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Dalwyn R. Davidson
VICE PRESIDENT
SYSTEM ENGINEERING AND CONSTRUCTION

November 9, 1979

Mr. James G. Keppler
Director Region III
Office of Inspection and Enforcement
U.S. Nuclear Regulatory Commission
799 Roosevelt Road
Glen Ellyn, Illinois 60137

RE: Perry Nuclear Power Plant
Final Report on Eccentric Jacket
on Class IE Small Power and
Control Cable

Dear Mr. Keppler:

This letter constitutes the report required by 10CFR50.55(e) on the deficiency concerning eccentric jackets on Class IE small power and control cable. This item was first discussed in a telephone conversation between Mr. M. R. Edelman of the Cleveland Electric Illuminating Company, and Mr. Jim Konklin of the NRC Region III Office of Inspection and Enforcement on June 27, 1979. An interim report addressed to yourself was later written on July 18, 1979, and an extension to the due date for this report was granted by J. Konklin on September 28, 1979.

Description of the Deficiency

The Rockbestos Company was contracted by the Cleveland Electric Illuminating Company to manufature Class IE small power and control cable for the Perry Nuclear Power Plant. As part of this contract, the specification required the cable to conform to Insulated Cable Engineering Association (ICEA) Standard S-68-516. Referring to the cable's jacket, this standard states in part that the minimum thickness shall be not less than 80 percent of the recommended nominal jacket thickness. Although no defects were found during either final inspection or receipt inspection, a later CEI laboratory examination revealed that while the average jacket thickness was acceptable per ICEA S-68-516, some of the cable jacket was suspected of falling below the 80 percent minimum requirement.

To date CEI has examined 176 samples obtained randomly from approximately 1,200 reels of cable received from Rockbestos. Thirty-three of these

samples are suspected of being nonconforming according to ICEA S-68-516. The following is a breakdown of the 33 suspected nonconforming samples:

Percent of Jacket Thickness	Number Found
70% - 80%	24
60% - 70%	6
50% - 60%	2
46.7%	1

Fourteen of these samples were re-evaluated at the Rockbestos facilities on June 21, 1979. Using calibrated equipment, we were able to verify that four of the fourteen samples re-evaluated actually fell below the 80 percent minimum jacket thickness. It should be noted that the 46.7 percent reading above was later found to be 53 percent of jacket thickness when checked with Rockbestos calibrated equipment.

Analysis of Safety Implication

Although the individual unjacketed conductors have been qualified to IEEE 383, Section 2.4 (LOCA) as documented in the Rockbestos qualification report dated February 1, 1977, there was some concern that the cable jacket would not be able to fulfill its intended function (to provide fire retardency and to contain and protect the individual conductors), and that incipient faults could occur if the jacket is severely damaged during installation. Since it is felt that such a fault could adversely affect the safe operation or shutdown of the nuclear power plant, extensive evaluation was required to establish the adequacy of the cable jacket to perform its intended safety function.

Corrective Action

In order to evaluate the adequacy of the cable jacket, it was necessary to:

1. Further define and clarify the intent of the ICEA requirement.
2. Perform flame tests to qualify cable without jackets to IEEE 383.
3. Perform cable-pulling tests that would exceed worst case pull tests.

Inquiries to the ICEA revealed that the 80 percent value was determined by a consensus of the manufacturers of cable and not by design analysis. The 80 percent tolerance in wall thickness is allowed to compensate for variations in jacket thickness that are inherent in the jacketing process. These variations may be due to design of the cable core and/or limits of the control equipment in the jacketing process. ICEA's information further states that the jacket thicknesses suggested by this standard

provides adequate and sufficient protection for cables in the majority of applications, if the cables are installed and used in the manner normal for their construction. It is, however, incumbent upon the specifier of cable to evaluate whether the requirements of the standard he is using are sufficient for the application. ICEA standards then are intended to assist the user in selecting and obtaining proper product for his particular need, but do not preclude the use of cable not conforming to the standard. See Attachment A for details of ICEA information.

In order to determine flame retardent ability of a cable with reduced jacket thickness, a flame test was performed in accordance with IEEE 383 at the Rockbestos facilities in New Haven, Connecticut on October 4, 1979. The cable tested consisted of three 8' specimens each of 2/c #6 AWG power cable and 9/c #14 AWG control cable. Each of the six cable specimens had a 20" section of the outer jacket removed, exposing the underlying binder tape. The cable was arranged in a single layer in the center portion of a vertical metal tray with a separation of approximately one-half the cable diameter between each specimen. The lower end of this section was located at the approximate point of flame contact so the flame enveloped the unjacketed portion of the specimen (length of burn area was approximately 22"). The test was conducted for ten minutes at 70,000 BTU's followed by an additional ten minutes of 210,000 BTU's. The cable did not propogate flame (see Attachment B and C for engineering analysis and test report). It was therefore, concluded that in the event of reduced jacket thickness or partial removal of the cable jacket, the cable will meet the flame test requirements of IEEE 383-1974.

To determine the mechanical suitability of cable supplied by Rockbestos Company, a cable jacket qualification test was conducted on August 17, 1979, at the Rockbestos facilities to determine whether the effectiveness of the Hypalon jacket is impaired when wall thickness is reduced below the specified minimum requirement. The qualification test consisted of pulling three cable speciments through a 1" conduit containing 4-90° bends (360° total) with 6" radii (see Attachment D). It should be noted that the project design criteria is limited to bends totaling no more than 290°. In addition, specimens with jacket thicknesses far thinner than those received at the site were utilized. In order to compare results of jacket thickness, the following specimens were utilized in the test:

Specimen Number & Description	Length	Jacket Thickness Nominal Recommended	Nominal Actual	Minimum Recommended	Minimum Actual
1) #14, 2C Firewall III	70'	.045"	.048"	.036"	.040"
2) #14, 2C Firewall III	70'	*	.021	*	.018
3) #10, 2C Firewall III	65'	.045	.037	.036	.024

*This cable was made with a jacket thickness approximately 50 percent of nominal and was made especially for this test.

Specimens #1 and #2 were pulled through the conduit four times and inspected for damage after each cycle. Specimen #3, which is a section of cable with thinnest jacket received at the Perry Nuclear Power Plant, was pulled through the conduit run only once. Cables were pulled at a rate of 26 FPM, and no pulling lubricant was used. Since the maximum pulling tension and the maximum side wall pressures are two parameters which should not be exceeded when pulling cable, pulling tensions were continuously monitored and are recorded below:

PULLING TENSIONS

Specimen #1 standard jacket wall thickness

1. Cycle	Manufacturer's Maximum Recommended	Test Results Min.	Test Results Max.	Visual Inspection
1	66	140 lbs.	240 lbs.	No damage
2	66	160	220	No damage
3	66	130	250	No damage
4	66	140	280	No damage

Specimen #2 reduced (50%) jacket wall thickness

2. Cycle	Manufacturer's Maximum Recommended	Test Results Min.	Test Results Max.	Visual Inspection
1	66	140 lbs.	210 lbs.	No damage
2	66	160	270	No damage
3	66	140	220	No damage
4	66	120	300	No damage

3. Cycle	Manufacturer's Maximum Recommended	Test Results Min.	Max.	Visual Inspection
1	180	140 lbs.	260 lbs.	No damage

Since side wall pressures can not be measured, they were calculated using the above pulling tensions. The results are as follows:

Specimen	Sidewall Pressure Recommended Maximum	Actual Minimum	Actual Maximum
1	300 lbs.	260 lbs.	560 lbs.
2	300	240	600
3	300	280	520

Visual inspection after each pull test revealed superficial scuffing on all specimens, and transverse wrinkles appeared in the jacket of Specimen #2. As a result of this inspection, it was concluded that the specified jacket thickness could be reduced by 50 percent without adversely affecting the fire retardency or mechanical purpose of the Hypalon jacket.

Since pulling lubricant is required to be used during installation at the Perry Nuclear Power Plant, a specimen identical to Specimen #2 was pulled through the conduit using Ideal Yellow 77 pulling lubricant to obtain a comparison between laboratory tests and field conditions. Pulling tensions of only 10 lbs. were experienced during this pulling test.

Following the pulling tests, Specimens #1 and #2 were given a 4.1 kV, five-minute high pot test utilizing a Peschel Electronics high voltage electrical test set. The set was calibrated on April 3, 1979, to the National Bureau of Standards and is due for recalibration in April 1980. No leakage current was experienced.

Summary

During the flame test:

1. Cable without any jacket was tested and did not propagate flame.

During the cable-pulling qualification tests:

1. The project design criteria for total number and degrees of bends was exceeded.
2. Pulling tensions and sidewall pressures were exceeded.
3. Jacket thickness thinner than those experienced on the site was used.

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In spite of the severity of these conditions, the cable met the IEEE 383 qualification requirements for flame retardency and the Hypalon jacket did not show any adverse signs of damage. From the results of these tests, it was concluded that the cable received at the Perry Nuclear Power Plant could be utilized without jeopardizing the safe operation and shutdown of the plant. It is therefore felt that the facts stated in this report, which are supported by actual test results, and our assessment of the results justify our position that the extent of eccentricity experienced on cable jackets at the Perry Nuclear Power Plant no longer constitutes a significant deficiency.

Very truly yours,

Dalwyn R. Davidson

Dalwyn R. Davidson
Vice President
System Engineering and Construction

DRD:ge

cc: Victor Stello, Director
Office of Inspection and Enforcement
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

INSULATED CABLE ENGINEERS ASSOCIATION, Inc.
P.O. Box P · South Yarmouth · Massachusetts 02664 (617) 394-4424

August 24, 1979

RECEIVED
AUG 29 1979
PLANT PROJECT QUALITY ASSURANCE

Mr. Timothy A. Boss
Quality Assurance Engineer
The Cleveland Electric Illuminating Company
P.O. Box 5000
Cleveland, Ohio 44101

Dear Mr. Boss:

I have received the letter you sent to our association secretary requesting information on the interpretation and derivation of the 80% minimum wall thickness requirements that appear in our standard S-68-516.

We are pleased to provide you the following answers to your questions:

1. Does the 80% value in IPCEA standard S-69-516 refer to an average figure or does it refer to minimum requirements anywhere in the cable jacket?

   The 80% value applies to a single point reading anywhere in the cable jacket and is 80% of the value given in the standard, not 80% of the measured average diameter.

2. Was the 80% value in IPCEA standard S-68-516 developed or determined? That is, was it developed from design analysis or was it determined from what the manufacture could meet?

   The 80% value was determined by consensus of the manufacturers of cable. This spread in wall thickness is allowed to compensate for variation in jacket thickness that are inherent in the jacketing process. These variations may be due to design of the cable core and/or limits of the control equipment in the jacketing process.

   Note that in the case of jackets over certain metallic sheathed and armored cables, the minimum point thickness is 70%, reflecting, again, process variables in these types of products. We infer from your questions that these types of cables are not of instant concern.

3. If the 80% value was developed from design analysis, could you please send me a copy of the analysis?

   Since value was determined, no design analysis can be provided.

Continued...

TO: Mr. Timothy A. Boss
The Cleveland Electric Illuminating Company
August 24, 1979

4. If the 80% value was determined, why was 80% used as opposed to 70% or 90%?

It was determined that 80% was required to accommodate the process (See #2), therefore, a value of 90% could not be used. A value of 70% was not required to accommodate the process variations.

5. Is the 80% value necessary for proper operation or protection of the cable?

A cable which has a jacket with a minimum point thickness of 80% or more of the thickness designated in Standard S-68-516 does meet the requirement of the standard as to jacket thickness. We feel that the jacket thicknesses suggested by this standard provide adequate and sufficient protection for cables in the majority of applications, if the cables are installed and used in the manner normal for their construction. It is, however, incumbent upon the specifier of cable to evaluate whether the requirements of the standard he is using are sufficient for the application. As we state in the foreword of our standards, they are intended to assist the user in selecting and obtaining proper product for his particular need, but do not preclude the use of cable not conforming to the standard.

I trust that this information will be helpful.

Very truly yours,

John V. Lipe

John V. Lipe
President

JVL:mtd

PERRY NUCLEAR POWER PLANT PROJECT ORGANIZATION

THE CLEVELAND ELECTRIC ILLUMINATING COMPANY
AND KAISER ENGINEERS, INC.

PP-6 REV. 8-79

MEMORANDUM

PAGE NO.

TO T. A. Boss ROOM 2C 204 FROM E. C. Willman DATE November 8, 1979
PHONE 393 ROOM LB 155
SUBJECT Engineering Analysis of Rockbestos Flame Test for SP-560

The Rockbestos flame test dated October 25, 1979 successfully demonstrates that the cables supplied under SP-560, that have a thinner than specified jacket, are suitable for safety related usage with respect to their ability to resist fire. The basic concern was that if a thin jacket cable was subjected to a fire, the flame might propagate. The flame test used representative samples of our cables. These cables had their jackets removed for an area of 20 inches and the flame was directed at this area. The flame test was run at 70,000 BTU's (the normal IEEE 383 level) for ten minutes and 210,000 BTU's for ten more minutes. The removal of the jacket and the higher heat rating are much more severe conditions than IEEE 383 requires.

At the completion of the test, the burned area was 22" and the flame did not propagate. This meets the requirements for passing IEEE 383. Therefore, the cable is suitable for safety related use.

D. R. Green
Senior Project Engineer

ECW/llc

cc: SO/DC - LA 101 (2)
EDS File

1344 173

ATTACHMENT "C"

THE ROCKBESTOS COMPANY
NEW HAVEN, CONNECTICUT 06504 USA TELEPHONE: (203) 772-2250 TELEX: 710-465-2149

October 25, 1979

Mr. David R. Green,
Senior Project Engineer
The Cleveland Electric Illuminating Company
c/o Perry Nuclear Power Plant
P. O. Box 5000
Cleveland, Ohio 44101

Dear Mr. Green:

At the request of R. G. Boudon, we are forwarding, attached, our report of the IEEE-383 cable tray flame test performed on SP-560 cables to demonstrate performance with portions of the jacket removed.

We had originally intended to include these results with our final report following CEI witnessing of other proposed testing.

Very truly yours,

THE ROCKBESTOS COMPANY

G. G. Littlehales,
Manager, Quality Assurance

ebn
att.

cc: E. J. D'Aquanno
F. R. Postma
R. G. Boudon

Perry Nuclear Power Plant
P. O. P-1641
Class 1E Small Power
and Control Cable
per SP-560

SUBJECT: Report of cable tray flame test on Firewall III cables with jackets partially removed

On October 4, 1979 the following cable tray flame test was performed in accordance with IEEE-383-1974, except as noted below. A ribbon gas burner was employed.

Cable tested was produced on P. O. P-1641 for Perry Nuclear Power Plant. It consisted of three 8' specimens each of 2/C 6 AWG power cable and 9/C 14 AWG control cable, arranged in a single layer in the center portion of a vertical metal tray, with a separation of approximately one-half the cable diameter between each specimen.

Each of the six cable specimens had a 20" section of the outer jacket removed, exposing the underlying binder tape. The lower end of this section was located at the approximate point of flame contact, so that the flame enveloped the unjacketed portion of the specimen.

The test was conducted for ten minutes at 70,000 ETU's, after which it was continued for an additional ten minutes at 210,000 BTU's.

Results: Propagation of flame - none
Length of burned area - approx. 22"

Conclusion: In the event a portion of a cable jacket is below the specified minimum wall thickness, or in the extreme event of tearing or partial removal of a cable jacket, the cable will still meet the flame test requirements of IEEE-383-1974.

Test Performed By:
K. J. Giannotti, Test Engineer

Witnessed By:
E. J. D'Aquanno, Chief Engineer
G. G. Littlehales, QA Manager
F. R. Postma, VP Marketing & Sales

Report by GG Littlehales
G. G. Littlehales
10/25/79

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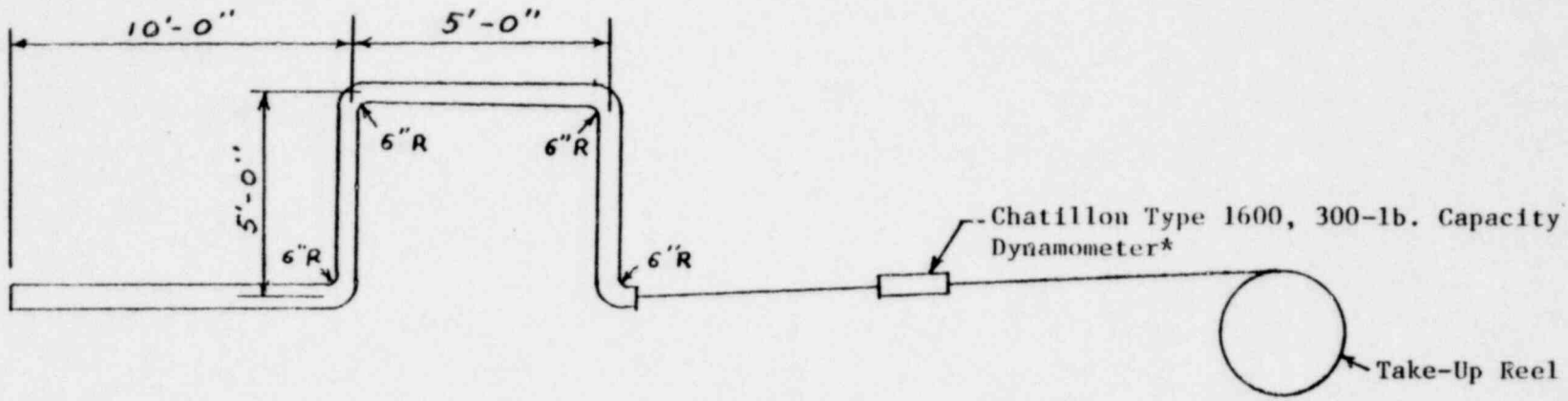
ATTACHMENT D



*Calibrated August 15, 1979; due for recalibration. Calibration traceable to National Bureau of Standards.

17/S/1/mm

ATTACHMENT "B"

THE CLEVELAND ELECTRIC ILLUMINATING COMPANY SO/157

S-1
REV. 8-78

MEMORANDUM

TO B. L. Barkley ROOM 1A 100 FROM E. C. Willman DATE September 18, 1979
D. R. Green 1B 155 PHONE 393 ROOM 1B 155
SUBJECT Engineering Analysis of Rockbestos Cable Pulling Test, SP-560

The Rockbestos cable pulling test has successfully demonstrated that the cables supplied under SP-560 are suitable for safety related use. A cable with a jacket thickness less than we have found during our sampling program was subjected to forces far in excess of those that will be encountered during installation. Even after this severe test, no significant mechanical damage could be found. The cable then passed a functional electrical test. The pulling test was documented in a Rockbestos test report dated August 23, 1979. The following is an analysis of the test with comments.

Test Cables

The cables used during the test were as follows:

Cable Type	Spec. Thickness	Minimum Found	Percentage
Standard 2/c #14	.045"	.040"	89
Thin Jacket 2/c #14	.045"	.018"	40
2/c #10	.045"	.024"	53

The standard 2/c #14 was a normal production cable used as a control for the test. The thin jacket 2/c #14 was specially manufactured for the test. The 2/c #10 was obtained from our cable yard and is from a reel that had the thinnest jacket found during our sampling.

To date, we have examined 176 samples, obtained randomly from approximately 1500 reels of cable received from Rockbestos. Thirty-three of these samples have been found to be nonconforming to our minimum specified jacket thickness, as required by I.C.E.A. S-68-516 which is referenced in SP-560, 2:07.4b. The required minimum is 80% of the specified jacket thickness. The measurements were obtained on uncalibrated instruments in our lab. Fourteen of these samples were evaluated at Rockbestos and four were found to be below the 80% minimum. This might be interpreted as indicating large errors in our instruments; however, my interpretation is that the discrepancy is more a result of the random distribution of the thin spots throughout the cables.

TO ROOM FROM ROOM DATE
PHONE
SUBJECT

The following is a breakdown of the thirty-three nonconforming samples our lab found.

Minimum Jacket Thickness	Number Found
70% - 80%	24
60% - 70%	6
50% - 60%	2
* 46.7%	1

* A piece of this same sample was found to be 53% when measured on Rockbestos' calibrated instruments.

The use of the 40% test sample, as can be seen from the preceeding information, leads to more severe conditions than will be encountered when using the cables on site. To further reinforce the test, the worst cable found during random sampling (2/c #10 46.7%) was also used as a test sample.

Test Apparatus and Equipment

The cable samples were pulled through a 25 ft. continuous run of 1" steel conduit. The run contained a straight 10 ft. section, four 90° bends each with a 6" radius, and three 5 ft. straight sections between the bends. The pulling force was supplied by motor driven equipment normally used for cable reeling. I continuously monitored pulling tension using a Chatillion type 160, 300 lb. capacity spring scale. The scale was calibrated 8/15/79, using standards traceable to the National Bureau of Standards. The voltage withstand test was run on a Peschel Electronics high voltage electrical test set which was verified to have a current calibration tag. The continuity test was done with an uncalibrated volt-ohm meter.

The test apparatus included bends totaling 360°. The project design criteria limits us to bends totaling no more than 290°. We are allowed to pull the cable out of a pull box and again pull through bends totaling 290°. The use of bends totaling 360° is therefore, a more severe condition than we will incur during cable pulling on site.

TO ROOM FROM DATE
PHONE ROOM
SUBJECT

Pulling Test

When pulling cable, there are two parameters that should not be exceeded. These are the maximum pulling tension for the type of cable involved, and the maximum sidewall pressure. The maximum pulling tension is generally determined by multiplying the total copper area of the cable in CM by .008. Rockbestos' tensions are in agreement with this method. Maximum allowable sidewall pressure is generally regarded to be 300 pounds per foot of bend radius. Rockbestos uses this value.

Each of the 2/c #14 cables were pulled four times. The pull wire was tied to the cable so that the cable was pulled as a whole. This is equivalent to pulling with a basket grip, which will be the site procedure. No cable pulling compound was used. Pulling tensions were continuously monitored and sidewall pressures were calculated as twice the pulling tension, because the final bend was 1/2 foot in radius and occurred at the end of the pull where the tension is greatest.

After this phase of the test, the 2/c #10 cable was pulled one time. Then, a second piece of the thin jacket 2/c #14 was pulled one time using pulling compound. The following values for pulling tension and sidewall pressure were recorded.

Cable Type	Pulling Tension in Pounds max. recommended/actual max.	Sidewall Pressure in Pounds Per Foot max. recommended/actual max.
Standard 2/c #14	66/280	300/560
Thin Jacket 2/c #14	66/300	300/600
2/c #10	180/260	300/520
Thin Jacket 2/c #14 with compound	66/10	300/20

The cables were physically examined after the pulling test. Superficial scuffing was found on the 2/c #14 jacket and some rippling was found on the thin jacket 2/c #14. The other two cables were

TO ROOM FROM DATE
PHONE ROOM
SUBJECT

undamaged. Both of the 2/c #14 cables were subjected to a continuity test which they passed. They were also subjected to a high voltage dielectric test of 1 kV AC for 1 minute, followed by 4 kV AC for 4 minutes. Both of the cables also passed this test. No leakage current was detected.

Conclusion

Before drawing a conclusion from the test, the function of the cable jacket should be discussed. The only necessary purpose of the cable jacket for the Rockbestos SP-560 cables is to provide mechanical protection to the individual insulated conductors during installation. The individual unjacketed conductors have been qualified to function during a loss of coolant accident (LOCA), postulated to occur at any time during 40 years of operation, under conditions as prescribed by IEEE 383-1974. This is documented by a Rockbestos qualification report dated February 1, 1977.

The only other item to be considered is how we can assure ourselves that we will not exceed normal cable pulling parameters during installation. The contractor has been issued a list of maximum recommended pulling tension which will be continuously monitored during installation, so that they are not exceeded. The sidewall pressure cannot be continuously monitored, but with adequate design control and proper pulling tensions, the sidewall pressure of 300 pounds per foot will not be exceeded. Also, pulling compound will be used and this dramatically reduces the pulling force required. In addition to these safeguards, to prevent the pulling parameters being exceeded, we also have demonstrated a wide margin exists between the maximum recommended values and what the cable can survive.

The pulling test was more severe in thinness of cable jacket, number of bends, pulling tension, and sidewall pressure than what will occur during on-site pulling. During the test, no significant damage was found to the cable. Therefore, it has been proven that the Rockbestos cables supplied under SP-560 are suitable for safety related use.

BCW/llc

cc: T. A. Boss - 2C 204
SO/DC - 1A 101 (2)
EDS File

ATTACHMENT "F"

THE ROCKBESTOS COMPANY
NEW HAVEN, CONNECTICUT 06534 USA TELEPHONE (203) 772-2250 TELEX 710-465-2149

August 23, 1979

Mr. David R. Green,
Senior Project Engineer
The Cleveland Electric Illuminating Company
c/o Perry Nuclear Power Plant
P. O. Box 5000
Cleveland, Ohio 44101

Dear Mr. Green:

Attached is our report of the special conduit pull test performed August 17, 1979 at our New Haven plant.

Please contact Gene D'Aquanno or me if you have any further questions.

Very truly yours,

THE ROCKBESTOS COMPANY

G. G. Littlehales,
Manager, Quality Assurance

ebn
att.

cc: R. G. Boudon
E. J. D'Aquanno
E. S. Reed
F. R. Postma
J. Furness, GAI

The Rockbestos Company
285 Nicoll Street
New Haven, Conn. 06511

August 23, 1979

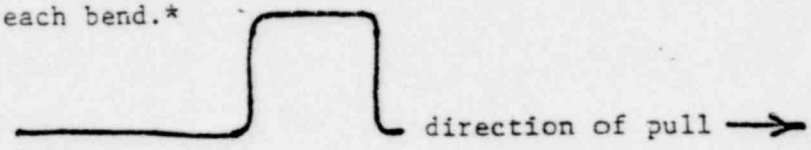
TEST REPORT

Objective: To determine whether the function of hypalon (CSPE) cable jackets is impaired when wall thickness is reduced below the specified minimum.

Test Description: Simulated severe installation procedure using Firewall III cable with reduced jacket wall thickness. Conduit pull test using 2/C 14 AWG cable, and achieving 300 lbs. sidewall pressure is considered to be representative of maximum exposure of cable to severe physical stress.

Equipment:

1. 25 ft. continuous run of standard one-inch metal conduit, consisting of a straight 10-foot length and four 90° bends, each with a 6" radius, and 5-foot straight runs between each bend.*



2. Chatillon Type 160, 300 lb. capacity dynamometer. Unit calibrated 8/15/79 using standards traceable to the National Bureau of Standards.

3. Peschel Electronics, Inc. high voltage AC test set serial #745. Unit calibrated 4/3/79 using standards traceable to the National Bureau of Standards.

*The original test plan called for five 90° bends.

During preliminary trials it was found that with five bends, the cable became "locked" into the conduit and was impossible to pull without exceeding acceptable tension. It was therefore necessary to modify the conduit run to include four bends only.

Specimens for Test:

1. Approximately 70' of Rockbestos 2/C 14 AWG Firewall III with hypalon jacket of standard thickness.

2. Approximately 70' of 2/C 14 AWG Rockbestos Firewall III with hypalon jacket approximately 50% of specified nominal thickness.

Note that the specified jacket wall thickness for the above cables is .045" Specified minimum thickness is .036".

Specimen #1 had an average minimum jacket wall thickness of .048" with a measured spot minimum of .040". The average jacket wall thickness was .067".

Specimen #2 had an average minimum jacket wall thickness of .023", with measured spot minimums of .018" and .020". The average jacket wall thickness was .033".

Both specimens had been electrically tested at 4.0 KV AC for 5 minutes prior to the installation test.

Specimens for Test (Cont'd.):

Both specimens were identical in construction and materials to cable shipped to Perry Nuclear Power Plant on Contract SP-560.

Test Procedure:

Test specimens #1 and #2 were pulled through the conduit run four times each and inspected for damage after each cycle. Cables were pulled dry, as removed from the reels, and no pulling lubricant was used. Pulling tensions were continuously monitored and recorded below.

After testing, specimens #1 and #2 withstood a dielectric test of 1.0 KV AC for 1 minute, followed by 4.0 KV AC for four minutes.

A specimen of 2/C #14 AWG Firewall III identical to Specimen #2 was pulled through the conduit run using Ideal Yellow 77 pulling compound. Pulling tension was monitored and is recorded below.

Details of Test:

1. A feed line was threaded through 20' conduit run and attached to take up 38' from exit end of conduit.

2. Cable specimen was attached to feed line by twisting stranded copper cable conductors to feed line.

3. Specimen was pulled through conduit until feed line connection passed exit end of conduit.

4. Connection between feed line and specimen was cut, and dynamometer tied in. Specimen was threaded through one attaching eye on the dynamometer and securely knotted. The feed line was tied into the other attaching eye.

5. Specimen was pulled through conduit at approximately 26 fpm, until dynamometer reached take-up 38' from exit of conduit. Pulling tension was continuously monitored. Approximately 35' of specimen was pulled through conduit while conduit was completely filled with cable. This 35' section was then visually inspected for any evidence of damage.

6. Specimen was pulled completely through conduit and onto take-up reel. It was then removed from reel and made ready for next pull cycle. Procedure was repeated for a total of four pull cycles on each specimen.

7. After all pulling cycles were completed, specimens received a 1.0 KV AC one minute, dielectric test. After one minute, voltage was increased to 4.0 KV AC and maintained for an additional four minutes. This testing was performed using Peschel Electronics, Inc. high voltage AC test set, serial no. 745.

PULLING TENSIONS

Specimen #1 standard jacket wall thickness

1.

Cycle	Min.	Max.	Visual Inspection
1	140 lbs.	240 lbs.	No damage
2	160	220	No damage
3	130	250	No damage
4	140	280	No damage

Specimen #2 reduced (50%) jacket wall thickness

2.

Cycle	Min.	Max.	Visual Inspection
1	140 lbs.	210 lbs.	No damage
2	160	270	No damage
3	140	220	No damage
4	120	270	No damage

Minor transverse wrinkles appeared in the jacket of Specimen #2 during testing.

3. A specimen identical to Specimen #2 was pulled using Ideal Yellow 77 pulling lubricant. Pulling tension was 10 lbs.

It should be noted that pulling tensions during the test far exceeded the recommended 66 lbs. maximum for this cable.

Max. sidewall pressure was calculated at -

440 to 560 lbs. for Specimen #1, and
420 to 540 lbs. for Specimen #2.

Conclusion:

There was no significant difference in test results between the standard wall and reduced wall specimens. Therefore, we conclude that reduced hypalon (CSPE) jacket wall thicknesses with minimum walls averaging 50% of specified thickness, and spot minimums as low as 40% of specified thickness, will have no detrimental effect upon the ability of the cable jacket to perform its intended protective function.

Date of Test: August 17, 1979
at The Rockbestos Company, New Haven, Ct.

Test Performed By: K. J. Giannotti, Test Engineer
J. C. Sanches, Senior Quality Aide

Witnessed By: E. J. D'Aquanno, Chief Engineer
G. G. Littlehales, QA Manager
T. A. Boss, CEI QA
E. C. Willman, CEI Engineer
J. Furness, GAI Quality Engineer

Report by G. G. Littlehales
G. G. Littlehales
8/23/79

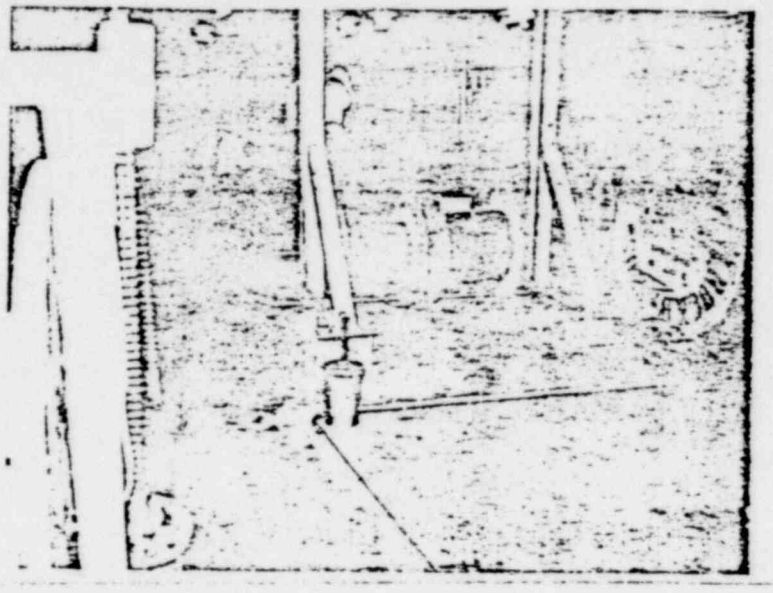
Additional Data:

After performance of the above testing, a specimen of 2/C 10 AWG Firewall III with minimum jacket wall 47% of specified thickness was subjected to one pulling cycle. This sample had been selected by CEI from Rockbestos Firewall III cable shipped to them.

Pulling tension was 280 lbs. maximum, and there was no observable damage to the jacket.

ATTACHMENT

CONDUIT LAYOUT,
PULL IS IN DIRECTION
OF PHOTOGRAPHER



MONITORING TENSION
WITH DYNAMOMETER

VIEW TOWARD
TAKE-UP