UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	Docket Nos. 50-348-CivP
ALABAMA POWER COMPANY	)	50-364-CivP
	)	
(Joseph M. Farley Nuclear Plant, Units 1 and 2)	)	
	)	(ASLBP NO. 91-626-02-CivP)

REBUTTAL TESTIMONY OF JAMES G. LUEHMAN, NORMAN MERRIWEATHER, CHARLES J. PAULK, JR. AND HAROLD WALKER
ON BEHALF OF THE NRC STAFF CONCERNING V-TYPE TAPE SPLICES

Q1. State your full name and current position with the NRC.

A. James G. Luehman, Senior Enforcement Specialist, Office of Enforcement (OE).

Norman Merriweather, Reactor Inspector (Electrical), Region II.

Charles J. Paulk, Jr., Reactor Inspector, Plant Systems Section, Division of Reactor Safety, Region IV.

Harold Walker, Senior Reactor Systems Engineer, Plant Systems Branch, Division of Systems Technology, Office of Nuclear Reactor Regulation (NRR).

Q2. Have you prepared a copy of your Professional Qualifications?

A. (All) A copy of each of our Professional Qualifications has been previously admitted into evidence as Staff Exh. 1.

Q3. What is the purpose of your testimony?

A. (All) The purpose of our testimony is to rebut the portions of the Alabama Power Company (APCo) testimony regarding the violations of the environmental qualification

(EQ) requirements for the V-type tape splices at the Farley nuclear plant. The APCo testimony which is the subject of this rebuttal testimony is contained in Direct Testimony of Jesse E. Love, James E. Sundergill and David H. Jones on Behalf of Alabama Power Company (ff. Tr. 978) and Direct Testimony of Philip A. DiBenedetto on Behalf of Alabama Power Company (ff. Tr. 1227).

Testimony of Love, Sundergill and Jones

Q4. Do you agree with APCo's explanation of a V-type configuration? (pp.46-47, A38).[1]

A. (Paulk) Mechanically, yes, I agree with the description of a V-type configuration. Electrically, I disagree. APCo makes it sound as if the bare wire is completely insulated, but it is not in a V-type configuration unless the tape is applied through the open space between the wires to seal the joint. This could be made in the same manner as an in-line configuration.

(Merriweather) In general yes. However, the bare leads were terminated with ring tongue lugs and the lugs were placed back to back and bolted together with some type of bolt and nut. Then the two lugs were covered with tape. This is the configuration shown as figure 3 in the Justification for Continued Operation (JCO) contained in Bechtel letter AP-13169 dated July 21, 1987 (Staff Exh. 18). There could be other types of mechanical connections such as where the leads are twisted together and then taped.

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[1] Each question to the Staff witnesses will be followed either by a reference to the APCo direct testimony by page and answer number, or by a citation to the record.

Q5. Did NQRN-3, Rev. 1 (Staff Exh. 21) document qualification for the Okonite tape? (p.47, A39).

A. (Paulk and Merriweather) The EQ file at the time of the September inspection addressed a 5 KV in-line tape insulated splice configuration. This is discussed in paragraph 5.a, at page 4 of NRC Inspection Report Nos. 50-348/87-25 and 364/87-25 (Staff Exh. 11) dated October 19, 1987. The test report included in the file was identified as Okonite Test Report NQRN-3. We don't recall any analysis in the EQ file addressing the bases for extrapolation of the 5 KV test results to lower voltage applications. The focus of the inspection was on the V-type tape insulated splices (terminations) and APCo's JCOs. As indicated in the Inspection Report, the team was concerned that the V-type tape insulated splice configuration was not covered by design drawings or engineering instructions. As stated in the Staff's direct testimony (ff. Tr. 343 at 6), Mr. Jones was asked about what was expected in these configurations and he indicated that Raychem splices should have been installed. We had no reason to question his statement. Thus, the team's conclusion as set forth in Staff Exh. 11 at page 3 was:

> The root cause of these unqualified configurations was determined to be due to incomplete design drawings/engineering work instructions and misinterpretation of electrical notes and details by craft.

(Walker) The NQRN-3 report qualifies tape splices for a specific set of conditions, i.e., an in-line splice made of T-95 insulating tape with No.35 tape serving as a jacket. The report does not qualify the splice in question for submergence or instrumentation circuits.

Q6. Could the Notes and Details, had they been followed by the craft, produce qualified terminations? (pp.47-48, A39).

A. (Paulk) I believe that qualified Raychem connections (splices/terminations) could have been made if the Notes and Details had been properly followed by the craft people.

Q7. Was the "submergence test" of the Wyle test report 17859-02P (APCo Exh. 27) "not a valid application for Farley" as APCo claims? (p.51, A42).

A. (Paulk) No. I believe this statement by the APCo is misleading. The enclosure had a weep (drain) hole in the bottom to prevent any accumulation of water as well as equalize the pressure on the enclosure. Also, there was a level control system to prevent the specimens from being submerged (APCo Exh. 27, p. VIII-2).

(Merriweather) As far as the tested configuration is concerned, the report indicates that the splices were located at the bottom of a NEMA 12 box (classified as dust-tight and drip-proof) with a 1 1/4" LB fitting on top with a 18" long 1 1/2" OD rigid conduit section. The bottom of the box contained a 1/4" drain hole. The rigid conduit was oriented in the test chamber away from the chemical spray nozzles, so that the splices would not be subject to direct spray. However, because this is not a sealed enclosure and the conduit nipple was not sealed, pressure would be equalized in the box along with chamber pressure. It is considered reasonable that moisture may have been in the bottom of the enclosure, which is one of the reasons for the drain hole in the bottom of the box.

Located inside the enclosure were 6 V-type splices. Four of the six specimens were made with Okonite tape and were identified in the test as specimens B4, B5, B6,

and B7. Three of the Okonite splices were placed on the lower ledge of the box. Only two of the specimens were monitored for leakage current to ground (specimens B4 and B5). Specimen B4 had leakage current greater than 250 ma. The other specimen had a maximum leakage current of 7 ma; it too was located at the bottom. Post LOCA functional tests measured insulation resistance when the chamber temperature was at 205 degrees F. These measurements showed that insulation resistance values were less than 5E4. Even after the splices were removed from the chamber the resistance values at ambient temperature did not improve significantly.

Insulation resistance values of this magnitude would allow significant leakage current to ground which is not considered desirable or acceptable in instrument circuits. If submergence was the failure mode for specimen B4 it does not explain these low insulation values when the specimens were removed from the test vessel and out of the submerged condition. This data is considered inconclusive and was not considered adequate to establish qualification for V-type splices at Farley.

The test report states at Section IX, Paragraph 3.0, Results, that specimen B4 apparently arced at the crotch of the splice to the NEMA 12 enclosure. It also states in part that it is not known why this specimen (B4) failed the test. Additionally, in Section VIII-1, Accident (LOCA) Test, Paragraph 2.2, Chamber Preparation, it indicates that "the chamber water level control valve was adjusted to ensure that the specimens did not become submerged during the chemical spray period in the test." As far as I can tell from reviewing the report there was no test anomally reported where this level control valve failed to function properly. Based on this the report does not support the statement

that the splices were submerged. However, they were subject to moisture intrusion, which would be expected for a V-type splice.

Q8. Do you agree with APCo that the insulation would prevent grounding absent submergence? (p.51, A42).

A. (Paulk) No, I do not. I was personally involved in a failure due to moisture intrusion into the opening of a V-type configuration similar to the type constructed by APCo. The moisture was the result of condensation only, nothing as drastic as a LOCA environment. Additionally, the connections at Farley utilized a very short length of insulation material as demonstrated in the Wyle test report 17947-01 (APCo Exh. 39), which would result in a shorter path to ground.

(Merriweather) In Wyle test report 17859-02P (APCo Exh. 27), the post LOCA insulation resistance values were low. These values were also measured at a temperature that was lower than the temperature at which specimen B4 failed. Thus, it raises a question as to whether the leakage current was caused only by moisture intrusion or serious degradation of the insulation may have occurred. These insulation resistance values were not consistent with results achieved in the NQRN-3 test.

Q9. Was the moisture intrusion pathway as described by APCo? (pp.52-53, A43).

A. (Paulk) The moisture intrusion pathway is not as APCo would have the Board believe. With the wires placed together, no tape material is between the wires, therefore, moisture has a straight shot to the connection. Additionally, the lengths of the tape insulation on

the connections (splices) installed at Farley were less than 2 inches. APCo claims that the tape is self-fusing, but fails to mention that the T-95 tape must be totally encapsulated in the No. 35 tape because it liquifies and runs when heated as stated in MLEA Letter 90-159, dated July 12, 1990 (Staff Exh. 67). The T-95 tape discussed in Staff Exh. 67 is the same as that used at Farley. It is not the newer tape referred to in the Jones, Sundergill, Love testimony (p.67, A56).

Q10. What do you think of Mr. Love's "engineering judgment" concerning the terminations with respect to the configurations? (pp.53-54, A43).

A. (Paulk) On the basis of my experience as an electrician in the Navy, and having been a Leading Petty Officer for a section of electricians, I do not agree with Mr. Love's assessment of the connections (splices) based on the skill of the craft. The connections (splices) that I observed at Farley would have been reworked if they were made by an electrician working for me. They were not done in accordance with instructions, therefore, the electricians violated APCo procedures. It appears that APCo's quality assurance/quality control programs failed also.

(Merriweather) I do agree with APCo that moisture in a single connection on an ungrounded electrical system would not cause electrical fault current to flow. However, in cases where the electrical system is grounded a single failure could cause fault current to flow. A ground detection system on DC systems is a typical example where a pre-existing ground is put on an electrical system to detect grounds, so that a ground of a certain magnitude in a single connection could cause current to flow possibly causing

spurious operation of equipment. However, in this case we are talking about a common mode failure which could cause multiple faults to ground on ungrounded systems. The water could create phase to phase faults by either creating a pathway for electrical current flow to another splice in the same enclosure or to another splice through the enclosure ground.

Q11. What is your response to APCo's position on the volts per mil analysis? (p.55, A44).

A. (Walker) In his testimony Mr. Love states that since the NQRN-3 test report (APCo Exh. 25) qualified the tape materials (Okonite T-95/No.35) to environmental parameters at a voltage of 5000 volts, it could be applied for in-line power cable splice configurations at lesser voltage based on a volts per mil analysis. The Staff does not agree. This type of analysis has been presented to the Staff on previous occasions. However, the Staff did not find it persuasive and therefore rejected it. The Staff is of the opinion that this type of analysis has no experimental or analylitical basis to support its use in environmental qualification, and to date has not seen any evidence to the contrary. Therefore, Mr. Love's statement on this issue is not consistent with the NRC Staff position and is not supported by facts or reasonable engineering judgment. In fact, if Mr. Love's position on this issue were correct, then a single test would be sufficient to qualify all cable with similiar insulating material. Mr. Love's position is not consistent with what has been done in industry nor is it consistent with what has been accepted by the NRC Staff.

Q12. Did Wyle test report 17947-01 (APCo Exh. 27) "bound the installed configurations"? (pp.56-57, A46).

A. (Paulk) APCo had no idea as to how many configurations existed in the plant. APCo did not have any configuration control when it came to tape insulated connections (splices). APCo's testimony may give the impression the tested connections (splices) came straight out of the plant (A45), when they were actually made at Wyle Labs. APCO's testimony may also give the impression that an electrician from the plant made the test samples (A46), but the Wyle report states that the connections (splices) were made by Wyle personnel under the direction of a Farley representative.

Q13. Was the testing "highly conservative"? (p.58, A47).

A. (Paulk) APCo states in A47 of the direct testimony of Messrs. Jones, Sundergill, and Love that the tested connections (splices) were installed in condulets without covers and with conduit openings exposed. The test report, in Section VI, Section 2.1, page VI-3, refers to Specimen 10.1A ... Enclosure Type: Type C condulet with cover and gasket. Mr. Sundergill testified (Tr. 1015) that one of his people told him that the covers were off during the testing. However, during the evaluation for Waterford, discussions that I had with the Wyle person in charge of the test revealed that all condulets and openings were sealed as they would have been in the plant. This would have been less conservative because it would have been harder for moisture to enter the condulet.

The pictures in the report show that the open end of the V-type connections (splices) were facing downward and in an enclosed limit switch compartment of a motor operated valve. Also, the connections (splices) that were in the cable tray were

connected so that the open end of the connection (splice) was in the air. This would be less conservative because the area of interest (the open end) was not in contact with the ground plane.

Another non-conservatism was the acceptance criterion. The criterion was that no fuses blew. The problem is that the fuses in the test circuits were 30, 50, 70, and 150 amps. These values are much too large for components like solenoid valves or instrument circuits.

Q14. Did the testing show that the splices were qualified for use in instrument circuits? (p.59, A49).

A. (Merriweather) Prior to the test being performed instrument circuits had not been identified with V-type tape splices. It was only after the test that APCo identified V-type tape splices in instrument circuits. Thus, the population of splices inspected included solenoid valves, motor operated valves, pump motors, and fan motors. This did not address the configuration of transmitters or other instrument circuits that might have had V-type tape splices. Instrument circuits typically use twisted shielded pairs which may have required a special termination detail to address the termination with the shield. Standards require that the shield be grounded at one point to prevent circulating currents which can affect the instrument output.

(Walker) Generally, qualification cannot be determined without knowing the specific application. However, for instrumentation circuits, a somewhat specialized application where circuits operate on 4-20 ma, I can state that qualification has not been

demonstrated. For this application, if circuits are going to be relied on throughout a design basis event (i.e., during and following), then the tested circuits should be energized throughout the test (i.e., the simulated design basis event). In the Wyle test report No. 17947-01, only two specimens (Nos. 10.1A and 10.1B) that could potentially be used in an instrumentation circuit remained energized throughout the test. However, the test ran for 39.4 hours and the requirement for Farley (in accordance with Mr. Sundergill's testimony, page 64, line 2) is 33 days.

APCo is apparently using the Arrhenius technique to demonstrate that the test which was conducted for 39.4 hours is sufficient to demonstrate qualification under the Farley requirement of 33 days. APCo's approach to the resolution to this problem is questionable. For example, it is not clear that the activation energy identified in APCo Exh. 39 and apparently used by APCo is correct for Okonite T-95 and No.35 tapes (1.23 ev and 0.65 ev, respectively). However, if we used these values of activation energy with the assumption that the Arrhenius technique is acceptable for post-accident operability calculations, our conclusion is that Wyle test report 17947-01 demonstrates that the T-95 insulating tape is acceptable for the Farley application, but the No.35 jacket tape is not acceptable. This is true because if an activation energy of 1.23 ev is used with T-95 tape, a post-accident period of more than 33 days can be established. However, if an activation energy of 0.65 ev is used with No. 35 tape, a post-accident period of 33 days cannot be established. Because the T-95 and No.35 tapes should be used together in order to make an acceptable splice, this combination of the two tapes is not qualified because the T-95 is not sufficient for splicing without the No.35.

It should also be recognized that assumptions about the performance of specimens for long periods following a test are not reliable because specimens have been known to fail several days into a design basis event simulation (i.e., during the required post accident operability period).

Q15. Why do you believe that APCo is wrong concerning qualification in instrument circuits? (p.59, A49).

A. (Paulk) First, on the basis of the statement of the purpose of the test (APCo Exhibit 39), the test was not intended to demonstrate qualification for instrument circuits. Second, the test circuitry would have difficulty identifying any leakage from the connection (splice) because of the location of the grounds and the apparent lack of verification of an adequate ground. Third, the sizes of the fuses in the test circuits (i.e., 30 to 150 amps) were too large for instrument circuits.

(Walker) There are two specimens in the Wyle test report that could have potentially been considered for instrument circuits, (specimens 10.1A and 10.1B). However, as indicated in the answer to the previous question, the required post-accident operability time has not been demonstrated for these two specimens. Therefore, qualification for instrument circuits for the Farley application has not been demonstrated for the specimens in Wyle test report No. 17947-01. In addition, Regulatory Guide 1.97 Rev. 2, dated December 1980, provides NRC Staff guidance to licensees concerning instrumentation that must remain functional during and following a design basis event (DBE). It clearly identifies some instrumentation that must remain functional during and following a DBE.

Farley has a post-accident operability requirement of 33 days (792) hours), the test ran for only 39.4 hours. Therefore, qualification for the required time in the relevant environment was demonstrated neither by test nor by calculations.

Q16. Mr. Walker, explain why your analysis of the test report (1) does apply to Farley; (2) is valid with respect to energizing the circuits; and (3) correctly characterizes the use of the test curve (Arrhenius techniques). (pp.61-64, A52 and A53).

A. (1) At the time that the original analysis was conducted it did not consider the Farley application, and consequently should not be rigidly applied to the Farley plant. However, I have subsequently had an opportunity to look at APCo Exh. 39 which includes what appears to be a more complete Wyle test report No. 17947-01 and some additional information that included a test plan and some analyses. As a result of reviewing this information for the Farley application, I've concluded that it does not demonstrate qualification for the Farley application, primarily for the reason stated in my response to APCo A49, although there are some other questions concerning grounding of the test set-up that should be addressed.

(2) My analysis is valid with respect to energizing circuits because during a design basis event some instrumentation is required for accident monitoring and therefore must remain functional in order to provide information at all times. Consequently, when a test is conducted on a component that will potentially be used in an instrumentation circuit, the test must demonstrate the capability of that component to provide information continuously through a simulated design basis event. A specimen that does not remain

energized throughout the test (i.e., the simulated design basis event) will not have demonstrated this capability, and consequently qualification will not have been demonstrated.

(3) The Arrhenius technique has been accepted by the NRC Staff for use in conjunction with accelerated aging. The purpose of accelerated aging is to put specimen(s) in an end-of-life condition prior to being subjected to a design basis loss of coolant accident (LOCA). The Arrhenius technique is commonly used and widely accepted by both the NRC and industry for pre-aging (i.e., to put the specimen in an end-of-life condition prior to LOCA testing). The NRC Staff has not generally accepted nor does it recommend this technique to calculate required post-accident operability time. Nevertheless, there have been a few specific occasions where circumstances were such that the Staff accepted this technique for demonstrating required post-accident operability time. On these occasions the transient portions of both the simulated accident (the test), and the calculated accident profile (this is also known as the qualification profile and is represented by figure 4 of qualification plan No. 17942-01 on page 24 of APCo Exh. 39) were not used. In other words, the technique was applied subsequent to the transient and only after the temperatures had stabilized or were very near stable. The Staff has no policy of general acceptance for this purpose, but has accepted the technique for this purpose on a limited number of occasions and on a case-by-case basis. In the case of Farley, the test temperature stablizes at 240°F which is about 75 minutes into the test. The qualification profile becomes nearly stable at about 175°F which is the 2.5 hour point into the qualification profile. If these points are used, a post-accident operability period

of 33 days cannot be established for the No.35 jacket tape. Nevertheless, if APCo dissagrees with these points and chooses to pick a nonconservative point at 1.5 hours into the qualification profile, the No.35 jacket tape still cannot be qualified, as a matter of fact it cannot even come close to being qualified.

Q17. What is your response to Mr. Sundergill's criticism of Mr. Paulk's testimony? (pp.67-68, A56).

A. (Paulk) APCo critcizes my testimony concerning the testing done for Arkansas Nuclear One (ANO). My misstatement that the tape was not self-vulcanizing has been corrected to reflect that the tape was unvulcanized (uncured) (Tr. 343). The remaining statements were accurate. My statements do not invalidate the Okonite report, but reinforce it. The Okonite report required the T-95 tape to be totally encapsulated by the No. 35 tape. A source of my statements in my direct testimony was MLEA Letter 90-159, dated July 12, 1990 (Staff Exhibit 67), which forwards the results of thermal testing of Okonite T-95 taped splices. The report states that "[a]t elevated temperatures, T-95 will flow unless restrained by a suitable covering (viz. No. 35 jacketing tape)." Another source for my statements was the MLEA Memorandum dated June 19, 1990 (Staff Exh. 68), in which an Okonite representative told MLEA that "Okonite has been telling utilities for years that T-95 splice tape should not be used for bolted V splices without a No. 35 jacket." However, APCo did not totally encapsulate the T-95 tape in any of its V-type tape insulated connections (splices). On the basis of our discussions with electricians at the plant, we determined that there was confusion as to how the splices should have been made and what material should have been used.

Q18. Why are "installation deviations" an EQ rather than a maintenance or QA concern? (pp.68-70, A57).

A. (Paulk) Environmental qualification is more than just performing a test on equipment and documenting that test. It involves all aspects of an organization. The maintenance department has the responsibility of maintaining equipment in a condition similar to that tested to ensure that the qualification is not voided. This view is consistent with Mr. Woodward's testimony, in response to Judge Morris's question, that the EQ requirements were integrated into the plant organization, rather than "creating a separate organization somewhere whose job is EQ management." (Tr. 1301).

(Merriweather) The DOR Guidelines specifically stated that the EQ program should include an as-built inspection in the field to verify that equipment was installed as tested. IE Bulletin 79-01B required licensees to evaluate the qualification of their equipment against the guidelines. It was clear that installation requirements were part of the overall EQ program. A failure to identify and perform required EQ maintenance is also considered an EQ program breakdown. However, in cases where corrective maintenance is performed, that maintenance may void the previous qualification of the component. An example of this may be installing non-EQ replacement parts in an EQ device. This is clearly the result of maintenance activities; however, it is also related to a deficiency in the EQ program.

Q19. APCo states that the installation instructions were adequate. What is the Staff's position? (pp.70-71, A58).

A. (Paulk) If the appropriate procedures were followed for the connections (splices), I believe correct and reproduceable connections (splices) could have been made. For example, an APCo document, Working Specifications for Installation of Cables (APCo Exh. 38), provides instructions for "the installation of the power, control, communications, and lighting cables, the method of making the terminals, and any splices which may be necessary." For 1000 volt general purpose cable used in 575 volt service (power cables for motors and motor operated valves), the electrician is instructed to make the connections as provided for Cable Codes B01 - B99. The instructions for the Cable Codes B01 - B99 refer the electrician to Drawing A-172396 (Bates 001785) for splices and Drawing A-172398 (Bates 001792) for terminations. These drawings show an in-line connection (splice/termination) for the 1000 volt cable, one of which uses a heat shrinkable insullation kit and the other uses T-95 and No. 33 tapes.

Q20. Mr. Jones testified on cross-examination that there were only about 250 V-type tape insulated connections (splices) at the Farley site. (Tr. 1010-11). Do you agree?

A. No, I do not. I believe Mr. Jones meant to say that there were approximately 250 components per unit affected. On the basis of the resident inspector's Inspection Report Nos. 50-348/87-17 and 50-364/87-17 (Staff Exhibit 17), there were 84 solenoid valves per unit with two connections per solenoid (336 connections), 104 motor operated valves per unit with at least three connections each (624 connections), and 10 fan motors per

unit with at least three connections each (60 connections). These figures do not include any instrumer.ts, which would have two connections each.

Q21. Why did Circulars 78-08 and 80-10 provide sufficient notice of a concern, contrary to APCo's position? (pp.71-71, A59).

A. (Luehman) The Staff's "clearly should have known" finding for V-type tape insulated connections (splices/terminations) is based only in part on the Circulars. First, the Circulars merely establish that, prior to the deadline, the Staff was concerned about splices (connections). Since APCo acknowledges that splices (connections) had to be qualified and they recognized that, using the Circulars for that purpose is unnecessary. Second, the Circulars provided APCo an opportunity to review its splices (connections/terminations). On page 73 of their direct testimony, Messrs. Jones and Love stated with regard to Circular 80-10, "APCo, and Bechtel, during that time would have read the Circular and concluded that at Farley an appropriate (i.e., qualified) material (Okonite T-95/No. 35) was used." What installation or QA records could they have based that conclusion on? APCo has produced no records to support this inaction and, after the fact, we know the danger of assumption.

The Circulars aside, the Staff maintains that APCo "clearly should have known" of these splice (connection) problems because (1) even the most minimal of an installation and verification program would not have allowed V-type tape insulated connections (splices) where in-line or Raychem splices (connections) were required, and (2) the use of alternate materials and a test for a 5000 volt tape insulated connection

(splice) does not demonstrate qualification at reduced voltages without a documented evaluation.

Testimony of DiBenedetto

Q22. Is it true that the Staff was not concerned with the qualification of tape insulated connections (splices) until 1987? (p.64, A71).

A. (Paulk) I do not believe so. In 1980, when I entered the world of commercial nuclear power, I was aware that tape insulated connections (splices) and terminal blocks were not considered to be very reliable because of the problems experienced at TMI. The message was clear to me that the NRC was concerned. In a general sense, Circulars 78-08 and 80-10 demonstrate that.

(Merriweather) In the case of Farley they did not identify tape splices in their IE Bulletin 79-01B submittal so the Staff did not review this issue until the September 1987 inspection. In regard to other EQ inspections I know from experience that the qualification of tape splices had been reviewed as early as March 1985 during an EQ inspection. The EQ inspections would only examine a small sample of the components on the EQ Master List, so that every EQ inspection may not have reviewed the same items at each plant.

Q23. Is Mr. DiBenedetto's account of the situation at Calvert Cliffs accurate? (p.64, A72).

A. (Paulk) No. While Mr. DiBenedetto is correct that the licensee at Calvert Cliffs did not use approved materials, the problems were not limited to power applications. The use of tape insulated connections (splices) was also found in control and instrument circuits.

(Merriweather) Not exactly. The NRC inspection report identified unqualified wrap-around tape splices on safety-related solenoid valve pig-tail leads in the Calvert Cliffs Unit 2 East Piping Penetration Room Auxiliary Feedwater System on blocking valve Nos. 2-SV-4530 and 2-SV-4531. These wrap-around splices were located in condulets similar to the splices found at Farley. BG&E did not have documentation to support the qualification of the tape splices. The splices were made by bolting the two wire leads together and wrapping 3-4 turns of standard electrical tape around the connected leads. The licensee implemented an immediate inspection plan on Unit 2 identifying numerous other EQ problems such as unidentified limitorque wiring, unqualified terminal blocks and other unqualified wrap-around tape terminations. Based on these inspection results the other unit was shutdown to inspect for similar deficiencies.

Q24. Is it accurate to say that "the only issue at Farley was whether a 'V' rather than an 'in-line' connection ... made a difference to qualification"? (p.65, A73).

A. (Paulk) No. Also of concern were the different materials used for the connections (splices) as well as the undetermined number of configurations. Some connections (splices) were made with T-95 tape alone, others were constructed with materials (e.g., black vinyl tape) that did not have their qualification documented.

(Merriweather) I do not agree. At the time of the inspection in September 1987 the only qualified tape splice that the licensee had in the file was for a 5 KV in-line power cable. This report alone would not support the qualification of the splice generically for low voltage applications.

Q25. Is the only similarity between Calvert Cliffs and Farley the use of tape as an insulating material? (p.65, A74).

A. (Merriweather) The similarity exist in the fact that both licensees did not include electrical tape splices (terminations) on the list of electric equipment important to safety and they had tape splice configurations installed in their plants that were not addressed in the qualification files.

Q26. Was APCo's reliance on the skill of the craft, etc. a practice that was "fairly normal in the industry at the time ? (p.67, A75).

A. (Paulk) Not to the extent APCo relied on it to make tape insulated connections (splices/terminations). Other licensees relied very little on skill of the craft. While many licensees would allow skill of the craft, they also rely on the craftperson to use approved procedures and qualified materials to fabricate a tape insulated connection (termination/splice) in a qualified configuration.

(Merriweather) Based on my experience terminating, soldering and splicing have been considered special processes that should be controlled by procedures and drawings.

Q27. Please explain "skill-of-the-craft."

A. (Paulk) The term "skill-of-the-craft" is used to indicate that a craftsperson is capable of performing a task without any instructions because of his training and/or experience. The concept of skill-of-the-craft is not bad itself, but the way it was implemented at Farley was not good. The interviews that we conducted indicated that there was not a consistency in the training of the craftspersons. There was also a different level of experience among the workers. One of the electricians who installed the T-95 only tape insulated connections (splices) inside containment had been reassigned as a janitor by the time we interviewed him.

Q28. What is your response to Mr. DiBenedetto's comments on the Wyle test (APCo Exh. 39)? (p.78, A89).

A. (Walker) It should be clearly understood that the test specimens did not come from the Farley plant, but were specimens assembled by Wyle to represent the many configurations at Farley. One of the more important concerns in my opinion is how closely the specimens represented the Farley installations. For example, a significant number of instrumentation circuits in most plants are on 18 to 22 gage cable, while the specimens tested were splices mounted on 12 gage (12 AWG) and larger cable. If the intent was to include representation for instrumentation circuits, then specimens mounted on 18 to 22 gage cable should have been included in the test, or APCo should state that there are no splices on 18 to 22 gage cable at Farley.

Mr. DiBenedetto stated that "when vendors EQ test their own equipment, they test one piece of equipment for everything supplied throughout the nuclear industry." (p.78, A90) However, Mr. DiBenedetto did not mention that in those instances, vendors provide sufficient details to assure that the one piece of equipment is indeed representative of the other supplied equipment.

Q29. Does this conclude your testimony?

A. (All) Yes.