

TVA EMPLOYEE CONCERNS
SPECIAL PROGRAM

REPORT NUMBER: CO19201-SQN

REPORT TYPE: Sequoyah Nuclear Plant Element
(Final Report)

REVISION NUMBER: 8

TITLE: Conduit

PAGE 1 OF 15

REASON FOR REVISION:

Revised to include TAS and SRP comments	Revision 2
Revised to include SRP comments and finalize report	Revision 3
Revised to include SRP and TAS comments	Revision 4
Revised to include SQN response and finalize report	Revision 5
Revised to include TAS and SRP editorial comments and finalize report	Revision 6
Revised to include additional evaluation resulting from NRC comments	Revision 7
Revised to include additional SQN and corporate response and finalize report	Revision 8

PREPARATION

PREPARED BY:

Henry W. Joffe 4/21/87
SIGNATURE DATE

REVIEWS

PEER:

Charles A. Manning 4-21-87
SIGNATURE DATE

RCM
4/22/87

Randal A. Gibbs 5/1/87
SIGNATURE DATE

CONCURRENCES

8705120390 870508
PDR ADOCK 05000327
P PDR

SIGNATURE DATE

CEG-H Paul T. Howard 4-22-87
SRP: James W. Gipe 5-1-87
SIGNATURE DATE

APPROVED BY:

M. J. Martin 5/4/87
ECSP MANAGER DATE

N/A
MANAGER OF NUCLEAR POWER DATE
CONCURRENCE (FINAL REPORT ONLY)

*SRP Secretarys signature denotes SRP concurrences are in files.

I. INTRODUCTION

Eight concerns (categorized below) were evaluated at Sequoyah Nuclear Plant (SQN) as a result of the generic applicability determination resulting from the Watts Bar Nuclear Plant (WBN) Employee Concern Task Group (ECTG) Element Report Conduit, CO19201, within the Construction Category.

IN-85-512-003 Quality of Conduit Materials
IN-85-512-002

IN-85-341-001 Torquing of Flexible Conduit Couplings
OW-85-007-008

IN-85-138-001 Condulet Cover Installation

IN-85-201-003 Excessive Conduit Bends
IN-85-856-004
EX-85-066-002

No related site specific concerns were identified. Due to the Browns Ferry Nuclear Plant (BFN) evaluation, flexible conduit installation deficiencies resulting from the generic implication of Significant Condition Report (SCR BFNEEB 8632) are addressed. Also, the generic implication of the WBN-NCR 6529 related to SNP was evaluated.

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II. SUMMARY OF PERCEIVED PROBLEMS

- (a) Quality of conduit material may not be assured at the time of receipt and maintained through proper storage techniques.
- (b) Site procedures for the installation of flexible conduit may not require proper tightening of the couplings which contributes to loose and damaged flexible conduit. Additionally, site procedures may not have adequately addressed flexible conduit installations related to seismic and thermal movement nor minimum bend criteria considerations.
- (c) Control methods may not be in place to prevent dirt and debris from entering conduit bodies while condulet and pull box covers, etc., are removed.
- (d) Allowable cable side wall pressures may have been exceeded resulting from excessive conduit bends between pull points.

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III. METHODOLOGY

- (a) 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.
- (b) Reviewed the WBN ECTG Element Report Conduit (CO19201), applicable sections, to determine the applicability to SQN.
- (c) Sequoyah Standard Practice SQA-45 was reviewed to determine the procedures implemented for receipt inspection and storage requirements for permanent plant material.
- (d) 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.
- (e) 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.
- (f) Discussions were held with cognizant Power Stores Unit (PSU) supervision personnel to identify any related quality problems associated with conduit materials.
- (g) Walkdowns were conducted with PSU warehouse personnel to observe actual storage facilities.
- (h) Cognizant Division of Nuclear Quality Assurance (DNQA) personnel were interviewed to determine receipt inspection and surveillance requirements for conduit materials.
- (i) M&AI-6, "Installation of Conduit and Junction Boxes", Revision 6 was reviewed to determine the tightening requirements for flexible conduit couplings.
- (j) Discussion was held with cognizant Modifications and Additions Unit (M&A) personnel related to tightening of flexible conduit couplings.

III. METHODOLOGY (continued)

- (k) Discussion was 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.
- (l) Discussion was held with cognizant DNE Electrical Engineering (EE) personnel to discuss the movement requirement for flexible conduit installations for floor mounted equipment.
- (m) Discussion was held with cognizant DNE (site) EE personnel to discuss the minimum length requirements of flexible conduit connections for floor mounted equipment.
- (n) 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.
- (o) Discussions were held with cognizant M&A Unit Engineering and craft personnel pertaining to conduit cover installation, procedure clarifications related to excessive conduit bends, and craft training with emphasis on G-40 requirements and guidelines to prevent the installation of damaged conduit components.
- (p) 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.
- (q) 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 Rev. 1) for adequacy related to the generic implication of WBN-NCR-6529 and related issues. |
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IV. SUMMARY OF FINDINGS

- (a) Review of the QTC expurgated files and other files revealed no additional pertinent information than that discussed in findings below.
- (b) The WBN ECTG Element Report Conduit (CO19201) contained sections which related to material problems, loose flexible couplings, fish tape and debris, and excessive conduit bends which were pertinent to the SQN evaluation.

IV. SUMMARY OF FINDINGS (continued)

- (c) Sequoyah Standard Practice SQA-45, Revision 21 stated "The power stores and QA staff supervisor are responsible for the receipt and receipt inspection as defined in AI-11 (reference paragraph 17.D, page 59). Additionally, paragraph 19.D page 59 states, "Handling, storage, and shipping shall be in accordance with the requirements of AI-36."
- (d) Administrative Instruction AI-11, revision 37 stated "PSU clerks shall receive non-QA, and/or non-CSSC items." No guidelines are established to describe what constitutes acceptable material or what actions are to be performed if defective materials are delivered, i.e.; over, short, substitute, damaged, or defective (OSSD or D) items.
- (e) Review of Administrative Instruction AI-36, revision 9, indicated the storage levels as specified are in compliance with the appropriate ANSI Standard (ANSI 45.2.2-1978) and conduit bodies are stored as Tubular products which require level D storage.
- (f) Discussions with cognizant PSU supervision personnel indicated no quality problems had been identified with conduit or conduit fittings.
- (g) Walkdowns with PSU personnel of Level D storage areas for conduit bodies revealed scattered surface oxidation (rust) on some conduit bodies with more severe rusting at the threaded area. Approximately 1 to 2 percent of the conduit bodies were judged not acceptable for installations--assuming the entire length would be installed. The storage area and placement of material were in compliance with the requirements of Level D storage as specified by ANSI 45.2.2-1978.
- (h) Discussion with cognizant DNQA personnel indicated receipt inspection was performed per the requirements of AI-11 and surveillance activities were in accordance with the frequencies specified in Surveillance Instruction Letter (SIL-181). Level D storage areas were subject to surveillance activities performed by QA. No known quality problems with conduit or fittings had been identified.

IV. SUMMARY OF FINDINGS (continued)

- (i) Review of M&AI-6, revision 6, revealed installation of conduit and conduit systems were performed in accordance with the National Electric Code and flexible metal conduits were installed in accordance with the specific instructions included in paragraph 3.2.6 which adequately addresses the tightening requirements of the flexible conduit coupling. Verification is performed by QA personnel (Reference paragraph 4.0 item E). No deficiency was noted.
- (j) M&A personnel stated that loose couplings on flex conduits had not been encountered during installation inspections. | R7
- (k) Discussions with cognizant Central Staff personnel revealed SCRFN8632 to be potentially generic to SQN as related to the lack of guidelines for flex conduit installations contained within General Construction Specification (G.C.S) G-3. The policy memorandum from W. S. Raughley to Those listed dated May 14, 1986, was determined to be fully adequate to address the thermal & seismic flexible conduit issues related to the Code of Federal Regulation Section (10 CFR 50.49) pipe mounted devices, and all 10 CFR 50.49 equipment, such as motors and chillers, at a point 6 feet or greater above the floor level. However, floor mounted 10 CFR 50.49 equipment at a point less than 6 feet above the floor level was not addressed and is considered inadequate in this respect since a minimum length of 18 inches is required for flexible conduit to allow a one inch movement. No objective evidence was found which ensures this 18 inch criterion was met during flexible conduit installations. Additional comments related to the W. S. Raughley policy memo are included in paragraph IV.Q. of this report. | R7
- (l) Discussions with cognizant DNE EE personnel revealed 10 CFR 50.49 floor mounted equipment below a point 6 feet above the floor level would be acceptable, provided the flexible conduit minimum length is 18 inches, to accommodate one inch movement during a seismic event.
- (m) Discussions with cognizant DNE EE personnel revealed that before the issue of G.C.S-G40, revision 0, dated August 6, 1975, no minimum length criteria had been established for flex conduit installations. It was noted however, that N2E-860, revision 0 issued November 6, 1973, required a one inch movement with no length given. Before this date, G.C.S. G-3 was utilized and consequently could have resulted in flexible conduit installations which do not conform to the requirements of G.C.S G-40 nor the 18-inch minimum length criteria for floor mounted 10 CFR 50.49 equipment.

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- (n) M&AI-6, revision 6, does not address the installation of conduit or pull box covers to prevent dirt and debris from entering the conduit between cable pull activities, or for the initial installations of conduit bodies. Also, the procedure contains no guidelines for the craft to assure that damaged or defective conduit components are not installed.
- (o) Discussions with cognizant M&A engineering and craft supervision indicated recognition of the need for procedural clarification in regard to covering all openings in the conduit run by either permanent and/or temporary means. Additionally, it was recognized that paragraph 3.1.1 of M&AI-6 should contain a precaution to the installer not to exceed 360 degree accumulations of bends between pull points in the conduit body, and verification should be performed by QA personnel. It was also noted that no formal training by TVA was in place to ensure the craft were familiar with the G-40 requirements and good practice methods to prevent the installation of damaged or defective conduit components.
- (p) Discussion with cognizant DNE EE Unit Conduit and Grounding Group revealed that walkdowns controlled by Special Maintenance Instruction SMI-0-317-32 were performed by SQN to identify excessive conduit bends. A sample of 16 worst-case conduits using the criteria of multiple bends (>360°), long lengths, elevation changes, and conduit overfill (>30% full) were chosen for evaluation. No conclusive evidence has been documented to show that sidewall pressure or pull tension criteria has been violated at this time.
- (q) As a result of the NRC review of Element Report CO19201-SQN, Rev. 6 entitled, "Conduit", additional evaluation was deemed necessary to determine the adequacy of the implementation of the requirements of M&AI-6, Rev. 6 in regard to the tightening requirements of flexible conduit couplings.

During an NRC Safety System Outage Modification Inspection performed during December of 1986 and January of 1987, several flexible conduit connections were determined to be loose or improperly installed and are to be considered as findings or observations contained in Inspection Reports 50-327,328/86-68.

Since the established program for flexible conduit installations (M&AI-6, Rev. 6) requires torquing of the flexible conduit coupling per the manufacturer's instructions and verification was performed by QA/QC personnel, the implementation of the established program was questioned.

During evaluation of the implementation aspect of this issue by the WBNP-ECTG on 2/26/87, it was noted that SQ-CAR-87013 had been issued and indicated the requirements of M&AI-6 Section 3.2.6.4 had not been followed, in that the manufacturer's instructions had not been utilized during the installation of Thomas & Betts flexible conduit assemblies. The specific violation noted, resulted from failure to torque the flexible conduit coupling per the manufacturers instructions.

As a result of the NRC observations and the issuance of SQ-CAR-87013 the credibility of the established program is questioned. Past installation practices are suspect of being deficient related to all suppliers/manufacturer's instructions where torquing instructions are required (Ref. G.C.S.-G40) and a determination must be made to identify and correct these deficiencies. Since the established program requires the preparer of the Work Plan, or Work Release/Maintenance Request to specify the installation criteria, the manufacturer's instructions should be made available to the preparer for inclusion into the appropriate work control documentation. Training of the appropriate personnel (craft, engineering, and inspection) should be given to ensure the appropriate manufacturer instructions are followed during the installation and inspection activities associated with flexible conduit assemblies.

A review of Special Maintenance Instructions SMI-0-317-33, Rev. 1, dated 08/11/86 entitled "Walkdown Procedure for Identifying Flexible Conduit Connections in Violation of General Construction Specification Number G-40" was performed and conversations with Central Staff DNE Personnel were conducted to determine if the tightening requirements for flexible conduit assemblies were verified during the walkdown activity. The results of the review and conversations indicated the primary purpose of the walkdown (SMI) was to assure that installed flexible conduits have adequate lengths for thermal and seismic movement for installed Class 1E equipment and devices on the 10 CFR 50.49 list in response to the generic implications raised for the WBN NCR-6529. The preparer of the SMI established the requirements of the instruction primarily as directed by the W. S. Raughley memo, dated 05/14/86, titled, "Electrical Issues - Flexible Conduit." The following comments are submitted:

- a. The W. S. Raughley memo, dated 5/14/86 does not fully address the generic implication of the WBN-NCR 6529. Instructions were not prescribed to identify and resolve flexible conduit minimum bend radius violations nor to ensure other aspects of flexible conduit assemblies (such as torquing per the manufacturer instructions) were adequate. Additionally, 10 CFR 50.49 floor mounted equipment at a point less than 6 feet above the floor is not addressed. (Ref. CO19201 - SQN, para K)

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- b. Even though the Policy memo discussed above did not address the minimum bend radius of the flexible conduit assembly, the preparer of the SMI defined a deficiency as any condition found that is outside the limitations defined in Attachment 1 (Ref. para 3.3) and directions were given to the walkdown personnel to document these deficiencies (Ref. para 5.3.1.a). Contrary to the above requirements, the flexible conduit assemblies were not inspected for minimum bend radius violations per Table 3.2.6-1 of Attachment 1. The walkdown program did include 10 CFR 50.49 equipment less than 6 feet above the floor which was evaluated for thermal/seismic movement considerations even though this issue was not addressed in the above mentioned Raughley memo. |R7
- c. The walkdown performed did not include the verification of torquing of the flexible conduit coupling per the manufacturer's instructions. |

Conclusions:

- (a) No guidelines are established in AI-11 to define what constitutes acceptable conduit and fitting material or what actions are to be taken if defective materials are delivered. No quality problems with conduit or conduit fittings have been documented, therefore, Employee Concerns IN-85-512-002 and IN-85-512-003 were determined to be not factual.
- (b) M&AI-6, revision 6, the controlling procedure for conduit system installation, adequately addresses flexible conduit coupling tightening requirements. M&AI-6 is inadequate by not requiring the installation of conduit or pull box covers to prevent dirt or debris from entering the conduit between cable pulling activities. Employee Concern IN-85-138-001 was considered factual. M&AI-6 is also inadequate by not containing instructions to the craft to prevent the installation of damaged or defective conduit components. (CATD C019201-SQN-06) |R7
- (c) The requirements for flex conduit installation for 10 CFR 50.49 pipe mounted equipment and floor mounted equipment as stated in G.C.S G-3 inadequately addressed minimum lengths required to accommodate thermal and seismic movements of the equipment. Current requirements for flex conduit installation as stated in G-40 does |R7

accommodate seismic and thermal movement considerations. The potential for imposing unqualified stress to pipe mounted devices or floor mounted equipment by over-extending flex conduit during thermal and/or seismic movement of the pipe or equipment and the subsequent stresses imposed on the cable inside the flex conduit installed prior to the issuance of G-40 should be re-evaluated by DNE.

The W. S. Raughley memo, dated 5/14/86 does not fully address the acceptability or prescribe the necessary instructions for all active TVA nuclear sites to follow which would ensure past flexible conduit installations are in compliance with or meet the intent of General Construction Specification G-40, Rev. 9, SRN 11. Implementation of the Policy memo at each site would only partially address the generic implication of WBN NCR-6529. (CATD 19201-NPS-01)

The findings noted above related to the tightening of flexible conduit couplings indicated that G.C.S.-G40 should be revised to include specific torque values as required per the applicable manufacturer in order to assure this information is available to the constructing organization. (CATD 19201-NPS-02)

The specific CAR (SQ-CAR-87013) should be re-evaluated for significance and generic applicability based primarily on the uncertainty and lack of clearly established requirements related to this issue (as contained in G.C.S.-G-40) which is utilized at all active TVA nuclear sites. The disposition of this CAR should include steps to identify the manufacturers, determine which require torquing of the connectors, and provide verification that past installations meet those requirements. The ARPR should include the necessary procedure revisions (including those involved in maintenance activities); training of appropriate personnel, and verification that all future work activities are performed in accordance with those instructions. (CATD 19201-SQN-07)

Note: The generic implication of employee concerns IN-85-341-001 and OW-85-007-008 was deemed factual since weaknesses were identified in the implementation of the requirements of M&AI-6.

Contrary to the requirements of SMI-0-317-33, Rev. 1 related to flexible conduit installation deficiencies, the minimum bend radius was not verified in accordance with Table 3.2.6-1 of Attachment 1. (CATD 19201-SQN-08)

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- (d) It was concluded that conduit runs containing more than 360° of accumulated bends between pull points were installed at SQN. Therefore, the Employee Concerns IN-85-201-003, IN-85-856-004, and EX-85-066-002 are considered to be factual. DNE is evaluating the findings established during the walkdowns governed by SMI-0-317-32. Reference SQN Element Report C010900 for further details.
- (e) M&AI-6, revision 6 does not include provisions to cover all openings in the conduit runs, by either permanent or temporary means, to prevent dirt and debris from entering the conduit body and is considered inadequate in this area. Additionally, no precaution to the installer of the conduit run exists which prevents exceeding 360 degree accumulations of bends between pull points within the conduit body. No quality assurance inspection exists which ensures excessive bend criteria are not violated.

Employee Concerns IN-85-138-001, IN-85-201-003, IN-85-856-004 and EX-85-066-002 are valid because of the controlling procedure deficiencies noted above. Reference Construction Category C010900 Element Report for SQN for details on DNE's evaluation of sidewall pressure tests and multiple bend criteria results and details on SQN's walkdowns.

V. ROOT CAUSE

- (a) AI-11 was inadequate in that nonsafety-related items were being received by nontechnical personnel without guidelines established to require the examinations which detect burrs, sharp edges, flattened threads or irregularities detrimental to the installation of cables during pulling activities. The apparent cause of this deficiency is management oversight resulting from the lack of awareness that defective "nonsafety-related" items such as conduits and fittings may have a direct impact on plant operation or safety-related features such as cables.
- (b) Because of an oversight by the DNE preparer/reviewer or the lack of consideration for the required Safe Shutdown Earthquake and interface movement criteria, General Construction Specification, G-3 did not provide guidance for installing flexible conduit offsets, lengths, and thermal/seismic movement allowances. The attempt to correct the movement criteria for floor mounted equipment as contained in Sequoyah Specific Construction Specification N2E-860 was inadequate in that the movement criteria for this floor mounted equipment as established by DNE, contained insufficient qualifying instructions for utilization during installation. In conclusion, the design criteria were not established or conveyed to the responsible construction organization in a manner which would ensure the proper installation of flexible conduit assemblies.

V. ROOT CAUSE (continued)

(b) (continued)

The need for establishment of these specific criteria may not have been recognized by DNE personnel. It should also be noted that the established program for generic applicability determination is deficient or weak in that significant conditions such as those identified on SCR BFN EEB 8632 (related to this issue) remained unidentified at other plants largely because of this generic applicability determination being performed by the initiating organization with limited knowledge of the generic implications. Similar weaknesses were also noted in the CAR(SQ-CAR-87013) and re-evaluation related to significance and generic applicability was determined necessary.

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(c) DNE specification writers had not recognized the importance of establishing a procedural control program to prevent dirt and debris from entering the conduit or to ensure good workmanship practices were utilized during conduit installation. This type of requirement should have been a part of the specification in use at all TVA sites.

(d) Because of the lack of understanding of/or an oversight by the preparer and reviewer, General Construction Specification G-40 issued by DNE did not restrict conduit bends in excess of 360 degrees between cable pull points as required by the National Electric Code. This action resulted in inadequate installation criteria supplied to DNC which allowed the potential for excessive bends between pull points to exist during conduit system installation. Reference Construction Category CO10900 Element Report for SQN.

VI. CORRECTIVE ACTION

The following CATDs led to the following Corrective Action Plans (CAPs) from SQN Line Management.

CATDs CO19201-SQN-01 through 05 are restart items.

- * CATD CO19201-SQN-01 - A memorandum from D. W. Wilson, Project Engineer, Sequoyah Engineering Project, to Z. M. Kabiri, Manager, Site Services, on October 21, 1986 (RIMS #B25 861021 039) requested that Administrative Instruction AI-11 be revised to include specific guidelines for receipt inspection of non-QA/non-CSSC items with emphasis placed on the quality of conduit material and accessories.

- CATD 19201-NPS-02 G-40 or appropriate engineering requirement specifications will be revised to add a table of maximum and minimum torque values for each flexible conduit fitting in each size used by TVA. DNE will establish values for future installation requirements and backfit as required. SCR W-577-R was written on March 3, 1987 and will assure that proper corrective action is taken.
- CATD 19201-SQN-07 CAR-87013 has been reevaluated by Electrical Modifications and QA and we concur that this is a nonsignificant condition. We do feel that this CAR should have been sent out to all active TVA nuclear sites for generic applicability and have requested the Quality Systems Branch to initiate.

Engineering has determined the liquid tight flexible connector manufacturers, by brand name, that have furnished connectors for SQN.

Technical information on torquing requirements were obtained. This research indicated that the manufacturers recommend adherence to UL 514B requirements for torquing because the connectors are UL approved per those tests.

G-40 or appropriate engineering requirement specifications will be revised to add a table of torque values (as shown in UL 514B) for flexible conduit fittings to be used for future installations. Regarding current installations, no corrective action will be required based on the plant's maintenance history. The lack of torque values has not been shown to be a significant problem. We conclude that this work is not a restart item. Estimated design completion date for this activity is October 1987.

M&AI-6 will be revised to incorporate changes to G-40. Affected site personnel will be trained on the site procedure revisions.

- CATD 19201-SQN-08 During the performance of SMI-0-317-33, Rev. 1, the bend radius requirement was inadvertently omitted. After further study, we have decided to eliminate this requirement from the procedure. Flexible metal conduit provides only mechanical protection for cables and no failures have to date been attributed to bend radius violations. Also, in general the seismicity of the equipment does not depend on the bend radius of the flex conduit as long as there is adequate movement (which we have assured) and the flex conduit does not exceed 6'-0". Based on the above, we conclude that this work is not a restart item. After plant restart, a flex bend radius sampling (per MIL STD 105D) will be performed. Estimated completion date for this activity is October 1987.

VII. GENERIC APPLICABILITY

Violations in cable side wall pressure because of excessive conduit bends are potentially generic to BLN and BFN. Additionally, the lack of inspection requirements for condulet cover installations, flexible conduit couplings, and quality of conduit materials are potentially generic to BLN and BFN.

Issues pertaining to Flexible Conduit Configuration as described in SCR BFN EEB 8632 may be generically applicable to WBN.

VIII. ATTACHMENTS

- A. SCR BFNEEB 8632

- B. Policy memorandum from W. S. Raughley to Those listed dated May 14, 1986

- C. Listing of concerns indicating Safety Relationships and Generic Applicability

- D. WBN-NCR-6529

SIGNIFICANT CONDITION REPORT

RIMS Accession Number

022 '86 0703-005

A. Identification and Documentation (Must complete within 8 days.)

1 Project/Plant and Unit BFN/ Common Units 1, 2, 3 077 7/3/86		2 Date 6/27/86	3 SCR Number and Rev. SCRBFNEEB8632
4a Preparer and Organization Walter J. Dembosky		4b NU CON NCR No./Deficiency Report (For NU CON Use Only) NA	4c ASME Code <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
5a Contract Number N/A		5b Vendor N/A	
5c Requirement Violated Flexible conduit seismic and thermal movement considerations			
5d Source of Requirement General Construction Specification G-40 (3.2.6)			
5e Description of Condition The installation of flexible conduit was not specifically addressed in General Construction Specification G-3. The lack of guidance for installing flexible conduit offsets, lengths and thermal/seismic movement allowances creates uncertainty as to whether installed flexible conduit can perform it's safety function.			
5f System Various		5g UNID/Component Code (For DNE Use Only) N/A	
6 Date of Occurrence Unknown <input type="checkbox"/> Estimated <input type="checkbox"/> Actual		7 Method of Discovery Generic Implications Review	
8 Significant Condition Adverse to Quality <input checked="" type="checkbox"/> Yes 077 7/3/86 <input type="checkbox"/> No		9 Organization to Determine Corrective Action BFEP/EEB	
10a If significant, NEB-NLS Contact T. G. Chapman		10b Date 7/7/86	10c Contacted by W. J. Dembosky
11 Is a Potential Generic Condition Evaluation Required? If no, describe in block 28. <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No		12 Branch Chief/Project Engineer/DNQA Quality Site Manager (Distribute as required—see block 30.) Don F Faulkner For WSR 7/3/86	
13 Root Cause			

B. Determination of Corrective Action (Must complete within 60 days.)

14a Corrective Action Policy memo -	
14b Coordination Review of DNE Work (Provide initials)	14c Scheduled Date of Completion
15a Action Required to Prevent Recurrence (ARPR)	

(cont on p. 2)

15a ARPR (continued)

15b Scheduled Completion Date of DNE Work → _____

16 Does the corrective action deviate from a design criteria requirement? Yes No

17 Design Criteria Document Number _____

18 Exception Request Number _____

19 Is an ECN required?
 Yes No
 If yes, ECN number _____

20 Impact on Schedule?
 Affects project completion schedule
 Affects schedule of related activities
 No impact

21a Verification of Adequacy and Accuracy of Blocks 13-20 Above → _____

Signature and Date _____

21b Approval Signature and Date (Distribute as required - See block 30.) _____

RIMS Accession Number _____

22 Is it a generic condition? Yes No

If yes, describe. _____

23 Preparer and Date _____

24 Supervisor and Date _____

25 ARPR Recommended By and Date _____

26 ARPR Approved By and Date _____

27 Concurrence of Designated Quality Reviewer for ARPR and Date (Distribute as appropriate - See block 30.) _____

RIMS Accession Number _____

28 Remarks

The generic review for this condition was handled as a result of SCR's for other projects.

See Continuation Sheet

29 All DNE/NU CON Action Complete (Attach Completion Verification Sheet) → _____

Signature, Organization, and Date _____

30 (If needed, attach a separate sheet for additional distribution.)

- RIMS, SL 26 C-K
- NU CON Site Dedicated Data Base
- NMRG
- DNE Project Engineer
- NU CON Project Manager
- Manager, Engineering Assurance
- Director of DNE
- NEB-CMS (for ASME Code Items)
- Director of DNQA

- NRC Resident Inspector
- Director of NU CON
- Records Storage Facility
- ANI (For ASME Code Items Only)
- DNQA Site Quality Manager
- Preparer

RIMS Accession Number _____

B. Determination of Corrective Action (Continued)

FOR DNE USE

FOR NU CON USE

C. Closure

Indicate additional distribution with an "X".

1. Tabulate Data on All Failed and/or Affected Components, Structures, and Systems: Give descriptions, model and manufacturers' numbers, and original and revised design criteria and/or specifications. (See Note 5.)

2. Failure Mechanisms of Affected Components, Structures, and Systems: State whether each affected component, structure, and system became open or closed, inoperative, or shorted; or had shortened life, reduced accuracy, increased drift, reduced capacity, etc. (See Note 6.)

3. Alternate Uses and Generic Implications: Identify alternate uses of the components, structures, and systems in the plant. Discuss generic implications. (See Note 7.)

4. Component, Structure, and/or System Failure Mode(s): Give description and extent of effects of failures on each component, structure, and/or system involved. (See Note 8.)

ENGINEERING REPORT

RIMS Accession Number
 (By DNE for CP Plant)
 (By Site Director's
 Organization for OL Plant)

ER Rev. 0

Part A - Description of CAQ (DNE Use)	CAQ Report No. and Rev SCRBFNEEB8632	Plant and Unit BFN/COMMON 1, 2, 3 973/21	Site Director's Contact and Date Notified (OL Nuc Plants Only) Steve Willard 7/7/86
	Definitive Statement of CAQ (See Note 1.) The installation of flexible conduit was not specifically addressed in General Construction Specification G-3. The lack of guidance for installing flexible conduit offsets, lengths and thermal/seismic movement allowances creates uncertainty as to whether installed flexible conduit can perform it's safety function.		
Part B - Failure Evaluation (DNE Use)	* See Note 2 on page 4 for completing Part B - Part B continued on pages 2 and 3*		
	<input type="checkbox"/> Yes (OL Nuclear Plants Only) Preparation of Failure <input type="checkbox"/> No Evaluation is required?		Due Date of Failure Evaluation
			FSAR Revision Required? <input type="checkbox"/> Yes <input type="checkbox"/> No
	Conclusions (See Note 3.)		
	Recommendations (See Note 4.)		
Suggested Corrective Action			
Part C - Safety Evaluation (Site Director Use)	Date Failure Evaluation Received		Date Management Notified
	Operational Limitations/Actions		
	Justification For Continued Operation		
	Conclusions		
	Indeterminate Item?		<input type="checkbox"/> Yes <input type="checkbox"/> No
	Potentially Reportable to NRC?		<input type="checkbox"/> Yes <input type="checkbox"/> No
	Deficiency Adversely Affects Safe Operation of Plant?		<input type="checkbox"/> Yes <input type="checkbox"/> No
	DNE Contact		Approved By and Date
Prepared By and Date			

5. Cause of the CAQ: Discuss what the CAQ was due to, e.g., a program breakdown, new regulation, analysis or design error, test results showing a deficiency, and/or failure to meet design criteria and/or purchase specifications. Include calculations, analysis results, test results, and/or purchase requirements not met, or other bases. (See Note 9.)

6. Consequences on Plant Design Functions: Discuss effects of failures on all involved component's, structure's, and system's ability to perform their plant design functions. (See Note 10.)

7. Justification for Conclusions in Failure Evaluation: Discuss the reasoning based on the information above which leads to the conclusions stated. (See Note 11.)

Prepared By and Date

Coordinated in Site Director's organization with:

Verified By and Date

Discipline Lead Engineer(s) and Date

Approved By and Date

Those listed

W. S. Raughley, W8 C126 C-K

May 14, 1986

ELECTRICAL ISSUES - FLEXIBLE CONDUIT

The purpose of this memorandum is to provide guidance for each Lead Engineer to determine the adequacy of flexible conduit lengths for thermal and seismic movement for installed Class 1E equipment and devices on the 10CFR50.49 lists.

General Construction Specification G-40, presently defines the minimum flexible conduit length for thermal movement based on conduit size (Section 3.2.6.3) and seismic movement (Section 3.2.6.2). These requirements were incorporated into G-40 as outlined in Attachment 1.

In January 1986, it was discovered that some flexible conduit at WBN was not installed in accordance with the requirements of G-40. Further study has revealed that thermal movements for pipe-mounted devices and seismic movement for certain floor-mounted equipment was not based on worst-case conditions. The Civil Engineering Branch has issued a calculation package, "Seismic/Thermal Movements - Class 1E Electrical Conduit" (B41 860428 001) defining the maximum worst case seismic/thermal movements for all plants (Attachment No. 2). The values in this calculation, summarized in Table A, may be used to evaluate movements for each plant, or specific movements for each piece of equipment or device may be obtained. The seismic and thermal movements for pipe-mounted devices are shown in load tabulations and isometric drawings which can be obtained from DNE - Civil Engineering Branch and can be used to identify seismic/thermal pipe movements which exceed the 1-inch criteria for evaluating devices on a case by case basis.

The original scope of this item was to only look at devices on mechanical systems which had not been thermally exercised to their limit; however, since the plants have not experienced a seismic event, movements for all devices are in question.

Based on preliminary information from WBNP, the problem of short flexible conduit lengths for pipe-mounted devices or floor-mounted equipment does not appear to be extensive.

The following course of action shall be taken to resolve the flexible conduit issue:

1. All 10CFR50.49, electrically-operated, pipe-mounted devices that experience movement (thermal plus seismic) of greater than 1 inch shall be inspected per the flexible conduit requirements of SRN-G-40-11 (Attachment 3).
2. A random sample of 10CFR50.49 electrically-operated, pipe-mounted devices that experience movement of 1 inch or less shall be inspected per MIL STD 105D based on a 96% confidence factor.

2
Those listed
May 14, 1986

ELECTRICAL ISSUES - FLEXIBLE CONDUIT

3. All flexible conduit connected to floor-mounted cast or forged 10CFR50.49 equipment, such as motors and chillers, at a point six feet or greater above floor level shall be inspected to assure that the flexible conduits meet the requirements of SRN-G-40-11.

IMP.
If the inspections reveal unacceptable installations, the flexible conduits shall be documented and reworked, replaced, or referred to DNE for disposition on a case-by-case basis.

The fragnet for resolving the flexible conduit issue is Attachment No. 4. This effort should be started immediately to expedite completion of the flexible conduit issue.

W S Raughley
W. S. Raughley

J. D. Collins, P-110 SB-K
G. T. Hall, DNE, DSC-A, Sequoyah
H. C. Rutherford, A7-BFN ENG
J. L. Springer, 9-111 SB-K

DL
DLL:BB

076120.09

TABLE A
SEISMIC/THERMAL MOVEMENT

PROJECT	FLOOR-MOUNTED EQUIPMENT AND DEVICES				PIPE-MOUNTED DEVICES' MOVEMENT IN ALL DIRECTIONS (INCHES)
	SHEET METAL CONST. HORIZ MOVEMENT (IN.)	CAST OR FORGED EQUIPMENT			
		CONNECTION HEIGHT	HORIZ	VERT	
BFN	<u>+ .5</u>	≤ 3 Feet	<u>+0.75"</u>	<u>+0.15"</u>	<u>+3.6</u>
		≤ 6 Feet	<u>+1.25"</u>	<u>+0.31"</u>	
		≤ 9 Feet	<u>+2.0"</u>	<u>+0.5"</u>	
SQN	<u>+ .5</u>	Same as BFN	"	"	<u>+4.0</u>
WBN	<u>+ .5</u>	Same as BFN	"	"	<u>+4.0</u>
BLN	<u>+ .5</u>	Same as BFN	"	"	<u>+3.7</u>

ATTACHMENT #1

Page 1 of 2

SQN (CP 5-27-70), WBN (CP 1-23-73), and BLN (CP 12-24-74)

Electrical Cable Issues

Issue: Flexible Conduit Connections to Class 1E Equipment

<u>Time Frame</u>	<u>DNE Document (Section)</u>	<u>DNE Requirement</u>
11/6/73	N2E-860 (SQN only) (Section 2.5)	Use length of flex. conduit to allow 1-inch movement in all directions connecting to Class 1E equipment.
and 8/6/75 to 10/21/80	G-40 R0 thru R2 (Section 3.2.6)	Use minimum 18-inch length of flex connecting to Class 1E equipment.
<hr/>		
10/21/80 to 1/15/86	G-40 R3 thru G-38 R9 (Sect. 3.2.6)	Above plus addressed flexible conduit connections to thermal (pipe) movements.

066120.03

CHS: 4-30-86

BFN (CP 5-10-67)
Electrical Cable Issues

Issue: Flexible Conduit Connections to Class 1E Equipment

<u>Time Frame</u>	<u>DNE Document (Section)</u>	<u>DNE Requirement</u>
5/10/67 to 1/15/86	G-3 issued 12/17/62 and later revisions (Section B.10)	Provide flexible conduit connections to equipment (such as motors, valves, lighting fixtures). No specific require- ment for min. lengths of flexible conduit relative to seismic and thermal (pipe) movements.
1/15/86 to 3/17/86	G-40 R9 (Sect. 2.3 and 3.2.6)	Addresses type of flexible conduit and lengths (per size conduit) relative to seismic and thermal (pipe) movements.

066120.03

CHS: 5-12-86
~~4-30-86~~

TITLE SEISMIC / THERMAL MOVEMENTS - CLASS IE ELECTRICAL CONDUIT				PLANT/UNIT ALL PLANTS
PREPARING ORGANIZATION CEB-MA2		KEY NOUNS (Consult RIMS DESCRIPTORS LIST) FLEXIBLE CONDUIT, CLASS IE, G-40		
BRANCH/PROJECT IDENTIFIERS CEB-MA2-006		Each time these calculations are issued, preparers must ensure that the original (RO) RIMS accession number is filled in.		
		Rev	(for RIMS' use)	RIMS accession number
		RO		B41 '86 0428 001
APPLICABLE DESIGN DOCUMENT(S)		R _		
		R _		
SAR SECTION(S)	UM-ID SYSTEM(S)	R _		
Revision 0	R1	R2	R3	Statement of Problem This calculation is needed to document the maximum seismic / thermal movements of Class IE electrical equipment where flexible conduit is attached to pipe mounted devices on thermally moving systems and to floor mounted equipment in Category I structures.
ECN No. (Indicate if Not Applicable)				
Prepared <i>Gordon C. Hale</i>				
Checked <i>Alan D. Sowards</i>				
Reviewed <i>B.B. Neely 4/26/86</i>				
Approved <i>Thomas C. Linn 4/28/86</i>				
Date APR 28 1986				
Use form TVA 105.34 if more room required.	List all pages added by this revision.			
	List all pages deleted of this revision.			
	List all pages changed by this revision.			
Does this revision contain any unverified assumptions? (YES or NO)				
NO				
Abstract Hand calculations, shake table test results and piping analysis results were used to provide conservative maximum thermal / seismic movements for Class IE equipment with flexible conduit attached. Maximum movements of pipe-mounted devices on thermally moving systems and floor mounted equipment in category I structures are provided.				
This calculation is used to support revision 10 to the General Construction Specification G-40 and corrective action for NCR 6529 and NCR 6569. Also used to document the Seismic Simulation Test Program on Motor Control Center in the TVA MEDS document retrieval system.				
Microfilm and return original to G.C. Gale W9 C137 C-K.				

EX-11673 3064

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Appendix A Maximum Movements for Bellefonte Nuclear Plant	
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1.0 Purpose

The purpose of this calculation package is to provide maximum movements for flexible conduit connections that are attached to class IE equipment and subject to thermal and seismic movement.

This calculation is used to support the maximum movements given in Revision 10 to General Construction Specification G-40.

2.0 Scope

This calculation covers flexible conduit attachments to class IE pipe mounted devices on thermally moving systems and attachments to floor mounted equipment in category I structures.

3.0 Pipe Mounted Equipment

3.1 Browns Ferry Nuclear Plant

A piping analysis survey was made in reference 7.1 to determine maximum thermal and seismic movements for control air flex hose applications on the Main Steam Safety Relief Valves (MSSRV) at Browns Ferry. These represent maximum thermal pipe movements in the plant due to the high temperature of the main steam line. This is also an enveloping seismic condition due to the long extended structure of the MSSRV. The enveloping movement for combined thermal and seismic loading is 3.60 in. in any direction in the horizontal plane and 1.25 in. up in the vertical direction.

Another piping analysis survey was made

in reference 7.2 to determine maximum movements for pipe mounted devices on piping systems attached to the torus having flexible conduit attachments. The enveloping movement for combined thermal, seismic and torus loading is 1.0 in. in each direction.

3.2 Bellefonte Nuclear Plant

A survey of the piping analysis of the main steam line (reference 7.3) was made for this calculation. The end of the extended valve structures on the main steam system valves were used for maximum thermal and seismic motion by the same reasoning used for Browns Ferry. Tabulated movements are shown in Appendix A. The enveloping

movement for thermal and seismic loading is 3.70 in. in any direction.

3.3 Watts Bar Nuclear Plant

Informal consultation with the supervisor of the rigorous piping analysis section was made to determine enveloping seismic and thermal movements for pipe mounted devices with flexible conduit attached. The main steam system was used as the basis for this. A conservative estimated envelope of 4.00 in. in any direction was given for combined thermal and seismic movement.

3.4 Sequoyah Nuclear Plant

Based on the similarity between Watts Bar and Sequoyah, the same combined seismic and thermal movement envelope will be used.

4.0 Floor Mounted Equipment

4.1 Cast or Forged Equipment

For all plants where: cast or forged Class IE equipment is grouted to the floor, temperature = 650 °F for carbon steel, height of flex conduit attachment above floor is 9 ft. and horizontal distance from center line of equipment support to conduit attachment is 4 ft, thermal movement = ΔX where;

coefficient of thermal expansion = $\alpha = 7.33 \times 10^{-6}$ in/in/°F

$$\Delta X_V = 7.33 \times 10^{-6} \frac{\text{in}}{\text{in} \cdot \text{°F}} \text{ and, } \times (650 - 70) \text{°F} \times (9 \times 12) \text{in} = 0.459 \text{in.}$$

and,

$$\Delta X_H = \text{''} \times \text{''} \times (4 \times 12) \text{in} = 0.204 \text{in.}$$

<u>Maximum Thermal Movement (in)</u>	
vertical	horizontal
1/2	1/4

* Linear interpolation may be used for smaller values (see summary).

Seismic movements of cast and lagged equipment in the vertical direction are negligible because this type of equipment is so rigid vertically and the vertical seismic excitation is relatively small.

Seismic movements in the horizontal direction are given by engineering judgement as follows for various heights of flexible conduit attachment above floor.

<u>Height above floor (Ft)</u>	<u>Maximum Horizontal Seismic Movement (in)</u>
1 1/2	1/4
3 1/2	1/2
4 1/2	3/4
6 1/2	1 3/8
7 1/2	1 3/8
9	1 3/4

Linear interpolation may be used for intermediate heights.

4.2 Equipment using sheet metal construction
Switchgear and motor control centers (MCC's)
are considered. A calculation was made (see
following page) to show the maximum displacement
at the top of an MCC panel due to seismic
excitation. The test was conservative in several
respects. The test specimen was excited at its
resonant frequency. It is unlikely that the random
excitation of a seismic event would dwell at one
frequency long enough to establish resonance. The
damping effect of flexible conduit and electrical
cables attached to the top of the unit was
not considered in the test. Damping was
not considered in the displacement calculation.
Construction and behavior of electrical switchgear
panels is considered to be similar to

Seismic / Thermal Movements - Class IE Flexible Conduit

COMPUTED HELL DATE 4-23-86
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Calculate maximum deflection at top of MCC panel from Seismic Simulation Test Program (See Appendix B)

the differential equation of free vibration is

$$m \ddot{x} + c \dot{x} + Kx = 0$$

where x = deflection, $\ddot{x} = a$ = acceleration and damping = c and is conservatively ignored

$$mg = -Kx \quad \text{or} \quad x = mg / K$$

Frequency of vibration approximated by $\omega = \sqrt{K/m}$

$$\text{substituting } K = \omega^2 m$$

$$x = mg / \omega^2 m$$

where $x = \Delta$ and $\omega = 2\pi f$

$$\Delta = \frac{g}{(2\pi f)^2} = \frac{G(386)}{(2\pi f)^2}$$

f	G^*	Δ
① 8.75	3.4	0.43
② 35	② 4.6	0.04

* Using input acceleration 1.37 g

① resonant frequency

② highest frequency, maximum acceleration tested

Seismic / Thermal Movements - Class IE Flexible Conduit

SHEET 9 OF 13

COMPUTED HPH DATE 4-23-86

CHECKED ABS DATE 4-26-86

MCC's so that a maximum deflection
at the top of MCC's and switchgear
is 1/2 inch.

5.0 Flexible Conduit With Both Ends Attached to Same Rigid Structure

In some cases flexible conduit is used to facilitate installation of electrical equipment for alignment purposes only. Relative motion between each end of the flexible conduit may be considered zero for seismic loading when both ends of the conduit are attached to the same rigid structure.

Seismic / Thermal Movements - Class IE Flexible Conduit

COMPUTED DEH DATE 4-23-86
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6.0 Summary

The following table is a summary of the maximum seismic / thermal displacements of flexible conduit for situations explained in this calculation. These apply to BFN, SQN, WBN and BLN.

<u>Application</u>	* Maximum Movement (in)	
	<u>Horizontal</u>	<u>Vertical</u>
<u>Pipe Mounted Equipment</u>	± 4.0 see 3.3	± 4.0
<u>Floor Mounted Equipment</u>		
cast or forged ≤ 3 ft above floor	0.75	0.15
" " " ≤ 6 ft " "	1.25	0.31
" " " ≤ 9 ft " "	2.0	0.50
sheet metal equipment	0.5	0

* These are rounded values.

7.0 References

- 7.1 EN DES Calculation, Seismic / Mechanical
Analysis of Metal Bellows Corporation 1/2-inch
Instrument Flex Hse for MSSRV Control Air
MEDS No. CEB820913023.
- 7.2 OE Calculation, Browns Ferry Nuclear Plant Summary
of Piping Analysis NI-274-VALVE
Meds No. B22860416109.
- 7.3 OE Calculation, Analysis of Main Steam Problem
N4-1SM-A, RIMS No. B41860123004.

INFORMATION ONLY-NO CHECKING REQUIRED

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APPENDIX A

Maximum Movements for Bellefonte Nuclear Plant

Seismic / Thermal Movements - Class IE Flexible Conduit

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INFORMATION ONLY + NO CHECKING REQUIRED

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APPENDIX B

Seismic Simulation Test Program
on Motor Control Center

ATTACHMENT # 3

SRN-G-40-11
Page 1 of 10

PRELIMINARY

TABLE OF CONTENTS - Change the titles of sections 1.4, 3.2.6.2, 3.2.6.3, and 4.0 to read:

1.4 Definitions

3.2.6.2 Floor-Mounted Equipment and Devices, Seismic Movement Considerations in Seismic Category I (Class I at BFN) Structures

3.2.6.3 Pipe-Mounted Devices, Thermal/Seismic Movement Considerations

4.0 DIVISION OF NUCLEAR CONSTRUCTION/OFFICE OF NUCLEAR POWER QUALITY CONTROL

PREFACE - Change the first paragraph to read:

. . .future nuclear plants. This specification also applies to future modifications and their subsequent maintenance activities at Browns Ferry Nuclear Plant (BFN) in accordance with N. R. Beasley's memorandum to G. R. Hall dated January 15, 1986 (B22 860115 015). This specification may be used. . .

Section 1.2, Page 1-1 - Change first paragraph, first sentence to read:

It is the responsibility of the Division of Nuclear Engineering (DNE) to prepare. . .

Section 1.2, Page 1-2 - Change last paragraph, first sentence to read:

It shall be the joint responsibility of DNE and the Division of Nuclear Construction (NU CON)/Office of Nuclear Power (ONP) to record. . .

Section 1.3, Page 1-2 - Change to read:

The DNE Electrical Engineering Branch (EEB) Central Staff is responsible for the contents of this construction specification. NU CON or the ONP site director is responsible for enforcing the requirements of this general construction specification.

Section 1.4, Page 1-2 - Change title and add definitions.

1.4 Definitions

Seismic Category I (Class I at BFN). Those structures, systems, or components which perform primary safety functions. They are designed and constructed to assure achievement of their primary safety functions at all times including a concurrent Safe Shutdown Earthquake (SSE).

066104.03

Seismic Category I(L)(Class II at BFN). Those portions of structures, systems, or components which perform secondary safety functions to the extent that only limited structural integrity is required. They are designed and constructed to assure achievement of their limited structural integrity at all times including a concurrent SSE.

Safe Shutdown Earthquake. An earthquake which produces the maximum vibratory ground motion for which structures, systems, and components which perform a primary safety function are designed to remain functional.

Section 2.2, Page 2-1 - Change to read:

Major materials and those of a special nature used in the installation shall be designated on DNE detailed design. . .

Section 2.3, Page 2-1 - Change first paragraph, last sentence to read:

. . .flexible conduit, and other minor materials necessary for installation but not requisitioned by DNE.

Section 2.3, Page 2-2 - Change first paragraph, last sentence to read:

DNE approval for their use is contingent upon the following:

Section 2.3, Page 2-2 - Change third paragraph, second sentence to read:

The following types of stainless steel flexible conduit are acceptable for these applications: ServicAir Company SS60, SS63, or SS63C series, or American Boa, Inc., type NBI-0 or NBI-1 series, or equal.

Section 2.3, Page 2-3 - Change first paragraph, first sentence to read:

Pressure-tight stainless steel flexible conduit (ServicAir SS63C extra flexible stainless steel) as defined on the respective project's design drawings and as approved for use by DNE, shall be used for installations where an equipment seal is required.

Section 2.3, Page 2-3 - Change last paragraph to read:

If additional restrictions or limitations are required on miscellaneous materials to be purchased by NU CON/ONP, these restrictions. . .

Section 3.1.1, Page 3-1 - Change to read:

Installation of conduit, boxes, fittings, and accessories shall conform to the respective sections of the latest edition of the National Electric Code (NEC), and the design drawings. . .

Section 3.1.2, Page 3-1 - Change to read:

If interferences occur, the NU CON/ONP electrical engineer shall. . .

Section 3.1.3, Page 3-1 - Change first sentence to read:

. . . promptly, the DNE project shall be consulted for concurrence after NU CON/ONP has coordinated. . .

Section 3.1.2.3, Page 3-2 - Section is incorrectly numbered.

Change to read 3.2.1.3.

Section 3.2.2.2, Page 3-3 - Change second paragraph to read:

In seismic Category I (Class I at BFN) structures, exposed conduits shall. . .

Section 3.2.2.4, Page 3-3 - Change first sentence to read:

In nonseismic Category I (Class I at BFN) structures, galvanized steel members may. . .

Section 3.2.2.8, Page 3-4 - Change second sentence to read:

The conduit interconnecting the two conduit bodies shall be sized by NU CON/ONP in accordance with DS-E13.1.4.

Section 3.2.4.2, Page 3-8 - Change last sentence to read:

An electrically conductive, antiseize compound for metal surfaces (Thomas and Betts Company "Kopr-Shield"; Jet-Lube, Incorporated "SS-30"; Burndy "Penetrox E"; or equivalent) shall be applied to the male conduit threads.

Section 3.2.4.4, Page 3-9 - Change first sentence to read:

. . . embedded applications in nonseismic Category I (Class I at BFN) office and service buildings.

Section 3.2.6.1, Page 3-10 - Change first paragraph, first sentence to read:

. . . equipment and devices that rotate, vibrate, are subject to. . .

Section 3.2.6.1, Page 3-11 - Change first paragraph, second sentence to read:

. . . functioning as the equipment or device grounding conductor, . . .

Section 3.2.6.1, Page 3-11 - Change second paragraph to read:

Flexible conduit shall be installed between conduit fittings in exposed lengths not exceeding 72 inches, except as noted on design drawings. (For exceptions not noted on design drawings contact DNE project for resolution.) Rigid conduit shall be located as near the equipment and device as practical. The flexible conduit shall be prepared, assembled, and installed in accordance with manufacturer's instructions, including any torquing requirements where applicable. The minimum recommended bend radii given in Table 3.2.6-1 shall not be violated. Flexible conduit shall be installed without twist and should be oriented away from heat radiating sources, such as a hot pipe and its insulation. After installation, the flexible conduit shall not be tight or stretched between flexible conduit fittings.

Section 3.2.6.2, Page 3-12 - Change the title of section 3.2.6.2 to read:

3.2.6.2 Floor-Mounted Equipment and Devices, Seismic Movement Considerations in Seismic Category I (Class I at BFN) Structures

Section 3.2.6.2.1, Page 3-12 - Remove section number "3.2.6.2.1" and change the first paragraph to read:

During . . . allow for relative displacement of equipment or devices and a rigid conduit system. To ensure . . . floor-mounted equipment and devices (such as motors. . .

Section 3.2.6.2.1(a), Pages 3-12 and 3-13 - Change to read:

(a) When conduits connect to the top of seismic Category I (Class I at BFN) or Category I(L) (Class II at BFN) floor-mounted equipment and devices, an 18-inch minimum exposed length of flexible conduit shall be installed between the flexible conduit fittings installed at the rigid conduit coupling and the equipment or device. The actual minimum conduit length required for a particular installation shall be as specified on design drawings or as calculated by NU CON/ONP using the equation in Figure 3.2.6-1. This minimum length of flexible conduit will insure that floor-mounted equipment and devices are capable of sufficient movement in any direction. The minimum bend radii for flexible conduit given in Table 3.2.6-1 shall not be violated. Where physical limitations . . . requirements, the NU CON/ONP electrical engineer shall be notified for resolution (by established procedures) with DNE project.

Figure 3.2.6-1, Page 3-12 - Delete figure and note.

Section 3.2.6.2.1(b), Page 3-13 - Change to read:

(b) . . . floor-mounted equipment, such as control panels, . . .

Section 3.2.6.2.1(c), Page 3-13 - Change to read:

- (c) . . . floor-mounted devices, such as motors, . . . to accommodate its minimum bend radius. (See Table 3.2.6-1.)

Section 3.2.6.2.1(d), Page 3-13 - Replace with the following:

- (d) In cases where flexible conduit is used for alignment purposes only and both ends of the flexible conduit are rigidly attached to the same seismic structure, the relative displacement between ends is zero and therefore exempt from thermal/seismic considerations.

Section 3.2.6.2.1(e), Page 3-13 - Add new section.

- (e) Conduit connections to cable trays should be avoided; however, if conduits are connected to seismic Category I (Class I at BFN) cable trays, an 18-inch minimum length of flexible conduit shall be installed as in (a) above.

Section 3.2.6.3, Pages 3-13 and 3-14 - Replace (existing text, Table 3.2.6-1 and Figure 3.2.6-2) with the following:

3.2.6.3 Pipe-Mounted Devices, Thermal/Seismic Movement Considerations

Where electrical connections must be made to devices (such as motor-operated valves, solenoid-operated valves, and temperature switches) which are attached to a mechanical flow system designed for thermal movements, flexible conduit shall be used to compensate for any expansion/ contraction and seismic movement.

Typically, flexible conduit connected to pipe-mounted electrical devices which are subject to thermal movements are in the 1/2-inch through 1-1/2-inch range. Excessive lengths in smaller flexible conduit sizes shall be avoided to decrease stress and prevent pull-out at flexible conduit fittings.

3.2.6.3.1 Seismic Category I (Class I at BFN) Structures

Flexible conduit to pipe-mounted devices in seismic Category I (Class I at BFN) structures shall be installed to compensate for combined thermal/seismic movements. The minimum length of flexible conduit shall be as specified on design drawings or as calculated using the equation in Figure 3.2.6-1. This minimum length of flexible conduit will insure that pipe-mounted devices are:

3.2.6.3.1 Seismic Category I (Class I at BFN) Structures (Continued)

capable of sufficient movement in any direction. The minimum bend radii for flexible conduit given in Table 3.2.6-1 shall not be violated.

3.2.6.3.2 Nonseismic Category I (Class I at BFN) Structures

Flexible conduit to pipe-mounted devices in nonseismic Category I (Class I at BFN) structures shall be installed to compensate for thermal movements only. However, installing conduit per the given equation for seismic Category I (Class I at BFN) structures will provide adequate compensation for nonseismic Category I (Class I at BFN) thermal movements.

Section 3.3.3, Page 3-15 - Change first sentence to read:

. . . boxes located in seismic Category I (Class I at BFN) structures shall. . .

Section 3.3.4, Page 3-16 - Change second paragraph, second sentence to read:

The size lettering shall be determined by NU CON/ONP, depending on the box size.

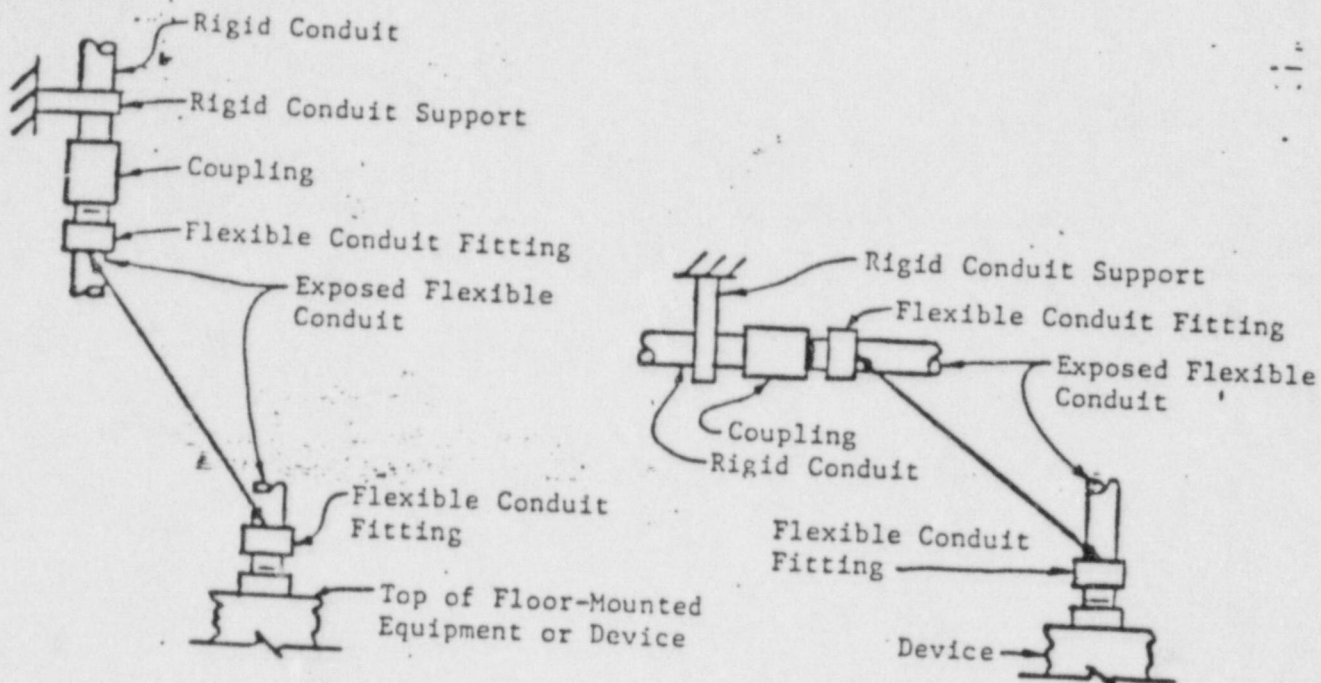
Section 4.0, Page 4-1 - Change title to read:

DIVISION OF NUCLEAR CONSTRUCTION/OFFICE OF NUCLEAR POWER QUALITY CONTROL

Section 4.0, Page 4-1 - Change to read:

NU CON/ONP has the responsibility. . . .

Figure 3.2.6-1



Typical Arrangement of Floor-Mounted Equipment or Device and Pipe-Mounted Device

The equation for calculating the minimum length of exposed flexible conduit required between flexible conduit fittings installed at rigid conduit couplings or pipe-mounted device is as follows:

$$FL = SD + K$$

Where,

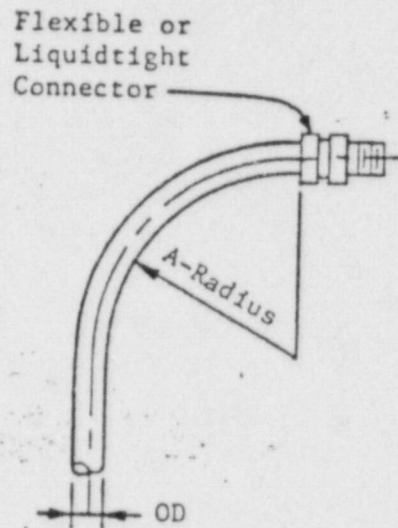
FL = Minimum exposed flexible conduit length between flexible conduit fittings.
 (See Note 1.)

SD = Field measured straight line distance between flexible conduit fittings.
 (When an obstacle prevents a straight line measurement of SD, the proposed flexible conduit route shall be determined and that distance shall be used for SD.)

K = 1 inch or 4 inches (1-inch flexible conduit length is required for maximum seismic movement in any direction at all nuclear plants; 4-inch flexible conduit length is required for maximum combined seismic/thermal movement in any direction at all nuclear plants.)

- Note 1: For flexible conduit cut length, the field shall add to the minimum calculated length (FL), the flexible conduit length required for conduit fittings and any additional length required for bend radii. The minimum bend radii for flexible conduit given in Table 3.2.6-1 shall not be violated. Any exceptions to minimum calculated lengths (FL) and/or minimum bend radii shall be approved by DNE for Class 1E installations.
- Note 2: Exposed flexible conduit lengths shall not exceed 72 inches or be less than 18 inches, except as noted on design drawings, for Class 1E installations. For exceptions not noted on design drawings, contact DNE engineering project for resolution.

Table 3.2.6-1

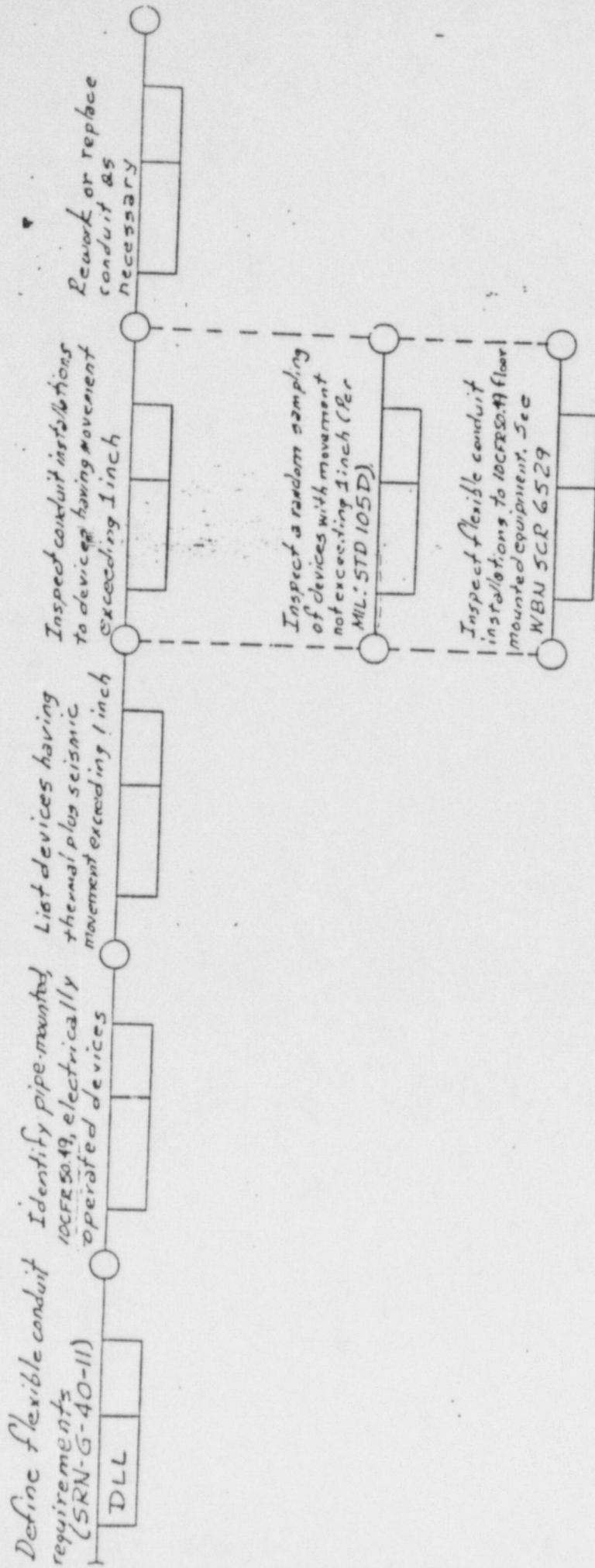


Minimum Bend Radii for Flexible Metal Conduit							
Dimensions-Inches							
Conduit Trade Size (Inches)	Anaconda Type U.A.		ServicAir SS63		American Boa Bl-0		
	A ¹ (Min.)	OD (Nom.)	A ¹ (Min.)	OD (Nom.)	A ¹ (Min.)	A ² (Min.)	OD (Nom.)
1/2	3.5	.84	2.5	.69	2.7	1.17	.67
3/4	5	1.05	3.8	.94	4.5	1.23	1.04
1	6	1.32	5	1.25	5.9	1.38	1.24
1-1/2	5.5	1.90	7.5	1.75	8.6	2.55	1.91
2	7	2.38	10	2.28	9.8	3.81	2.38
2-1/2	9.5	2.88	12	2.78	11	4.54	2.93
3	11.5	3.50	15	3.28	12.8	5.27	3.47
4	14	4.50	20	4.50	19.7	8.74	4.53
5	20	5.57	25	5.56	26.2	12.20	5.61
6	30	6.63	30	6.63	31.7	14.71	6.59

1. Installations where seismic and/or thermal movement considerations are applicable.
2. Installations where seismic and/or thermal movement considerations are not applicable.

ATTACHMENT # 4

FLEXIBLE CONDUIT- 10CFR 50.49 EQUIPMENT AND DEVICES (ALL PLANTS)



ATTACHMENT - C

EX -85-066-002 T50183	CO	19200 N WBN	YYYY REPORT	SR	THERE ARE NOT ENOUGH CONDUILETTES IN CONDUIT RUNS. AUXILIARY AND REACTOR BUILDINGS. CONSTRUCTION DEPT. CONCERN. CI HAS NO ADDITIONAL INFORMATION.
IN -85-138-001 T50039	CO	19200 N WBN	YYYY REPORT	SR	DURING CABLE PULLS, FISH TAPE, MUD, DIRT (WATER) IS LEFT IN THE CONDUIT. PULLING HOOKS GET JAMMED AND ARE LEFT IN CONDUIT. QC & CRAFT SUPERVISOR ARE INVOLVED.
IN -85-201-003 T50157	CO	19200 N WBN	YYYY REPORT	SR	TOO MANY BENDS IN 1" CONDUIT RUN IN UNIT 1 REVERSE OSMOSIS ROOM ELEV. 75' AT 4-V. THERE WERE NO FITTINGS USED TO RUN THIS CONDUIT MAKING IT EXTREMELY DIFFICULT AND TIME CONSUMING TO PULL CABLE THROUGH THIS CONDUIT. CI STATED THAT FITTINGS IN LIEU OF BENDS SHOULD HAVE BEEN USED TO FACILITATE CABLE PULLS. CONSTR. DEPT. CONCERN. NO FOLLOW UP REQUIRED.
IN -85-341-001 T50189	CO	19200 N WBN	YYYY REPORT	SR	FLEXIBLE STAINLESS STEEL CONDUIT FROM VARIOUS EQUIPMENT AND PENETRATIONS INSIDE THE CONTAINMENT IS NOT TORQUED ENOUGH AT THE FLEX AND FITTING ATTACHMENT POINTS. QC ACCEPTED THE WORK. STAINLESS STEEL FLEXIBLE CONDUIT CAN BE PULLED APART AFTER BEING ACCEPTED BY QC. ALL PENETRATIONS AND ELECTRICAL EQUIPMENT INSIDE CONTAINMENT. UNIT 1 & 2 ARE AFFECTED. CONSTRUCTION CONCERN. CI HAS NO ADDITIONAL INFORMATION.
IN -85-512-002 T50046	CO	19200 N WBN	YYYY REPORT	SR	UNIT 2 CONDUIT FITTINGS RECENTLY ISSUED TO THE FIELD (TRADE NAME "ERICKSONS") ARE OF INFERIOR MATERIAL (SIMILAR TO PENTER). INFERIORITY IS PARTICULARLY EVIDENT IN THE INTERNAL THREADED AREA, WHERE THREADS ARE ROUGH AND FLATTENED. PER DIRECTION OF FOREMAN (NAME KNOWN) CRAFT (DISCIPLINE KNOWN) ARE REQUIRED TO UNDERCUT EXTERNAL THREADS ON CONDUIT TO ALLOW USE EXPRESSED ON 3/4", 1" AND 1 1/2" SIZES. NO FURTHER SPECIFICS ARE AVAILABLE.
IN -85-512-003 T50046	CO	19200 N WBN	YYYY REPORT	SR	CONDUIT RECENTLY ISSUED TO FIELD FOR USE ON UNIT 2 EXHIBIT A NUMBER OF PIECES WITH RIDGES AND BURNS IN THE INSIDE DIAMETER. THE POTENTIAL EXISTS FOR WIRES TO BE DAMAGED, IF CRAFT PERSONNEL HAD NOT NOTED THESE DISCREPANCIES. NO SPECIFIC SIZES OR LOCATIONS ARE AVAILABLE.
IN -85-856-004 T50094	CO	19200 N WBN	YYYY REPORT	SR	CONDUIT HAS AS MANY AS FIVE 90 BENDS IN SOME INSTANCES AND CABLE CANNOT BE PULLED. (NAMES KNOWN TO QTC AND RELEASE OF THIS INFORMATION WOULD JEOPARDIZE CI'S CONFIDENTIALITY)... NO MORE DETAILS AVAILABLE. NO FOLLOW UP REQUIRED.
OH -85-007-008 T50224	CO CO	15100 S WBN 19200	YYYY REPORT	SR	WATTS BAR HAS HAD TOO MANY INSTANCES OF UNCRAFTSMAN-LIKE ELECTRICAL WORK, INCLUDING POORLY BENT AND INCOMPLETELY SCREWED TOGETHER CONDUIT (AUXILIARY BLDG), AND CABLES DAMAGED DUE TO SLAG FROM WELDING OPERATIONS OVERHEAD (TURBINE BLDG, ELEV. 729'). NO SPECIFIC LOCATIONS OR UNIT NUMBERS KNOWN. CONSTRUCTION DEPT. CONCERN. CI HAS NO FURTHER INFORMATION. NO FOLLOW UP REQUIRED.

ATTACHMENT - D
SHT-2 OF 3

OFFICE OF CONSTRUCTION
NONCONFORMING CONDITION REPORT

LOP

1A. *Requirement Violated or Not Implemented:
Flexible conduit installation

*Source of Requirement:

SRN-G-40-9

*Description of Nonconformance: Flexible conduit connections to equipment are not installed to compensate for thermal or seismic movement. The sample referenced on RO of this NCR indicated several cases where thermal and seismic criteria were violated. 69 percent had less than min. displacement for thermal considerations, 10 percent were less than 16" long and 16 percent had zero displacement. During the investigation for RI of this NCR, it was observed that the min. bend radius for several flex conduits had been violated.

*Apparent Cause: Failure by electrical craft to follow General Construction Spec. G-40 for seismic considerations. Electrical drawings do not identify components which are part of a mechanical system designed for thermal movement. In the cases where the min bend radius Responsible Organization OC (see continuation page)

10. NCR No.: 6529 Rev. 2

10. REF. NCR of

AUDIT No.: 6529 RO, RI

10. PLANT: WNP

12. UNIT: 1

17. SYSTEM: Various

16. ASME CODE: Yes No

14. CONTRACT No.: 8/8

11. INITIATING

UNIT: SB/C & T

11. VENDOR

NAME: WVA

ADDRESS: WVA



2. Initiator Henry P. Lewis Date 3-5-86 Approved [Signature] Date 3-5-86

3. Corrective Method: Rework Repair Use-As-Is Reject Other

(Check Block and Detail Below)
Refer to OE for disposition.

Recommended By Henry P. Lewis Date 3-5-86 Approved [Signature] Date 3-5-86

4. As Detailed in Section 3 Other (See Continuation Page)
 Referred to Design Project Organization (DPO): DPO Contact for Oral Approval Judy Wington
Responsible Manager [Signature] Date 3/5/86

5. As Detailed in Section 3 Other (See Memorandum)
DPO _____ Date _____

6. Approved Correction Reviewed and Accepted By: _____
Authorized Nuclear Inspector _____ Date _____

7. Approved Correction Completed, and Item Released From Nonconforming Status
Responsible Individual _____ Date _____ Approved By _____ Date _____

8. Significant CAI? Yes No If yes, to No 6529-5
Estimated Cost _____ Reviewer [Signature] Date 3-2-86

ATTACHMENT - D
SHT-3 OF 3

WSN-QCI-1.02, R13
Attachment B
Page 1 of 1
LOP

LOP

Project: Water Bar Nuc Plant		NONCONFORMING AND SIGNIFICANT CONDITION REPORT CONTINUATION PAGE		MCRASH No. 6529 Rev. 2	
Item No.	REMARKS				
1A	<u>Apparent Cause</u> was violated, it appears to be damage due to heavy construction activity.				