TVA EMPLOYEE CONCERNS
SPECIAL PROGRAM

REPORT NUMBER: 19200

REPORT TYPE: Subcategory - Construction

REVISION NUMBER: 2

TITLE: Conduit and Cable Tray

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REASON FOR REVISION:

Revised to Include TAS & SRP Comments and to Include Additional Evaluation at SQN Resulting From NRC Comments. (General Rewrite) Revision 1

Incorporate additional corrective action plans and minor revisions. Revision 2

(Finalize Report)

PREPARATION

PREPARED BY:

[signature]	SIGNATURE	7/13/87 DATE
[signature]	SIGNATURE	7/13/87 DATE
[signature]	SIGNATURE	7/17/87 DATE
	SIGNATURE	DATE

REVIEWS

PEER:

Charles A Mann / James E Blackburn	SIGNATURE	7-14-87 / 7/23/87 DATE

TAS:

James E Wortley III	SIGNATURE	7/28/87 DATE

CONCURRENCES

			CEG-H: Jack T. Howard	7-27-87
			SRP: Jimmie W. Jiggetts	7-29-87
SIGNATURE	DATE		SIGNATURE	DATE

APPROVED BY:

James R Russell	7-28-87		N/A	
ECSP MANAGER	DATE		MANAGER OF NUCLEAR POWER CONCURRENCE (FINAL REPORT ONLY)	DATE

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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.

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

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CONSTRUCTION SUBCATEGORY REPORT
19200

Conduit and Cable Tray

Executive Summary

Summary of Issues

This report evaluated a total of twenty-three (23) employee concerns. These concerns were divided into three (3) main groups consisting of: conduit, cable tray, and conduit fittings. The concerns were generally site-specific to Watts Bar Nuclear Plant (WBN) with two (2) exceptions which were specific to Bellefonte Nuclear Plant (BLN). The perceived problems related to each main group resulted in twelve (12) problem areas identified in the conduit group; two (2) problem areas in the cable tray group, and one (1) problem area in the conduit fittings group.

The twelve problem areas in the conduit group can generally be discussed collectively for specific and non-specific hardware concerns as: inadequate work practices or deficiencies, inadequate design guidance, rework of conduit systems, and quality problems related to conduit materials. Of the twelve problem areas, five produced negative findings at WBN and required additional corrective action. These five (5) areas were also deemed generic and were evaluated at all active TVA nuclear sites.

The two (2) problem areas in the cable tray group were not factual and were non- generic.

The one (1) problem area in the conduit fittings group was factual and generic to all active TVA nuclear sites except BFN.

Within the conduit group factual problem areas were determined to be: 1) conduits had excessive bends between pull points, 2) poor quality conduit materials had been received, 3) cable overcrowding had occurred, 4) flexible conduit installations were questionable, 5) deficiencies existed in the good industrial practice of protecting installed conduit. The one (1) concern voiced in the conduit fitting group revealed a deficiency related to the control of reactive metals within the confines of the Reactor Building.

The remaining issues and/or concerns were either not factual or TVA had properly addressed the issues and taken the appropriate actions.

The attached "Tracking Summary Table" lists the perceived problem areas and generally depicts the significance of each issue covered in this report.

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Major Findings

The evaluation of the conduit grouping of concerns revealed three (3) DNE design deficiencies which have the potential to adversely affect each active site's reliability and suitability-for-service related to the established requirements. The three deficiencies noted relate to the conduit installation criteria specified by DNE in the design output document G.C.S-G40 or the retroactivity (backfit) aspect of those established requirements pertaining to past installations. The question of "backfit" resulted from formerly deficient design output documents G.C.S.-G3 and N2E-860. The specific deficiencies noted were: 1) conduits had accumulated bends of more than 360° between cable pull points, 2) conduit overfill occurred because of inadequate DNE routing assignment controls, 3) and flexible conduit installations are questionable related to minimum length, bend radius, and the connector torquing requirements.

Concerns which dealt with the quality of conduit materials were substantiated to varying degrees from site to site and identified deficiencies involving the procurement process, receipt inspection, material issue, and/or installation procedures. Additionally, the employee concern related to conduit cleanliness revealed that an infraction had occurred in the good industrial practice program of providing protection to the conduit system when the permanent pull box covers, etc. were removed. This lack of protection allowed dirt and debris to enter the conduit introducing the potential to damage the cables during pulling activities.

Inadequacies were identified in the existing programs related to the DNE evaluation of retrofit (backfit) requirements of newly established or revised criteria related to the past installations of flexible conduits. In addition, programs which were developed to document conditions adverse to quality (CAQs) were neither effectively nor accurately assessed for significance or generic applicability. It was also noted that when problems were identified in the appropriate nonconformance reports, haphazard and inadequate responses from the affected sites masked or hampered the resolution of the issue identified. In some cases the correction methods specified by DNE (in response to the problems identified) were inappropriate to ensure consistent, complete and accurate resolutions. These inadequate correction methods did contribute to (at least in the major issue of flexible conduit) site procedure violations.

The single finding in the conduit fittings group was that DNE had not effectively controlled or accounted for non-coated zinc reactive metals within the confines of the containment vessel at all sites except BFN. This lack of control and accountability introduced the potential for more hydrogen to be produced within the confines of the containment than was anticipated by the calculation packages prepared by DNE.

Collective Significance of Findings

Weaknesses were identified in the DNE Electrical Design Organization, which resulted in inappropriate installation criteria and correction methods being issued. Deficiencies were present in the design output document related to excessive conduit bends, flexible conduit installations and the perceived

problem associated with the use of reducing bushings (actually determined to be a result of cable overcrowding). These deficiencies were in turn propagated throughout the work controlling procedures utilized by the construction forces. These conditions resulted in the need for post-construction walkdowns, re-inspections, engineering evaluations, and laboratory tests. All of these activities contribute to the potential for plant rework and may affect each active TVA nuclear site's reliability or suitability-for-service given the established requirements. The issues of excessive conduit bends and overcrowding of the conduit system places some of the installed cables at all active sites in an indeterminent status. The potential exists that the allowable cable side wall pressures may have been exceeded during the cable pulling activities. DNE is presently evaluating these and other similar cable problems to determine each site's needs to meet those reliability or suitability-for-service requirements. Further discussions related to cable overcrowding is contained in the Construction Category Cable Report 10900.

The adequacy of flexible conduit installations at all active sites was also indeterminate and requires a re-evaluation by DNE. Reconsideration must be given to all aspects of the installation process to ensure the intent of the established requirements are met. The evaluation of this issue is underway by DNE at SQN and this baseline evaluation program will probably provide a basis for evaluating similar conditions at other sites.

The suitability for service of each active site was not compromised by the deficiencies associated with poor quality conduit materials nor the poor work practices associated with conduit cleanliness. As related to the introduction of uncontrolled die cast zinc (reactive metals) inside containment at WBN, SQN, and BLN, it is significant to note, that more hydrogen may be produced during a design basis event than was anticipated. DNE was ineffective in establishing adequate controls for such materials and additional engineering evaluation is required to determine the impact on post accident plant operation.

The programmatic deficiencies identified throughout this report can be summarized as: inadequate control of the retroactivity (backfit) of newly established or revised requirements; inadequate identification, control, and determination of those corrective actions required; and inadequate responsibility assignment to determine how wide-spread (generic) or significant deficiencies are throughout the TVA organization.

An overview of the technical deficiencies contained in this report indicate that each active TVA nuclear site's reliability or suitability for service would not have been compromised had the design output documents accurately reflected the needed requirements. Additionally, had the proper DNE evaluation of the flexible conduit issue taken place in 1980 as requested by NSRS, and in subsequent revisions to those established requirements, the question of suitability-of-service related to this issue would have been resolved well before the start-up schedule.

Employee effectiveness in the constructing organization indicated that the construction work control was adequate to ensure that the minimum requirements established by DNE were met when these requirements were properly included in construction specifications. The employee effectiveness was compromised when DNE directives were supplied via the memo type approach.

Causes of the Major Findings

Conduit problems such as excessive bend violations and flexible conduit installation deficiencies generally resulted from the lack of adequate guidance and criteria in the design output documents G.C.S-G40, G.C.S.-G3, and N2E-860 (within the timeframes that each was effective). The associated work controlling procedures were in turn inadequate in those areas. The chronological events relative to the flexible conduit issue indicated that as problems were identified, timely, adequate and effective responses to completely resolve the issue were not provided. The DNE evaluation related to the revised or newly established criteria was sometimes inadequate to ensure that past flexible conduit installations would perform their intended function. Problems which were identified in appropriate non-conformance reports were inadequately reviewed for significance and generic applicability and may be attributed (in part) to the inadequate coordination and communication of the design and construction efforts. The site responses were either not adequate to fully address the issue or non-existent (i.e.; not documented). In some cases, the correction methods specified by DNE were inappropriate to ensure that past flexible conduit installations were acceptable.

Related to the quality aspect of conduit materials, procurement controls, receipt inspection, and in some cases the installation procedures were not adequate to prevent or detect suspect conduit materials before issue or installation. Inconsistencies were also identified related to the application of the DNE requirements (established by memo) for procuring conduit and associated hardware from a QA approved vendor.

Conduit cleanliness concerns basically resulted from deficiencies in a "good industry practice" program which would require protection of permanent plant material and equipment. The work controlling procedures were inadequate to provide this protection when the conduit systems were installed or if the permanent pull box covers etc., were removed.

The issues of conduit overfill resulted from inadequacies in the DNE Cable Routing Program and is discussed in the Construction Category Report 10900 entitled "Cable".

The lack of control of reactive metals within the confines of containment was attributed to inadequate DNE procurement controls and procedural guidelines for limiting or identifying the use of the noted fittings inside containment.

Corrective Action of Major Findings

In general, to provide assurance that each active TVA nuclear site is suitable-for-service (given the established requirements) related to the installed conduit systems, requests were made for DNE to evaluate past conduit installations that have the potential to adversely affect the safety of plant operations. In response to the problems identified as excessive conduit bend violations and conduit overcrowding, DNE is evaluating the entire cable installation program and in so doing will effectively address these as well as other similar cable problems. The issue of flexible conduit installations prompted a request for DNE to perform a complete re-evaluation of the existing

installations related to 10 CFR 50.49 equipment and pipe mounted devices. Commitment was made by DNE to thoroughly investigate this issue and establish complete and acceptable guidelines for each site to utilize in order to qualify or evaluate existing installations. Commitment was also made by DNE to identify and rework any deficient conduit system or flexible conduit installation.

In order to assure that the identified programmatic deficiencies related to the improper evaluation of retroactivity (backfit) of new or revised requirements and the improper control of conditions adverse to quality; DNE and ONP (respectively) were requested to ensure the proper evaluation was performed and documented, and that a clear line of responsibility was established to ensure accurate resolution of those problems identified as CAQs. In response to those requests, the appropriate DNE engineering requirements procedures were revised to clearly indicate that the proper evaluation of all new/revised requirements was required and that this evaluation would be documented. This documentation is now required to contain the logical reasoning in support of the actual determination of retroactive (backfit) application. ONP responded to the CAR deficiency by describing the current CAQR program which places the responsibility of the determination of generic applicability and significancy of the condition within two (2) organizations within TVA and stated that the tracking of those deficiencies would be performed in a single program.

The inconsistencies identified related to the procurement of quality conduit materials and deficient site work controlling procedures were requested to be strengthened. The response from DNE generally imposed more stringent controls for the procurement of conduit materials. This was to be accomplished by deleting the section in the material specification which allowed the waiver of any and/or all of the inspections, tests or tests reports. Additionally, the appropriate design output document would be changed to require adherence to the revised material specification. In light of those quality assurance requirements, (i.e., documentation) DNE committed to investigate the industry practice, and TVA's specific needs to determine whether further upgrading will be required for conduit procurements. Commitments were made from each affected site to strengthen the appropriate work controlling procedures in an effort to identify defective or suspect conduit materials. Similarly, each affected site committed to strengthen the work controlling procedures (utilized to install conduit systems) to provide added protection of the installed conduit by placing permanent or temporary covers on all openings in an effort to prevent dirt or debris from entering the conduit system.

Discussion of the corrective action required to resolve the conduit overfill issue is contained in the Construction Category Report 10900 entitled "Cable".

In order to provide a more accurate estimate of hydrogen release within the confines of the containment vessel during a design basis event, requests were made for DNE to implement more stringent controls for non-coated zinc reactive metals and to evaluate the potential effect of an indeterminent amount of die cast zinc conduit fittings within the confines of the Containment Building. In response, DNE committed to revise the design output document G.C.S-G40 to control zinc materials inside the Reactor Building and to utilize TVA

specification 21.001 for conduit material procurements to ensure only coated materials were supplied by vendors. A commitment was also made to evaluate or obtain accurate inventories of die cast zinc (reactive metals) inside the containment and include their inventory in the hydrogen calculation packages. Additionally, procedures would also be developed to describe or control the inventory and/or calculation methods used for future updates of the appropriate calculation packages.

CORRECTIVE ACTION TRACKING SUMMARY
REPORT 19200
CONDUIT AND CABLE TRAY

Executive Summary Table

ISSUES	SR	NS	FINDINGS	CAUSE	CORR ACT.	SIGNIFICANCE	COLLECTIVE SIGN.
(a) Fish tape, pulling hooks, and other pulling devices in conduit were not removed between cable pulls.	X		Acceptable practice. All cables receive a functional and/or pre-operational test. Installed cables nor their functions were compromised by the presence of fish tape, etc. This issue was factual but not a problem and considered non-generic.	None	None	None	None
(b) Conduits had accumulated bends in excess of 360° between pull points.	X		Factual at WBN, BFN, SQN, and BLN. Issue was generic.	Inadequate design output documents and site work controlling procedures.	DNE to complete the evaluation of the cable side wall pressure testing conducted at Central Lab and disposition the installed conduit at WBN, SQN, BFN, and BLN. Rework conduit systems as required. (CATD 19200-NPS-01, 19201-SQN-05) SQN incorporate bend criteria into M&AI-6. (CATD 19201-SQN-04). BFN revised M&AI-27 as a result of this evaluation. No CATD was required.	Contributed to the potential to exceed the maximum cable side wall pressure allowables (values).	Some conduit installations at all active TVA sites are questionable.

CORRECTIVE ACTION TRACKING SUMMARY
REPORT 19200
CONDUIT AND CABLE TRAY

Executive Summary Table

ISSUES	SR	NS	FINDINGS	CAUSE	CORR ACT.	SIGNIFICANCE	COLLECTIVE SIGN.
(c) Conduit congestion and major rework occurred partly because TVA compromised specifications and accepted off-scale equipment. Note - Compromised specifications and off-scale equipment was perceived to relate to piping or any permanent plant feature which was not installed per established DNE guidelines.	X		Rework occurred since conduit is installed field routed on a management assumed risk basis. No instances of rework resulting from compromised specifications were found. Issue was considered non-generic.	None	None	None	None
(d) Conduits issued to the craft were damaged and made of poor quality or inferior materials.	X		Site work controlling procedures (except BFN) exhibited weaknesses in either the procurement, receipt, issue or installation processes. Strengthening those procedures was deemed necessary to more accurately detect damaged or defective	Deficient DNE Directives	SQN to revise AI-11 to establish specific guidelines for receipt inspection of conduit materials. (CATD 19201-SQN-01) SQN to initiate appropriate training for conduit installations i.e., G40	Installation difficulties had been encountered. The potential to damage the cable during pulling activities was present due to defects such as burrs, sharp edges, etc. This evaluation revealed	Three of the four active TVA nuclear sites exhibited weaknesses in site procedures involving procure-

Executive Summary Table

ISSUES	SR	NS	FINDINGS	CAUSE	CORR ACT.	SIGNIFICANCE	COLLECTIVE SIGN.
(d) Continued			conduit and associated hardware. DNE directives to procure conduit from a QA approved vendor was not consistently utilized for procuring conduit systems. Issue was generic.		requirements. (CATD 19201-SQN-06) BLN to revise BNP QCP 1.1 to assign the responsibility for determining the material storage level requirements. Also, BNP 10.12 required revision to detect material defects at the time of issue. In addition, BNP-QCP-3.32 and BNP-QCP-3.2 required revision to inspect conduit and fittings for irregularities that have the potential to damage the cable at the time of installation. (CATD 19200-BLN-01) WBN to strengthen the receipt inspection procedure WBN-QCP 1.06 to identify conduits defects. (CATD 19200-WBN-03). Corporate DNE was requested to re-emphasis the directive to procure conduit and fitting	that all installed cables receive either a pre-operational or a functional test and this provides assurance that the installed cables will perform their intended function. Plant safety was not compromised.	ment, receipt, issue, and/or installation of conduit systems.

Executive Summary Table

ISSUES	SR	NS	FINDINGS	CAUSE	CORR ACT.	SIGNIFICANCE	COLLECTIVE SIGN.
(d) Continued					from a QA approved vendor by properly placing the requirements in the appropriate design output documents. (CATD 19200-NPS-06)		
(e) Conduits were not installed in accordance with as-designed drawings with respect to junction box/ conduit interface.	X		The ERT investigation report revealed a particular conduit perceived as an improper installation. DNE issued drawings and inspection of the specific conduit identified no deficiencies. This concern was not factual. Issue considered non-generic.	None	None	None	None
(f) Improper spare conduit fire barrier plugs were installed.	X		The proper fire barrier plugs are specified by DNE and were observed in the field. Temporary caps were used during construction but were removed before transfer to nuclear power. This concern was not factual. Issue considered non-generic.	None	None	None	None

CORRECTIVE ACTION TRACKING SUMMARY
REPORT 19200
CONDUIT AND CABLE TRAY

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ISSUES	SR	NS	FINDINGS	CAUSE	CORR ACT.	SIGNIFICANCE	COLLECTIVE SIGN.
(g) Cable over-crowding occurred because of the use of reducing bushings and undersized wall sleeves.	X		The use of reducing bushings was factual but acceptable since it posed no threat to the pulled cable as long as requirements in applicable design standards and procedures for conduit fill and maximum pull tension were met. No undersized wall sleeves were noted during the evaluations. The issue of cable over-crowding was generic because of improper routing assignment by DNE and did not result from the use of reducing bushings nor undersized wall sleeves. See the Construction Report 10900 "Cable" for complete evaluation.	Improper DNE routing assignment (Reference CO10900)	See report CO10900	The allowable maximum cable side wall pressures may have been exceeded during installation activities.	Overcrowding of the conduit systems places some of the installed cables at all active TVA sites in an indeterminant status.

Executive Summary Table

ISSUES	SR	NS	FINDINGS	CAUSE	CORR ACT.	SIGNIFICANCE	COLLECTIVE SIGN.
(h) Flex conduit couplings were not properly torqued and conduit may not be completely screwed together.	X		G.C.S-G40 did not effectively address each manufacturer's torquing requirements (such as Thomas & Betts) and the required information may not have been available or utilized at all active TVA nuclear sites. Because of the WBN evaluation, incompletely screwed together conduit was perceived to be in reference to flexible conduit installations. Issue was generic.	Deficient DNE guidance.	DNE to revise G.C.S-G40 to properly address the torquing requirements of flexible conduit assemblies. (CATD 19201-NPS-02)	No assurance exist that each site was aware of the torquing requirements (values) and this may have resulted in recent findings of loose conduit couplings by NRC at SQN.	Past flexible conduit installations at all active TVA nuclear sites require re-evaluation by DNE.
					DNC-BLN to revise the applicable site installation/ inspection procedures to require torquing of flex conduit couplings to manufacturer's instructions. (CATD 19200-BLN-03)	Torquing of the flexible conduit couplings at BLN was not performed to any prescribed value.	Some flex conduit assemblies may not perform their intended function.
			SQ-CAR-87013 was not properly evaluated for significance or generic applicability.	Failure to identify common use of G.C.S.-G40 and it's deficiency. In addition, the established	SQN was requested to reevaluate the significance and generic applicability determination of SQ-CAR-87013 in order to allow the established program to address torquing deficiencies at all	Inadequate determination of significance and generic applicability allowed questionable flexible conduit installations to go unidentified and not properly evaluated at other affected TVA sites.	Some flex conduit assemblies may not perform their intended function.

Executive Summary Table

ISSUES	SR	NS	FINDINGS	CAUSE	CORR ACT.	SIGNIFICANCE	COLLECTIVE SIGN.
(h) Continued				program did not effectively ensure the accuracy of this determination.	active TVA nuclear sites. (CATD 19201-SQN-07)		
			Timely and adequate response by DNE to the NSRS request to evaluate past flexible conduit installations for thermal movement considerations in 1980 was not provided. This resulted in significant and reportable NCRs being generated at WBN in December of 1985 after an unresolved item was issued by the NRC. This unresolved item resulted in NRC violation 390/86-02. These deficiency reports documented violations of flexible conduit assemblies involving thermal movement and minimum bend radius considerations. Approximately six months later BFN issued	Backfit application of the newly established requirements in GCS G-40 SRN-2 and in subsequent revisions to GCS G-40, was not adequately performed by DNE. Note - These newly/revised requirements were not	DNE was requested to clearly list in the construction specification revision blocks all new/revised requirements/criteria contained in the new revision and to include a positive statement if the criteria is required to be retroactive or not. The evaluation of backfit application was requested to be documented and contain the logical reasoning in support of this determination. (CATD 19200-NPS-04)	Flexible conduit assemblies may not be installed to accomodate the required thermal and seismic movement of 10 CFR 50.49 (safety-related) equipment and pipe mounted devices. This fact as well as the potential minimum bend radius issue may result in unqualified stresses being imposed on the affected 10 CFR 50.49 devices and/or the associated cables.	Each active TVA nuclear site's suitability-of-service (given the established requirements) was affected by untimely and inaccurate evaluation of those requirements established in 1980 and in subsequent revisions to those

Executive Summary Table

ISSUES	SR	NS	FINDINGS	CAUSE	CORR ACT.	SIGNIFICANCE	COLLECTIVE SIGN.
(h) Continued			SCR BFNEEB8632 to document deficiencies of seismic and thermal movement criteria and minimum bend radius for installed flexible conduit assemblies.	adequately addressed in former design output documents G.C.S. G-40, G.C.S. G-3, nor N2E-860 (for SQN).			requirements (related to the entire flexible conduit issue). It should be noted that had the proper DNE evaluation been conducted as problems were identified, the question of suitability-of-service would have been resolved well before the startup schedule.
			Inadequate determination of the significance and generic applicability of conditions described on nonconformance reports or	The established programs did not ensure the	ONP was requested to assign the responsibility to a single organization for coordination,	Various aspects of the deficiencies identified thru investigation of the flexible conduit	DNE must establish a qualification plan to evaluate

Executive Summary Table

ISSUES	SR	NS	FINDINGS	CAUSE	CORR ACT.	SIGNIFICANCE	COLLECTIVE SIGN.
(h) Continued			related documents was noted during investigation of the flexible conduit issue. Additionally, generic responses from the affected organization (when conditions were deemed generic) were inadequate or nonexistent; i.e. not documented.	accuracy of this determination nor did they effectively assign the responsibility of this task. Weaknesses were also noted in those programs related to tracking these deficiencies until completion.	followup, and documentation of adverse conditions for all sites (including the generic applicability review of NRC items). (CATD 19200-NPS-05)	issue were not or would not have been addressed at all active TVA sites (given the implementation of the established programs.) This deficiency contributed to a piecemeal approach to the flexible conduit issue resolution.	the major flexible conduit issue at all active TVA Nuclear Sites. Given the established requirements each TVA site's suitability-for-service is questionable.
			Correction methods specified by DNE were not adequate to address deficiencies identified as violations of minimum bend radius' nor that 10 CFR 50.49 floor mounted equipment where the flex conduit connection was located at a point less than 6 feet above the	No clear cause was determined. It was conceivable that Revision 1 to WBN NCR 6529 which added	DNE corporate was requested to reevaluate the correction methods specified in the W. S. Raughley memorandum dated 5/14/86 and establish accurate criteria for all sites to follow to	Floor mounted 10 CFR 50.49 equipment was not properly evaluated by DNE to ensure adequate thermal and seismic lengths were verified after installation. Additionally, complete evaluation	All four active sites were affected by inadequate correction methods specified by DNE and a total re-evaluation

ISSUES	SR	NS	FINDINGS	CAUSE	CORR ACT.	SIGNIFICANCE	COLLECTIVE SIGN.
(h) Continued			floor. Note - flex conduit connections in this range must accomodate a 1-inch movement.	minimum bend violations was inadvertently omitted or was not known to the preparer of the required corrective actions. Similarly, the preparer of the corrective action plan may not have been aware that assurance did not exist that the flex conduit minimum length criteria for floor mounted 10CFR50.49	ensure that existing flexible conduit installations meet the intent of the established requirements. (CATD 19201-NPS-01) DNE was requested to revise the installation guidelines related to the disposition of NCR BFNEEB8632 to include all 10 CFR 50.49 equipment. (CATD 19200-NPS-02) SQN was requested to resolve the flexible conduit installation deficiency described in the W.S. Raughley memo dated 5/14/86 and include 10 CFR 50.49 floor mounted equipment in this evaluation. (CATD 19201-SQN-02)	of the generic implications of WBN NCR6529 was not performed in that the as-installed condition of flexible conduit assemblies (related to minimum bend radius') was not prescribed.	of the flexible conduit issue is required.

Executive Summary Table

ISSUES	SR	NS	FINDINGS	CAUSE	CORR ACT.	SIGNIFICANCE	COLLECTIVE SIGN.
(h) Continued				equipment was taken into consideration during installation activities.			
			During the walkdown conducted according to SMI-0-318-33 Revision 1 (issued to verify the adequacy of the flexible conduit installations at SQN), it was discovered that the minimum bend radius was not verified as required by the walkdown procedure. Approximately 75 percent of the affected equipment had been evaluated by DNE at SQN at the time of this finding.	This procedure violation occurred (in part) because of inadequate directions given by DNE in the W. S. Raughley memorandum dated 5/14/86. The preparer of the SMI inadvertently omitted this inspection. No clear directions	DNE was requested to evaluate this omitted inspection. (CATD 19201-SQN-08)	The minimum bend radius for flexible conduit assemblies at SQN have not been verified.	DNE will determine the MBR acceptability at SQN after restart by performing a mil-standard sampling program according to 105D. This sampling program may result in the re-evaulation of the conclusions drawn based on the previous walkdown data.

CORRECTIVE ACTION TRACKING SUMMARY
REPORT 19200
CONDUIT AND CABLE TRAY

Executive Summary Table

ISSUES	SR	NS	FINDINGS	CAUSE	CORR ACT.	SIGNIFICANCE	COLLECTIVE SIGN.
(h) Continued				had been given to inspect the M.B.R.			
(i) Covers were left off of conduits and pull boxes allowing dirt and other debris to enter.	X		The appropriate site procedures did not contain adequate instructions to prevent dirt and debris from entering the conduit system. The issue was factual and generic to all active TVA sites.	Inattention to a good industrial practice of providing protection to permanent plant material and equipment.	Installation procedures at WBN, BFN, SQN, and BLN were requested to be revised to provide adequate protection to the installed conduit systems. (CATDs; 19200-WBN-01, 19200-BFN-01, 19201-SQN-03, and 19200-BLN-02)	The installed cable systems were subject to potentially damaging effects of foreign debris entering the conduit. However, the completed cable systems were subject to a functional and/or preoperational test and this provides objective evidence that the installed cables will perform their intended functions.	All active nuclear sites displayed weaknesses in their attentiveness to provide good industrial practices to protect permanent plant equipment. Since this type of protection should be a part of all established programs, strengthening or establishing either a design requirement or corporate division level policy should be taken into consideration.

Executive Summary Table

ISSUES	SR	NS	FINDINGS	CAUSE	CORR ACT.	SIGNIFICANCE	COLLECTIVE SIGN.
(j) Conduits were not properly sealed to prevent water from entering.	X		Temporary construction activity allowed water to enter unsealed conduits at junction boxes 5317, 5318, and panel 2-L-344 at WBN. Proper DNE evaluation was performed and no detrimental effect was determined. Permanent protection was provided by removing the temporary condition and installing permanent sheltering and covers. This issue was factual and proper action was taken by TVA. Issue considered nongeneric.	Temporary construction condition.	None	None	None
(k) Installed conduit was subsequently removed and reworked	X		No specific conduit was identified throughout this investigation. However review of the BLN investigation report indicated that the conduit was located in the Decontamination Room which was subject to major conduit rework per DNE ECN 1951 issued in November 1983. No conduit was identified where major rework was not specified by DNE. The concern as investigated was not considered factual and was deemed nongeneric.	None	None	None	None

CORRECTIVE ACTION TRACKING SUMMARY
REPORT 19200
CONDUIT AND CABLE TRAY

Executive Summary Table

ISSUES	SR	NS	FINDINGS	CAUSE	CORR ACT.	SIGNIFICANCE	COLLECTIVE SIGN.
(l) Undersized conduit penetrations are being used creating the potential for cable overcrowding.		X	DNE allowed the use of 1-1/2-inch conduit penetrations in a 2-inch conduit system at BLN. Introducing the potential to exceed the maximum allowed fill. Eight conduit penetrations were involved. Design calculations were performed as a result of this evaluation and revealed that the maximum fill had not been exceeded. The cable routing program was being updated to reflect the proper size conduit. This issue was factual but not a problem and specific to BLN.	DNE inadvertently failed to update the cable routing program.	DNE is presently updating the cable routing program. (No CATD was required)	None	None
(m) Erickson - Type conduit fittings thought to be aluminum may not be properly controlled.	X		Fittings were determined to be die-cast zinc and not properly accounted for in the inventory process used by DNE to estimate the amount of hydrogen release following a borated water spray (i.e., post-accident condition). Calculation packages assume total consumption of reactive metals within containment and that con-	G.C.S. G-40 did not properly control reactive metals within the confines of the containment.	DNE to establish controls for reactive metals inside containment and incorporate these fittings into inventories at WBN and SQN and evaluate zinc inventories at BLN. Additionally, TVA specification 21.001 was suggested to be utilized for	More hydrogen may be produced inside containment at WBN, SQN, and BLN following a borated water spray than was anticipated by the calculation packages prepared by DNE.	DNE is required to evaluate this finding on post-accident plant operation.

CORRECTIVE ACTION TRACKING SUMMARY
REPORT 19200
CONDUIT AND CABLE TRAY

Executive Summary Table

ISSUES	SR	NS	FINDINGS	CAUSE	CORR ACT.	SIGNIFICANCE	COLLECTIVE SIGN.
(m) con't			duit fittings are coated similar to the conduit run. The concern was factual and generic to WBN, SQN, and BLN. NOTE-TVA specification 21.001 was not consistently utilized for conduit procurements to ensure only coated fitting were supplied by vendors.		conduit material procurements to ensure only coated materials were supplied. (CATDs; 19200-NPS-03, 19200-BLN-04, 19203-SQN-01, 19203-SQN-02, 19203-SQN-03, and 19200-WBN-02)		

1.0 CHARACTERIZATION OF ISSUES

1.1 Introduction

This subcategory report for Conduit and Cable Trays in the Construction Category addresses 23 concerns in safety-related areas. Twenty-one concerns were specifically identified at Watts Bar Nuclear Plant (WBN) and two were specifically identified at Bellefonte Nuclear Plant (BLN). These concerns pertained to material specifications, identification markings, installation and damage of conduit and cable trays. Of the 21 concerns generated at WBN, ten identified issues which were generic to other TVA sites. No generic implications were found related to the two concerns generated at BLN. The concerns were broken down into three elements and evaluated as follows: R2

Conduit	Cable Tray	Conduit Fittings
EX-85-052-002	IN-85-181-002	IN-85-374-002
EX-85-066-002	WI-85-100-022	
EX-85-092-001	IN-85-186-004	
EX-85-162-001		
IN-85-008-004		
IN-85-138-001		
IN-85-201-001		
IN-85-201-003		
IN-85-341-001		
XX-85-094-003 (Specific to BLN)		
IN-85-512-003		
IN-85-663-008		
IN-85-856-004		
IN-86-119-001		
IN-86-262-004		
IN-86-276-001		
OW-85-007-008		
IN-85-512-002		
BNP QCP 10.35-8-18 (Specific to BLN)		

1.2 Description of Issues

1.2.1 Conduit

The concerns noted specific and nonspecific hardware problems involving conduit. The employees questioned the installation methods and materials used in conduit installation activities. They also raised questions about potentially damaging the conduits/cables by using improper installation methods.

One concern reported fish tape, pulling hooks and other cable pulling devices were left in conduit between cable pulls. The concern also reported that conduit was so full that some pulling devices may not have been removed. This part of the concern was related to conduit overfill and will be addressed in the Construction Category Cable Pulling Issue Report No. 10900. The cleanliness aspect of the concerns was attributed to the lack of controls to ensure condulet covers (etc.) were installed. Conduit installation, potential damage, and material problems perceived were:

a. Fish tape, pulling hooks, and other cable pulling devices in conduit were not removed between cable pulls. (Non-Generic)

b. Conduits had accumulated bends more than 360 degrees between cable pull points. (Generic)

c. Conduit congestion and major rework occurred partly because TVA compromised specification and accepted "off-scale" equipment. (Non-Generic)

Note - Compromsied specifications and off scale equipment was perceived to relate to piping or any permanent plant feature which was not installed according to the established DNE guidelines. | R2

d. Conduits issued to the craft were damaged and made of inferior materials. (Generic)

e. Conduits were not installed in accordance with as-designed drawings with respect to junction box/ conduit interface. (Non-Generic)

f. Improper spare conduit fire barrier plugs were installed. (Non-Generic)

g. Cable overcrowding occurred because of the use of reducing bushings and undersized wall sleeves. (Generic)

h. Flex conduit couplings were not properly torqued and conduit may not be completely screwed together. (Generic)

i. Covers were left off of conduits and pull boxes allowing dirt and other debris to enter. (Generic)

j. Conduits were not properly sealed to prevent water from entering. (Non-Generic)

k. Installed conduit was subsequently removed and reworked. (This was a BLN-specific concern.) (Non-Generic)

l. Undersized conduit penetrations are being used, creating the potential for cable overcrowding. (This was a BLN-specific concern.) (Non-Generic)

1.2.2 Cable Trays

The three concerns pertaining to cable trays questioned the proper installation and identification markings. (Non-Generic)

Problems perceived to exist were:

a. Cable tray wall penetrations were not properly installed because the fire barriers have gaps between board pieces greater than 1/8-inch and wall and floor penetrations are stuffed with cotton.

b. Cable tray wall penetrations were not identified by name or number.

1.2.3 Conduit Fittings

One concern questioned the use of specific fittings as follows: (Generic)

o Erickson-type fittings, discovered to be non-magnetic, were thought to be aluminum. Aluminum is a material which is undesirable in the Reactor Building because it would react with Boron and increase the hydrogen concentration inside containment in the event of an accident.

2.0 SUMMARY

2.1 Summary of Issues

The issues evaluated in this report pertained to concerns questioning the adequacy of the installation, material, and damage to potentially safety-related conduit, cable trays, and conduit fittings.

2.2 Summary of the Evaluation Process

The methodology generally used was to determine the applicable upper-tier and site procedures, and industry standards associated with the concern or related issue. A review of the procedures was then performed to determine if the issues raised were procedurally addressed. Listings of NCR's and work documents were reviewed to determine if previous documentation existed on the subjects. The expurgated Quality Technology Company (QTC) files were researched for additional information. Informal walkdowns were performed in some cases to verify the as-built condition of pertinent features and to substantiate conclusions. Cognizant personnel associated with the area of concern were interviewed and in some cases direct input was obtained from the Nuclear Regulatory Commission (NRC) related to specific issues.

When a determination was made that the perceived problem had been fully investigated and the findings completely addressed the issue, a conclusion was made.

This conclusion determined the concern to be factual or not factual. Factual meant the perceived problem was found to exist. A further discussion of whether the problem had or had not been previously addressed by TVA was included. Concerns (as stated) determined to be not-factual meant the problem was not found to exist. |R2

If the concern was found to be factual, a determination was made if an uncorrected problem potentially exists at other active nuclear plant sites. Problems such as procedural inadequacies of General Construction Specifications (design out-put documents) would potentially affect QA programs at each site and were evaluated accordingly. If a concern was deemed to have generic potential, investigations were made for all applicable sites and the evaluation process varied with the investigation results related to the specific topic of the concern.

Example: If a site specific hardware concern was evaluated and was found to be factual resulting from the lack of guidance in a design output document, the generic evaluation at other active TVA nuclear sites may have been performed by reviewing the appropriate work controlling procedures when no other related site specific concern was identified. Conclusions were then drawn based on the objective evidence discovered during the evaluation.

2.3 Summary of Findings

2.3.1 Conduit

The findings concluded that of the twelve perceived problem areas, five were found to present problems requiring additional corrective action. These five areas were also deemed potentially generic to other sites. The areas were:

a. Conduits had accumulated bends of more than 360° between cable pull points.

b. Flex conduit couplings were not adequately torqued.

Note: The evaluation of the Flexible Conduit Coupling Torque Issue revealed design output document deficiencies related to the minimum bend radius, and the minimum length requirements for flexible conduit assemblies pertaining to the qualification of past installations.

c. Conduits were of poor quality and/or inferior material.

d. Covers were left off of conduits and pull boxes allowing dirt and debris to enter the conduit systems.

e. Conduit overfill occurred because of inadequate DNE routing assignment controls.

2.3.2 Cable Trays

The findings concluded the perceived problems in this issue did not exist. Cable tray wall penetrations were found to be correctly installed and identified.

2.3.3 Conduit Fittings

Uncontrolled die cast zinc procurement was found and the potential exist for an indeterminate amount of zinc to have been installed inside containment at WBN, SQN, and BLN. It was established that the Erickson type fittings were made of die cast zinc rather than aluminum as perceived by the concerned individual. Since zinc or zinc coatings contribute to the hydrogen build-up inside containment following a

borated water spray, the appropriate design calculations/ inventory for hydrogen concentration should include these and other reactive metals. Present calculations for each site (except BFN which is exempt from this requirement) assumes the fittings in the conduit run to be zinc coated similar to the conduit and do not distinguish or include those fittings that were supplied as die cast zinc. Lack of controls and inspection requirements in the governing design output document allowed the potential for these "solid" die cast zinc fittings to have been procured and installed within the confines of containment. Since the established calculations assume total consumption of reactive metals inside containment during a Design Basis Event, (borated water spray) more hydrogen may be produced than was anticipated. The employee concern was considered factual related to this issue and generally three actions are required.

1. Ensure accurate inventories of reactive metals within the confines of containment are established and included in the appropriate calculation package (including future updates)

2. Revise design output document G.C.S.G-40 to effectively control reactive metals inside containment, and

3. Utilize TVA Procurement Specification Number 21.001 to prevent procurement of die cast zinc conduit materials.

2.4 Summary of Collective Significance

The Collective Significance for the issues in this subcategory revolves around the fact that design output installation procedures and material procurement controls have been recognized to be inadequate in the areas of providing effective guidance for certain conduit installation methods, providing QA specifications for conduit requisitions and receipt inspection, controlling installation of reactive metal fittings inside containment, and establishing installation criteria for flex conduit. Site work controlling procedures in turn were inadequate in the same areas as the design output procedures and also lacked controls required to protect installed conduit and cables. Management effectiveness for DNE and DNC organizations was in need of improvement for each area

mentioned above. Employee effectiveness was compromised and hindered by the inadequate procedures. It is significant to note, that had the design out-put documents been accurate, each sites reliability and suitability-for-service would not have been compromised. Close coordination of the Design and Construction effort could have assisted in the identification and resolution of those identified deficiencies.

It is also significant to conclude that the deficiency related to protection of permanent plant material (conduit cleanliness) was considered a breakdown in a "good industry practice" program.

2.5 Summary of Causes

2.5.1 Conduit

Conduit problems (such as excessive bend violations, and flexible conduit installation deficiencies) generally resulted from the lack of adequate guidance and criteria in the design output documents G.C.S.G-40, G.C.S.G-3, and N2E-860. The associated work controlling procedures were in turn inadequate in those areas. The chronological events relative to flexible conduit issue indicate that additional weaknesses were present in the established program as follows:

a. As problems were identified - timely, adequate, and effective responses and complete resolutions of the issue were deficient. Retroactivity of newly established requirements and/or the accompanying DNE "engineering evaluation" related to the flexible conduit issue contributed to flexible conduit installation deficiencies. This resulted in the engineering evaluations being performed after the fact (only after outside auditing agencies identified significant concerns). This fact indicates that the coordination and communication of the design and construction effort was inadequate. |R2

b. Problems which were identified in the appropriate non-conformance program were inadequately reviewed for generic implications and site responses were not adequate to fully address the issue or were non-existant (i.e., not documented). In some cases, the correction methods specified by DNE were inappropriate to ensure consistent, complete and accurate resolutions of the problems identified. These inadequate DNE guidelines resulted in and/or contributed to violations that related to failure to follow established procedures which were generated to investigate and resolve the issue at the site level.

Inspections did not effectively control the procurement and/or receipt of damaged or defective conduit or associated components and in some cases the installation procedures did not require an inspection for defects such as burrs or sharp edges which would be detrimental to the cables during pulling activities. It should be noted that both DNE and DNC were inconsistent in the application of the DNE requirement to procure conduit and associated hardware from a QA approved vendor requiring a certificate of conformance as established in March of 1978.

Conduit cleanliness concerns basically resulted from inadequate work controlling procedures which allowed dirt and debris to enter the conduit. This was considered a breakdown in a "good industry practice program" which would require protection of all permanent plant material and equipment. This type of requirement should be a part of all established programs.

Conduit overfill resulted from inadequacies in the DNE Cable Routing Program and is discussed in the Construction Category Report 10900 entitled, "Cable".

2.5.2 Cable Tray

No cause was assigned to the cable tray concerns. No problem existed.

2.5.3 Conduit Fittings

Conduit fitting problems, as voiced, were caused by inadequate DNE procurement controls and procedural guidelines for limiting or identifying the use of the noted fittings within the confines of the containment.

2.6 Summary of Corrective Action

2.6.1 Conduit

a. Conduit had accumulated bends of more than 360° between cable pull points.

DNE is to evaluate previously installed conduit violating the 360 degree bend requirement. This evaluation is pending results of sidewall pressure testing being conducted at Central Laboratory. Action is also required at SQN to incorporate the bend criteria into site procedures. (CATDs C019201-SQN-04, 05; and 19200-NPS-01)

Response:

DNE directed the Modifications and Additions Unit to revise M&AI-6 to require an inspection for the 360° bend criteria.

Walkdown instruction SMI-0-317-32 was issued and performed to identify conduits with multiple bends between pull points that have a potential safety impact. Commitment was made to rework deficient conduit system after the DNE evaluation as required.

TVA DNE is continuing resolution of the cable sidewall pressure testing issues steming from the testing at the Central Laboratory with the NRC and will provide any additional required corrective action. Calculations for BFN and BLN are yet to be completed.

b. Torquing of flex conduit coupling deficiencies were specifically noted at WBN, SQN and BLN. The work controlling procedure used at BFN acknowledged torquing of the flexible conduit coupling per the manufacturers instruction similar to the SQN established program. However, during evaluation of the implementation of the established program at SQN, it was discovered that the manufacturer's instructions were not effectively controlled and utilized during the installation process as noted on SQ-CAR-87013. Since the availability of the manufacturer's instructions is not effectively controlled, BFN's performance related to this issue is also questioned. The generic evaluation of this condition would address any CAQ condition at BFN, WBN, and BLN. Corporate DNE was requested to provide the necessary torque valves to the constructing organization by listing those requirements in the design output document (G.C.S.G-40).

(CATD - 19201-NPS-02)
(CATD - 19200-BLN-03)
(CATD - 19201-SQN-07)

Response:

G.C.S-G40 or the appropriate engineering requirements will be revised to list the applicable torque valves for flexible conduit couplings and SCR W-577P was issued to address this issue. DNE will evaluate the back-fit requirements of this issue.

BLN will revise site procedures resulting from revision of G.C.S-G40. Additionally, SQN deemed SQ-CAR-87013 to be generic to all sites and initiated this action.

In order to address the additional weaknesses of the established program related to timeliness, adequacy of response, and correction method specified by DNE the following actions were deemed necessary:

1. Corporate DNE was requested to clearly list in the construction specification blocks all new or revised requirements/criteria contained in the new revision and include a positive statement assessing whether or not these new requirements were to be retroactive. The DNE evaluation related to this retroactive determination was requested to be documented and contain the logical reasoning in support of that justification. Reference to this documentation was deemed necessary for retrieval and review and would provide valuable input to management personnel related to establishing the appropriate checks and balances to ensure the quality of the finished product. (CATD 19200-NPS-04)

   Response:

   Corporate DNE revised NEP 5.1 and 5.5 on March 5, 1987 (which governs how changes to construction specifications are made) to clearly distinguish the new or revised requirements and to require that the engineering evaluation related to retroactivity be documented. This action has been performed and is deemed complete by this evaluation.

   Note - Proper closure documentation for this action has been generated.

2. Corporate ONP was requested to designate responsibility to a single organization for coordination, follow-up, and documentation of adverse conditions for all sites, including generic reviews of applicable NRC items. (CATD 19200-NPS-05)

Response:

The current CAQR program limits the responsibility of generic reviews of CAQ's to two organizations and tracking of the adverse conditions will be through a single program.

3. Weaknesses that were identified in the DNE correction methods (related to the flexible conduit issue) resulted in a request for corporate DNE to establish acceptable criteria for all active TVA nuclear sites to follow which would ensure that past flexible conduit installations are in compliance with or meet the intent of the applicable specification revision notice (SRN-11). This action would fully address deficiencies which were present in the original design output documents as well as the inadequate directions given by DNE related to the generic implications of WBN-NCR-6529 and similar non-conformance reports. (CATD 19201-NPS-01, CATD 19201-SQN-02, CATD 19200-NPS-02)

   Response:

   DNE will re-evaluate the instructions given in the W. S. Raughley memorandum and develop a total plan to resolve this issue and TVA will generate CAQR's as required.

   SQN is performing a walkdown of flexible conduits in accordance with SMI-0-317-33 and will correct any discrepancies found.

   A random sample of flexible conduits at BFN will be inspected for thermal/seismic movement criteria on floor mounted 10 CFR 50.49 equipment less than 6 feet above the floor in addition to those requirements stated in the Raughley memorandum dated May 14, 1986.

Additional site specific action was deemed necessary at SQN related to the inadequate assessment of the significance and generic applicability of those conditions described on SQ-CAR-87013. Since G.C.S.G-40 is inadequate related to torquing flexible conduit couplings and is utilized at all active TVA nuclear sites; a request to the SQN Site Director was made to re-evaluate the significance and generically applicable determination. A re-evaluation of this CAR was deemed necessary to allow the established CAQR program to be effectively utilized to promptly identify the deficiency at all affected sites and track the successful completion of those required actions. (CATD 19201-SQN-07)

Response:

Re-evaluation of SQ-CAR-87013 by Electrical Modifications and QA determined that the condition described was non-significant but generic to other active TVA sites. The Quality Systems Branch was requested to initiate this generic review.

Revision to G.C.S.G-40 and site procedure M&AI-6 would be initiated to reflect the torquing values as shown in UL-514B. Backfitting of these requirements was not considered necessary at SQN based on plant maintenance but training to the appropriate personnel would be given.

Upon investigation of the flexible conduit issue related to CATD 19201-SQN-02 (which primarily addressed the implementation of the W. S. Raughly memo dated May 14, 1986), it was discovered that the minimum bend radius of the flexible conduit installations was not verified as required by the implementing special maintenance instructions (SMI-0-317-33 Revision 1). Response from the SQN Site Director was deemed necessary and resulted in the issuance of CATD 19201-SQN-08 to document this deficiency.

Response:

The bend radius inspection requirement will be eliminated from SMI-0-317-33 Revision 1. After plant restart, a flex bend radius sampling (per MIL-STD-105D) will be performed.

c. Poor quality of conduit materials.

In response to the findings on the quality of conduit material, WBN, SQN and BLN projects were requested to revise site procedures to inspect for conduit defects during material receipt, issue, and installation. Action was deemed necessary for corporate DNE to ensure consistent application of the quality assurance requirements associated with the procurement of conduit and accessories by revising design output documents to include the appropriate quality statements consistent with the DNE requirements established in March of 1978. (CATDs 19200-NPS-06, 19200-BLN-01, 19201-SQN-01; 19201-SQN-06, and 19200-WBN-03)

Response: Each affected site committed to strengthen the appropriate procedures to prevent/detect defective or suspect conduit material. Corporate DNE committed to revise the appropriate design output document to impose TVA Specification 21.001 for conduit procurements and to conduct an investigation to determine the quality assurance requirements in light of those directions given by memorandum in 1978.

d. The findings that conduit and pull box covers were left off allowed dirt and debris to enter installed conduits, and resulted in a request to revise site procedures at WBN, BFN, SQN, and BLN to incorporate requirements for providing the appropriate protection. (CATDs 19200-BLN-02, 19201-SQN-03, 19200-BFN-01, and 19200-WBN-01)

Response: Each affected site committed to strengthen work controlling procedures to provide protection or identify deficiencies related to conduit cleanliness.

e. Corrective actions for conduit overfill concerns will be supplied by Construction Category Report No. 10900 titled "Cable" in the cable pulling issue.

2.6.2 Cable Tray

No corrective action is required.

2.6.3 Conduit Fittings

The finding that die cast zinc conduit fittings were not included in inventories for reactive metals inside containment resulted in actions by DNE to establish controls for reactive metals in G-40 and to incorporate these fittings into inventories at WBN and SQN, and evaluate zinc fitting inventories at BLN. Additionally, it was suggested that TVA specification 21.001 be utilized to ensure that coated conduit materials were supplied by the contractor. (CATDs 19200-BLN-04, 19203-SQN-01, 19203-SQN-02, 19203-SQN-03, 19200-NPS-03, and 19200-WBN-02)

Response: Generally, G.C.S-G40 will be revised to provide more stringent controls of die-cast zinc materials inside containment. This revision to G.C.S.-G40 will address procurement of conduit materials and will require TVA Specification R2

Response-Con't:

21.001 to be utilized during procurement. A committment was made to distinguish die-cast zinc conduit materials in the inventories of reactive metals. Procedures would be generated describing the process used to control or describe calculation and inventory methods. R2

3.0 EVALUATION PROCESS

3.1 General Methods of Evaluation

The general evaluation methodology used at nuclear plant sites consisted of a compilation of applicable procedures and industry standards. A review of requirements was made to determine if the issues raised were procedurally addressed.

NCR logs were reviewed and potentially applicable NCRs were evaluated to determine if any previous documentation existed on the subjects.

Expurgated QTC files were reviewed for any additional relevant information or investigations that would assist in identifying specific items related to the concerns.

Walkdowns were performed with selected personnel to obtain additional information. This included discussions of acceptable practices and standards associated with the subjects of concerns.

Documents were researched as necessary to provide additional data or substantiate conclusions.

This generalized approach was used to understand the requirements, acceptable practices, historical and active corrective action, and to substantiate the conclusions of the investigation.

3.2 Requirements or Criteria Established for Individual Issues

Evaluation of the Conduit and Conduit Fitting issues involved specific investigation of the concerns at WBN and BLN, and generic evaluation of certain potentially applicable concerns at Browns Ferry Nuclear Plant (BFN) and Sequoyah Nuclear Plant (SQN). Generically applicable requirements or criteria are listed for all plants and any additional site-specific criteria is listed by plant site.

3.2.1 Conduit

TVA Division of Nuclear Engineering (DNE) General Construction Specification G-40 (G.C.S.G-40) "Installing Electrical Conduit and Conduit Boxes" establishes the requirements for field installation of conduit. A review of the procedure was performed to determine the requirements related to cleanliness, the maximum number of bends allowed between cable pull points, the use of reducing bushings, and flexible conduit installation criteria.

TVA DNE "Standard Procurement Specification for Rigid Steel Conduit (Zinc Coated)," No. 21.001, dated February 2, 1981, was reviewed to determine the detailed material requirements for purchasing conduit and fittings.

DNE Engineering Procedure EP 22.29, Revision 0, titled, "Procedures to Determine Acceptable Sidewall Pressure Exerted on Class IE Cables in Existing Conduit Installations," was reviewed to determine the methodology for establishing sidewall pressure calculations for cable inside conduit.

DNE's Engineering Procedure 5.01, "Purchase Requisition - Evaluation of Bids and Recommendation/Rejection of Contract Award - Revisions to Contracts," was reviewed to determine organizational responsibilities for specifying and purchasing conduit system components.

DNE Electrical Design Guide DS E13.1.1, "Cable Pull Point Location and Support," was reviewed to determine the design requirements for cable pull boxes.

National Electric Code, Article 350, was reviewed to determine the nationally recognized standard for cable pull points.

Underwriters Laboratory Standard (UL) UL-6 was reviewed to determine the recognized standard thread requirements for conduit.

WBN

Discussions were conducted with DNE's Conduit and Grounding Section Supervisor, Fire Protection Section engineers and Procurement engineers regarding cable sidewall pressure, use of fireplugs in spare conduits, conduit bend restrictions, purchase specifications, and inspection and storage requirements for conduit.

Watts Bar Site Quality Control Procedure WBN QCP-3.05, Revision 25, "Inspection of Cable Installation," was reviewed to determine the inspection requirements for verifying conduits were clean before cable pulls and to determine cable pull tension requirements.

Watts Bar Administrative Instruction AI-6.5, Revision 7, was reviewed to determine the responsibilities for review of equipment condition before transfer to the Office of Nuclear Power (ONP).

Watts Bar Quality Control Procedure, WBN QCP-1.52, Revision 6, "Preventive Maintenance," was reviewed to determine the requirements for inspecting flex conduit during routine plant maintenance inspections.

Watts Bar Quality Control Instruction, WBN QCI-1.06, Revision 1, "Receiving," was reviewed to determine the requirements for inspecting conduit for material deficiencies and defects.

Watts Bar MAI-13, "Installation of Conduit and Junction Boxes," was reviewed to determine the flex conduit torque requirements for work done by the Modifications Unit.

The DNC report for Concern IN-86-262-004 was reviewed to determine DNC's response in regard to fish tape and other pulling devices being left in conduit.

DNE's WBN calculation WBNPEVAR8602006, titled "Determination of Class IE Electrical Cable Weight/Foot and Outside Diameter" was reviewed to determine the data used to establish allowable cable sidewall pressures.

DNE drawing 45W874-3, Revision 7, was reviewed to determine the conduit identifiers at junction box 27 for WBN.

Crouse-Hinds Vendor Catalog 7F-5 was reviewed to identify the standard type metal fireplugs requisitioned for WBN.

QTC-ERT Investigation Report IN-85-008-004 was reviewed to assess the findings and conclusions for Concern IN-85-008-004.

Nuclear Safety Review Staff Report I-85-465-WBN was reviewed along with DNC's response memorandum from G. Wadewitz to E. R. Ennis, dated November 20, 1985, to determine completion of corrective action for Concern IN-86-119-001.

WBN NCR 6347 was reviewed along with DNE's response memorandum from F. W. Chandler to J. A. Raulston, dated November 8, 1985, to determine the extent of cable bend violations at Watts Bar.

WBN NCR 6437 was reviewed to determine the disposition and corrective action required relating to loose flex conduit fittings.

Discussions were conducted with DNC WBN Electrical Engineering Unit engineers to determine construction practices regarding cable pulls, types of fireplugs used for spare conduit wall sleeves, conduit field routing, reducing bushings and quality of issued materials.

Discussions were conducted with DNC WBN Procedures and Training Section personnel to determine proposed changes to Watts Bar Quality Control Procedure WBN QCP-3.03 in relation to conduit inspections.

Discussions were held with WBN electrical quality control personnel to determine if problems had been encountered with the quality of conduit fittings and accessories.

BFN

Reviewed Browns Ferry Nuclear Plant (BFN) Standard Practice BF 16.4, Revision 2, dated July 14, 1986, "Material, Components, and Spare Parts Receipt, Handling, Storage, Issuing, Return to Storeroom, and Transfer" to determine if receipt inspection was performed on conduits and accessories.

Reviewed BFN Technical Standard TS 01.00.15.14.03, "Equipment and Material Storage Requirements for Nuclear Power Stores," Revision 0, dated March 24, 1985, to determine if the level of storage of conduit products is consistent with ANSI 45.2.2 (1972).

BFN MAI-27, "Installation of Electrical Conduit Systems and Junction Boxes," Revision 1, was reviewed to determine the acceptance criteria related to conditions which may be encountered that would be detrimental to the cable during pulling activities and the installation requirements related to tightening flexible conduit couplings, conduit cover installation, and excessive conduit bends.

Walkdowns were conducted with BFN Power Stores personnel to observe conduit storage areas and to visually examine conduits and fittings for defects such as burrs and sharp edges, which could damage cable during pulling activities.

Discussions were held with cognizant DNE electrical engineering personnel to determine if deficiencies had been identified related to flexible conduit installations specifically related to tightening of the flexible conduit couplings.

Discussions were held with cognizant BFN Modifications and Additions (M&A) personnel to determine if problems had been identified related to the loosening of flexible conduit installations as a result of improper tightening of the flexible conduit couplings.

Discussions were held with DNE electrical engineering site representatives at BFN to determine what actions had been taken to identify and resolve problems associated with excessive conduit bends.

SQN

Reviewed Quality Technology Company (QTC) expurgated files, as well as other files for additional pertinent information, reports and any corrective action recommendations available on concerns.

Reviewed applicable sections of the WBN ECTG Element Report titled "Conduit" (CO19201), to determine the applicability to SQN.

Sequoyah Standard Practice SQA-45 was reviewed to determine the procedures implemented for receipt inspection and storage requirements for permanent plant material.

Reviewed Administrative Instruction AI-11, "Receipt Inspection, Nonconforming Items, QA Level/Description Changes and Substitutions", Revision 37, to determine the inspection requirements for noncritical systems, structures and components (non-CSSC) items.

Reviewed Administrative Instruction AI-36, "Storage, Handling, and Shipping of QA Material", Revision 9, to determine the storage requirements related to conduit material and ensure compliance with American National Standards Institute (ANSI) 45.2.2-1978.

Discussions were held with cognizant Power Stores Unit (PSU) supervision personnel to identify any related quality problems associated with conduit materials.

Walkdowns were conducted with PSU warehouse personnel to observe actual storage facilities.

Cognizant Division of Nuclear Quality Assurance (DNQA) personnel were interviewed to determine receipt inspection and surveillance requirements for conduit materials.

M&AI-6, "Installation of Conduit and Junction Boxes", Revision 6, was reviewed to determine the tightening requirements for flexible conduit couplings.

Discussions were held with cognizant Division of Engineering (DNE) Central staff personnel to discuss the generic application of SCR BFNEEB8632 and the adequacy of the policy memorandum from W. S. Raughley to Those listed dated May 14, 1986. |R2

Discussions were held with cognizant DNE Electrical Engineering (EE) personnel to discuss the movement requirement for flexible conduit installations for floor mounted equipment. |R2

Discussions were held with cognizant DNE (site) EE personnel to discuss the minimum length requirements for flexible conduit connections for floor mounted equipment. |R2

Reviewed M&A Instruction M&AI-6, Revision 6 to determine the procedure requirements related to conduit cover installations and craft surveillance instructions for identifying damaged or defective conduit components.

Discussions were held with cognizant DNE EE (site) group leader to determine what actions SQN had taken to identify and resolve problems associated with excessive conduit bends.

Performed an additional evaluation of the implementation of the requirements of M&AI-6 related to the torquing of flexible conduit couplings and evaluated the special maintenance instruction (SMI-0-317-33 Revision 1) for adequacy related to the generic implication of WBN-NCR-6529 and related issues.

BLN

Cognizant DNC Electrical Engineering Unit (EEU) personnel were interviewed to determine if specific knowledge of the perceived problems existed.

Site documentation programs were reviewed for the site-specific concerns.

Site procedures BNP-QCP-3.32, "Raceway and Electrical Hanger Verification," BNP-QCP-3.34, "Electrical Cable Installation," BNP-QCP-3.2, "Conduit Systems," and Standard Operating Procedures EEU-SOP-231, R0, and EEU-SOP-200, R2, were reviewed to determine site criteria and the time of incorporation of certain requirements into the procedures.

Site evaluations for BLN specific employee concerns were reviewed.

Site NCR 4254, documenting deficiencies with conduit runs installed and accepted prior to January 1, 1984, was reviewed for programmatic corrective actions.

Site procedure BNP-QCP-1.1 was reviewed for criteria to establish damaged or unacceptable material inspections and BNP-QCP-1.2, "Storage of Permanent Plant Material," for storage level requirements. BNP-QCP-10.12, "Issue of Permanent Plant Material," was reviewed for issue inspection criteria.

3.2.2 Cable Tray

No generic implications resulted from this evaluation. Therefore, the criteria and methodology listed below was pertinent to WBN only. Quality Technology Company (QTC) was contacted for any additional information.

Watts Bar Quality Control Procedure WBN-QCP-3.04 (all revisions), "Inspection and Documentation of Cable Tray Systems," was reviewed to determine the acceptance criteria for inspecting and documenting cable trays and penetrations.

Watts Bar Quality Control Procedure WBN-QCP-1.55, Revision 6, "Seals, Fire Stops, and Cable Coatings," was reviewed to determine the acceptance criteria for cable tray fire stops.

Standard series TVA DNE Drawing 45W883, "Conduit and Grounding, Penetration Sealing and Fire Stop Details," was reviewed to determine the installation requirements for cable tray firestops.

IEEE Standard 690-1984, "Standard for the Design and Installation of Cable Systems for Class IE Circuits in Nuclear Power Generating Stations," was reviewed to determine design considerations for firestops.

TVA DNE purchase Contract 78K51-823599 for fireproofing fiber-type insulation board and bulk ceramic fiber insulation was reviewed to determine the material specifications for cable tray firestops.

Discussions were conducted with DNQA Civil Quality Control Unit (CQC) inspectors, DNE Fire Protection Section engineers, Modifications engineers, and DNC Electrical Engineering Unit (EEU) engineers to determine installation and design requirements for cable trays at WBN.

Civil Quality Control (CQC) inspection report Test 35 for penetration O-CTP-290-314 was reviewed to determine if the penetration was properly identified and if the installation was acceptable in preparation for a walk-through.

A walk-through was conducted with a Civil Quality Control inspector to evaluate proper installation and identification of cable tray penetrations.

Surveillance Instructions (SI) 7.24 through 7.30 were reviewed to determine identification requirements of penetrations for transferred equipment.

3.2.3 Conduit Fittings

WBN

Quality Technology Company (QTC) was contacted for any additional information to assist in identifying the specific fitting related to this concern.

DNE Construction Specification G-40, "Installing Electrical Conduit Systems and Conduit Boxes," was reviewed to determine the material requirements for conduit fittings.

IEEE Standard 690-1984 "Standard for the Design and Installation of Cable Systems for Class IE Circuits in Nuclear Power Generating Stations," was reviewed to determine why zinc and aluminum are restricted inside containment.

DNE's Engineering Procedure EP 5.01 was reviewed to determine material responsibilities for conduit fittings at TVA Nuclear plants.

DNE's "Standard Procurement Specification for Rigid Steel Conduit (zinc coated)," No. 21.001, dated February 2, 1981, was reviewed to determine TVA's applicable standards and detailed requirements for purchasing conduit.

Discussions were conducted with DNE's procurement engineers to determine the contract specification requirements for conduit fittings at TVA Nuclear plants.

Discussions were conducted with EEU engineers, an electrical craft foreman, construction materials personnel, and Electrical Quality Control Unit (EQC) inspectors to determine the history behind non-magnetic fittings discovered on site which were thought to be aluminum.

Discussions were conducted with an Office of Nuclear Power (ONP) Technical Services metalurgist to determine the material composition of a sample of Erickson type fittings.

DNE's WBN calculation WBNSSG4-002, "WBN Hydrogen Volume Percent Inside Containment Following a LOCA," was reviewed to determine the calculation methodology used to determine the total surface area of zinc inside containment.

A telecon was conducted with DNE's Nuclear Engineering Supervisor (onsite) and Nuclear Engineering Branch (NEB) Chemical Analysis Section supervisor to determine if Erickson type fittings not accounted for in WBNSSG4-002 represented a potential problem.

4.0 FINDINGS

4.1 Findings on Conduit

4.1.1 Generic

As a result of the investigations into the WBN specific concerns, eight concerns involving five perceived problems were deemed potentially generic to all active TVA nuclear sites. The problem areas were:

a. Conduits had accumulated bends more than 360 degrees between cable pull points.

b. Flex conduit couplings were not properly torqued.

c. Conduits issued to the craft were damaged and made of inferior material.

d. Covers were left off conduits and pull boxes allowing dirt and other debris to enter.

e. Inadequate DNE controls caused conduit overfill.

The National Electrical Code prohibits accumulated bends of more than 360 degrees between cable pull points. A review of the TVA Construction Specification G-40 revealed no past requirements existed to prevent excessive conduit bends between cable pull points until Revision 8 was issued on October 10, 1985. The indeterminate status of the installations which may have excessive conduit bends and conduit overfill may have allowed cable sidewall pressures to be exceeded at all sites. Additionally, review of the DNE General Construction Specification G-40 determined potential generic applicability for the concerns associated with flex conduit coupling torque and the quality of conduit material. Conduit cover installation deficiencies resulted from weaknesses in a good industrial practice of providing protection to permanent plant items.

Conclusion

Because of a lack of design output requirements in the TVA DNE General Construction Specification G-40, and the results of the WBN-specific evaluations, generic applicability was determined to be potential for all active TVA nuclear plant sites for five of the perceived problems. These problems were related to issues from eight employee concerns on excessive conduit bends, flex coupling torque, quality of material, conduit cover installations, and conduit overfill.

4.1.2 Site-Specific

4.1.2.1 Discussion

Nineteen employee concerns, grouped into the issue of conduit were site-specific to WBN with two exceptions. One was a concern specific to BLN and received under the plant's exit interview employee concern program, and the other was received by QTC specific to BLN.

The findings discussed below (unless otherwise noted) will detail findings specific to WBN. |R2

a. Fish tape, pulling hooks, and other cable pulling devices in conduit were not removed between cable pulls. Note - The cleanliness aspect of employee concern IN-85-138-001 was attributed to condulet cover installation deficiencies and is discussed in paragraph i of this report.

   This concern also reported that conduit was so full that some pulling devices may not have been removed. This portion of the concern will be addressed in the Construction Category Report Number 10900 titled "Cable" in the cable pulling issue. The fact that fish tape could not be removed was attributed to conduit overfill violations and was addressed in the above mentioned report. |R2

   Note - The issue of overfill was also evaluated by DNE in subcategory report EN-23801.

   Discussions with DNC WBN electrical engineers revealed it was common practice for construction to leave fish tape or other pulling devices in large conduits for future cable pulls. This was determined to pose no detrimental effect to installed cables. All cables receive a functional and/or pre-operation test which assures that they can perform their intended function.

   The DNC response to this employee concern revealed the specific conduit identified was a non-QA installation and, therefore, would not have an adverse effect on nuclear safety. The DNC report for IN-86-262-004 (T2S 86 0519 113) also confirmed that fish tape and other pulling devices posed no threat to installed cable.

b. Conduits had accumulated bends more than 360° between cable pull points.

   A review of the QTC expurgated files revealed no additional pertinent information was available.

Review of National Electric Code, Article 350, revealed the following statement regarding excessive conduit bends:

> "A run of conduit between outlet and outlet, fitting and fitting shall not contain more than the equivalent of four-quarter bends (360° total), including those bends located immediately at the outlet or fitting."

Review of Construction Specification G-40 (past revisions) revealed no previous requirements to prevent excessive conduit bends between cable pull points. Revision 8 incorporates the requirements from the National Electric Code discussed above.

This area of concern was deemed to be potentially generic to all active nuclear plants. Site-specific findings follow.

Note: Conduit bend radius violations relate to minimum cable bend violations and this issue is discussed in the Construction Category Report 10900 titled "Cable." |R2

WBN

Review of WBN NCR 6347, initiated on September 26, 1985, revealed instances of conduit runs which have more than 360° accumulated bends between cable pull points.

Review of F. W. Chandler's response memorandum to J. A. Raulston, dated November 8, 1985 (B43 85 1108 933), revealed calculations were performed for conduit runs identified by NCR 6347 to determine if cable sidewall pressures were exceeded during cable pulls. Cables identified with sidewall pressures greater than allowable limits were to be rerouted.

Review of the latest revision of WBN site procedure QCP-3.03 and DNE Design Standards, DS-E13.1.4 and DG-E13.1.1, revealed that all have incorporated the new requirements stating that conduit runs shall not contain more than four 90° bends (360° total) between cable pull or termination points.

Discussion with DNE's Conduit and Grounding supervisor revealed sidewall pressure calculation records were used to analyze conduits to determine whether there was a need to replace existing conduit. DNE's Engineering Procedure, EP 22.29, Revision 1, "Procedures to Determine Acceptable Sidewall Pressure Exerted on Class IE Cables in Existing Conduit Installations at Watts Bar Nuclear Plant," along with DNE's calculation WNBPEVAR8602006, "Determination of Class IE Electrical Cable Weight/Foot and Outside Diameter" were used to identify cables which violate acceptable sidewall pressures. Unacceptable violations will result in the replacement of conduit and repulling of the cable per the direction of DNE.

Review of Engineering Procedure EP-22.29, revealed that the purpose of the procedure was to establish a sampling program to determine whether maximum allowable sidewall pressure had been exceeded for Class IE cables at WBN.

Review of DNE's calculation WBNPEVAR8602006 revealed its purpose was to determine the average and maximum cable outside jacket diameters, average and maximum cable weight/foot, and maximum insulated single conductor outside diameter for each cable mark number to calculate sidewall pressure and to determine cable pull tensions.

BFN

A review of the site procedure governing conduit installation, MAI-27, Revision 1, "Installation of Electrical Conduit Systems and Junction Boxes," revealed sufficient precautions to the installer exist to prevent an excess of 360° of bends between cable pull points. The acceptance criteria does not clearly require QA/QC verification. A procedure revision request was generated to correct this deficiency.

Discussion with cognizant DNE electrical engineers revealed that the action to be performed by BFN related to excessive conduit bends had not been determined by DNE. These actions will respond to deficiencies resulting from past installations under previous revisions of G.C.S.G-40, before the inclusion of requirements for the control of excessive bends. The actions required will be determined from DNE's evaluation of sidewall pressure testing conducted at the TVA Central Laboratory. Preliminary information indicates the testing for maximum sidewall pressure calculations will address the issues of excessive conduit bends, conduit overfill, and maximum pull tension.

SQN

SNP MAI-6 did not contain a requirement prohibiting the installation of conduit exceeding a 360° accumulation of bends between pull points. No verification by QA/QC was performed to ensure the 360° criteria had not been exceeded.

Discussion with cognizant DNE Electrical Engineering Unit Conduit and Grounding Group Leader revealed the actions to be performed by SQN related to excessive conduit bends had not been determined by DNE. The actions required will be determined from DNE's evaluation of sidewall pressure testing conducted at the TVA Central Laboratory. Preliminary information indicates the testing for maximum sidewall pressure calculations will address the issues of excessive conduit bends, conduit overfill, and maximum pull tension.

BLN

A review of the BLN site procedures used to control the installation of all conduit revealed a requirement to limit the total number of bends between pull points to less than 360°. Standard Operating Procedure (SOP) EEU-SOP-200, Revision 2,

"Embedded Conduit and Grounding," issued November 12, 1976, specified an inspection for excessive conduit bends. Also, EEU-SOP-231, Revision 0, issued March 5, 1980, "Exposed Conduit with the exception of the Reactor Building," limits the total number of bends to 360°. For quality-related installations after July 31, 1984, the bend requirement was added to BNP-QCP-3.2, Revision 6 for conduit and BNP-QCP-3.34, Revision 3 for cable pulling.

Discussions with cognizant electrical engineering personnel revealed that although a requirement for limiting bends to 360° has been incorporated in BLN procedures for an extended period, there is reason to question the acceptability of installations existing before the Quality Control/Engineering organization split on January 1, 1984. As a result of this question of acceptability, NCR 4254 was written to document various deficiencies discovered with conduit installations accepted before January 1, 1984. The resulting disposition of the NCR is: "All completed and accepted conduit installations during the applicable period are to be reinspected, documented, and reworked as necessary to the requirements of BNP-QCP-3.2, Revision 12." This NCR will include a verification requirement for previously accepted conduit for conformance to the excessive bend criteria.

c. Conduit congestion and major rework occurred partly because TVA compromised specification and accepted "off-scale" equipment.

Note: Concerns relating to "cluttered" conduit were perceived to refer conduits in congested areas. |R2

WBN

Discussions with DNC electrical engineers revealed that conduits were field routed (not poorly engineered) and, in some cases, were installed before the design of piping or other obstructing features were complete. This required conduit to be installed on an accepted "risk basis." Conduits were |R2

installed in this manner with the understanding that rework would be required in the event that subsequent installations of other features caused conflicts. This would cause rework of conduit resulting in instances of congestion. No instances involving congestion or rework resulting from compromised specifications were found.

d. Conduits issued to the craft were of poor quality and made of inferior materials.

This area of concern was deemed to be potentially generic to all active nuclear plants. Site-specific findings follow.

WBN

Review of Watts Bar Quality Control Procedure WBN QCP-1.36, "Storage and Housekeeping," revealed that WBN has a procedure which requires inspection of equipment for proper storage (level C, for conduit fittings and level D, for conduit) and to identify damage or deterioration while in storage.

Review of Watts Bar Quality Control Procedure WBN QCP-1.52, Revision 6, "Preventative Maintenance," identified the Material Services Unit was responsible for inspecting materials before issue.

Review of DNE Engineering Procedure EP 5.01 revealed that it was the responsibility of the originating engineering section to specify any special material requirements.

Review of Watts Bar Quality Control Instruction WBN QCI-1.06, Revision 1, "Receiving," revealed no specific requirements for inspecting conduit for material defects.

Discussion with DNC electrical engineers revealed that WBN has experienced problems with poor quality conduit supplied by vendors in the past.

Discussion with DNE cognizant procurement engineers determined conduit material contracts for WBN presently require limited quality assurance requirements and suppliers with an approved QA program. On March 31, 1978, DNE issued a memorandum to DNC (DES 78 0331 023) which outlined the guidelines by which QA materials were to be purchased by DNC. Conduit, fittings and accessories were among the items listed which required the supplier/manufacturer to have an approved QA program. Before March 31, 1978, TVA did not have a QA program governing conduit procurement. Also, memorandum (DOC 780310 002) supplied information related to typical QA materials. Conduit and fittings were included. |R2

Discussion with a Material Quality Control inspector revealed that the receipt inspection of both conduit and fittings consisted of verifying the materials specified, size and quantity by visual inspection, with no specific procedural requirement for inspecting for defects. It was understood that general inspections for obvious damaged or defective material would be required.

Material deficiencies specifically related to the procurement of Erickson type fittings will be discussed in the issue titled "Conduit Fittings" in this report.

BFN

Review of Standard Practice BF 16.4, Revision 2, indicated that the Power Stores supervision has overall responsibility for the receipt inspection and acceptance of procured items. Quality Control personnel are responsible for receiving QA materials and Power Stores storekeepers are responsible for other items. The receipt inspections performed for all items are documented.

A review of Technical Standard TS 01.00.15.14.03 defines outdoor storage and the requirements meet or exceed ANSI 45.2.2 specifications.

Walkdowns with Power Services Unit (PSU) personnel of storage areas for conduit and conduit fittings revealed scattered surface oxidation (rust) on some conduit with more noticeable rusting at the threaded area. The storage area and placement of material were in compliance with the requirements of ANSI 45.2.2-1972 and no burrs sharp edges, defects, etc., were noted which would be detrimental to the cable or insulation during cable installation activities.

A review of MAI-27, "Installation of Conduit Systems and Junction Boxes," revealed conditions detrimental to cable installation such as burrs, cuts, sharp edges, rough surfaces, etc., were part of the criteria an inspector would use to verify a quality installation. The conditions, if found to exist, would be corrected before acceptance, preventing damage to the cable insulation during pulling operations.

SQN

Review of Sequoyah Standard Practice SQA-45, Revision 21, revealed the Power Stores and QA staff supervisor are responsible for the receipt and receipt inspection. The Power Stores clerks receive non-QA material. A review of Administrative Instruction AI-11, Revision 37, indicated inadequate guidelines are established to describe what constitutes acceptable material or what actions are to be taken if defective material is delivered.

A review of AI-36, Revision 9, showed the storage levels as specified are in compliance with the appropriate ANSI standards (ANSI 45.2.2-1978), and conduit is stored in Level D storage, which is outside storage with minimal protection from the elements.