2.2 Summary of the Evaluation Process (continued)

- Interviews with cognizant ONP, DNE, and DNC employees, including management, craft, engineering, and inspection personnel.

- The compilation and review of previous work reports and studies conducted on each concern during the previous concerns evaluation program.

2.3 Summary of Findings

2.3.1 Cable Pulling

2.3.1.1 Generic

In July 1985, a Nuclear Safety Review Staff (NSRS) investigation of cable pulling activities at WBN (NSRS report I-85-06-WBN) concluded that DNE and DNC's established and documented program was inadequate to accomplish cable pulling activities. The investigation identified three problem areas with the cable pulling program:

- The fact that TVA did not include sidewall pressure calculations in their cable pull procedure,

- The way TVA defined their method of calculating maximum pull tension, and

- The way DNE resolved the question of exceeding minimum bend radius.

The report also concluded that such improper installation of cables could potentially invalidate the environmental qualification certification of safety-related cables.

Sidewall Pressure

DNE's position on sidewall pressure was that installed cable was acceptable, and the ongoing evaluation would provide documentation to verify it's adequacy. For this reason, a SWP test was conducted at TVA's Central Laboratories titled, "Cable Sidewall Bearing Pressure Test." The objective of the test was to determine the maximum SWP possible on cable pulls without cable

2.3.1.1 Generic (continued)

degradation. The test setup was arranged through preliminary screening and a field inspection of 81 worst-case conduits obtained at WBN. Representative samples of power, control, signal and instrument, and coaxial cables from TVA's nuclear power plants were pulled through a conduit test setup containing four horizontal 90-degree bends. The applied tension was controlled and measured during each cable sample pull to achieve maximum SWP. With the exception of the larger power cables, each cable was tensioned to near its ultimate breaking strength. Test results of 600-1500 lb/ft were reported. To evaluate cable at each site (other than WBN), the Electrical Engineering Branch (EEB) provided guidance to each engineering project to develop and implement a sampling program using EEB-EP 22.29 as a guide. The procedure provided guidance for selecting a sample of conduits which met the worst-case configurations for multiple bends, long lengths, high percentage of cable fill, and elevation changes at each site.

At the writing of this report, SQN had selected sixteen conduits and had performed SWP calculations. Sampling programs were not available for review at BLN and BFN. DNE was also involved in contract negotiations with a third party engineering company to evaluate the methods used for selecting the worst-case conduits. For this reason, the resolution of the sidewall pressure issue was open pending DNE's final response.

Maximum Pull Tension

The industry considered sidewall pressure as the limiting factor for cable pulling activities, therefore, the SWP resolution will also determine the resolution to MPT.

Minimum Bend Radius

MBR concerns were actively being evaluated by DNE. During the period of February 28 through April 15, 1985, TVA's Nuclear Safety Review Staff conducted an investigation at Watts Bar Nuclear Plant in regards to the adequacy of cable installation and

2.3.1.1 Generic (continued)

inspection. A major thrust of this inquiry was the establishment of and adherence to cable bend radius criteria. TVA had used this report (I-85-06-WBN) in addition to the manufacturer's requirements to form a basis for its evaluation. Each of the areas of potential concern was being resolved into elements for further analysis. In each case the actual bend radius to which cable had or could have been subjected was determined. DNE had identified the elongation stress as the critical parameter in determining the acceptability of the bend. The evaluation indicated that the minimum bend to which a cable could have been subjected was that of one times its overall diameter. Preliminary conclusions indicated that the worst-case bend did not reduce the cables capability to perform its safety-related function. The effects of excessive bending on shielded cable was being evaluated separately.

A final report providing a comprehensive detailed analysis of each concern including evaluation results, conclusions, and recommendations was not yet available for review.

SWP, MPT, and MBR issues were to remain open until DNE's final response to questions raised in NSRS report I-85-06-WBN were made available.

2.3.1.2 Site Specific - WBN

The major subissues in the cable pulling subsection were MBR, SWP, and MPT. The majority of the concerns in this subsection dealt with one of these three subissues. All three subissues had been identified previously in NSRS report I-85-06-WBN. As a result of the recommendations made in this report, DNE was evaluating all three subissues for all sites. The actions taken were described in more detail in the generic portion of the cable pulling subsection (section 2.3.1.1). However, specific cases were summarized below.

Some concerns gave specific locations where MBR problems were present. The areas mentioned were located and examined. In neither case were problems identified and the concerns were not verified as

2.3.1.2 Site Specific - WBN (continued)

factual. All other MBR concerns were generic in nature. WBN Nonconformance Reports (NCRs) 4194, 4274, 4933, and 5062 were written to notify DNE of potential MBR problems throughout the plant. They had dispositions which were questioned in NSRS report I-85-06-WBN. The evaluator questioned the relaxation of manufacturer's MBR values because there was insufficient documentation for justification of the new values. Other actions taken and planned were described in section 2.3.1.1. These concerns were considered to be factual and identified a problem, but corrective action was initiated before the evaluation of the issue was undertaken.

Many concerns (under the SWP and MPT subissues) dealt with changing cable pulling requirements with no effort at evaluating past cable installations. Review of all revisions of General Construction Specification G-38 revealed that this procedure did not require that all cable pulls be monitored until 1984. Site procedures also reflected this. In 1985, G-38 was revised to include most cable pulls in the pull tension monitoring program. NSRS report I-85-467, 466, 568, 573, 518, 575-WBN evaluated some of the concerns on the subject. This report tied the concerns to NSRS report I-85-06-WBN which was discussed in section 2.3.1.1. These concerns were factual and identified a problem, but corrective action for the problem was initiated before the evaluation of the issue was undertaken.

There were concerns which reported the use of trucks and come-alongs to pull cable (under the SWP and MPT subissues). In most cases, it was noted that the break ropes were bypassed with steel chokers. The use of steel chokers was verified in interviews. However, the stated purpose for their use was to prevent injuring personnel if a break rope snapped in a mechanically assisted pull. The use of steel chokers for safety purposes was verified in the investigation conducted due to NSRS report I-85-467, 466, 568, 573, 518, 575-WBN. Existence of abuse was verified in an investigation connected with pulling the unit 1

2.3.1.2 Site Specific - WBN (continued)

Reactor Coolant Pumps motor leads. It was verified that these leads did have break ropes bypassed and that the pull did not stop when the break rope snapped. These concerns were factual and identified a problem for which corrective action had been, or was being, taken as the result of the evaluation.

Four concerns were generated under the inspection subissue as the result of a specific instance in which a QC inspector was prevented from entering a room while a cable pull was in progress. This particular event did occur at WBN. The cable in question was scrapped, and the foreman and general foreman were disciplined. This subissue was factual and identified a problem, but corrective action for the problem was initiated before the evaluation of the subissue was undertaken.

Many concerns were just general cases of excessive MPT. One of these concerns had recommended that the cable be pulled to the first outlet before making the pull test on the cable. The Project Manager's Office (PMO) report written in response to this concern did not agree with the concern. The report stated that the suggestion was contrary to site procedures and General Construction Specification G-38 and could not be used. This concern was not factual. Another of these concerns was investigated in NSRS report I-85-852-WBN. The particular cable in question was located. A review of NCRs revealed that this cable had been scrapped as part of the disposition of NCR 6001. The NCR stated that this cable was pulled approximately 20 feet without the presence of a QC inspector. No further action for this concern was necessary. The concern was factual and presented a problem, but corrective action for the problem was initiated before the evaluation of the issue was undertaken. The rest of the concerns in the MPT area were so vague that a meaningful evaluation was impossible. However, their solution was tied to the DNE evaluation of SWP problems which was described further in section 2.3.1.1. These concerns were factual and presented a problem but corrective action for the problem was initiated before the evaluation of the issue was undertaken.

2.3.1.2 Site Specific - WBN (continued)

One of the subissues dealt with poor quality work. One concern dealt with poor quality work of second shift electricians. An Employee Response Team (ERT) report was written on this concern. As a part of this report, the concerned individual was interviewed again and indicated that the problem was with aesthetic rework and not with poor quality work which could affect plant safety. No further evaluation was deemed necessary. The concern was not factual. An incident was reported which alleged that non-electricians were used to pull cable. NSRS report I-85-445-WBN was reviewed in relation to this concern. Some of the interviews conducted in the report revealed that non-electricians had been used in the past to perform electrician's work. However, the specific work performed by non-electricians could not be discovered. The report concluded that all safety-related pulls would be inspected by QC and discrepancies would be noted at that time. The concern was factually accurate, but what it described was not a problem (i.e., not a condition requiring corrective action by ONP). Another concern alleged that a cable to one of the unit 2 CRDM coolers had been pulled with a seven to eight inch split in the insulation. No evidence of this was ever uncovered in interviews with the QC inspectors who watched the pulls to these coolers. The concern was not factual. One concern expressed the opinion that cable pulling procedures were silly and stupid. A review of the site procedures revealed they were as directed by General Construction Specification G-38 which was based on industry standards and the National Electric Code. The concern was not factual. The rest of the concerns in the poor quality work section dealt with a management emphasis on quantity over quality or were so vague that a meaningful evaluation was impossible. The quantity over quality issue was verified in interviews with inspectors and electricians. An example was cited by inspectors who were required to watch simultaneous pulls. They had essentially verified the correct type cable was being pulled and that the ends went

2.3.1.2 Site Specific - WBN (continued)

to the correct locations. Both areas had been tied to SWP problems being evaluated by DNE. This effort was described further in section 2.3.1.1. The concerns identified a problem, but corrective action was initiated before the employee concerns evaluation of the issue was undertaken.

SWP problems were mentioned specifically in nine concerns. They all reported a lack of conduit isometric drawings or lack of SWP calculations. A review of General Construction Specification G-38 did reveal that SWP calculations were not a requirement until November 20, 1985, with Specification Revision Notice SRN-G-38-6. The absence of a SWP calculation requirement had also been noted in NSRS report I-85-06-WBN. Interviews with DNE personnel involved with this issue revealed that a program had been established to evaluate the SWP problem. EEB-EP22.29 established the criteria for selecting problem conduit runs. There were to be 100 cases studied. However, only 81 cases meeting the worst- case criteria were found. Walkdowns were conducted and sketches were made of these conduit runs. EEB performed the SWP calculations from these sketches. Twelve of these conduits (more than the three percent acceptance criteria) contained cables whose SWP values had been exceeded. DNE had determined from Energy Power Research Institute (EPRI) report EL-3333 that TVA's SWP values were four to five times too conservative. A SWP test was developed to determine actual SWP values. This test and later developments were described in section 2.3.1.1.
The subissue was factual and identified a problem, but corrective action for the problem was initiated before the evaluation of the issue was undertaken.

Seven concerns dealt with overfilled conduit. WBN NCR 6609 had been generated when specific instances of conduit overfill were discovered. In the course of dispositioning this NCR, DNE discovered the cable outside diameters used by Watts Bar Engineering Project (WBEP) in their conduit fill program were not auditable. Significant Condition Report (SCRs) WBNEEB8589 and 8590 were generated as a result.

2.3.1.2 Site Specific - WBN (continued)

Samples of the cable types used were sent to Singleton Labs and new average cable outside diameters (ODs) were determined and incorporated into TVA Design Standard DS-E12.1.13. These values had been given to the Computer Methods Branch to incorporate into the conduit fill program. The DNE project engineer was to evaluate the program for conduit overfill problems and generate NCRs as necessary. The new values had not yet been added to the program. The subissue was factual and identified a problem, but corrective action for the problem was initiated before the evaluation of the issue was undertaken.

One of the subissues dealt with the improper routing of cable. This evaluation concentrated on the improper routing of temporary cables because the concerns were worded such that the problem was with routing cables outside cable trays - not routing through the wrong trays. In relation to this, NCR W-283-P and NSRS report I-85-362-WBN were reviewed since both discussed problems with cables routed outside cable trays. NSRS report I-85-362-WBN concentrated on cable problems in the manholes while NCR W-283-P was more general in scope. WPs M5515-1 and NW283P-1 were generated because of the NCR and the NSRS report to identify all cables routed outside cable trays. Corrective action was to have permanent cables replaced in trays, temporary cables not in use removed, and temporary cables still in use placed under the Temporary Alteration Control Form program under AI-2.15. All field work because of those workplans was complete. Workplan (WP) M5515-1 was still open pending a revision to AI-2.15 to incorporate provisions for handling temporary cables. This subissue was factual and identified a problem, but corrective action for the problem was initiated before the evaluation of the subissue was undertaken.

There was one subissue which dealt with the use of an improper cable lubricant on asbestos jacketed cables. The use of Yellow 77 (an improper cable lubricant for asbestos jacketed cable) was verified in an investigation conducted due to Allegation Report 1-80. The only asbestos jacketed cables found to have been pulled with Yellow 77 were non-QA cables for the ice condenser air handling unit backdraft damper controls. The cables were repulled

2.3.1.2 Site Specific - WBN (continued)

using the proper type cable lubricant. This subissue was factual and identified a problem, but corrective action for the problem was initiated before the evaluation of the subissue was undertaken.

One subissue reported pulling improperly sized cables to the 480V receptacles in the Additional Diesel Generator Building and that when the problem was discovered, the engineer's supervisor told him to ignore it. An interview with the engineer revealed there was a problem with the wire size to the 480V receptacles in the Additional Diesel Generator Building which had been dispositioned acceptable by DNE in a demonstration. This demonstration had been conducted in an environment which in no way resembled the configuration in the plant. The same situation was found to have existed at other areas in the plant in interviews with DNC personnel. In these situations,a smaller size wire had been spliced to the cables and these smaller cables were connected to the receptacles.
In relation to the second portion of the concern, the engineer was asked if he was told to ignore the problem. The supervisor had indeed said this, but the engineer had continued investigating the problem. The subissue was factual and presented a problem for which corrective action had been, or was being, taken as a result of an evaluation.

A concern dealt with improperly supported Nuclear Instrumentation System (NIS) cables. Review of design drawings did indicate a large unsupported distance between the raceway where the cables exited to the detectors. An interview with a Westinghouse engineer verified that the cables were installed as required by Westinghouse design. The concern was factually accurate, but what it described was not a problem (i.e., not a condition requiring corrective action).

Two concerns were evaluated which dealt with inadequately cleaned conduit. No interviews ever revealed a problem with rocks or water in conduit during a cable pull. All individuals emphasized that conduits were required to be cleaned before the first cable was pulled through the conduit. The concerns were not factual.

2.3.1.3 Site Specific - SQN

The cable pulling concerns at SQN were divided into five areas: MPT and SWP, MBR, 480-volt receptacles, NIS cable, and cable routing. Except in those cases where there were individual concerns in an area, the concerns were not evaluated on a case-by-case basis. Instead the area was evaluated.

SWP and MPT subissues were determined to be factual and identified a problem, but corrective action for the problem was initiated before the evaluation of the subissue was undertaken. NSRS report I-85-06-WBN concluded that the established program (applicable to SQN) was inadequate to accomplish the cable pull activities and that improper installation of cable could potentially invalidate the environmental qualification of the cable.

DNE was actively evaluating SWP since the industry considered SWP as the limiting factor. A selection of sixteen worst-case conduits was made by a designer who had been involved with the design of most of the conduits in the Auxiliary Building. Conduit configurations were tabulated, isometric sketches were drawn, and cable pull cards were obtained for SWP calculations. The final calculation for each pull direction was not yet available for review.

SCR SQNEEB8529 was generated to document conduit overfill of 55 conduits (considered as part of the SWP and MPT subissues). The SCR was dispositioned use-as-is. The reason given for this was that exceeding conduit fill did not constitute a failure - it was a violation of values given to prevent damage to cable during installation. However, it was later discovered that cable outside diameters used in the cable fill program were not auditable. New values were being incorporated into the conduit fill program to determine if there were any problem conduits. NCRs will be written on any conduits where SWP values may have been exceeded.

2.3.1.3 Site Specific - SQN (continued)

The MBR subissue was determined to be factual and identified a problem, but corrective action for the problem was initiated before the evaluation of the subissue was undertaken. A review of NSRS report I-85-06-WBN revealed that a comprehensive review of cable bend radius issues from 1979 through 1985 identified several areas of potential inadequacies. The findings of this report were reviewed for applicability to SQN. The Electrical Engineering Branch was conducting a study to determine the effects of the worst-case bends to which a cable had or could have been subjected. Preliminary conclusions of the study indicated that the worst-case bend did not reduce the cables available elongation properties below that required for it to perform it's safety-related function. Final recommendations were to be formulated which, if necessary, may include cable testing, surveillance inspections or rework, or replacement of the cable in question.

The SQN concern which dealt with excessive MBR for Conax connectors was factual. A Corrective Action Report (CAR) had been initiated and all unacceptable connectors had been reworked.

The subissue which dealt with improper wiring to 480-volt receptacles was not factual at SQN. The receptacles at SQN were rated to be used with three conductor number 2 American Wire Gauge (AWG) wire and were acceptable based upon a walkthrough, review of the manufacturer's catalog, and through discussions with an Electrical Maintenance engineer.

The subissue dealing with NIS cables which was determined generic to SQN through the WBN evaluation was not factual at SQN. The design of the system was different between SQN and WBN. The SQN orientation did not have the large distances found between the raceway and the detectors as specified in the employee concern.

One subissue dealt with improper routing of cable. The evaluation concentrated on permanent cables because the problem with temporary cables at WBN was associated with construction activities.

2.3.1.3 Site Specific - SQN (continued)

Based upon interviews with two Modifications engineers and field observations, the concern was found factual and presented a problem for which corrective action had been, or was being, taken as a result of an evaluation.

2.3.1.4 Site Specific - BFN

The cable pulling concerns at BFN were divided into four areas: MPT and SWP, MBR, 480-volt receptacles, and cable routing. Except in those cases where there were individual concerns in an area, the concerns were not evaluated on a case-by-case basis. Instead, the area was evaluated.

SWP and MPT issues were determined to be factual and identified a problem, but corrective action for the problem was initiated before the evaluation of the subissues was undertaken. The calculation of sidewall pressure was not addressed in Construction Specification G-4, and G-3 did not limit the number of degrees of bend in conduit runs between pull points. SCR BFNEEB8631 reported that sufficient installation guidance was not given to ensure that the sidewall pressure of cables was not exceeded.

The cable outside diameters used in the conduit fill program were not auditable. This problem was associated with the SWP subissue. The new values were being added to the conduit fill program to determine if there were any problem conduits. NCRs will be written on any conduits where SWP values may have been exceeded.

Final resolution of the SWP subissue was to depend on DNE's ongoing evaluation and final report as discussed in previous sections of this report.

The MBR subissue was determined to be factual. SCR BFNEEB8634 was written because Construction Specification G-4 did not provide installation guidance to ensure that cables were installed without violating cable manufacturer's limitations on cable bend radius. An ongoing evaluation by the

2.3.1.4 Site Specific - BFN (continued)

Electrical Engineering Branch (mentioned in previous sections of this report) was to determine the resolution to the MBR issue. Final recommendations were to be formulated which, if necessary, may include cable testing, surveillance inspections or rework, or replacement of cable in question.

The subissue which dealt with improper wiring of 480-volt receptacles was not verified at BFN. Based upon a walkthrough and a review of the manufacturer's catalog information, the receptacles were determined to be properly installed.

One subissue dealt with improper routing of cables. Based upon a review of Discrepancy Report (DR) BF-DR-86-0120, cables could be found running outside of cable trays at BFN and the concern was verified. The cables were dispositioned use-as-is.

2.3.1.5 Site Specific - BLN

The cable pulling concerns at BLN were divided into four areas: MPT and SWP, MBR, 480-volt receptacles, and cable routing. Except in those cases where there were individual concerns in an area, the concerns were not evaluated on a case-by-case basis. Instead, the area was evaluated.

SWP and MPT subissues were determined to be factual and identified a problem, but corrective action for the problem was initiated before the evaluation of the subissues was undertaken. Problem Identification Report PIR BLNEEB8518 reported that SWP calculations were not considered in the design process and Construction Specification G-38, Revision 5, did not address SWP.

In relation to the MPT subissue, NCR 2987, Revision 0, was reviewed. It was written to report that cables installed from October 14, 1983 until March 1, 1984, were installed and accepted by Quality Control without using the new break rope requirements as given in General Construction

2.3.1.5 Site Specific - BLN (continued)

Specification G-38 (SRN-G-38-2). Cable pulled during this period was sampled to determine if cable damage had occurred and no further problems were identified. The NCR was closed on February 20, 1986.

DNE was actively evaluating SWP and MPT subissues caused by inadequate procedures for cable pulling and inadequate control over conduit overfill. Actions being taken were summarized in Generic Section 2.3.1.1. Final resolution was to depend on DNE's ongoing evaluation and final report. At the writing of this report, data had not been collected for the specifics on worst-case conduit arrangements at BLN.

The MBR issue was determined to be factual at BLN based upon program inadequacies identified in NSRS report I-85-06-WBN. A memorandum was issued by W. S. Raughley (EEB) on September 2, 1986, which provided direction to each project for steps necessary to resolve MBR concerns for Class 1E installations. At the writing of this report, the MBR problems had not been resolved. EEB's ongoing evaluation was responsible for providing a resolution to the problem. Final recommendations were to be formulated which, if necessary, may include cable testing, surveillance inspections or rework, or replacement of cable in question.

The subissue which dealt with improper wiring of 480-volt receptacles was not factual at BLN. The receptacles were observed to be wired with three conductor number 2 AWG wire spliced to a smaller wire before termination. Based upon a walkthrough and a review of TVA drawing number SGW1740-ED-33, the receptacles were determined to be properly installed.

The issue raised by the concerns for cable routing was factual since problems with cable routing were documented. However, these were isolated instances and had been addressed prior to the evaluation. These included NCR 4975, Revision 0, which was

2.3.1.5 Site Specific - BLN (continued)

written because cable was not routed properly at the point where the cable transitioned from a conduit to a cable tray. The NCR was issued on August 12, 1986, and had not been closed out. NCR 7249 was also written due to improper cable routing from a cable tray to a conduit. The cable was pulled back and reinstalled according to DNE routing, and the NCR was subsequently closed out. The Quality Control Procedure for routing cable was reviewed and determined to be adequate.

2.3.2 Splicing

2.3.2.1 Generic

The findings were handled on a site specific basis for this issue.

2.3.2.2 Site Specific - WBN

One of the splicing concerns gave a specific instance of cable splicing and then placing the splice in conduit. The test card was obtained on 2-3V-31-7229 (the cable questioned in the concern). This card and an interview with the responsible Electrical Engineering Unit (EEU) engineer pinpointed the splice in a condulet. A review of Standard Drawing SD-E12.5.6 note 6A and WBN drawing 15W810-3, Revision 15, revealed that splices were allowed in condulets. The cover was removed from the fitting and the splice was located. It was in the condulet as allowed by procedure. The concern was factually accurate, but what it described was not a problem (i.e., not a condition requiring corrective action). There were three other concerns in the subissue of splices in conduit whose descriptions were so vague that a meaningful evaluation was impossible. It was possible that the concerned individual was confused about the acceptability of splices in condulets as discovered with cable 2-3V-31-7229. Procedurally (SD-E12.5.3 and E12.5.6) a splice was not allowed in a conduit or cable tray. However, the only technical consideration noted was that the splice was not easily accessible if a problem developed with it. These concerns were not factual.

2.3.2.2 Site Specific - WBN (continued)

One of the concerns dealt with electricians who were hired to specifically perform splices which was work that they were not trained for. An example was given in which one of the splices performed by these electricians had failed the high potential test. The concerned individual believed that the potential test might miss more of the bad splices. The specific example given was not verified. Therefore, individuals in EEU and QC were interviewed on the possibility of the high potential test passing a bad splice. They stated that this test was conducted to verify the splice was acceptable. If the splice was unacceptable, the test would catch it. They were also questioned about hiring electricians to specifically perform splices. They stated electricians had not been hired to perform specific jobs. The concern was not factual.

A concern was evaluated that the NRC had investigated a splicing problem at WBN but the concerned individual did not know of any corrective action which had occurred as a result of this investigation. The DNC NRC open items log was reviewed. No open items were noted with splicing other than those NCRs listed in the next paragraph. Any corrective action, if any was necessary, must be complete. The concern was not factual.

One of the generic splicing concerns was tied to the resolution of five NCRs. The concern dealt with improper splicing and splice documentation. NCRs 6208 and 6224 were concerned with safety-related splices in harsh environments which were not made in accordance with Standard Drawing SD-E12.5.7-1. Rework of the splices was to be performed under WP N6224-1 (unit 1) and FC900A (unit 2). Neither workplan was complete. NCR 6536 was written because 600 volt connectors were listed in site procedures to be used in 6.9-KV splices. Work on this NCR was to be performed under WP N6536-1 which was not yet complete. NCRs 6623 and 6774 stated that cable splices and terminations made before December 2, 1985 did not meet current requirements as specified in DNE's Standard Drawings, General Construction Specification G-38, and the manufacturer's application guide. These NCRs were dispositioned

2.3.2.2 Site Specific - WBN (continued)

use-as-is by DNE. The concern was factual and identified a problem, but corrective action for the problem was initiated before the evaluation of the concern was undertaken.

One concern reported bad splices under the switchyard which had caused problems. An interview with the switchyard foreman revealed no problems had been identified with any splices under the switchyard. Particular splices that the foreman was familiar with were viewed in a walkthrough of the area. No problems were noted with the area (it was clean and dry) or with the splices themselves (they were located and tagged as required by procedures). The concern was not factual.

2.3.2.3 Site Specific - SQN

MAS-85-003 was a SQN specific concern which dealt with a splice on the Component Cooling System CS pump which had been taped instead of using Raychem. A discussion revealed that the concern was written on cables 1PL47355 and 1PL47365. These cables had been inspected, and cable 1PL47355 had been reworked using Raychem. The concern was factual and identified a problem, but corrective action for the problem was initiated before the evaluation of the concern was undertaken.

WBN NCRs 6208, 6224, 6536, 6623, and 6774 were also evaluated at SQN in relation to a general splicing concern. NCRs 6208 and 6224 were evaluated together because they dealt with the same subject. These NCRs were generic to SQN and corrective action had been carried out by ONP. In an interview with the person in charge of the Experience Review Program, it was revealed that all splices in question had been inspected and corrections had been made as required. This documentation had been sent to the Environmental Qualification Project to become a part of the EQ binder. These NCRs were closed on the SQN site. NCR 6536 was not applicable to SQN because the Thomas and Betts 54500 series connectors had not been used on 6.9KV splices. As stated in section 2.3.2.2, NCRs 6623 and 6774 were dispositioned

2.3.2.3 Site Specific - SQN (continued)

use-as-is by DNE. The concern was factual and identified a problem but corrective action for the problem was initiated before the evaluation of the concern was undertaken.

2.3.2.4 Site Specific - BFN

WBN NCRs 6208, 6224, 6536, 6623, and 6774 were also evaluated at BFN on the subject of poor splicing practices. NCR 6536 was not found to be applicable to BFN based on the fact that MAI-13 (the BFN procedure for installing cable) listed the correct butt splice connectors for 0 through 600-volt and 601 through 15,000-volt applications. NCRs 6623 and 6774 were deemed non-generic because of the fact that BFN was committed to General Construction Specification G-4, not G-38 until after December 2, 1985. G-4 did not require the use of Raychem.

A problem was recognized with NCRs 6208 and 6224. Improper splicing in harsh environments below the maximum flood level existed at BFN. This problem was being handled by SCR BFNEQP8501. Discussions with EQF engineers revealed that they were committed to perform walkdowns on all cable termination splices for all safety-related equipment. The concern was factual and identified a problem, but corrective action for the problem was initiated before the evaluation of the concern was undertaken.

2.3.2.5 Site Specific - BLN

WBN NCRs 6208, 6224, 6536, 6623, and 6774 were evaluated at BLN on the subject of poor splicing practices. NCR 6536 was not generic to BLN since Thomas and Betts connectors were not used at BLN. The problems identified because of NCRs 6208, 6224, 6623, and 6774 were not applicable to BLN since the splices had already been reworked by way of BLN NCR 2494. This NCR reported that the shim in Raychem type NPKV-2-14 kits was being omitted when the Raychem sleeve was being used as the lug and bolt cover sleeve. All Class 1E installations using

2.3.2.4 Site Specific - BLN (continued)

NPKV-2-14 splice kits in harsh environments were reworked to the proper configuration. Splices in mild environments were determined by EQP to be acceptable without a shim.

2.3.3 Cable Terminations

2.3.3.1 Generic

See sections 2.3.3.2, 2.3.3.3, 2.3.3.4, and 2.3.3.5 for details of the conclusions reached at each site for SCR WBNEEB8537.

2.3.3.2 Site Specific - WBN

One subissue dealt with non-electricians terminating cables. Two reports (NSRS report I-85-445-WBN and the ERT report written for EX-85-148-001, IN-85-474-001, and IN-85-705-001) were reviewed relative to this area. In both reports, instances of non-electricians performing electrical tasks were discovered. The practice was stopped in DNC. Subjourneymen were no longer used in DNC, and provisions had been made to inform subjourneymen of the limits of their duties if they ever return.

The ONP response gave the checks present in the system to ensure substandard work was detected. In both reports, it was impossible to determine which work had been performed by unqualified personnel. However, it was determined that if the work was performed on safety-related equipment it would have been verified by a QC inspector. The concern was factual and identified a problem, but corrective action for the problem was initiated before the evaluation of the concern was undertaken.

One of the concerns in this issue named a specific junction box which was a source of bent lug and MBC problems. The junction box (1918) was located in the unit 2 Accumulator Room Number 4. Problems with bent lugs were verified. The junction box installed in the field was found to be smaller than the box DNE had specified. The box was replaced with a larger box on WP FR063B-Z. The workplan was craft

2.3.3.2 Site Specific - WBN (continued)

complete and was on hold for inspection. The concern was factual and presented a problem for which corrective action had been, or was being, taken as a result of an evaluation.

The micro-limit switches specified in one of the termination concerns was located. The concern was with violations of MBR to make terminations. The MBR on the back of the termination slips read approximately two times the value obtained after calculations using 47A800 (the TVA drawing which gave actual cable outside diameters for various types of cable). Therefore, the MBR of the installed cables was acceptable. The concern was not factual.

Three concerns reported a lack of megger and continuity tests in the cable installation process. A review of site documents revealed that in ONP, the megger and continuity tests were performed by QC if the cables were safety-related. Otherwise, the tests were performed by the craft. In DNC, the megger test was deleted from site procedures on May 1, 1984, due to the fact that Institute of Electrical and Electronics Engineers (IEEE) Standard 690-1984 did provide for functional testing as an alternative to the megger test. Presently, QC performs continuity tests for safety-related cables. It was possible that the concerned individual was not aware that the megger test had been deleted as a requirement for safety-related cables. Non-QA cables were handled under SGP-14. This procedure required the engineer to perform a megger test. This was not being done as verified in interviews with former EEU engineers. The concerns were found factual and presented a problem for which corrective action had been, or was being, taken as a result of an evaluation.

One concern dealt with recrimping a lug. General Construction Specification G-38 revealed that recrimping was allowed as long as: 1) the orientation of the recrimp was the same, 2) the

2.3.3.2 Site Specific - WBN (continued)

crimp tool was calibrated, and 3) the recrimp was compared to a properly performed crimp. It was also true that the lug crimp was a part of the inspection criteria for safety-related cables. The concern was factually accurate, but what it described was not a problem (i.e., not a condition requiring corrective action).

Another of the concerns dealt with a problem with installing lugs backwards. A knowledgeable Electrical Quality Control (EQC) inspector was interviewed for information on the subject. The only way it was determined that lugs could be installed backwards would be if the cables were terminated back to back and the lugs were installed such that they were not flush (SD-E12.5.7-1 and E12.5.5-1 were used to illustrate how the problem could occur). He stated that this was not a widespread problem and that if the lugs were installed this way the termination would be unacceptable to the inspector. The concern was not factual.

Four concerns were identified which dealt with the misapplication of AMP Diamond Grip Insulated (PIDG) lugs. These lugs were to only be used on solid conductors. This problem had been identified in NCR 6076 which DNE had dispositioned use-as-is. NSRS report I-85-101-WBN differed with this. As a result, Engineering Change Notices (ECNs) 5879 and 5880 were written to replace or solder over these lugs if they were used with solid conductors. WPs E5879-1 and 2 were reviewed. The workplans had replaced or soldered over unit 1 misapplications of PIDG lugs. The unit 2 work had not yet begun. There were other side issues identified with NSRS report I-85-101-WBN. The only other issue pertinent to the lug problem was the revision of all DNE, DNC, and ONP procedures to prohibit the use of PIDG lugs on solid conductors. All applicable documents have been revised. The concerns were factual and identified a problem, but corrective action for the problem was initiated before the evaluation of the concern was undertaken.

2.3.3.2 Site Specific - WBN (continued)

Two concerns dealt with relugging a cable without the proper paperwork. A review of the revision of WBN-QCI-1.07 which was applicable in the timeframe of the concern revealed that no rework release was required because the work fell under the jurisdiction of WBN-QCI-3.06-3. The concerns were not factual.

One of the concerns dealt with six or seven unit 2 Reactor Building fans whose leads had been lugged but not terminated. It was stated in the concern that these terminations had been documented, and the documentation was in the vault. The concern also mentioned that the leads were worn and frayed. It was verified through an interview with the responsible DNC Mechanical Engineering Unit (MEU) engineer that the Upper Compartment Coolers and the Containment Air Return Fans had been balanced which verified the leads were terminated. Visual observation of the handswitches in the Main Control Room (MCR) verified that all four Lower Compartment Coolers were operating. Since the CRDM fan leads were listed as not terminated on the cable master summary, they were not considered further since the concern stated that the questionable terminations were documented. The other portion of the concern which dealt with frayed and damaged leads was investigated for the Upper Compartment Coolers. The Containment Air Return Fans and Lower Compartment Coolers were QA fans whose leads were not only examined by the QC inspector, but also by the environmental qualification group onsite since these fans were 10 CFR 50.49 applicable. The leads of Upper Compartment Coolers 2A and 2D were examined. The braided covering for the leads was frayed, but there was no damage to the conductors. An interview with an EQC inspector revealed that the braided covering was cut back to apply Raychem materials. He stated that the covering would be trimmed back neatly for a QC inspector. Since these were non-QA cables, the electricians had not bothered to trim the covering. This was only a

2.3.3.2 Site Specific - WBN (continued)

cosmetic problem. A review of Standard Drawing SD-E12.5.6 verified in step 7D that braided type coverings over insulation were to be removed to assure a minimum seal length under the heat shrink. The concern was not factual.

Two concerns reported poor wiring work and improper electrical termination techniques. The vagueness of the concerns precluded any attempt to properly evaluate the concerns. There were established programs for handling QA and non-QA cables. The non-QA program was covered in SOP-14 and required the use of the system engineer for inspection. The QA cable termination program was contained in WBN-QCI-3.06-3 and required the use of a QC inspector for verification of acceptance criteria. The concerns were not factual.

2.3.3.3 Site Specific - SQN

The only generic subject in the splicing issue dealt with the misapplication of PIDG lugs.

As required by NSRS report I-85-101-WBN and SCR WBNEEB8537 (which was generated as a result of the NSRS report), a replacement program for PIDG lugs on solid conductors was developed at SQN. The work was carried out in Special Maintenance Instruction SMI-2-317-25. Work on the surge suppression networks had not begun because the Compliance Section had been asked to justify not replacing these lugs. The EEB engineer responsible for resolving the issue stated rework was required for all networks on valves whose solenoids were required to energize to perform their safety function. It was requested that those which did not energize to perform their safety function be replaced or soldered over eventually. The concern was factual and identified a problem, but corrective action for the problem was initiated before the evaluation of the concern was undertaken.

The particular cable in question in concern XX-85-027-012 could not be identified from the information on the K-form. The concern was with a SQN unit supervisor who cut insulation back from termination lugs to make them appear properly | R3

2.3.3.3 Site Specific - SQN (continued)

installed. Since there was limited information, the inspection process for terminations was examined to uncover what was in place to detect a problem of this type. The impression received from all interviews was that the actions would be impossible to hide from a QC inspector, therefore indicating the cable could be non-QA. There were tests in place (megger and functional), as well as a visual inspection of the terminations which should have identified any discrepancies. The tests dated from 1973 (when CTI-10 was issued) and the visual inspection dated from 1975 (when the inspection group was set up). Prior to that, the engineer was to inspect the termination though no acceptance criteria was in the procedure for inspection of termination lugs. The procedures in place from 1976 were adequate to ensure proper termination of QA cables. Prior to that time, the procedures were inadequate in that no termination criteria was given, but vendor literature was quite specific on how terminations were to be performed. As the concern was worded, the incident was an isolated case and was in violation of established procedures. Since it was isolated and the procedure/vendor literature was adequate, no further action was necessary. The issue was not factual. R3

2.3.3.4 Site Specific - BFN

NSRS Report I-85-101-WBN described a condition concerning the misapplication of AMP PIDG terminal lugs. According to the manufacturer, these lugs were not intended to be used with solid conductor wire. Generic SCR WBNEEB8537 had been generated as a result. DNE was actively evaluating the condition and had identified three instances of solid conductor wire purchased for use at BFN on the Electrical Master Bill of Material. Further evaluation was required to determine the extent of PIDG lugs used with solid conductor wire. DNE was in the process of scheduling walkdowns similar to those conducted at WBN and SQN. The concern was factual and identified a problem, but corrective action for the problem was initiated before the evaluation of the concern was undertaken.

2.3.3.5 Site Specific - BLN

NSRS report I-85-101-WBN described a condition concerning the misapplication of AMP PIDG terminal lugs. According to the manufacturer, these lugs were not intended to be used with solid conductor wire. As a result of generic SCR WBNEEB8537, Revision 0, a "Potential Generic Condition Evaluation" was conducted and as a result of that evaluation the condition was determined not to exist at BLN. The concern was not factual.

2.3.4 Inspection of Cable

2.3.4.1 Generic

The findings were handled on a site specific basis for this issue.

2.3.4.2 Site Specific - WBN

One of the concerns in this subsection reported that craft were ordered not to wait on QC inspectors at QC hold points. A review of NCRs revealed that nine had been written on the subject. However, the termination, pull, or splice documentation was not complete until the inspector signed the cards. The checks in the system were adequate to prevent uninspected work from going undetected. The concern was factual and identified a problem, but corrective action for the problem was initiated before the evaluation of the concern was undertaken.

Another of the concerns dealt with a QC inspector who had been prevented from viewing a cable pull. This particular instance was discussed in section 2.3.1.2. As reported previously, the cable was scrapped and the foreman and general foreman were disciplined. The concern was factual and identified a problem, but corrective action for the problem was initiated before the evaluation of the concern was undertaken.

2.3.4.2 Site Specific - WBN (continued)

Another concern was generated because it was reported that a QC inspector had inspected the relugging of a cable without any paperwork. Review of the applicable site document indicated that there was no requirement to have termination paperwork present while the termination was performed. The cable in question was identified, and termination documentation dated in the timeframe given in the concern was located in the DNC records vault. The concern was not factual.

One of the concerns in this subsection dealt with engineering inspections which were not thorough in the timeframe of 1978 through 1979. Four individuals who had been involved in the inspection process in the timeframe noted were interviewed. All individuals stated that they did a thorough job as long as they were asked to view only one pull. At that time, however, engineers were allowed to watch multiple cable pulls. Two of the engineers interviewed had been asked to watch multiple pulls. One of these individuals had responsibility for the unit 1 Reactor Building and was to watch four crews. Both of the engineers who had watched multiple pulls stated that they were kept so busy that all they could verify was that the cable was the right type and that the ends went to the correct places. Present practice does not allow QC inspectors to view more than one cable pull at a time. The concern was factual and identified a problem, but corrective action for the problem was initiated before the evaluation of the concern was undertaken.

2.3.4.3 Site Specific - SQN

There was no SQN evaluation for this issue.

2.3.4.4 Site Specific - BFN

There was no BFN evaluation for this issue.

2.3.4.5 Site Specific - BLN

There was no BLN evaluation for this issue.

2.3.5 Fireproofing Cables

2.3.5.1 Generic

The findings were handled on a site specific basis for this issue.

2.3.5.2 Site Specific - WBN

There were nine concerns evaluated at WBN for this issue.

One of the fireproofing concerns reported incorrect layers of insulation on conduit and cable tray wrap. The ERT report on this concern detailed an investigation in which two installations had been destructively examined in the area given in the concern. No discrepancies were noted. The concern was not factual.

Another fireproofing concern reported that insulators were inserting cables in penetrations. A PMO report on this concern was reviewed. The report discovered that the international agreement between the electrician's union and the insulator's union specified the tasks to be performed by each union in breaching and pulling cables through penetrations. In this division of duties, electricians were to install cables. Interviews with an electrical job steward, an electrical superintendent, and a general foreman did not reveal any discrepancies. The concern was not factual.

Three fireproofing concerns dealt with bunching cables and coating them with Vimasco so thickly that heat was not allowed to dissipate. NSRS report I-85-569-WBN was reviewed in relation to these concerns. The report verified that cables were bunched together in V1, V2, and V3 (low, medium, and control) level trays but not in V4 (480 V) or V5 (6900 V) level trays. However, the V1, V2, and V3 level cables were bunched based on approval by DNE. The concern with heat buildups was

2.3.5.2 Site Specific - WBN (continued)

not validated because (1) cables in V4 and V5 level trays were not bunched, (2) cables in V1, V2, and V3 level trays were based on a random arrangement, and (3) evaluations conducted by DNE. However, no evidence supported the fact that the effects of Vimasco with respect to ampacity had been specifically documented for all WBN applications.

The report asked that documentation be provided to show the ampacity effect of the Vimasco coating on cables. It also asked that WBN applications be reviewed to determine that no problems existed with present cable sizes. As a result, the ampacity tables were updated to incorporate the effect of Vimasco and placed in DS-E12.6.3. A sampling procedure had been drafted at WBN to ensure the adequacy of installed cable size. The NSRS later recommended that there be testing of WBN cables with conditions typical for installed cables. However, no satisfactory response to the recommendation on testing cables for typical conditions in the plant had been received. The concern was factual and presented a problem for which corrective action had been, or was being, taken as a result of an evaluation.

One of the fireproofing concerns dealt with the removal of Vimasco with sharp instruments. NCRs 5094 and 5612 reported cable damage because of the removal of Vimasco cable coating. The response to these NCRs was to prohibit the use of sharp tools to remove Vimasco and to provide a requirement to visually inspect cable before Vimasco was reapplied. This was added to DNC instructions but had not been included in ONP procedures. The concern was factual and presented a problem for which corrective action had been, or was being, taken as a result of an evaluation.

Another of the fireproofing concerns reported that Vimasco cable coating had been applied over large pieces of trash. An interview with the former section supervisor of the group which inspected the coating application revealed that cable cleanliness was a QC hold point. A review of WBN-QCP-3.7 verified that the cables were required to be

2.3.5.2 Site Specific - WBN (continued)

inspected for cleanliness and signed off by a QC inspector before Vimasco was applied. The concern was not factual.

XX-85-094-005 dealt with the use of a fish hook tool to breach fire barriers. The use of this type tool was not found factual in conversations with two Civil Quality Control (CQC) inspectors and the former CQC supervisor. WBN was using fiberglass rods or wooden broom handles to breach fire barriers. NSRS report I-85-702-WBN was discovered which dealt with the use of fish tape to breach penetrations. It was assumed that the concerned individual had meant fish tape. The use of fish tape to breach fire barriers was verified. The corrective action had been completed. It consisted of revising MAI-14 to prohibit the use of fish tape and to train maintenance personnel not to use fish tape to breach fire barriers. The concern was factual and identified a problem, but corrective action for the problem was initiated before the evaluation of the concern was undertaken.

One of the fireproofing concerns dealt with inadequate control of breaching permits. NSRS report I-85-699-WBN and an ERT report on IN-85-130-002 were reviewed in relation to this concern. The investigation uncovered the fact that ONP and DNC were using two different procedures to administratively control the breaching process even though DNC had been requested to use the ONP procedure. Surveillances conducted by WBN QA and the ERT group revealed several discrepancies. These discrepancies included outdated permits and nonexistent permits at breaches. DNC and ONP now use PHYSI-2 to breach penetrations behind the security barrier. This procedure had been revised to maintain a maximum of 25 breaches to provide better control of the breaching process. It also identified the groups who were to perform the breaching. Mechanical Maintenance was to breach for ONP and Modifications was to breach for DNC. A

2.3.5.2 Site Specific - WBN (continued)

walkdown was conducted of all fire barriers and discrepancies were corrected. The fire barriers were now under the Surveillance Instruction (SI) program and were to be walked down every 18 months. The only discrepancy noted was that SOP-42 (the DNC procedure which outlined how DNC was to request a breach behind the security barrier) referenced the Nuclear Services Branch group which did not exist. The concern was factual and presented a problem for which corrective action had been, or was being, taken as a result of an evaluation.

2.3.5.3 Site Specific - SQN

There were five concerns evaluated at SQN for this issue. At this site, individual concerns were not evaluated--they were evaluated on an issue basis.

The portion of the investigation conducted at SQN which dealt with removal of cable coating with sharp instruments was not found factual in conversations with Modifications and Electrical Maintenance personnel. The only example of the removal of Flamemastic was at penetrations where the cables were terminated. The procedure here was to flex the cable until the coating cracked, and then peel it off. However, there was nothing in site procedures which prevented the use of sharp instruments or any provisions for inspecting the cable for damage after the coating was removed. Therefore, the concern was factual and presented a problem for which corrective action had been, or was being, taken as a result of an evaluation.

The portion of the SQN investigation which dealt with the use of cable coatings and their effects on cable ampacity was factual. New ampacity tables, which were used to size cable, were developed to incorporate the effects of Flamemastic. This meant that all cables pulled and coated before the issuance of this table were in question. An evaluation of as-installed cables was scheduled. However, no work had been completed at the time the report was written.

2.3.5.3 Site Specific - SQN (continued)

The site procedural control of breaching concern was evaluated at SQN. The problem at WBN had resulted from the fact that multiple organizations were breaching fire barriers. This was not the case at SQN. They have had only one procedure for breaching fire barriers. They also had a surveillance program in place to verify the integrity of the penetration fire barriers. The subissue was not factual.

The use of a fish hook instrument to breach fire barriers was found not factual in interviews with a cognizant Modifications supervisor and general foreman. However, fish tape was allowed in M&AI-13. This was assumed to be the problem material. Fish tape had been deleted from MAI-14 at WBN and this should be evaluated at SQN because of this employee concern evaluation.

2.3.5.4 Site Specific - BFN

There were five concerns evaluated at BFN for this issue.

Several concerns described a condition involving bunched cables and excessive cable coatings. Discussions with three cognizant DNE engineers and review of Corrective Action Report (CAR) number BF-CAR-86-0078, revealed that cable coatings could be found thicker than 1/4-inch throughout the plant. This was in excess of the manufacturer's recommendation. At the writing of this report, BFN was in the process of writing a walkdown procedure. The subissue was factual and identified a problem, but corrective action for the problem was initiated before the evaluation of the subissue was undertaken.

One of the fireproofing concerns involved breaching a fire barrier to pull cable without the proper form. Based on discussions with two cognizant Modifications engineers and review of Discrepancy Report number BF-DR-0397, BFN had been using improper forms to breach fire barriers. Corrective action had been initiated. All breaching of electrical fire barriers was suspended until

2.3.5.4 Site Specific - BFN (continued)

breaching procedures were correct. The subissue was factual and identified a problem, but corrective action for the problem was initiated before the evaluation of the subissue was undertaken.

One of the fireproofing concerns dealt with improper breaching of fire barriers with an "illegal" fish hook type tool. However, the concern was not a problem at BFN because they used a fiberglass wand to breach fire barriers. The concern was not factual.

One of the fireproofing subissues dealt with removing cable coating with sharp objects. An interview with a DNE engineer revealed that BFN would route a new cable rather than remove the cable coating. This did not cover work performed on a damaged or spliced cable. There were no precautions in site procedures to prevent this from occurring. Therefore, the subissue was factual and presented a problem for which corrective action had been, or was being, taken as the result of the evaluation.

2.3.5.5 Site Specific - BLN

There were four concerns evaluated at BLN for this issue.

Several generic fireproofing concerns dealt with excessive cable coating and bunched cable. This was not a problem at BLN because cable coatings were not used. An interview with the BLN Quality Assurance Manager verified that no fire retardant cable coatings were used at BLN. The concerns were not factual.

A BLN concern described an "illegal" fish hook type tool used to remove RTV at cable tray penetrations. Use of this type device was documented in NCR 4222. The identified cable was reworked. BLN was observed in the field to currently be using a metal split conduit type tool with a wooden head. The concern was factual, and identified a problem, but corrective action for the problem was initiated before the evaluation of the concern was undertaken.

2.3.5.5 Site Specific - BLN (continued)

One of the generic concerns involved breaching fire barriers without the proper form. The proper form was found in Attachment A of BNP-QCP-10.6 which required applicable drawing identification, location, component unique identification, special instructions, procedures, precautions, and engineering approval. A field evaluation of a breach revealed no problems. The subissue was not factual.

2.3.6 Maintaining Cables

2.3.6.1 Generic

There were no generic findings for this issue.

2.3.6.2 Site Specific - WBN

One of the concerns which dealt with maintaining cables reported steel filings in conduit which could cause damage to cables. Site procedures were reviewed to determine if there were any requirements for installing condulet covers after 1) the conduit was installed or 2) cables were pulled in the conduit. No provisions were found. Interviews were conducted which revealed that no effort was made to install the covers until just before the conduit transfers. Examples of dirty conduit were found in the unit 2 Boron Injection Tank Room on elevation 713. The concerns were factual and presented a problem for which corrective action had been, or was being, taken as the result of the evaluation.

Two of the concerns dealt with leaving cable unprotected after it was pulled and before termination. Site procedures (WBN-QCI-3.05, WBN-QCP-3.05, and WBN-QCI-1.36) all had provisions for protecting cable in this situation. However, a walkdown of plant areas found examples of cables which were lying on the floor. It should be emphasized that in both cases the cables were in out of the way areas. Since the procedures did have provisions for protecting cable, the Assistant Construction Superintendents who perform the housekeeping walkdowns should be instructed to pay

2.3.6.2 Site Specific - WBN (continued)

more attention to this area. The concerns were factual and presented a problem for which corrective action had been, or was being, taken as the result of the evaluation.

Another concern dealt with a specific instance of cable damage in which it was alleged there was insulation damage and violations of MBR. This was verified in NSRS report I-85-123-WBN. Upon inspection by DNC EQC personnel, however, no problems were discovered. The cables met the MBR criteria and the nicks noted in the cables were not significant enough to require repair. The NSRS report had been in error. The cables were not reworked. The concern was not factual.

2.3.6.3 Site Specific - SQN

There was no SQN evaluation for this issue.

2.3.6.4 Site Specific - BFN

There was no BFN evaluation for this issue.

2.3.6.5 Site Specific - BLN

There was no BLN evaluation for this issue.

2.3.7 Insulation Damage

2.3.7.1 Generic

There was no generic issue.

2.3.7.2 Site Specific - WBN

There was no WBN evaluation for this issue.

2.3.7.3 Site Specific - SQN

There was only one concern evaluated at SQN for this issue.

2.3.7.3 Site Specific - SQN (continued)

The insulation damage concern evaluated at SQN dealt with insulation which had been cut off of a cable routed to the Condenser Circulating Water gate hoist motors. Interviews with SQN personnel revealed that these gates were no longer used. Therefore, there was no need for further evaluation.

2.3.7.4 Site Specific - BFN

There was no BFN evaluation for this issue.

2.3.7.5 Site Specific - BLN

One of the BLN concerns dealt with a lack of inspection of thermocouple leads whose damage had been described in BLN NCRs 1087 and 1101. The leads had been repaired using field change package 110. Westinghouse had recertified the leads. The concern was factual and identified a problem, but corrective action was initiated before the evaluation of the concern was undertaken.

The other BLN concern dealt with cable damage which had been taped. It was stated that this cable was located in the Turbine Building. The investigation conducted at BLN could not locate the problem in walkdowns of the area given in the concern. In addition, SRN-G-38-8 contained provisions for taping splices in mild environments (the Turbine Building was a mild environment). The concern was not factual.

2.4 Summary of Collective Significance

The subcategory findings revealed a general lack of management control over the issuance of adequate design output criteria, compliance with installation requirements, and a quality inspection program. The findings also indicated that for some issues there was a lack of employee understanding and execution of the technical requirements. Inadequate technical criteria, procedures, and training (both design and site) had contributed to the situation. The findings repeatedly indicated a lack of adequate technical criteria and procedures to control the work.

2.5 Summary of Causes

The causes were evaluated on an issue-by-issue basis and were as follows:

- Cable pulling problems were the result of inadequate design criteria and engineering guidance.
- Splicing problems were the result of inconsistent and unclear design criteria.
- Termination problems were caused by failure of TVA and Foxboro to follow vendor recommendations in the application of terminal lugs and failure by TVA to follow General Construction Specification G-38.
- Inspection problems were a result of management emphasis on quantity over quality.
- Excessive cable coating was a result of not following site procedures.
- DNE did not recognize a need to take into account ampacity losses covered by the application of cable coatings.
- Problems with maintaining cables in conduits resulted because management and employees did not recognize a need to protect installed cable when condulet covers were removed.
- No cause was determined for insulation damage.

2.6 Summary of Corrective Action

2.6.1 Corrective Action Already Taken

The following corrective actions had been performed:

- Construction Specification G-38 and G-40 had been revised to incorporate resolutions to SWP, MPT, and MBR issues.
- Walkdowns were conducted at WBN to select worst-case conduits for SWP calculations.
- Violations of procedures were discovered at WBN with corrective action which consisted of NCRs, time off without pay, and scrapping the questionable cables.

2.6.1 Corrective Action Already Taken (continued)

- Conduit overfill at SQN was documented by SCR SQNEEB8529. This SCR was dispositioned use-as-is.

- SW12 was issued to stop cable pulling at BLN until General Construction Specification G-38 was revised to incorporate SWP calculations.

- BLN NCR 2987 was written because break ropes had not been used according to SRN-G-38-2. The cables which had been pulled were sampled. No problem was uncovered, and the NCR was closed.

- At SQN, WBN generic NCRs 6208 and 6224 were evaluated. All questionable splices were inspected and corrective actions were made as necessary. The same was true of site specific concern MAS-85-003. The questionable splice was reworked with the proper materials.

- According to BLN NCR 2494, site personnel were omitting the shim in Raychem type NPKV-2-14 splice kits. Rework was performed on all Class 1E applications in harsh environments. Mild environment splices were dispositioned use-as-is.

- There was evidence to suggest subjourneymen were terminating cables at WBN. Provision was made for a form to be signed by subjourneymen to state they had been instructed on job requirements, safety, and QA responsibilities.

- At WBN, there were cases where an inspector was asked to watch more than one cable pull at the same time in the timeframe of 1978 through 1979. This was no longer the case since an inspector watched one pull at a time at the time of the evaluation.

- The use of fish tape to breach fire barriers at WBN was removed from site procedures as a result of NSRS report I-85-702-WBN.

- At BLN, NCR 4222 was written because of cable damage caused by a hook tool. The cable was reworked.

2.6.1 Corrective Action Already Taken (continued)

- BLN NCRs 1101 and 1087 were written because of thermocouple damage on the Makeup and Decay Heat Pumps. The rework was performed and the thermocouples were recertified.

- In addition, TVA had recently implemented an extensive trend analysis program to track, consolidate, and categorize identified conditions adverse to quality. This trend analysis program was to readily identify trends associated with cable at TVA nuclear plants.

2.6.2 Corrective Action Required

The following corrective action was not yet complete:

- DNE had initiated an extensive testing program to determine the adequacy of installed cables at all TVA nuclear plants. A test was conducted at TVA's Central Labs to determine the maximum SWP on cable pulls without cable degradation. To further verify the integrity of installed cable, DNE must complete an evaluation to determine the adequacy of how worst-case conduits were selected in their evaluation. For this reason, DNE EEB was negotiating with a third-party engineering company to perform the evaluation. If discrepancies were discovered, retesting or analysis was to be required. At the same time, each project was to complete screening programs according to the instructions given by EEB to determine their worst-case conduits. This information was then to be applied to the SWP test results to determine the adequacy of the installed cable. If cable SWP exceeded test values or acceptable margins, conduit rework and cable replacement was to be necessary. CATD 10900-NPS-01 was written. In the corporate line response, it was revealed that the SWP test at Central Labs concluded that allowable pressures were four to five times higher than previous manufacturer's limits. Initial calculations were complete at WBN while final calculations were complete at SQN. The test results at SQN concluded that cable pulling in the worst-case conduits did not result in excessive SWP values. These same calculations were to be performed prior to restart at BFN and before fuel load at BLN. An independent third party had concluded that the TVA testing was a reasonable basis for increased SWP values.

2.6.2 Corrective Action Required (continued)

- DNE must evaluate violations in MPT which occurred because of bad pulling practices, inadequate procedures, or instances where site personnel did not follow procedures. CATD 10900-NPS-01 was written. In the corporate line response, it was stated that TVA's practice of monitoring total tension rather than individual tension did assure individual conductor strength limits were not exceeded and was consistent with IEEE 690-1984.

- DNE was actively involved in an evaluation to determine the adequacy of installed cable in regards to MBR. The determination was to be based on consultations with and recommendations from the cable manufacturers, a review of the cable materials and construction involved, the particular application of the cable at TVA nuclear plants, and a review of TVA and industry environmental qualification testing. Finally, recommendations were to be formulated which, if necessary, would include cable testing, surveillance inspections or rework, or replacement of the cables in question. CATD 10900-NPS-01 was written. The corporate line response was that EEB had made a determination of the long and short-term effects on the integrity of the cable and its ability to perform its safety-related function as a result of being subjected to the reduced bend radius. In particular, EEB had identified the elongation stress, to which a cable was subjected as the result of a bend, as the critical parameter in determining acceptability. The evaluation of the concerns indicated that the MBR to which cables could have been subjected was that of one times its overall diameter. Preliminary conclusions of the study indicated that this worst case bend at SQN did not reduce the cable's available elongation properties below that required for it to perform its safety-related function.

- NCRs W-290-P and 6295 had been generated on violations of MBR in the MCR and violations because of nonexistent acceptance criteria in MAI-4 and 5. These procedures had been revised to give MBR acceptance criteria. However,

2.6.2 Corrective Action Required (continued)

the NCRs were still open. CATD 10900-WBN-01 was written. As a response, it was stated that TVA had recognized that there was a possible problem with all cables concerning bend radius. DNE was currently working on the cable bending radius problems documented on NCRs 6295 and W-290-P.

- Cable outside diameters used by each engineering project in their conduit fill programs were inadequate. The new cable outside diameters were given in Design Standard DS-E12.1.13, which was generated because of SCRs WBNEEB8589 and 8590. Each project was to evaluate their program for conduit overfill. If problems were discovered, NCRs were to be generated and corrective action taken as required. CATD 10900-NPS-05 was written. The line response was that evaluations would be performed on any existing overfilled conditions to determine the impact on cable ampacity, SWP as a result of cable pulling, and raceway structural support systems.

- Several NCRs (4194, 4274, 5062, and 4933) were generated which dealt with exceeding minimum bend radius of cables. The disposition of these NCRs was in question because of the findings of NSRS report I-85-06-WBN and will depend on DNE's final response to this report. The line response to this was given in CATD 10900-NPS-01 mentioned previously.

- PIR WBNEEB8534 was written to identify the fact that cable SWP calculations were not considered in the design process. This condition was identified in NSRS report I-85-06-WBN. NCR 6270 was issued for tracking purposes. DNE's final response to I-85-06-WBN will be required to disposition this NCR. The line response to this was given in CATD 10900-NPS-01 mentioned previously.

- It was determined that 480-volt receptacles in the fifth diesel area at WBN were sized for numbers 4 through 8 AWG wires while DNE specified a number 2 AWG wire. Corrective action must be initiated to splice a smaller wire to the

2.6.2 Corrective Action Required (continued)

existing wire. CATD 10900-WBN-02 was written. The line management response stated that these receptacles had recessees for pressure connectors with a diameter of 0.312 inch. These receptacles had three single conductor size 2 cables (diameter 0.292 inch) routed to them. Two receptacles were field checked and no loose terminations were found. The installed cables met all the requirements of the National Electric Code.

- NCR W-283-P was written to document unidentified cables throughout the plant. NSRS report I-85-362-WBN also identified this problem. The corrective action consisted of accounting for all unidentified cables. Those cables still in use were to be placed under the Temporary Alteration Control Program. This program had not yet added provisions to include temporary cables. CATD 10900-WBN-04 was written. Electrical Maintenance had not yet revised AI-2.15. After the revision, workplan M5515-1 was to be closed.

- SCR BFNEEB8631 was written because cable SWP calculations were not considered in the design process. The resolution depended on DNE's ongoing evaluation of SWP problems discussed previously. The line response to this was given in CATD 10900-NPS-01 mentioned previously.

- Violations of MBR at BFN were being tracked by SCR BFNEEB8634 whose resolution was tied to DNE's ongoing evaluation of MBR problems discussed previously. The line response to this was given in CATD 10900-NPS-01 mentioned previously.

- At BLN, the fact that cable SWP calculations were not considered in the design process was tracked by PIR BLNEEB8518. The resolution depended on DNE's ongoing evaluation of SWP problems discussed previously. The line response to this was given in CATD 10900-NPS-01 mentioned previously.

- Violations of MBR at BLN were being tracked on PIR GENEEB8605 whose resolution was tied to DNE's ongoing evaluation of MBR problems discussed previously. The line response to this was given in CATD 10900-NPS-01 mentioned previously.

2.6.2 Corrective Action Required (continued)

- Splicing problems at WBN were tied to the resolution of NCRs 6208, 6224, and 6536. The rework required was not yet complete. CATD 10900-WBN-06 was written. The line response was that the NCRs were being tracked in TROI and that the corrective actions had been specified in 50.55(e) reports and in memorandum B26 860218 147.

- Splicing problems at BFN were being tracked by SCR BFNEQP8501. The BFN EQ project was committed to a walkdown of all cable termination splices on safety-related equipment. CATD 10900-BFN-01 was written. All class 1E splices located in harsh environments were to be located, inspected, and, if inadequate, replaced within the requirements of G-38 before startup of the applicable unit.

- At WBN, junction box 1918 was found to have a bent lug problem. The box had been replaced with a larger box but the workplan (FR063B-Z) was not complete. CATD 10900-WBN-07 was written. The line response was that the correct size box had been installed and inspected.

- SOP-14, Revision 2, had a requirement to perform megger tests on non-QA power cables. This test was not being performed. CATD 10900-WBN-08 was written. The line response was that Electrical Engineering was to document training of SOP-14. Provision was to be made for training and periodic review of this procedure.

- Rework of AMP PIDG lugs on solid conductors at WBN was complete for unit 1 (ECN 5879). This had not been completed for unit 2 (ECN 5880). CATD 10900-NPS-03 was written. The line response was to replace PIDG lugs or solder over those lugs used in safety-related circuits where failure would create a safety concern.

- Rework of AMP PIDG lugs on solid conductors at SQN was conducted using SMI-2-317-25. All work was complete except for replacement of lugs on surge suppression networks for solenoid valves. The line response to this was given in CATD 10900-NPS-03 mentioned previously.

- BFN was in the process of scheduling walkdowns to determine if a problem existed with the use of AMP PIDG lugs on solid conductors. The line response to this was given in CATD 10900-NPS-03 mentioned previously.

2.6.2 Corrective Action Required (continued)

- DNE was actively evaluating ampacity losses because of cable coatings. The establishment of a sampling program to determine the adequacy of cables with respect to their ampacity rating at each site was requested by DNE. A schedule had not been established to finalize this work. CATD 10900-NPS-04 was written. The line response was that cable ampacity was to be evaluated in accordance with memorandum B43 861008 909 and DS-E12.6.3. CATDs 10900-WBN-10, 10900-SQN-02, and 10900-BFN-04 were written on the inadequacies of the Joslyn/Factory Mutual test results for derating factors of cable coatings. The SQN and WBN responses were to evaluate the tests. The BFN response stated that tray derating factors would be established based on as-built conditions.

- DNC had been required by the NRC to add statements to site procedures prohibiting the use of sharp instruments to remove cable coatings and to provide for a visual inspection of cable for damage before the coating was reapplied. ONP had not done this. This was also true at SQN and BFN. CATDs 10900-WBN-09, 10900-BFN-02, and 10900-SQN-04 were written. The line response from SQN and WBN was to add the precautions. The BFN response stated that DNC was to issue a division level procedure which contained guidelines for the removal of Flamemastic. Site procedures were to be initiated as required.

- In the past, fire barriers had been breached haphazardly at WBN. Only two groups were now allowed to breach fire barriers using one procedure, and a maximum of 25 breaches were allowed at one time. However, SOP-42 was out of date and required revision. It referenced a DNC group which no longer exists. CATD 10900-WBN-11 was written. The line response was to delete SOP-42 since requests for breaching were outlined in QCI-1.60.

- At SQN, there was evidence that Flamemastic had been applied thicker than required by site procedures. No corrective action had been initiated. The line response to this was given in CATD 10900-NPS-04 mentioned previously.

- Fish tape was used to breach fire barriers at SQN. The NSRS had recommended that WBN discontinue the use of fish tape to breach fire barriers. This must be evaluated at SQN. CATD 10900-NPS-02 was written. The line response was to review G-38 or other applicable procedures and revise as necessary.

2.6.2 Corrective Action Required (continued)

- Concerns which dealt with excessive cable coating were verified at BFN because of CF-CAR-86-078. A new sampling program mentioned in section 7.2.5.4 of this report on the adequacy of ampacity of installed cables was to be used to solve this problem. The line response to this was given in CATD 10900-NPS-04 mentioned previously.

- Because of BF-DR-0397, it was verified that fire barriers were breached at BFN using improper paperwork. All electrical fire barrier breaching had been stopped. New instructions must be written and approved. CATD 10900-BFN-03 was written. The procedures had been approved.

- At WBN, examples of steel filings in conduit were discovered. ONP and DNC procedures must be revised to include provisions for protecting cable when condulet covers were removed. CATD 10900-WBN-12 was written. Site procedures were being revised to add provisions for cable protection when condulet covers were removed.

- At WBN, it was alleged that cables were left unprotected after they were pulled. There were procedures which described how the cables were to be protected. There were also provisions for monthly walkdowns, but since examples of uncoiled cables were discovered, more emphasis must be placed on watching for poor cable practices. CATD 10900-WBN-13 was written. A memorandum was generated from John Porch (General Construction Superintendent) to John Poe (Electrical Superintendent) to add additional management attention to the cable protection issue. AI-1.8 was to be revised to add a requirement for the protection of cables in walkways.

- Although Yellow 77 had been banned from nuclear plant sites, the Materials Management System indicated this material was at WBN, BFN, and BLN. CATD 10900-NPS-06 was written. DNE was to issue a memorandum to all nuclear sites to remove all unused portions of Yellow 77. R3

- It was verified some permanent cables were routed outside cable trays at SQN. CATD 10900-SQN-01 was written. A walkdown was to be conducted of class 1E cables in trays.

2.6.2 Corrective Action Required (continued)

- At SQN, only class 1E cables had their pull tension monitored which was contrary to G-38. CATD 10900-SQN-03 was written. M&AI-4 was revised to require monitoring of non-1E cables' pulling forces.

- At WBN, a steel choker had been used as a safety precaution during cable pulls. Abuse of these chokers was verified to have occurred. CATD 10900-WBN-03 was written. DNC was to notify employees of the use of steel chokers as an industrial safety precaution. R3

- At WBN, interviews with electricians indicated they saw no need for the new cable pulling procedures. CATD 10900-WBN-05 was written. Training was to be provided for electricians involved in cable pulls.

3.0 EVALUATION PROCESS

3.1 Evaluation Methodology

The various issues raised by the employee concerns within this subcategory were investigated according to the Construction Evaluation Plan.

The following is a summary of the specific evaluation methodology utilized in the evaluation of the concerns contained within the seven issues comprising this subcategory.

3.1.1 Cable Pulling

The employee concerns contained within the issue were evaluated utilizing the following methodology:

- Standards and requirements for pulling cable were compiled and reviewed.

- Various memorandums, procedures, instructions, and practices from each site and design documents relating to all areas of the cable pulling program including MBR, MPT, SWP, and routing were compiled and reviewed.

- Plant walkthroughs were conducted to investigate concerns involving improper cable routing outside of cable trays and a specific concern which dealt with improperly sized cable for 480-volt receptacles.

3.1.1 Cable Pulling (continued)

- Informal interviews with 17 DNC engineering, inspection, licensing, and craft personnel; 21 DNE onsite and central staff engineering personnel; 16 ONP modifications, maintenance, inspection, QA, and engineering personnel; and one Westinghouse engineer were conducted concerning the following: |R3

  (1) current and past cable pulling practices such as swabbing conduit, mechanically assisted pulls, defective or otherwise damaged cable, conduit isometric drawings, quantity over quality, and violations of site procedures, and

  (2) past and present engineering requirements and the current engineering position on cable pulling issues such as SWP, conduit overfill, MPT, MBR, cable lubricants, and cable routing.

- NSRS/ERT/PMO and SQN GCTF reports pertaining to cable pulling concerns were compiled and reviewed for adequacy of previous evaluations.

- The WBN ECTG files were reviewed for additional information regarding this issue.

3.1.2 Splicing

This issue was investigated utilizing the following methodology:

- Standards and requirements for splicing were compiled and reviewed.

- Various memorandums; applicable WBN procedures, instructions, and practices; WBN generically applicable NCRs along with any site specific NCRs generated as a result of the WBN NCRs; and design documents relating to cable splicing were compiled and reviewed.

- Plant inspections were conducted to investigate a specific concern involving placement of a splice in conduit and splices under the switchyard.

3.1.2 Splicing (continued)

- Informal interviews with four DNC engineering and inspection personnel, eight DNE onsite and central staff engineering personnel, and three ONP modifications and maintenance personnel were conducted concerning: |R3

  (1) the location of splices in conduits,

  (2) the ability of the high potential test to detect a defective splice,

  (3) problems associated with splices located underneath the switchyard, and

  (4) WBN generic NCRs which dealt with inadequate instructions for the type of Thomas and Betts connectors used on 6.9-KV splices and inadequate instructions for installing Raychem splicing kits.

- The WBN ECTG files were reviewed for additional information regarding this issue.

3.1.3 Cable Terminations

This issue was investigated using the following methodology:

- Various memorandums, applicable TVA design standards, a General Construction Specification, IEEE Standard 690-1984, and WBN DNC and ONP procedures were obtained and reviewed.

- WBN NCRs which dealt with cable terminations and applicable NSRS reports were obtained and reviewed.

- Plant walk-throughs were conducted to:

  (1) investigate specific locations identified by the subject concerns, and

  (2) evaluate the condition of terminations in these locations.

- Informal interviews were held with five DNC engineering and inspection personnel, eight ONP modifications personnel and the WBN Instrument Maintenance supervisor, and six DNE personnel for the following reasons: |R3

3.1.3 Cable Terminations (continued)

(1) to investigate a bent lug problem in junction box 1918 at WBN,

(2) to determine which RB fans had been operated,

(3) to investigate termination documentation requirements,

(4) to discuss megger and continuity testing requirements,

(5) to discuss corrective action for NCR 4563, and

(6) to investigate the misapplication of PIDG lugs.

- The WBN ECTG files were reviewed for additional information regarding this issue.

3.1.4 Inspection of Cable

This issue was investigated using the following methodology:

- Construction inspection procedures, IEEE Standard 690-1984, and a General Construction Specification were compiled and reviewed.

- WBN NCRs which dealt with inspection of cable and a NSRS report were obtained and reviewed.

- Informal interviews were conducted with five DNC engineering, QA engineering, and inspection personnel and two ONP inspection and training personnel concerning:

  (1) past and present inspection practices concentrating on inspections between 1978 and 1979,

  (2) deletion of the megger test from the DNC testing program, and

  (3) violations of QC procedures.

- The WBN ECTG files were reviewed for additional information regarding this issue.

3.1.5 Fireproofing Cables

This issue was investigated utilizing the following methodology:

- WBN and SQN DNC and ONP procedures, BLN DNC procedures, and BFN ONP procedures relating to the application and removal of cable coatings and breaching of fire barriers were compiled and reviewed.

- Test reports dealing with variations of cable ampacities with various cable coating thicknesses, DNE and United Engineer's calculations, BFN Corrective Action Report BF-CAR-86-0078, and various memorandums on the subject of cable coatings were compiled and reviewed.

- NSRS/ERT/PMO reports, SQN GCTF reports, and NCRs pertaining to cable coatings and breaching fire barriers were compiled and reviewed for adequacy of previous evaluations.

- A plant walk-through was conducted at SQN in the Cable Spread Room for evidence of excessive cable coating.

- Informal interviews were conducted with seven DNE onsite and central staff personnel, 11 ONP modifications, safety, engineering, and inspection personnel, and four DNC engineering personnel concerning: |R3

  (1) corrective action required because of excessive cable coating thicknesses,

  (2) the extent of the cable coating thickness problem,

  (3) the procedure used to apply and remove cable coatings,

  (4) the procedure used to install and inspect conduit and cable tray wrap,

  (5) the resolution of NSRS recommendations which dealt with the testing environment used during the ampacity tests, and

  (6) past and present fire barrier breaching procedures.

- The WBN ECTG files were reviewed for additional information regarding this issue.

3.1.6 Maintaining Cables

This issue was investigated utilizing the following methodology:

- WBN DNC procedures relating to maintenance of cables after installation were compiled and reviewed.
- WBN site specific NCRs pertaining to maintaining cable were compiled and reviewed.
- A walk-through was conducted for a specific concern location in regard to inadequate maintenance of cables before termination and to determine damage associated with open condulets.
- Informal interviews were conducted with four DNC inspection personnel and one ONP modifications and QA engineers concerning the DNC procedure for installing condulet covers. |R3
- The WBN ECTG files were reviewed for additional information regarding this issue.

3.1.7 Insulation Damage

This issue was investigated utilizing the following methodology:

- Applicable design documents, SQN ONP documents, a vendor field change package, and various memorandums concerning specific insulation damage incidents at BLN and SQN were compiled and reviewed.
- A walk-through was conducted of the area specified at SQN for the condition and status of the cables in question.
- Informal interviews with five ONP operations, systems engineering, and maintenance personnel and two DNC engineering personnel were conducted concerning: |R3

  (1) the acceptability of taping insulation and

  (2) the present status of the Condenser Circulating Water gate hoist motors.

- The WBN ECTG files were reviewed for additional information regarding this issue.

3.2 Requirements and Criteria

The following is a listing of the various requirements and criteria which were utilized in deriving the findings contained within this subcategory report.

3.2.1 TVA General Construction Specifications

3.2.1.1 G-4, "Installing Insulated Cables Rated Up to 15,000 Volts Inclusive," revised January 9, 1973. Set the requirements for cable installation at fossil plants, dams, and the original construction of BFN.

3.2.1.2 G-38, "Installing Insulated Cables Rated Up to 15,000 Volts," Revision 0, dated July 25, 1973, Revision 1, dated October 22, 1975, Revision 2, dated August 3, 1978, Revision 3, dated September 27, 1982, Revision 4, dated March 28, 1984, Revision 5, dated February 13, 1985, Revision 6, dated September 15, 1985, Revision 7, dated January 15, 1986, and Revision 8, dated March 17, 1986. Set the requirements for cable installation at SQN and later nuclear plants including BFN modifications.

3.2.2 TVA Electrical Design Standards

3.2.2.1 DS-E12.1.5, "Minimum Radii for Field Installed Insulated Cables Rated 15,000 Volts and Less," Revision 0, dated September 20, 1983. Outlined the minimum bending radii for pulling cable during installation and for training cable after installation.

3.2.2.2 DS-E12.1.13, "Class 1E Contract Specific Cable ODs and Weights," Revision 2, dated April 15, 1986. Specified cable ODs and weights by mark number.

3.2.2.3 DS-E12.6.3, "Ampacity Tables for Auxiliary and Control Power Cables (0-15,000V)," Revision 0, dated September 2, 1986. Took the derating effects of cable coatings into account for sizing cables.

3.2.2.4 DS-E13.6.2, "Use of Conduit Bodies in Conduit Systems," Revision 0, dated November 15, 1983. Outlined the conditions for use of conduit bodies in conduit systems based upon the minimum bending radius requirements of cables.

3.2.3 Engineering Calculations

3.2.3.1 DNE calculation, "Ampacity Analysis of Class 1E Medium Voltage Power Cables in Cable Trays," Revision 0, dated February 2, 1984 (EEB 840203 901). The allowable ampacity was calculated for all Class 1E medium voltage power cables routed in cable trays and then compared with each cable's full-load current.

3.2.3.2 DNE calculation, "Justification of TVA DS-E12.1.5 Table 2 and 3 Cable Bend Radius Factors," Revision 0, dated August 6, 1985 (B43 850806 927). Provided further justification of the use of manufacturer's bend radius factors used in Tables 2 and 3 of DS-E12.1.5 based on manufacturer's testing and engineering information.

3.2.3.3 DNE calculation, "Determination of Class 1E Electrical Cable Weight/Foot and Outside Diameter," Revision 0, dated February 27, 1986 (B26 860227 007). Determined average and maximum cable outside jacket diameter, average and maximum cable weight/foot, and maximum insulated single conductor outside diameter for each cable mark number.

3.2.3.4 DNE calculation, "Justification of TVA's Ampacity Tables as Related to NV3, NV3A, and NV3B Cable Trays, Conduits With More Than Three Cables, Grouped Conduits, and Underground Conduit Banks," Revision 0, dated March 6, 1986 (B43 860307 902). Analysis justified the adequacy of existing TVA Electrical Design Standard ampacity tables for WBN.

3.2.3.5 United Engineer's calculation, "Evaluation of the Effect of Coating on Cable Ampacity," Revision 0, dated August 4, 1986. Developed an action plan to determine the derating effect of Flamemastic and to evaluate the effect on the installation.

3.2.3.6 DNE calculation, "Methodology Used as Basis for Cable Ampacities Shown in TVA Electrical Design Standard DS-E12.6.3," Revision 0, dated September 2, 1986 (B43 860902 901). Provided the justification for the new ampacity tables in DS-E12.6.3.

3.2.3 Engineering Calculations (continued)

3.2.3.7 DNE calculation SQN-E2-015, "Identifying Sidewall Pressure Violations," Revision 0, dated July 24, 1986. This calculation took walkdown data at SQN for worst-case conduits and used it to determine if cable SWP values had been exceeded (B25 860724 801).

3.2.4 TVA Drawings

3.2.4.1 Standard Drawing, SD-E12.5.3, "Cable Splicing Medium Voltage (5-15 KV) Insulated Conductors," Revision 2. Drawing depicted the splicing procedure for medium voltage cables.

3.2.4.2 Standard Drawing, SD-E12.5.6, "Cable Splicing 600V (or Less) Insulated Cable," Revision 6. Drawing depicted the splicing of low voltage cables

3.2.4.3 Standard Drawing, SD-E12.5.8, "Cable Splicing and Terminating 600V (or Less) Multi-Conductor Insulated Cable," Revision 2 and 3. Drawing provided the method for splicing and terminating low voltage cables. |R3

3.2.4.4 BLN drawing, SGW1740-ED-33, Revision 3. This was the schematic for the 480-volt normal AC auxiliary power distribution system.

3.2.4.5 WBN drawing, 45W883-3, Revision 15. The drawing was a detail of the termination of field cable to Conax assembly cable. |R3

3.2.4.6 Standard Drawing, SD-E12.5.7-1, "Cable Termination of 600V (or Less) Insulated Cable to Equipment Furnished with Pigtail," Revision 4. Drawing to be used to terminate 600V and less field cables to equipment furnished with pigtails (such as motors and solenoid valves).

3.2.4.7 Standard Drawing, SD-E12.5.7-2, "Cable Termination of 600V (or Less) Insulated Cable to Equipment Furnished with Pigtail," Revision 4. This drawing was a continuation of SD-E12.5.7-1 which incorporated the use of an adapter plate.

3.2.4.8 Standard Drawing, SD-E12.5.5-1, "Cable - Termination of Medium Voltage (5-15KV) Insulated Cable to Equipment Furnished with Pigtail," Revision 4. The drawing used to terminate 5-15KV field cables to equipment furnished with pigtails (such as motors and solenoid valves).

3.2.4 TVA Drawings (continued)

3.2.4.9 Standard Drawing, SD-E12.5.5-2, "Cable - Termination of Medium Voltage (5-15KV) Insulated Cable to Equipment Furnished with Pigtail," Revision 4. This drawing was a continuation of SD-E12.5.5-1 which incorporated the use of an adapter plate.

3.2.4.10 Standard Drawing, SD-E12.5.4, "Cable Termination of Medium Voltage (5-15KV) Insulated Cable," Revision 3. This drawing was the general procedure for terminating medium voltage cables.

3.2.5 NSRS/ERT/PMO Reports

3.2.5.1 ERT report for EX-85-148-001 and IN-85-705-001, Revision 3, dated February 11, 1986. Report written on subjourneymen terminating cables.

3.2.5.2 ERT report for HI-85-010-001 dated February 25, 1985. Report written on poor quality of second shift work.

3.2.5.3 ERT report for IN-85-130-002 dated September 18, 1985. Report used with NSRS report I-85-699-WBN to document the problems discovered while investigating breaching of fire barriers (T25 860423 092).

3.2.5.4 ERT report on IN-85-186-002 dated July 6, 1985. The report dealt with the incorrect application of conduit and cable tray wrap (T25 860423 092).

3.2.5.5 NSRS report I-85-06-WBN, "Investigation of an Employee Concern Regarding Cable Routing, Installation, and Inspection at [illegible]ar Nuclear Plant," dated July 8, 1985. Report dealt with design and construction problems w[illegible] MPT, MB[illegible] and SWP (QO1 850709 051).

3.2.5.6 NSRS report I-85-101-WBN, Subject: Improper Termination Techniques, dated September 23, 1985. Report dealt with the misapplication of AMP PIDG terminal lugs.

3.2.5.7 NSRS report I-85-123-WBN, Subject: Damaged Cable, dated June 28, 1985. Report dealt with concern IN-85-373-001 on the subject of damaged cables in the unit 2 RB Rod Drive Control Cabinet (T25 860423 099).

3.2.5 NSRS/ERT/PMO Reports (continued)

3.2.5.8 NSRS report I-85-445-WBN, Subject: Welders Terminating Electrical Cables, dated October 17, 1985. Report was written for concern IN-85-581-002 on the subject listed above (T25 860423 098).

3.2.5.9 NSRS report I-85-467, 466, 568, 573, 518, 575-WBN, Subject: Cable Pull Noncompliances, dated October 31, 1985. Report was written for concerns IN-86-201-001, IN-86-259-001, IN-86-199-001, IN-86-262-003, and IN-86-259-004 on various inadequacies in the cable pulling program (T25 860423 093).

3.2.5.10 NSRS report I-85-569-WBN, Subject: Cable Overheating Due to Cable Bunching and Fire-Retardant Coating, dated November 14, 1985. The report dealt with concern IN-85-259-005 on the subject listed above (T25 860423 095).

3.2.5.11 NSRS report I-85-570-WBN, Subject: Cable Arrangement in Cable Trays, dated November 1, 1985. The report was written on concern IN-86-268-003 and dealt with the separation of cables in cable trays (T25 860423 097).

3.2.5.12 NSRS report I-85-695-WBN, Subject: Supervisor Not Following Procedures, dated November 14, 1985. The report was written for concern IN-85-018-004 on the subject of breaching fire barriers (T25 860423 100).

3.2.5.13 NSRS report I-85-702-WBN, Subject: Breaching Electrical Penetrations, dated November 22, 1985. The report was used to evaluate concern XX-85-094-005 on the subject of the use of fish tape to breach penetrations (T25 860506 107).

3.2.5.14 NSRS report I-85-852-WBN, Subject: Cable Apparently Pulled Without Fuse Links, dated November 27, 1985. The report was written for concern IN-85-527-001 on the subject mentioned above (T25 860423 094).

3.2.5.15 PMO report on IN-85-201-002 dealt with the recommendation that a cable be pulled to the first outlet before making the pull test on the cable.

3.2.5.16 PMO report on IN-85-506-002 dealt with the issue of sloppy cable routing.

3.2.5 NSRS/ERT/PMO Reports (continued)

3.2.5.17 PMO report on IN-85-733-002 dealt with jurisdictional differences between insulators and electricians while breaching fire barriers.

3.2.5.18 NSRS report I-85-362-WBN, Subject: Electrical Manholes, dated October 22, 1985. Report used in connection with concerns IN-85-300-002, IN-85-506-002, IN-86-268-003, and WI-85-100-020 in the area of improper routing of cables.

3.2.6 WBN DNC Procedures

3.2.6.1 WBN-QCI-1.07, "Work Release," Revision 5, dated January 5, 1983. Procedure which defined the requirements for a rework release in 1982 through 1983.

3.2.6.2 WBN-QCI-1.36, "Storage and Housekeeping," Revision 13, dated April 1, 1986. Procedure which defined the housekeeping requirements for cable before and after the cable pull.

3.2.6.3 WBN-QCI-3.05, "Cable Installation," Revision 0, dated July 19, 1982 and Revision 10, dated November 26, 1985. Document which outlined the procedure for pulling cable.

3.2.6.4 WBN-QCI-3.06-4, "Cable Splicing," Revision 4, dated August 28, 1985. Document which outlined the procedure for splicing cable.

3.2.6.5 WBN-QCP-1.55, "Seals, Fire Stops, and Cable Coatings," Revision 6, dated March 6, 1985. Present site procedure for applying Vimasco cable coating.

3.2.6.6 WBN-QCP-3.03, "Inspection of Electrical Conduit and Junction Boxes," Revision 19 (draft). Revision 18 was dated February 27, 1985. Site procedure for inspection of conduit installation. It was reviewed for any reference to installing condulet covers.

3.2.6.7 WBN-QCP-3.05, "Installation, Inspection, and Testing of Insulated Control, Signal, and Power Cables," Revision 0, dated March 22, 1976; Revision 5, dated February 7, 1978; Revision 6, dated August 16, 1978; Revision 8, dated April 19, 1979; Revision 22, dated February 27, 1985; and Revision 25 dated November 26, 1985. This was the inspection procedure for pulling cable.

3.2.6 WBN DNC Procedures (continued)

3.2.6.8 WBN-QCP-3.06-3, "Inspection of Cable Termination and Insulation," Revision 3, dated May 1, 1984 and Revision 8, dated November 26, 1985. Inspection procedure for terminating cables.

3.2.6.9 WBN-QCP-3.06-4, "Inspection of Cable Splicing," Revision 4, dated August 28, 1985. Inspection procedure for splicing cables.

3.2.6.10 WBN-QCP-3.07, "Installation and Inspection of Electrical Penetration Pressure Seal, Fire-Stop Barrier and Flame Retardant Cable Coating," Revision 0, dated July 11, 1979; Revision 3, dated February 6, 1981; and Revision 4, dated May 20, 1981. Procedure used to apply Vimasco before WBN-QCP-1.55.

3.2.6.11 SOP-14, "Installation, Inspection, and Testing of Electrical Cable and Equipment," Revision 2, dated May 16, 1985. Procedure used to install and test non-QA cables and electrical equipment.

3.2.6.12 SOP-42, "Breaching and Sealing Behind Unit One Security," Revision 2, dated November 4, 1985. Procedure which defined the method DNC was to use to request fire barrier breaching.

3.2.6.13 WBN-QCI-1.60, "Work Control", Revision 0 dated March 28, 1986. Procedure used by DNC to breach untransferred unit 2 penetrations.

3.2.7 WBN ONP Procedures

3.2.7.1 MAI-4, "Installation and Inspection of Cable Terminations," Revision 3, dated January 23, 1986. ONP procedure which corresponded to WBN-QCI/QCP-3.05.

3.2.7.2 MAI-5, "Installation of Internal Wiring and Inspection of Electrical Equipment," Revision 8, dated October 1, 1986. ONP procedure for termination of vendor wiring.

3.2.7.3 MAI-14, "Installation and Inspection of Electrical Penetration Pressure Seals, Fire-Stop Barriers, and Flame-Retardant Cable Coating," Revision 6, dated February 25, 1986. ONP procedure which corresponded to WBN-QCP-1.55.

3.2.7 WBN ONP Procedures (continued)

3.2.7.4 MI-57.99, "Standard Electrical Tests," Revision 9, dated September 26, 1986. Electrical Maintenance procedure for verifying the adequacy of installed cables.

3.2.7.5 PHYSI-2, "Fire Protection Plan", Revision 26, dated June 6, 1986. Procedure used to breach all transferred penetrations.

3.2.7.6 MAI-3, "Installation and Inspection of Insulated Control, Signal, and Power Cables," Revision 7, dated October 10, 1986. Procedure used to pull cable in ONP.

3.2.8 WBN Nonconformances (NCRs) and Significant Condition Reports (SCRs)

3.2.8.1 NCR 3353, Revision 0, dated June 11, 1981. The NCR dealt with cable jacket damage during installation.

3.2.8.2 NCR 3354, Revision 0, dated June 11, 1981. The NCR dealt with cable jacket damage during installation.

3.2.8.3 NCR 3432, Revision 0, dated July 7, 1981. The NCR dealt with cable jacket damage during installation.

3.2.8.4 NCR 3962, Revision 0, dated February 12, 1982. The NCR dealt with cable jacket damage during installation.

3.2.8.5 NCR 4137, Revision 0, dated May 25, 1982. The NCR dealt with cable jacket damage during installation.

3.2.8.6 NCR 4194, Revision 1, dated October 22, 1982. The NCR dealt with exceeding the MBR of some cable types in trays with 90 degree elbows.

3.2.8.7 NCR 4274, Revision 1, dated May 9, 1983. The NCR dealt with exceeding the MBR of type WMT cable in 3 inch LBs.

3.2.8.8 NCR 4367, Revision 1, dated October 25, 1982. The NCR dealt with craft performance of work without proper documentation.

3.2.8.9 NCR 4413, Revision 0, dated October 29, 1982. The NCR dealt with exceeding the MPT of three cables during a pull.

3.2.8 WBN NCRs and SCRs (continued)

3.2.8.10 NCR 4418, Revision 0, dated November 1, 1982. The NCR dealt with exceeding the MPT of three cables during a pull.

3.2.8.11 NCR 4424, Revision 0, dated November 2, 1982. The NCR dealt with exceeding the MPT of a cable until it broke.

3.2.8.12 NCR 4456, Revision 0, dated November 17, 1982. The NCR dealt with damaged terminal lugs and improper type of lugs on cables.

3.2.8.13 NCR 4563, Revision 0, dated January 7, 1983. The NCR dealt with exceeding the MBR of type WPA cables while terminating them to micro-limit switches.

3.2.8.14 NCR 4581, Revision 1, dated February 17, 1983. The NCR dealt with various cables which were pulled without the presence of a QC inspector.

3.2.8.15 NCR 4652, Revision 0, dated February 15, 1983. The NCR dealt with damage to a cable caused by a drill during the installation of flex conduit.

3.2.8.16 NCR 4704, Revision 0, dated March 11, 1983. The NCR dealt with conduit and cables which were routed to the wrong train valve in the ERCW system.

3.2.8.17 NCR 4718, Revision 1, dated May 16, 1983. The NCR dealt with cable jacket damage during installation.

3.2.8.18 NCR 4777, Revision 0, dated April 11, 1983. The NCR dealt with cable jacket damage during installation.

3.2.8.19 NCR 4786, Revision 0, dated April 14, 1983. The NCR dealt with cables which were pulled without the presence of a QC inspector.

3.2.8.20 NCR 4790, Revision 0, dated April 14, 1983. The NCR dealt with running NIS cables from the detector junction box to the source range preamplifier for greater than 200 feet.

3.2.8.21 NCR 4921, Revision 0, dated June 14, 1983. The NCR dealt with cable jacket damage during installation.

3.2.8 WBN NCRs and SCRs (continued)

3.2.8.22 NCR 4933, Revision 2, dated September 7, 1983. The NCR dealt with violations of MBR in the Level 5 cable tray system.

3.2.8.23 NCR 4966, Revision 0, dated July 11, 1983. The NCR dealt with an inspector documenting a termination when the wrong crimping tool was used to crimp the lug.

3.2.8.24 NCR 5062, Revision 1, dated October 12, 1983. The NCR dealt with various violations of MBR with LL and LR condulet fittings.

3.2.8.25 NCR 5094, Revision 0, dated September 22, 1983. The NCR dealt with cable jacket damage during removal of Vimasco.

3.2.8.26 NCR 5095, Revision 0, dated September 22, 1983. The NCR dealt with cable jacket damage while pulling the cable.

3.2.8.27 NCR 5267, Revision 0, dated December 6, 1983. The NCR dealt with the improper application of Vimasco on cables.

3.2.8.28 NCR 5279, Revision 1, dated February 3, 1984. The NCR dealt with the improper routing of cable.

3.2.8.29 NCR 5465, Revision 0, dated February 24, 1984. The NCR dealt with lack of QC inspection for associated cables.

3.2.8.30 NCR 5592, Revision 0, dated April 18, 1984. The NCR dealt with lack of documentation on pull slips.

3.2.8.31 NCR 5612, Revision 1, dated June 12, 1984. The NCR dealt with damage to a cable because of removal of Vimasco.

3.2.8.32 NCR 5636, Revision 0, dated May 16, 1984. The NCR dealt with cable jacket damage during installation of a Kaowool fiber board.

3.2.8.33 NCR 5675, Revision 0, dated June 7, 1984. The NCR dealt with violations of MBR because of outdated acceptance criteria.