BFN Instrument Maintenance Section and BFN Task Force concerning the same three issues listed in paragraph 3.1.1.2(a) of this report. Additionally, the BFN Task Force was contacted to determine if the BFN Nuclear Performance Plan addresses and/or takes a position on the slope issue.

b. Reviewed design requirements for instrument line slope shown on three design drawings and one "G" specification.

c. Performed a general walkdown of BFN unit 2 Reactor Building instrument sensing lines to determine compliance with issued slope criteria.

d. Two Maintenance Standard Practice/Instructions covering the backfilling requirements for reactor vessel level sensing lines following maintenance and calibration were reviewed for adequacy.

e. Three pieces of correspondence were reviewed (B43 860701 905, B22 860715 001 and B22 860714 027) all dealing with the Electrical Engineering Branch (EEB) notification to BFN project to perform a "Potential Generic Condition Evaluation." (NCRs 6172 and 6359) |R1

3.1.1.4 BLN - Instrument Line Slope

Employee concerns were evaluated for generic applicability at BLN utilizing the following methodology:

a. Interviews were conducted with four individuals representing the Construction Instrument Engineering Unit and the Instrument Quality Control (QC) Unit concerning:

- What is the issued design output criteria for instrument line slope?

- What are other design output requirements which would control or clarify instrument line routings in regards to achieving required slope?

- What are the QC inspection requirements for instrument line slope?

- What program exists for obtaining approval of slope deviations?

- What is the current status of sensing line installation and inspection?

b. Design output document G-60 and revision notice SRN-G-60-1 were evaluated for adequacy of slope criteria.

c. QC Inspection Procedure QCP-4.3 revision 13 was reviewed to determine if inspection criteria for instrument line slope existed and was it consistent with design output criteria.

d. Reviewed ten QC inspection reports in the vault to determine their accuracy and correct applicability to the instrument lines inspected.

e. Reviewed records of BLN Site Employee Concerns Task Group (ECTG) to determine if any additional evaluations or action had been taken at a site level regarding this element.

f. Performed a general walkdown of BLN unit 1 Reactor and Auxiliary Building instrument line installations to determine compliance with design output slope criteria.

3.1.2 Compression Fittings

Instrument line compression fitting employee concerns were evaluated at the four TVA nuclear projects: WBN, SQN, BFN, and BLN. Because of the various stages of construction, operation, and licensing, the evaluation methodology varied at each project. Action taken at each project prior to the Employee Concerns Evaluation for this element also varied the evaluation methodology.

3.1.2.1 WBN - Compression Fittings

Employee concerns were evaluated at WBN utilizing the following methodology:

- Reviewed the files for the applicable concerns and the previous investigations and responses performed by Quality Technology Company (QTC), NSRS and WBN site personnel to determine the scope of the problems and to determine if previous responses adequately addressed the identified problems.

- Reviewed QTC expurgated files for additional information.

- Reviewed WBN IP Activity 1240 Evaluation Report and file to determine if project work adequately addressed all the identified problems.

- Reviewed the requirements for drain lines to determine if hydro testing is required.

- Reviewed the design and installation requirements to determine if unit 1 drain lines were correctly installed.

- Reviewed NSRS Reports I-85-329-SQN, I-85-514-001, and Q-85-795-001-02 and GCTF report on Concerns XX-85-050-003 and PH-85-002-027 to determine if the conclusions and recommendations agree with this evaluation.

3.1.2.2 SQN - Compression Fittings

Employee concerns were evaluated for generic applicability at SQN utilizing the following methodology:

- Interviewed plant personnel in the Instrument Maintenance (IM) Section, Mechanical Maintenance (MM) Section, and the Modifications Section at SQN to determine what problems have been experienced with compression fittings and if these problems have been corrected.

- Reviewed letter from Olson, Modifications Manager, SQN, to Abercrombie, Site Director, SQN, dated January 13, 1986, "Compression Fitting Evaluation Report," and interviewed modifications personnel involved in survey.

- Interviewed training personnel at SQN to determine what training for the installation of compression fittings was available. Interviewed IM, MM, Modifications and QA section supervisors to determine what training on compression fittings was required.

- Walked down approximately 50 percent of the instrument panels in the Auxiliary Building, elevations 669 and 690, and visually examined panels for obvious problems, leaking fittings on instrument and drain lines, and mismatch of fittings.

- Examined storage of compression fittings at SQN Power Stores.

- Reviewed SQN Construction Procedures Index dated November 13, 1985, and SQN Inspection Instructions Index dated * /24/86, to determine which procedures might contain installation and inspection requirements.

  * Month was unavailable because hole was punched through.

- Reviewed procedures on instruments, instrument lines, and piping to determine if any installation and inspection requirements applied to compression fittings.

- Interviewed former construction instrument engineer to determine if any procedures specified installation or inspection requirements for compression fittings during construction. Questioned MM, IM, and Modifications personnel if any plant procedures specify installation and inspection requirements.

- Interviewed QA personnel at SQN to determine what the inspection requirements were for the installation of compression fittings.

- Reviewed QTC expurgated files for the concerns addressed by this evaluation for additional information and reviewed NSRS reports I-85-325-SQN, IN-85-514-001, and Q-85-295-001-02, and SQN GCTF Report on concerns XX-85-050-003 and PH-85-002-027, to determine if the conclusions and recommendations agree with this evaluation.

- Reviewed WBN IP Activity 1240 Evaluation Report and file to determine if incorrect installations were acceptable.

3.1.2.9 BFN - Compression Fittings

Employee concerns were evaluated for generic applicability at BFN utilizing the following methodology:

- Interviewed supervisors in the Instrument Maintenance Section (IM) and the Modification Section (MODS) at BFN to determine if problems had been experienced with compression fittings and if these problems had been corrected.

- Interviewed training personnel at BFN to determine what training for the installation of compression fittings was available. Interviewed MM, IM, MODS, and QA section supervisors to determine what training for compression fittings was required.

- Interviewed QA supervisor at BFN to determine what the inspection requirements were for the installation of compression fittings.

- Interviewed supervisors in IM, MM, and MODS at BFN to determine what procedures existed detailing installation and inspections requirements for compression fittings.

- Examined storage of compression fittings at BFN Power Stores.

- Visually examined about a dozen instrument panels on elevation 593 of unit 2 Reactor Building for mismatched or leaking fittings.

- Reviewed QTC expurgated files for the concerns addressed by this evaluation for additional information and reviewed NSRS reports I-85-329-SQN, IN-85-514-001, and Q-85-795-001-02, and SQN GCTF Report for concerns XX-85-050-003 and PH-85-002-027, to determine if the conclusions and recommendations agree with this evaluation.

- Reviewed WBN IP Activity 1240 Evaluation Report and file to determine if incorrect installations were acceptable.

3.1.2.4 BLN - Compression Fittings

Employee concerns were evaluated for generic applicability at BLN utilizing the following methodology:

- Interviewed senior instrument engineer who was the group leader in BLN DNC Instrument Engineering Unit (IEU) responsible for the installation of tubing and tube fittings to determine how BLN DNC controlled the installation of compression fittings.

- Interviewed group leader in BLN DNC Instrument Quality Control (IQC) section to determine what QA was required for the installation of compression fittings. Reviewed and discussed Quality Control Procedure (QCP) BLN-QCP-4.3, Revision 13.

- Interviewed BLN DNC training clerk to determine what training was required for craft personnel on the installation of compression fittings.

- Interviewed three instrument mechanics in BLN ONP Instrument Maintenance (IM) Section to determine what training they had received and how they ensured compression fittings were properly reassembled.

- Reviewed QTC expurgated files for the concerns addressed by this evaluation for additional information and reviewed NSRS reports I-85-329-SQN, IN-85-514-001 and Q-85-795-001-02 and SQN GCTF Report on Concerns XX-85-050-003 and PH-85-002-027 to determine if the conclusions and recommendations agree with this evaluation.

3.1.3 Instrument Line Clamps

Instrument line clamp employee concerns were evaluated at the 4 TVA nuclear projects: WBN, SQN, BFN, and BLN. Because of the various stages of construction, operation, and licensing, the evaluation methodology varied at each project. Action taken at each project prior to the Employee Concerns evaluation for this element also varied the evaluation methodology.

3.1.3.1 WBN - Instrument Line Clamps

Employee Concerns were evaluated utilizing the following methodology:

- Reviewed previous investigations performed by NSRS to determine if these reports were adequate and addressed the areas of concern.

- Reviewed the WBN IP evaluation and results (Activity File 1220) to determine if work adequately addressed the areas of concern.

3.1.3.2 SQN - Instrument Line Clamps

Employee Concerns were evaluated for generic applicability at SQN utilizing the following methodology:

- Reviewed Significant Condition Report, (SCR) SQN CEB8612, to determine if it is applicable to the areas of concern.

- Reviewed the preliminary findings of the Bolt Torque Survey and interviewed the responsible Division of Nuclear Engineering (DNE) coordinator to determine if the survey adequately addresses the areas of concern.

- Reviewed Special Maintenance Instruction, SMI-0-317-25 RO, "Inspection and Corrective Maintenance of Small Diameter Instrument and Sensing Line," and interviewed the responsible mechanical maintenance coordinator to determine if instructions adequately addressed the areas of concern.

- Reviewed Construction Specification N2C-946, "Requirements for Tightening of Non High Strength Bolts in Friction-Type Connections," to determine if this specification was adequate and addressed the areas of concern.

- Reviewed Modification and Additions Instruction, M&AI 09, "Inspection of Bolted Connections", to determine if future instructions would adequately address the areas of concern.

3.1.3.3 BFN - Instrument Line Clamps

Employee Concerns were evaluated for generic applicability at BFN utilizing the following methodology:

- Reviewed the preliminary project instruction for class I small bore piping (1/2" to 2") and interviewed the responsible Instrument Maintenance Engineer to determine if the instructions adequately addressed the areas of concern.

- Interviewed the responsible Instrument Maintenance Engineer for class I instrumentation tubing to determine if the program adequately addressed the areas of concern.

- Reviewed the preliminary project instruction for the routing and qualification of instrumentation and control piping and tubing and interviewed the responsible individual to determine if the instructions adequately addressed the areas of concern.

3.1.3.4 BLN - Instrument Line Clamps

Employee concerns were evaluated for generic applicability at BLN utilizing the following methodology:

- Reviewed the relevant design drawings for instruments and controls to determine if the design drawings adequately addresses the areas of concern.

- Reviewed the QC procedure for instrument tubing installation and inspection to determine if the procedure adequately addresses the areas of concern.

- Interviewed the instrumentation engineer knowledgeable in the installation of instrument tubing and the related instrumentation hangers to determine if the work adequately addresses the areas of concern.

- Interviewed the instrumentation inspector knowledgeable in the inspection of instrument tubing and the related instrumentation hangers to determine if the work adequately addresses the areas of concern.

3.1.4 Instrument Line Bending

Instrument line bending employee concerns were evaluated at WBN. Since the WBN evaluation did not classify bending as generically applicable to other TVA nuclear projects, evaluations beyond WBN were not performed within this subcategory (Construction Subcategory report number 10700, "Instrument Tubing", evaluated other instrument tube bending issues; some of which were generically applicable to other sites.) |R1

- Reviewed WBN IP Activity file 1230 to determine methodology used to respond to concerns.

- Reviewed the corrective action response evaluations prepared by the Nuclear Safety Review Staff for concern numbers IN-85-021-001 and IN-85-824-002.

4.0 FINDINGS

The findings and conclusions relative to the issues contained within each of the four elements which comprise this subcategory are presented below by element and project. The findings and conclusions contained herein correspond to the applicable evaluation methodology which is detailed in Section 3.0 of this report.

4.1 Instrument Line Slope

While all Employee Concerns in this element were voiced as site-specific concerns, the ECTG evaluation process at each project was conducted as a generic evaluation. Consequently, the entire program for instrument line slope was evaluated at all four TVA projects which included the review of site-specific concerns. |R1

Based on the findings and conclusions below, the issue was found to be factual at WBN, SQN, and BFN and was not found factual at BLN. | |R1

4.1.1 WBN-Slope Findings and Conclusion

4.1.1.1 Findings

A. Concerns which identified System 68 slope deficiencies were substantiated by field walkdown and documented in Nonconformance Report (NCR)-6172, Revision 0 dated July 9, 1985.

B. Subsequent investigations revealed that the condition could exist in any of the sensing lines in the plant as documented in NCRs 6172, Revision 1 (unit 1) dated April 12, 1985 and 6359, Revision 0 (unit 2) dated October 1, 1985.

C. The slope deficiencies documented in NCRs 6172 and 6359 were determined to be significant and reportable to NRC.

D. Inadequate sensing line slope could result in the degradation of instrument measurement quality due to the effects of air entrapment in liquid-filled lines or condensate trapped in gas-filled lines.

E. Industry Standards (ISO Standard 2186 and ASME fluid meter applications) recommend that liquid-filled sensing lines be installed with a slope of one inch per foot, or greater, to prevent measurement errors due to entrapped air.

F. TVA's Norris Lab Tests (Report WR28-2-88-107 dated August 1985 and WR28-1-85-121) confirm industry standards slope recommendations but also show that one-half inch schedule 80 and 160 pipe will not trap air when the slope is reduced one-eighth inch per foot.

G. The sensing line slope criteria in effect at the time the deficiencies occurred was specified on WBN drawing 47W600-0-4, Note 2. The criteria recommends that sensing lines be sloped at one inch per foot, but allows a minimum of one-eighth inch per foot. No restrictions were specified on the application of the minimum. The criteria for gas-filled lines was in error with regard to the direction of slope. In addition, slope requirements for sensing line components such as root valves and flex hoses were not adequately defined or consistently applied.

H. Sensing lines were installed at the minimum of one-eighth inch per foot instead of the recommended one inch per foot.

I. Slope measurement errors were not considered when lines were installed or inspected. This was a problem since many lines were installed at

the minimum required slope. The accuracy of the gauge used to measure slope is typically plus or minus one-sixteenth inch per foot under ideal conditions and has been demonstrated to be as much as plus or minus one-eighth inch per foot under difficult measuring conditions encountered in the field. |R1

J. Inspection techniques (procedural requirements and training) have been inadequate. Lines have been installed and inspected which have now been found to have less than the minimum required slope of one-eighth inch per foot. |R1

K. Sensing lines have been damaged due to heavy construction and maintenance activity. Stepping, climbing, or supporting scaffolding or heavy equipment on sensing lines can cause damage which results in a change in line slope.

L. Concerns which identified slope deficiencies in sensing lines other than System 68 were found to be factual by the determination that slope problems were generic as documented in NCRs 6172, Revision 1 and 6359, Revision 0.

4.1.1.2 Conclusion

The employee concerns listed above are factual and are adequately addressed and resolved by the IP sensing line slope evaluation as summarized in the 1210 evaluation report.

4.1.2 SQN-Slope Findings and Conclusions

4.1.2.1 Findings

A. The Watts Bar Project handled the sensing line slope employee concerns by creating the IP which performed a case by case evaluation of selected safety-related and sensitive instrument sensing lines. A significant amount of rework has been identified as a result of these evaluations. The WBN approach differs from SQNs in that SQN

is utilizing several years of operating experience as their basis for acceptability of installed sensing line slopes.

B. Based on discussions with the Supervisor of Electrical Engineering I&C (SQEP), evaluations have been performed by NSRS, DNE, and GCTF concerning instrument sensing line slope adequacy. All reports basically agree that, based on several years of operating experience utilizing enhanced maintenance and calibration procedures, the installed configurations of sensing lines are technically and functionally acceptable. Maintenance/work requests do not reflect the existence of any operational problem which can be attributed to sensing line slopes.

C. The letter from Wohld to the MEB files dated November 11, 1978 provides solutions to pre-op test deficiencies which were attributed to air entrapment.

D. The letter from Pierce to Patterson dated December 5, 1978 acknowledges implementation of recommended corrective actions provided in paragraph C. This letter also mentioned that SQN would discuss with the Electrical Engineering Branch the need for a construction specification to prevent recurrence of slope problems on later plants.

E. NSRS Report Number I-85-590-SQN dated December 27, 1985 concludes that even though the employee concerns were found to be factual, there is no history of functional problems which would require further action. The NSRS report makes five recommendations related to closing this issue: |R1

1. A DNE evaluation of this issue should be completed and any identified corrective actions implemented by the site.

2. The reactor coolant system (RCS) flow transmitter sense line routings should be reverified to ensure that high point vent valves are clearly the high point in each line.

3. Plant procedures should be revised or developed to require safety-related sense lines which may be sensitive to air entrapment be backfilled during unit outages just prior to entering the mode in which the associated instrument is required to be operable. The procedure should require a channel check to verify normal indication when these instruments are returned to service. In addition, channel checks to determine if backfilling is required whenever one of these instruments is calibrated and returned to service during unit operation should be incorporated into the procedure.

4. Appropriate instrument sense line routing and slope criteria should be obtained from DNE and incorporated in site procedures for installation of new sense lines or significant modification to existing sense lines.

5. Because of the demonstrated generic effects of WBN NCR-6172 to SQN on improper instrument sense line slope, the WBN Construction NCR should be sent through design to SQN and to the other TVA plants for a generic review for applicability in accordance with DNE procedures.

F. The Vineyard to Rankin letter dated December 20, 1985 documents the results of DNE's evaluation of instrument sensing line slope, as requested by NSRS and SQN management. This letter summarizes corrective actions taken during pre-op testing and during normal plant operation for problems caused by inadequate sensing line

slope. Included in this evaluation were the results of a DNE and Maintenance walkdown of sensing lines, a review of maintenance histories and a review of maintenance procedures. This report concluded that no plant safety problem exists at SQN based on successful operating experience, current and planned instrument maintenance practices and administrative verification methods for entrapped air in sensing lines. |R1

G. The Abercrombie to Wilson memorandum dated April, 18, 1986 responds to the DNE evaluation report (reference paragraph F), basically agreeing with recommendations to monitor maintenance/work request trends. This memorandum states that programs are already in place to do trending and that the Instrument Maintenance Section is responsible for performing this function.

H. NSRS Report Number I-86-128-SQN dated February 25, 1986 is very similar to the report issued in paragraph E. Three recommendations were made related to closing this issue.

1. Engineering evaluation of instrument sensing line slopes

2. Returning transmitters to service

3. NCR-6172 evaluation for generic applicability to other TVA facilities.

I. The Mason to Whitt memorandum dated January 28, 1986 responded to NSRS Report Number I-85-590-SQN recommendations made in paragraph E.

J. The Whitt to Mason memorandum dated April 16, 1986 accepted all responses made in paragraph I.

K. The SQN GCTF evaluation report dated April 22, 1986 reiterates the results of previous NSRS and DNE evaluations. The GCTF endorses the recommendations made in the NSRS report (paragraph E) and makes no further conclusions or recommendations.

L. Individuals from the SQN Instrument Maintenance Section discussed existing maintenance and calibration techniques being applied to sensing lines and instruments with associated high points and low points in the line routings. Sensing lines susceptible to air entrapment have been identified and are adequately covered by procedures. Maintenance histories do not reflect any recurring problems in this area.

M. An independent review of maintenance/work requests (MRs and WRs) for a portion of safety-related instruments was performed, looking specifically for problems caused by possible air entrapment in sensing lines. Two hundred twenty two (222) records were reviewed, with approximately seven potentially related to air entrapment. Further review found that these MRs and WRs were issued in a timeframe when system maintenance involving numerous pump starts and stops were occurring.

N. A general review of various Norris Lab test reports was performed to determine the total effects of entrapped gas or air bubbles on an instrument's accuracy and performance. These reports validate the potential problems caused by gas or air bubble entrapment. The reports also establish minimum flow rates for backfilling of sensing lines.

O. Evaluation reports issued by NSRS, DNE, and GCTF all basically concluded that there was no safety problem at SQN involving sensing line slope, based largely on several years of operating experience. Since this operating experience does not include experience during and after a design-basis accident (DBA), the calculated effects of a DBA on sensing lines associated with post accident monitoring (PAM) instruments must be determined. Reg Guide 1.97 was reviewed

for any special conditions or criterion applicable to PAM instrument sensing lines. TVA's commitment to Reg. Guide 1.97 implementation at SQN is currently September, 1987.

4.1.2.2 Conclusions

A. All specific and generic concerns related to instrument sensing line slopes not conforming to the installation requirements of drawing 47W600-24 are factual. |R1

B. For "Normal" operating conditions, the installed configurations of sensing lines do not create an operating or safety concern.

C. Evaluations performed by NSRS, DNE, and GCTF do not address the acceptability of sensing line slopes during abnormal or accident conditions. Engineering design criteria is inadequate in this area.

D. Based on the results of Norris Lab testing, the SQN backfilling procedure for sensing lines should specify a minimum flow rate to assure that entrapped air or gas is purged from the line.

E. SQN Backfilling procedures should be evaluated to determine if restrictions are required on backfilling cold demineralized water into potentially hot process nozzles. |R1

4.1.3 BFN-Slope Findings and Conclusions

4.1.3.1 Findings

A. In an interview with the Principle Instrumentation Engineering (PIE), the following information was obtained.

- The PIE has prepared an informal summary document concerning BFN slope. This summary parallels SQN's position on slope which was based on acceptable operating experience. In order to close the slope issue at BFN, the summary recommends a walkdown program be performed to verify sensing line slope with any unacceptable installations being corrected. The summary also recommends that a review of maintenance records be performed to identify potential problem areas for further evaluation and action.

  Additionally, a review of maintenance calibration, backfilling, purging, and flushing procedures was recommended to verify their adequacy.

Note: The above summary document was informally prepared and presented to the Electrical Engineering Branch.

- The PIE indicated that there were detailed evaluations currently being performed on sensing lines associated with reactor vessel level and N_2O_2 sampling as a result of past operating problems. Reactor vessel level sensing line problems are documented on DCR-3155, ECN-P5291, and ECN-P5414.

B. The instrument sensing line slope criteria shown in drawings 47W600-16, 47W600-21, and 47W600-23 are inconsistent with two drawings specifying a minimum of 1/8" per foot and the third drawing specifying a minimum of 1/4" per foot. Later in the evaluation it was determined that General Construction Specification G-60 is also applicable to BFN and specifies slope criteria which is different than the three drawings. G-60 slope criteria is applicable to BFN future modifications. Besides being inconsistent, the slope criteria in these four documents is inadequate and confusing. |R1

C. The following are findings from a field survey of unit 2 Reactor Building instrument sensing lines:

- In general, most sensing lines appeared to have slope in excess of 1/8" per foot.

- Numerous cases of damaged lines were observed. Dips and low points caused by construction activities and slipped attachment hardware exist in all areas of the Reactor Building secondary area.

- Several areas of inadequate slope were pointed out which are currently under evaluation as part of the reactor vessel level instrument line evaluation.

D. The following information was obtained from two individuals from BFN Instrument Maintenance Section:

- With the exception of reactor vessel level and N_2O_2 sample sensing lines, no formal reviews of maintenance/work requests has ever been performed to identify operational problems caused by entrapped air/gas in inadequately sloped sensing lines.

- Maintenance histories are only available through the current computer data base for the last 3-4 years. Records prior to the development of the computer base are not indexed and easily retrievable.

- Because no detailed reviews have been performed to date, the two individuals interviewed were not in a position to make any judgments as to whether problems do or do not exist as a result of inadequately sloped sensing lines with the exception of reactor vessel level lines. |R1

- Backfilling procedures for the reactor vessel level instrument sensing lines are utilized to remove entrapped air/gas following maintenance and calibration.

E. The Raughley to Those Listed letter dated June 30, 1986 notified BFN project of the potential generic applicability of sensing line slope discrepancies and required an examination be performed to determine if the condition exists. (WBN NCRs 6172 and 6359) |R1

F. The Faulkner to Raughley letter dated July 14, 1986 responds to the letter discussed in paragraph E, and indicates that the slope generic condition "Does not Exist" at BFN. This letter included an attachment which states that the WBN NCR was written to document a Construction Caused Condition and identified no involved DNE failures which contributed to the condition. To the contrary, previous discussions with WBN IP personnel indicates that incorrect and inadequate slope criteria was a contributing factor to the WBN condition. The inconsistencies in slope criteria at BFN as pointed out in paragraph B do not reinforce DNE's position that this generic condition does not exist at BFN. This letter also references a letter which was sent to the Plant Manager and Modifications Manager which is reviewed in paragraph G.

G. The Stapleton to Lewis and Rinne letter dated July 14, 1986 notifies the Plant and Modifications Managers that responsibility for review and handling of the Potential Generic Condition Evaluation is forwarded to them for action. This letter is referenced in DNE's response to Raughley in paragraph F. To date (October 1986), no response to this letter has been made. |R1

H. Backfill procedures BF-IMSI-3005 and BF-IMSI-3005.1 were reviewed with the following findings:

- Backfill procedures do not specify a minimum backfill flow rate to assure removal of entrapped bubbles as recommended in Norris Laboratory Test Report WR280-1-85-121, dated February 1986.

- Backfill procedures do not contain any restriction for backfilling cold demin water back to a hot process nozzle resulting in thermal cycling and thermal fatigue.

- Backfilling of sensing lines to the reactor vessel is normally prohibited by General Electric. An approved deviation from General Electric should be referenced in these procedures. |R1

I. Met with a member of BFN Task Force:

- In early August 1986, the Electrical Engineering Branch (EEB) from Knoxville presented to the Task Force a proposed plan and fragment for resolving the sensing line slope issue at BFN. The approach presented in EEB's plan to the Task Force appears to be based on the informal summary document prepared by the Principle Instrument Engineer reviewed in paragraph A of this evaluation. EEB's plan appears to include all the steps necessary to verify and resolve the slope issue at BFN.

- The BFN Nuclear Performance Plan does not include a project statement related to sensing line slope.

4.1.3.2 Conclusions

A. The generic applicability of WBN and SQN employee concerns related to inadequate instrument sensing line slope was determined to be applicable to BFN. This conclusion is based on the fact that slope evaluations and rework are currently being performed on two systems and violations of slope criteria were visually located in the field.

B. The slope criteria in the three 47W600 drawings and General Specification G-60 should be revised for consistency. When revised, this criteria should include restrictions on the use of multiple high points and low points in liquid filled sensing lines.

C. The program for resolving the sensing line slope issue presented to BFN Task Force by the EEB appears to be adequate. EEB should make sure that the evaluation process and acceptance criteria addresses the effects of a Design Basis Accident (DBA) on each sensing lines ability to function during abnormal operating conditions. The elements of EEB's program are as follows:

- Browns Ferry Engineering Project (BFEP) review existing design requirements.
- Plant instrument maintenance section review maintenance records and identify problem areas.
- Central staff coordinate with SQN and WBN to ensure a uniform program.
- Establish program to resolve U2 Cycle 5 issues.
- Prepare list of sense lines to be walked down.
- Plant instrument maintenance review sense line purging, flushing and calibration methods. Determine required changes to installations and/or methods.
- Perform walkdowns of lines.
- Plant submit DCR.
- Prepare project instruction (PI) for walkdown.

- Prepare ECN.

- Plant perform modifications.

D. Plant instrument maintenance section should work with DNE to determine if revisions to backfilling procedures are required to address backfilling minimum flow rates and backfilling cold demineralized water back to a hot nozzle. |R1
The acceptability of backfilling to the reactor vessel should also be verified.

E. The manner in which the Potential Generic Condition Evaluation was processed appears to be inadequate and incomplete. (Reference paragraphs 4.1.3.1 E, F, and G.)

4.1.4 BLN-Slope Findings and Conclusions

4.1.4.1 Findings

a. Instrument line slope criteria is issued in General Construction Specification G-60. This |R1
criteria is used to install and inspect instrument lines that are totally field routed and is used for field routings between work point elevations in the Containment Building.

b. A review of G-60 found that there is currently a revision notice issued and pending incorporation (SRN-G-60-1). This revision notice made changes to the slope criteria in G-60. The coversheet for the revision notice did not accurately reflect the affected paragraphs of G-60 and required incorporation of the revision notice into G-60 within 90 days of issuance. At the time of the ECTG evaluation, incorporation had not been made and was delinquent.

c. Procedure QCP-4.3 Revision 13 which covers tubing and support installation and inspection was reviewed and found to be an excellent procedure for controlling instrument line

installations and inspections. This procedure is very strong in the area of QC inspection criteria and documentation.

d. Instrument line installations were inspected in the Containment Building, Auxiliary Building and main steam safety valve room in unit 1. All observed instrument line slope appeared to be in compliance with G-60 spec slope criteria.

e. Completed QCP-4.3 attachment A inspection checklists for the IX system were evaluated from the QC records vault. All checklists requiring slope inspection were accurately completed.

f. BLN employee concern files BLN-0212, 0213, 0335, 0411, 0514, 0539, and 0576 were reviewed for any additional information related to the concerns being evaluated. No additional information was gained from this review.

4.1.4.2 Conclusions

The generic applicability of instrument line slope employee concerns was not found to be factual at BLN. The program evaluated at BLN was well thought out, effectively implemented and assures the highest level of quality. |R1

4.2 Compression Fittings

While all employee concerns in this element were voiced as site-specific concerns, the ECTG evaluation process at each project was conducted as a generic evaluation. Consequently, the entire program for instrument line compression fittings was evaluated at all 4 TVA projects which included the review of site-specific concerns. |R1

Based on the findings and conclusions below, this issue was found to be factual at WBN, SQN, and BFN and was not found factual at BLN. | |R1

4.2.1 WBN-Compression Fitting Findings and Conclusions

4.2.1.1 Findings

A. Review of the files for Concerns IN-85-795-001 and IN-85-795-002 found that QTC had performed a field investigation at WBN of compression fittings. With support from DNC, QTC disassembled and examined 107 compression fittings and found 60 of the fittings incorrectly installed. Tubing was not deburred after cutting and was not correctly inserted into the fittings. Ferrules were not correctly installed in the fittings and the fittings were not properly tightened. In one case the ferrule was not recognizable. NCR-6278 was written September 9, 1985 to document the problems found during the QTC investigation. NCR-6278 and all concerns related to compression fittings were assigned to the WBN IP for evaluation and resolution. IP Activity 1240 was created to address the problems with compression fittings. |R1

Review of the file for Concern IN-85-514-001 found that this concern was to be addressed by the IP activity 1240 and NCR-6278. Review of the file for Concern PH-85-002-027 found no additional information. Concern IN-85-795-N04 was identified by NRC and no additional information was contained in the file.

Review of the file for SQN Concern JAM-85-001 found that this concern was similar to problems identified at WBN by NCR-6278. This concern had been addressed by the responsible supervisor as required by the employee concerns program in place at that time and the concern had been closed.

Review of the file for SQN concern HDE-85-001 found that this concern was similar to problems identified at WBN by the IP and documented on NCR-6278, Revision 1 dated January 30, 1986. This concern had been addressed by the responsible supervisor as required by the

employee concerns program in place at that time and the concern had been closed.

Review of the file for Concern XX-85-050-001 found that previous investigation and Report I-85-329-SQN dated February 13, 1986 had been performed by the NSRS. The NSRS determined that there was inadequate QA on the installation of compression fittings at SQN and, therefore, the concern was true. Review of the files for Concerns XX-85-050-002 and XX-85-050-003 found no additional information.

Review of the file for Concern IN-85-143-002 found that this concern would be addressed as part of the corrective action for NCR-6278.

B. No additional information was found during review of the QTC expurgated files.

C. WBN IP Activity 1240 was assigned responsibility for investigating and resolving all the problems associated with the use of compression fittings including the identified employee concerns and NCR-6278. A review of NCR-6728, the concerns and their previous investigations demonstrated that there was a serious problem with the installation of compression fittings at WBN. IP held a meeting with representatives from the WBN ONP, DNE and DNC to discuss the identified problems and determine required corrective actions. DNE decided to perform testing at TVA's Singleton Materials Laboratory to determine if the present incorrect installations identified in NCR-6278 would be acceptable for use as installed. DNE, ONP, and DNC would establish procedures and training programs to prevent further incorrect installations. IP would issue an evaluation report and track and coordinate all corrective actions.

During the IP, a new problem with the use of compression fittings was identified by a foreman in the Instrument Maintenance Section (IM) of WBN ONP. The foreman had found that Parker CPI (CPI) tube end reducers were being used with Imperial Eastman (I-E) nuts and ferrules. NCR-6278, Revision 1 was issued to document this new problem and was assigned to the IP for resolution. DNE agreed to perform testing on this installation to determine acceptability for use as installed.

Testing of compression fittings assembled both correctly and with the problems identified in NCR-6278, Revision 0 and NCR-6278, Revision 1 was performed at TVA's Singleton Materials Laboratory (SME). The fittings were subjected to axial tension test (pullout test), low-amplitude vibration test simulating extended plant operation, and high amplitude cyclic test simulating a seismic event. The results of test for correctly and incorrectly assembled fittings were compared and although some decrease in strength was noted, the incorrect assemblies were found to be acceptable when assemblies were leak tight. Flow test were also performed on tubing that was not deburred, and results were found to be acceptable.

IP reviewed the test results from SME and agreed that the incorrectly installed compression fittings were acceptable, if proven not to leak by hydrostatic testing or plant operation. IP discussed hydro testing with DNC and found that some instrument panels may not have been hydro tested past the panel isolation valve. Because of this, WBN will inspect all safety-related instrument panels for leaking fittings during the next heat-up and pressurization of unit 1. DNC was responsible for inspecting any unit 2 panels which were not hydro tested. Since the drain and vent lines were not hydro tested, ONP and DNC agreed to disassemble and inspect compression fittings in drain and vent lines for potentially radioactive systems.

IP reviewed DNE, DNC, and WBN ONP procedures and found that no requirements existed controlling the installation and inspection of compression fittings. To correct this problem, DNE revised General Construction Specification G-29 to detail the design requirements for compression fittings. WBN ONP then issued a Modifications and Additions Instruction, MAI-29 to implement these requirements and provide installation instructions and inspection requirements for work performed on unit 1. DNC revised Quality Control Instruction WBN-QCI--3.13-6 to include the installation and inspection requirements of G-29 for work performed on unit 2.

During evaluation of the compression fitting problems, IP found that no training had been provided to craft personnel. WBN ONP had just started teaching Power Operations Training Center Mechanical Maintenance Training (MMT) course MMT-28, "Initial Tube Fitting Installation" to craft personnel. To help prevent further problems with the installation of compression fittings, both WBN ONP and DNC agreed to require training for all craft personnel performing compression fitting work. DNC prepared a Craft Training Module CTM-61-07 using MMT-28 as a guide.

Details of the IP evaluation for compression fittings are contained in "Compression Fitting Evaluation Report" (RIMS F01 851211 601). This report also contains a copy of Action Plan for corrective actions and the minutes of meeting held to discuss resolution of compression fitting problems.

D. Reviewed the TVA and ASME Code requirements for hydro testing of drain lines and found that drain lines are not required to be hydro tested because they are TVA class G and H lines. The ASME code does not require these lines to be pressure tested. These lines are open-ended and

are not subjected to pressure. Also, the drain lines are only used periodically to drain small amounts of liquid from instruments prior to maintenance. Therefore, the potential for the leakage of contaminated water from drain lines with incorrectly installed fittings is minimal. Any incorrectly installed compression fittings in potentially radioactive systems were repaired during inspection of drain and vent lines performed as required by IP for corrective action designated in NCR-6278. |R1

E. Reviewed the design and installation of drain lines for unit 1 and 2 and found that drain lines for most instrument panels in unit 1 were |R1
originally connected to the radioactive waste |
drain system. NCR-W-130-P was written July 20, 1983 to document this problem, and drawings were changed to show that only the drain lines for radioactive systems were to be |
connected to this drain system. The drain lines |R1
for other systems were removed from the rad waste |
drain system in both units. The work for unit 1 was verified to be complete during the walkdown performed on the drain and vent lines for corrective action to NCR-6278.

F. The recommendations in the NSRS and GCTF reports were satisfied by the corrective actions specified in the IP Action Plan for compression fittings (1240-AP).

4.2.1.2 Conclusions

A. Installation

Compression fittings were not installed in accordance with the manufacturers' recommendations. Tubing was not deburred after cutting and was not correctly inserted into the fittings. Ferrules were not correctly installed in the fittings and the fittings were not properly tightened. Tube end reducers were used with different manufacturers' ferrules. Therefore, these concerns were factual. |R1

Testing was performed that showed that the present installation was acceptable if not leaking. Hydro testing has been performed on most lines. Inspections will be performed on panels for safety-related instruments and drain and vent lines for potentially radioactive systems. No major rework of compression fittings is required, but leaking fittings will be replaced through normal maintenance when found.

No formal training program existed during construction so this concern was factual. Both ONP and DNC established training programs and requirements for craft personnel performing compression fitting work in response to the identified problems. |R1 |R1 |

B. Quality Assurance

No TVA requirements for the installation and inspection of compression fittings existed. Neither ONP nor DNC had any procedures establishing the QA inspection requirements for compression fittings. Therefore, these concerns were factual. DNE has issued a specification detailing the design requirements for compression fittings. ONP and DNC have issued procedures detailing the installation and QC inspection requirements for compression fitting work. |R1 |R1 |R1

C. Hydro Testing

There are no TVA or ASME Code requirements to hydro test drain and vent lines. Because the drain lines are not subjected to pressure and only used to drain small amounts of liquid from instruments prior to maintenance, the potential for leakage of radioactive water is minimal. This concern was not considered factual. |R1

D. Drain Line Installation

The installation of drain lines on unit 1 was redesigned and corrected. A walkdown of these lines corrected any minor installation problems with compression fittings. Therefore, this concern was not found factual. |R1

4.2.2 SQN - Compression Fitting Findings and Conclusions

4.2.2.1 Findings

A. Cognizant IM personnel stated that problems had been identified with the installation of compression fittings early in the plant life. These problems had been discovered and repaired during normal maintenance. They also stated that they don't have many leaking or bad fittings now. Some incorrect installations have been found on new installations by modifications. MM or Modifications personnel did not report any problems. |R1

B. The "Compression Fitting Evaluation Report," dated January 13, 1986 (Olson to Abercrombie), stated that 306 fittings were inspected and only 5 defects were found. Personnel involved in the survey stated that all the fittings surveyed had been installed by Modifications. The survey was performed in late 1984, during the unit 2 cycle 2 outage.

C. IM training instructor stated that he had written a training class on compression fittings in late 1984. This class became Power Operations Training Center class MMT-28 in August of 1985. The course has been taught to most of personnel involved with the use of compression fittings. IM supervisor stated that all instrument mechanics are required to have training. MM supervisor required all annual fitters to have the training, but not hourly employees. Modifications stated that most fitters had attended training, but it was hard to be sure because of changing personnel.

D. A personal visual examination of approximately 50-percent of the instrument panels on elevations 669 and 690 of the Auxiliary Building was performed and no problems were observed. No signs of leaking fittings on instrument or drain lines were found.

E. Three drawers of compression fittings were examined at Power Stores and fittings were not mixed with different sizes, brands, or materials in the same bins.

F. The Construction Procedures Index and the Inspection Instructions Index were reviewed and no procedures were found which addressed the installation of compression fittings. The procedures on instruments, instrument lines, and piping were reviewed and no requirements were found for the installation or inspection of compression fittings. The lack of procedures during construction was confirmed during a telephone interview with a former construction instrument engineer. Personnel of IM, MM, and MOD stated that they had no procedures for the installation or inspection of compression fittings.

G. QA personnel stated that they now require inspection on all new installations in the reactor coolant system; however, this requirement is not contained in any plant procedure. QA inspections are not required on any other installations or on remakes of already installed fittings.

H. No additional information was found in the QTC files for the concern. The findings of the NSRS and GCTF reports are consistent with the results of this evaluation.

1. This evaluation concurs with the recommendation of the GCTF report and with NSRS recommendations delineated in reports I-85-329-SQN-02, I-85-329-SQN-03, Q-85-514-001-02, Q-85-795-001-02, and |R1

I-85-329-SQN-04, that a formal training program for craft and inspection personnel involved in the installation and maintenance of compression fittings be implemented. The program should ensure and document that only personnel satisfactorily trained should perform compression fitting work. NSRS also recommended that plant procedures include the installation instructions and inspection requirements for compression fitting work.

2. NSRS recommendations for I-85-329-SQN-01 and Q-85-795-001-01 stated that NCR-6278 be reviewed for generic applicability. NCR 6278, revision 1, was transmitted to the other plants by DNE in memorandum from J. A. Raulston dated February 25, 1986 (B45 860225 259). At the time of this evaluation (October 1986), SQN had not performed the generic condition evaluation of NCR 6278, revision 1, as requested by the DNE memorandum. |R1 |R1

3. NSRS recommendation for Q-85-514-001-01 addresses WBN site-specific observations concerning two specific tubes and does not pertain to other plants. |R1

I. The IP Activity 1240 was assigned responsibility for investigating and resolving all the problems associated with the use of compression fittings. To determine if the incorrect installations identified at WBN on NCR 6278, revisions 0 and 1 were acceptable for use as installed, DNE established a testing program at TVA's Singleton Materials Laboratory (SME) beginning September 11, 1985.

Testing of compression fittings assembled both correctly and with the problems identified in NCR 6278, revision 0, and NCR 6278, revision 1 was performed at SME. The fittings were subjected to axial tension tests (pullout test), low-amplitude vibration tests simulating extended |R1

plant operation, and high-amplitude cyclic tests simulating a seismic event. The results of tests for correctly and incorrectly assembled fittings were compared and although some decrease in strength was noted, the incorrect assemblies were leaktight. Flow tests were also performed on tubing that was not deburred, and results were found to be acceptable. |R1

IP reviewed the test results from SME and agreed that the incorrectly installed compression fittings were acceptable, if proven not to leak by pressure testing or plant operation.

4.2.2.2 Conclusions

A. Compression fittings may not have been installed in accordance with the manufacturers' recommendations; however, these installations are acceptable if the joint does not leak. This evaluation and past operating history at SQN showed that the fittings were not leaking, and therefore acceptable. This issue was not found to constitute a remedial problem. |R1 |

B. No formal training program on compression fitting installation existed during construction, therefore, this concern was factual. A training class on compression fittings has been taught since January 1985. However, a formal program with personnel training requirements has not been established. |R1 |R1

C. SQN has never had any procedures delineating the QA requirements for the installation of compression fittings, therefore, this concern was factual. No procedures have been written to implement recently issued requirements in General Construction Specification G-29, Part 3.M.13.1, for the installation and inspection of compression fittings. (Note: WBN has committed to have instructions controlling compression fitting work). |R1 |R1