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Per Vendor Data (QDR page F2)
This Report is Applicable

Technical Report

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REV.4

Final Report
F-C3016

QUALIFICATION TESTS OF ELECTRICAL CABLES UNDER SIMULATED REACTOR CONTAINMENT SERVICE CONDITIONS

by

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S. P. Carfagno
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June 1971

Prepared for

Rome Cable Division of Cyprus Mines Corr: ation
Rome, New York

THE FRANKLIN INSTITUTE RESEARCH LABORATORIES
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1. INTRODUCTION

The tests described in this report were conducted by The Franklin Institute Research Laboratories (FIRL), as part of a cable Qualification Test Program. The purpose of the overall program was to determine whether certain electrical cables manufactured by Rome Cable Division of Cyprus Mines Corporation would function properly under the environmental conditions expected to be present within the containment of a nuclear-fueled electrical power plant during normal service and following a loss-of-coolant accident. The test program included subjecting the cable samples to gamma radiation, thermal preconditioning, a prolonged exposure to steam and a chemical spray, and a series of electrical measurements.

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2. SAMPLE IDENTIFICATION

The seven cable samples tested consisted of 2 seven-conductor cables and 5 single-conductor cables as follows:

Sample No. A
7/C 12 AWG 7 Str., .030" EPR Insul. (C312), .060" Neoprene Jkt. Overall (C414).

Sample No. B
7/C 12 AWG 7 Str., .030" EPR Insul. (C312), .060" Neoprene Jkt. Overall (C414) - Aged 7 days at 100°C.

Sample No. C
1/C 12 AWG 7 Str., .030" EPR Insul. (C312), .020" Neoprene Jkt. (C417).

Sample No. D
1/C 12 AWG 7 Str., .030" EPR Insul. (C312), .020" Hypalon Jkt. (C181).

Sample No. E
1/C 12 AWG 7 Str., .030" EPR Insul. (C313), .020" Neoprene Jkt. (C424).

Sample No. F
1/C 12 AWG 7 Str., .030" EPR Insul. (C312), .020" Hypalon Jkt. (C181) Aged 7 days at 100°C.

Sample No. G
1/C 12 AWG 7 Str., .030" EPR Insul. (C312), .020" Neoprene Jkt. (C417) Aged 7 days at 100°C.

Each cable sample was approximately 30 feet in length.

See QDR page G24 for other samples including XLP insulation

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3. TEST PROGRAM

The test program performed on each of the cable samples consisted of the following sequence:

1. Gamma radiation to a dose of 60 megarad.
2. Pre-conditioning exposure.
3. Steam/chemical-spray exposure.
4. Additional gamma radiation dose of 240 megarad.
5. Additional gamma radiation dose of 200 megarad on remaining lengths of cable after 3-ft of each specimen was cut off.

In addition, measurements of insulation resistance and charging current were made on the samples as received, and after each of the above exposures.

3.1 Pre-Test Electrical Measurements

On March 29, 1971, measurements of insulation resistance (after the application of 500 V dc for 1 minute) and charging current (after the application of 6 kV ac for 5 minutes) were taken prior to the start of the test program. These measurements as well as those taken following the initial irradiation (Section 3.3) and following the pre-conditioning (Section 3.5) are given in Table 1. The single-conductor cables (except for the ends) were soaked in water at room temperature for 6 hours prior to taking the electrical measurements in these three cases. The measurements on the 7-conductor cables in these three cases were performed by connecting one electrode to conductors 1, 3, 5, and 7 and the second electrode to conductors 2, 4, and 6, as illustrated in Figure 1.

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TABLE 1. ELECTRICAL MEASUREMENTS*

Cable Sample	Pre-Test		Following Initial Irradiation to 60 Mrad		Following Pre-Conditioning for 6 hr @ 150°F, 100% Humidity	
	Insulation Resistance (MΩ)	Charging Current (mA)	Insulation Resistance (MΩ)	Charging Current (mA)	Insulation Resistance (MΩ)	Charging Current (mA)
A	6.0×10^5	4.7	1.8×10^5	4.7	4.5×10^5	4.7
B	5.0×10^5	6.7	6.0×10^4	4.7	4.0×10^5	3.9
C	1.0×10^6	3.3	2.0×10^6	3.4	2.0×10^6	3.2
D	5.0×10^5	3.1	7.0×10^5	3.1	2.0×10^6	3.0
E	1.0×10^6	2.9	$>1.0 \times 10^6$	3.2	2.0×10^6	2.9
F	2.0×10^6	3.0	2.0×10^6	2.9	$>2.0 \times 10^6$	2.9
G	6.0×10^5	3.3	1.0×10^6	3.2	7.0×10^5	3.2

*Insulation resistance measured after the application of 500 V dc for 1 minute. Charging current measured after the application of 6 kV ac for 5 minutes. Electrical measurements performed at a room temperature of approximately 75°F.

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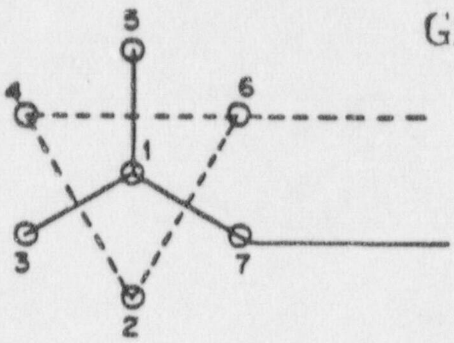

Figure 1. 7-Conductor Cable Electrical Measurement Connections

3.2 Initial Irradiation Exposure

Subsequent to the pre-test electrical measurements, the cable samples were mounted in a hot cell and irradiated to an integrated dose of 60 megarad (equivalent air dose).* The cable samples were then returned to FIRL for further testing.

3.3 Electrical Measurements Following Initial Irradiation

After receipt of the irradiated cable samples by FIRL, measurements of insulation resistance and dielectric withstand were taken in a manner identical to that described in Section 3.1. The results of these measurements are given in Table 1.

3.4 Pre-Conditioning

The cable samples were next pre-conditioned for a period of 6 hours at 150°F and approximately 100 percent relative humidity. This was done by placing the cable samples in an air-circulating oven at

*This as well as subsequent irradiations were performed by Radiation International, Inc., Parsippany, N.J., by exposing the cable samples to gamma radiation from a cobalt-60 radiation source. Appendix A contains a copy of the irradiation report.

150°F, with a water pan inside the oven to maintain the relative humidity at 100 percent.

3.5 Electrical Measurements Following Pre-Conditioning

Following the pre-conditioning, measurements of insulation resistance and dielectric withstand were again taken in a manner identical to that described in Section 3.1. Results of these measurements are also shown in Table 1.

3.6 Steam/Chemical-Spray Exposure

Following the electrical measurements described above, the cable samples were installed in a test chamber for exposure to a steam/chemical-spray environment. The cables were looped around a shelf of perforated sheet metal, simulating a cable tray, with one loop of each cable extending to the bottom of the tank, where it remained immersed in the chemical solution and steam condensate which collected below the drain level. Figure 2 shows the arrangement of the cables inside the test chamber. Figure 3 shows a typical electrical loading circuit of a 7-conductor cable sample as indicated in the test chamber. The single conductor cables were energized in a simple series electrical circuit.

The test cycle was conducted as follows: with the seven conductor cable samples carrying 6 amperes per conductor at 480 volts and the single conductor cable samples carrying 25 amperes at 480 volts, steam was admitted to the test chamber to increase the pressure to 66 psig within 10 sec. A pressure of approximately 66 psig and a temperature of approximately 303°F were maintained for a period of 4 hours. The temperature and pressure were then reduced to 284°F/36 psig over a period of one hour, and further reduced to 247°F/15 psig over a subsequent two hour period. These conditions were maintained for a period of 45 hours, after which the temperature and pressure were further dropped over a 2 hour period to approximately 211°F/ 1.0 psig. These conditions were then maintained for a period of 12 days. Throughout the test the temperature was maintained

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Figure 2. Arrangement of Cables in the Test Chamber

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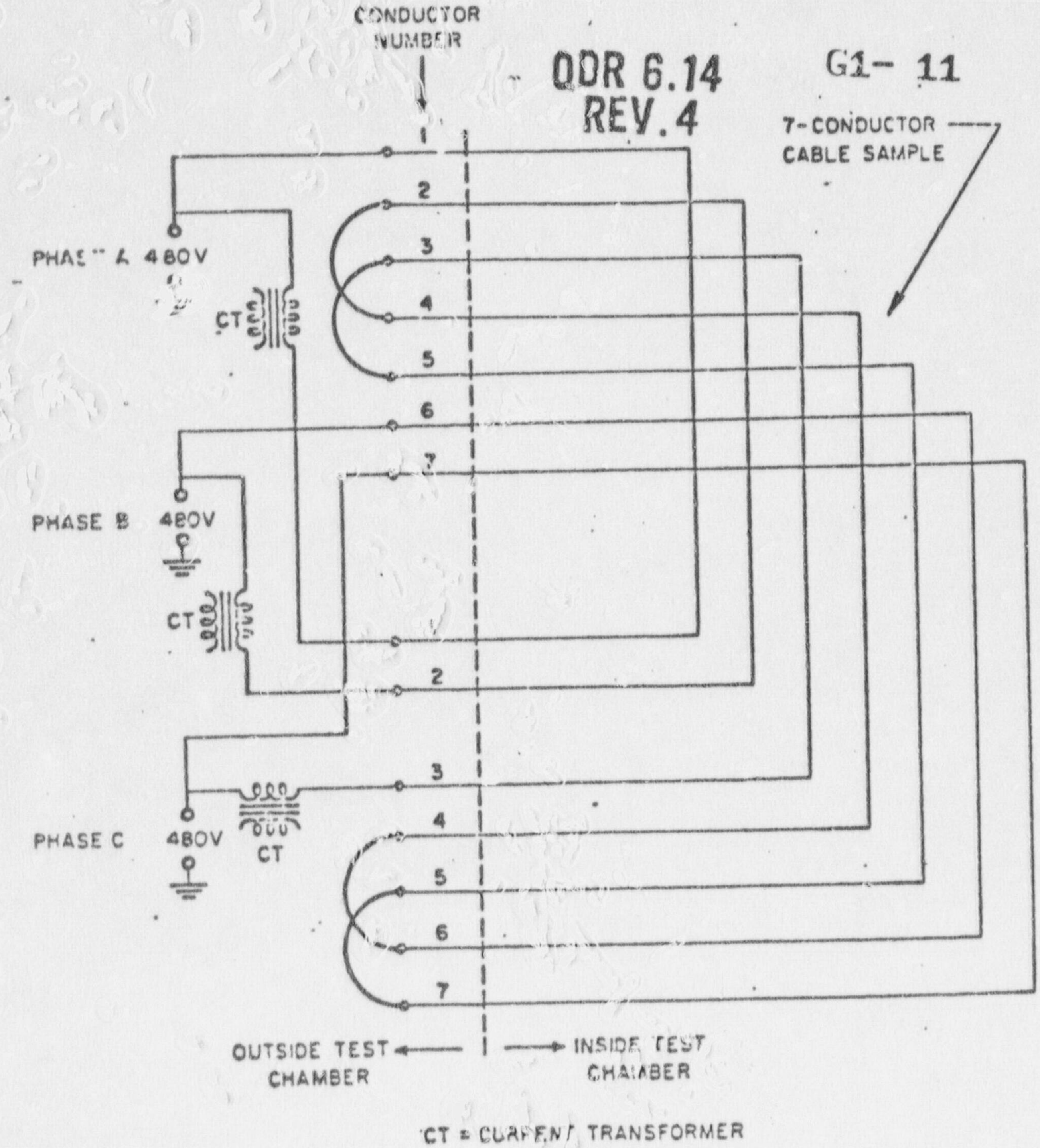

Fig. 3. Typical Electrical Loading Circuit

as nearly as possible at values corresponding to saturated conditions or 100 percent relative humidity.

Throughout the entire test, the cable samples were subjected to a chemical spray consisting of a 2000 ppm solution of boron as boric acid buffered with sodium hydroxide to a pH of 9.0.

Figure 4 illustrates the above test cycle in detail.

3.7 Electrical Measurements During Steam/Chemical-Spray Exposure

Just prior to shutting-off the steam in the test chamber at the end of the steam/chemical-spray exposure cycle, a further series of insulation resistance and charging current measurements were taken. At this point the ambient conditions were 1 psig/211°F. For the 7-conductor cable samples, the procedure differed from that used previously (Sections 3.1, 3.3, and 3.5) in that the voltage was applied to each of the conductors in turn while grounding the remaining six conductors.

As was done previously, measurements of insulation resistance were taken after the application of 500 V dc for a period of 1 minute and measurements of charging current were taken after the application of 6 kV ac for a period of 5 minutes.

This series of measurements as well as those taken subsequent to additional irradiations of 240 megarad (Section 3.9) and 200 megarad (Section 3.11) are shown in Table 2. The resistances were of the order of 10^3 to 10^5 megohms and the charging currents were 2 to 4 mA.

3.8 Irradiation to 300 Megarad

Subsequent to the above series of electrical measurements, the cable samples were exposed to an additional gamma radiation dosage of 240 megarad, as noted in Section 3.2, bringing the total dose to 300 megarad.

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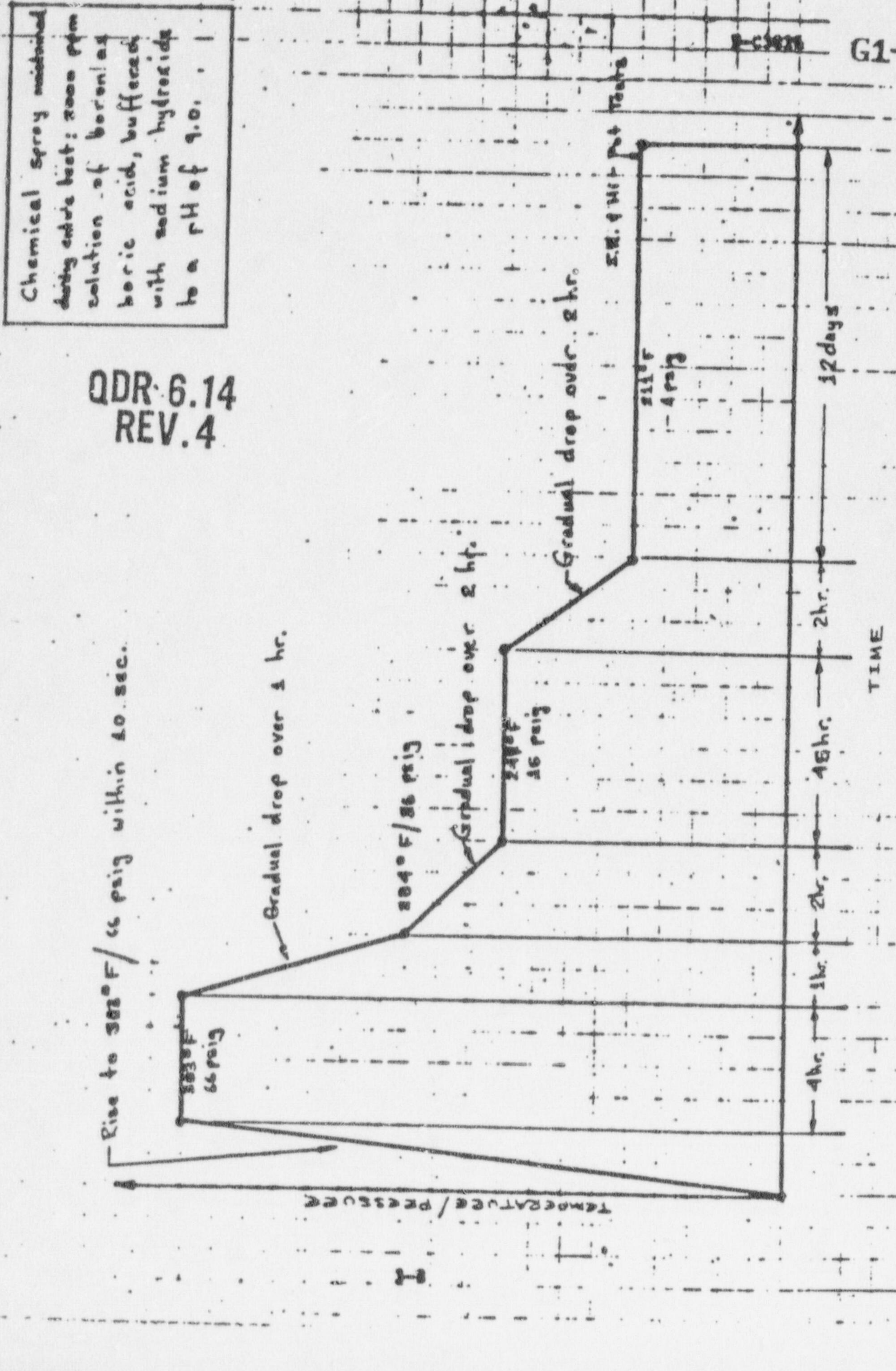

Figure 4. Steam/Chemical-Spray Exposure Cycle

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TABLE 2. ELECTRICAL MEASUREMENTS[1]

Cable Sample	Terminal Connections I	Terminal Connections II (Ground)	At Conclusion of Steam/Chemical-Spray Exposure[2]: Insulation Resistance (MΩ)	At Conclusion of Steam/Chemical-Spray Exposure[2]: Charging Current (mA)	After a Total Radiation Dose of 300 Mrad[3]: Insulation Resistance (MΩ)	After a Total Radiation Dose of 300 Mrad[3]: Charging Current (mA)	After a Total Radiation Dose of 300 Mrad: Insulation Resistance (MΩ)	After a Total Radiation Dose of 300 Mrad: Charging Current (mA)
A	1	All Others	4.6×10^3	2.0	4.0×10^4	1.9	1.1×10^5	1.7
	2	↓	3.3×10^3	3.5	6.8×10^4	2.8	2.0×10^5	2.1
	3	↓	3.6×10^3	2.5	5.0×10^4	2.1	1.9×10^5	2.0
	4	↓	3.6×10^3	2.5	4.6×10^4	2.1	2.0×10^5	2.05
	5	↓	3.5×10^3	2.4	5.1×10^4	2.8	2.1×10^5	2.0
	6	↓	3.5×10^3	2.5	5.0×10^4	2.5	2.2×10^5	2.02
	7	↓	3.5×10^3	2.5	5.2×10^4	2.3	2.1×10^5	2.01
B	1	↓	5.0×10^3	2.0	2.1×10^4	2.0	1.4×10^5	1.8
	2	↓	4.2×10^3	2.4	4.5×10^4	2.0	2.1×10^5	1.9
	3	↓	4.2×10^3	2.4	2.6×10^4	2.1	2.1×10^5	1.9
	4	↓	4.2×10^3	2.5	2.3×10^4	2.2	2.3×10^5	1.9
	5	↓	4.2×10^3	2.4	2.2×10^4	2.1	1.05×10^5	1.85
	6	↓	4.2×10^3	2.4	2.2×10^4	2.1	2.2×10^5	1.8
	7	↓	4.3×10^3	2.4	2.2×10^4	2.1	2.4×10^5	1.85
C		Ground	5.0×10^3	3.7	1.6×10^5	3.8	3.4×10^5	2.3
D		↓	2.5×10^6	3.3	1.5×10^5	3.7	1.8×10^5	2.9
E		↓	7.0×10^3	2.9	1.9×10^5	3.6	1.8×10^6	2.7
F		↓	8.5×10^4	3.3	4.1×10^5	3.7	5.0×10^5	2.7
G		↓	6.7×10^3	3.3	5.6×10^5	2.8	2.9×10^5	3.08

(1) Insulation resistance measured after the application of 550 V dc. for 1 minute. Charging current measured after the application of 6 kV ac for 5 minutes.

(2) Electrical measurements performed at a temperature of 211°F.

(3) Electrical measurements performed at a room temperature of approximately 75°F.

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3.9 Electrical Measurements Following Irradiation to 300 Megarad

Following irradiation of the cable samples to a total dose of 300 megarad, insulation resistance and charging current measurements were performed on the cable samples as described in Section 3.7. These measurements were conducted at Radiation International, Inc., by a representative from FIRL. The single conductor cables (except for the ends) were soaked in water for 6 hours at room temperature prior to taking the electrical measurements; the 7-conductor samples were kept dry.

The results of these measurements are shown in Table 2. As expected, the values of insulation resistance were considerably higher than those obtained at the elevated temperature near the conclusion of the steam/chemical-spray exposure. The values of charging current were approximately the same.

Three feet of cable was then cut off from each of the 30-ft cable samples for further physical measurements that were to be performed at the Rome Cable plant.

3.10 Irradiation to 500 Megarad

The shortened cables (approximately 27-ft long) were then submitted to an additional 200 megarad of gamma radiation, bringing the total cumulative dose to 500 megarad.

3.11 Electrical Measurements Following Irradiation to 500 Megarad

Following the last irradiation dose, the samples were returned to FIRL and subjected to a final set of electrical measurements. Insulation resistance and charging current measurements were taken on the cables in a manner identical to that described in Section 3.7, with the single conductor cables (except for the ends) being soaked for 6 hours in water at room temperature prior to undergoing the electrical measurements. The 7-conductor samples were kept dry.

The results of these measurements are shown in Table 2. Compared to the preceding set of electrical measurements (Section 3.9) the trend was toward lower values of charging current and higher values of insulation resistance.

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4. CONCLUSIONS

Two samples of seven-conductor cables and five samples of single-conductor cables identified in Section 2 of this report, and manufactured by Rome Cable Division of Cyprus Mines Corporation, were subjected to a series of environmental tests to determine their ability to withstand the conditions expected in nuclear-fueled power plant applications. The tests included an initial gamma radiation exposure to 60 megarad, pre-conditioning, and a steam/chemical-spray exposure. This was followed by further radiation exposures bringing the cumulative dose to 300 megarad and then to 500 megarad. The performance of the cables was monitored at each interval by measurements of dc insulation resistance and ac charging current.

From the results of these tests, it was concluded that the cables can be expected to perform without loss of function under the conditions simulated by the tests performed.

All cable samples performed satisfactorily without loss of function, through all tests. Electrical measurements performed at the conclusion of the steam/chemical-spray exposure, and again after exposure to a cumulative radiation dose of 300 megarad showed the insulation resistance to be of the order of 10^4 to 10^5 megohms, and the charging current to be 2 to 4 mA.

After all the cable samples received 300 megarad cumulative exposure and the electrical measurements were made, a three-foot length was cut-off from each cable and returned to Rome Cable for further testing. An additional dose of 200 megarad was then administered to each cable sample. The electrical measurements performed on all the cables was entirely satisfactory, with insulation resistance in the order of 10^5 megohms and charging current in the 2 to 3 mA range.

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5. CERTIFICATION

The undersigned certify that this report constitutes a true account of the tests that were conducted and the results obtained.

G.R. Boardman
G.R. Boardman
Research Engineer

S.P. Carfagno
S.P. Carfagno
Senior Staff Physicist

L.E. Witcher
L.E. Witcher
Test Engineer

Approved by:

W.H. Steigelmann
W.H. Steigelmann, Manager
Nuclear Systems Laboratory

Z. Zudans
Z. Zudans, Director
Mechanical and Nuclear Engineering

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APPENDIX A

IRRADIATION REPORT

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Radiation International, Inc. 81 EASTMANS ROAD, P. O. BOX 177 • PARSIPPANY, NEW JERSEY 07054 • (201) 887-4700

NUCLEAR DIVISION

May 18, 1971

Mr. W. H. Steigelman, Manager
Nuclear Systems Laboratory
Franklin Institute Research Laboratory
20th and Race Streets
Philadelphia, Pennsylvania 19103

Dear Mr. Steigelman:

The following summarizes parameters applicable to the irradiation of cable samples in FIRL Project 18I-C3016-01.

Fourteen cables were received (see attached) and subjected to irradiation as follows:

Step 1 - Exposed to dose of 60 Mrad.

Step 2 - Returned to FIRL for tests, and again received at RII.

Step 3 - Exposed to an additional dose of 240 Mrad.

Step 4 - Tested at RII by FIRL.

Step 5 - Exposed to an additional dose of 200 Mrad. (Total dosage - 500 Mrad.)

Irradiations were conducted using a 160,000 curie cobalt-60 source, with exposure in air at ambient temperature (68-70°F) at a pressure of -0.5" Hg. Temperature of the cable during exposure reached approximately 90°F, from radiant source heat.

All exposures were conducted at a dose rate of 2.2 Mrad per hour. Samples were mounted individually during exposure, and were rotated and turned during irradiation to assure a better uniformity. The minimum dose to the cable core was 500 Mrad, with a maximum dose to outer edges of the cable to 550 Mrad.

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Dose rates at key points were measured with a Victoreen Model 555 Radicon, with Probe (HA-100). This instrument is capable of measuring both instantaneous dose rates as well as integrated doses for specified periods of time. Dose uniformity over the cables (maximum to minimum ratio) was 1.1.

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Very truly yours,

RADIATION INTERNATIONAL, INC.

George R. Dietz
Manager, Nuclear Services

GRD:mr

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APPENDIX B

LIST OF INSTRUMENTS
USED IN OBTAINING
TEST DATA

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APPENDIX B

LIST OF INSTRUMENTS USED IN OBTAINING TEST DATA

1. General Radio Co. Megohmmeter Type 1862-B, 0.5 to 2 x 10^6 MΩ at 500 Vdc.
2. Beckman Insulation and Breakdown Test Set, Model 1000-AC/DC-ITS.
3. Honeywell-Brown Electronik 2-pen recorder, Model No. Y153X(220-VV-X-IV-K-(C) (V), Ranges: 0 to 500°F with type J thermocouples; 0 to 100 psig with Giannini Potentiometric Pressure Transducer.
4. Honeywell-Brown Electronik Multipoint Recorder, Model No. 15305846-24-02-2-000-030-10 097, 0 to 500°F with Type T thermocouples.

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MECHANICAL AND NUCLEAR ENGINEERING DEPARTMENT

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August 4, 1971

Mr. Frank E. LaGase, Manager
Comm. & Instr. Eng.
Rome Cable Division of
Cyprus Mines Corporation
421 Ridge Street
Rome, New York 13440

Subject: Addendum to Final Report F-C3016, "Qualification Tests of Electrical Cables Under Simulated Reactor Containment Service Conditions"

Reference: Letter of June 21, 1971 from F. E. LaGase (Rome Cable) to S. P. Carfagno (FIRL).

Dear Mr. LaGase:

In accordance with the referenced letter, we are pleased to submit herewith, the results of the qualification tests conducted by FIRL on various cable samples manufactured by Rome Cable, and not previously reported in the subject final report.

The test program to which the cable samples were subjected was identical to that in the subject final report.

Sample Identification

The five cable samples tested, and discussed herein included 3 seven-conductor cables and 2 single-conductor cables as follows:

Sample No. 2: 7/C 12 AWG 7 Str., Inorganic Tape, .030" EPR Insul. (C312)., .060" Hypalon Jkt. Overall (C181)

Sample No. 3: 7/C 12 AWG 7 Str., .030" XLP Insul. (C506), .020" Neoprene Sheath (C414), .060" Neoprene Jkt. Overall (C416)

Sample No. 6: 7/C 12 AWG 7 Str., Inorganic Tape, .030" EPR Insul. (C312), 1060" Hypalon Jkt. Overall (C181) - Aged 7 days at 100°C

Sample No. 11: 1/C 14 AWG Sol., .047" Special FR XLP Insul.

Sample No. 12: 1/C 12 AWG Str., .030" XLP Insul. (C500), .020" Neoprene Jkt. (C417)

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Test Program

Tables 1 and 2 are a chronological summary of the measurements of insulation resistance and charging current taken on the cable samples during the test program. The tables also indicate the Section in the subject final report to which one should refer for further information on the test program.

Conclusions

From the results of the tests previously outlined and further described in the subject final report, it was concluded that the five aforementioned cable samples can be expected to perform without loss of function under the conditions simulated by the tests performed.

Certification

The undersigned certify that this addendum letter constitutes a true account of the tests that were conducted and the results obtained.

G. R. Boardman

G. R. BOARDMAN
Research Engineer

Approved by:

Z. Zudans

Z. ZUDANS, Director

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Table 1

ELECTRICAL MEASUREMENTS(1)

Cable Sample	Pre-Test(2)		Following Initial Irradiation to 60 Mrad (3)		Following Pre-Conditioning for 6 Hr @ 150°F, 100% Humidity (4)	
	Insulation Resistance (MΩ)	Charging Current (mA)	Insulation Resistance (MΩ)	Charging Current (mA)	Insulation Resistance (MΩ)	Charging Current (mA)
2	7.0×10^5	6.8	2.3×10^4	4.3	7.0×10^5	4.3
3	8.0×10^5	6.9	1.4×10^5	6.9	7.0×10^5	6.9
6	1.5×10^6	4.0	2.1×10^4	4.5	6.0×10^5	4.5
11	5.0×10^5	2.3	4.2×10^5	2.5	3.4×10^5	2.3
12	-	2.5	2.0×10^6	2.5	$>2.0 \times 10^6$	2.6

(1) Insulation resistance measured after the application of 500 V dc for 1 minute. Charging current measured after the application of 6 kV ac for 5 minutes. Electrical measurements performed at a room temperature of approximately 75°F.

(2) See Section 3.1 of Subject final report for further details.

(3) See Sections 3.2 and 3.3 of Subject final report for further details.

(4) See Sections 3.4 and 3.5 of Subject final report for further details.

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Table 2
ELECTRICAL MEASUREMENTS(1)

Cable Sample	Terminal Connections I	II (Ground)	At Conclusion of Steam/Chemical Spray Exposure(2) Insulation Resistance (MΩ)	Charging Current (mA)	After a Total Radiation Dose of 300 Mrad(3) Insulation Resistance (MΩ)	Charging Current (mA)	After a Total Radiation Dose of 500 Mrad(4) Insulation Resistance (MΩ)	Charging Current (mA)
2	1	All Others	8.5×10^3	2.0	8.9×10^3	2.2	8.3×10^3	2.0
	2	↓	7.0×10^3	2.5	9.2×10^3	2.1	9.4×10^3	1.9
	3		6.8×10^3	2.5	7.8×10^3	2.1	8.4×10^3	1.9
	4		6.8×10^3	2.5	7.9×10^3	2.1	8.6×10^3	1.9
	5		6.3×10^3	2.5	8.2×10^3	2.2	9.3×10^3	1.95
	6		6.4×10^3	2.5	8.5×10^3	2.1	8.2×10^3	1.9
	7		6.4×10^3	2.4	8.0×10^3	2.1	8.9×10^3	1.85
3	1	All Others	9.6×10^2	3.2	2.0×10^5	3.3	7.0×10^4	3.01
	2	↓	7.0×10^2	3.3	1.8×10^5	3.3	3.6×10^5	3.0
	3		6.7×10^2	3.3	1.7×10^5	3.3	1.1×10^4	3.0
	4		7.1×10^2	3.2	2.0×10^5	3.3	2.9×10^5	2.9
	5		7.3×10^2	3.2	1.8×10^5	3.3	5.0×10^5	2.9
	6		7.1×10^2	3.3	2.5×10^5	3.3	1.1×10^5	2.95
	7		7.1×10^2	3.3	1.7×10^5	3.3	4.5×10^5	2.95
6	1	All Others	8.9×10^3	2.1	6.9×10^3	2.2	5.1×10^3	2.1
	2	↓	7.4×10^3	2.5	6.8×10^3	2.1	5.0×10^3	2.0
	3		7.4×10^3	2.6	8.2×10^3	2.3	5.2×10^3	2.0
	4		7.1×10^3	2.6	7.8×10^3	2.3	5.4×10^3	2.0
	5		7.2×10^3	2.6	7.5×10^3	2.2	5.3×10^3	2.0
	6		7.2×10^3	2.6	7.6×10^3	2.3	5.4×10^3	2.0
	7		7.1×10^3	2.6	7.2×10^3	2.2	5.3×10^3	2.0
11	1	Ground	2.5×10^1	4.2	2.25×10^3	3.3	7.8×10^2	3.0
12	1	Ground	1.5×10^4	2.4	5.0×10^4	3.8	4.8×10^4	2.6

(1) Insulation resistance measured after the application of 500 V dc for 1 minute. Charging current measured after the application of 6 kV ac for 5 minutes.

(2) Electrical measurements performed at a temperature of 211°F. See Sections 3.6 and 3.7 of Subject final report for further details.

(3) Electrical measurements performed at a room temperature of approximately 75°F. See Sections 3.8 and 3.9 of Subject final report for further details.

(4) Electrical measurements performed at a room temperature of approximately 75°F. See Sections 3.10 and 3.11 of Subject final report for further details.

QDR 6.14
REV 4

Rome Cable
CORPORATION

421 Ridge Street
Rome, New York 13440
Telephone 315/337-3000

Post Office Box 71
TWX 510/243-9732

December 19, 1983

Mr. Larry Gradin
Ecotech
5418 Tonnelle Avenue
North Bergen, NJ 07047

RE: Vermont Yankee Nuclear Generating Station

Dear Mr. Gradin:

Confirming our telephone conversation of December 19, the cables Rome manufactured for subject station back in 1968-1969 consisted of chemically crosslinked polyethylene insulation compound and PVC jackets. The cables were manufactured and tested in accordance with an EBASCO specification.

The crosslinked polyethylene compound used was a carbon black filled low voltage compound which complied with the requirements of ICEA Standard S-66-524. It was essentially the same type of crosslinked polyethylene identified as C506 compound (Sample No. 3) in the Addendum to Franklin Institute Report F-C3016. I believe that you do have a copy of this document.

Sincerely,

F. E. LaGase

F. E. LaGase,
Product Engineering Manager

FEL:ds

F4

Rome Cable

DIVISION OF

CYPRUS MINES CORPORATION

Quality Assurance Department
Certification

QDR 6.14
REV 4

INVOICE TO

VERMONT YANKEE NUCLEAR POWER CORP.
EBASCO SERVICES INC. AGENT
P.O. BOX 155
VERNON, VERMONT 05354

Customer's Order No. VY 7224-NY705155

Rome Cable Order No. ENN-01077

Date 4-22-71

MILL ORDER NOS. 81309, 81310 & 81311

SHIP TO

VERMONT YANKEE NUCLEAR POWER CORP.
C/O POWER STATION EBASCO AGNET
ATTN: D.J. STEVENS - PROJ. SUPT.
GOVERNOR HUNT ROAD
VERNON, VERMONT

Item No.	Quantity	Description	Applicable Specification
A.	14,810 FT.	3/C 12 STR. .030 XLP .015" SYN. TWIST TAPE .045" SYN. JACKET.	CX-68 & VYNP-IV-C 2C
B.	15,104 FT.	7/C 14 STR. .030" XLP .015" SYN. TWIST, TAPE .060" SYN. JACKET.	CX-68 & VYNP-IV-C 2C
C.	10,090 FT.	9/C 16 STR. .030" XLP .015" SYN. TWIST, TAPE .060" SYN. JACKET.	CX-68 & VYNP-IV-C 2C
E.	10,204 FT.	5/C 9 19/22 .030" XLP .015" SYN. TWIST, TAPE .060" PVC JACKET.	CX-68 & VYNP-IV-C 2C

SEE PAGE F2a

I hereby certify that the material described above was inspected under my general supervision and complies with the test requirements of CX-68 & VYNP-IV-C 2C as interpreted by Rome Cable Quality Assurance Procedures prior to being placed into stock or released for shipment.

Test records will be kept on file Two years from date of test, and will be made available for examination by authorized persons upon request.

Signed [signature]

Title SENIOR SUPERVISOR, Q.A.

FACILITY: Vermont Yankee TYPE: BWR

QDR NO.:	COMPONENT:	DESCRIPTION AND SERVICES:
6.14, Revision 5	Power and Control Cable	Control and Power Service
MANUFACTURER: Rome Cable (Cyprus)	MODEL/SERIAL NO.: XLP/PVC/PVC XLP/PVC	

PARAMETER:	QUALIFICATION STATUS:
Temperature	Qualified

REMARKS:

For Worksheets ELEC-4, 6, 8, 11, 12, 13

REVIEW

As indicated on the worksheets, the subject cables are located in primary containment, the steam tunnel and various areas of the Reactor Building.

Normal Temperatures - In Primary Containment

The average temperature for the drywell is 185°F (85°C) per Section 7.0 of the EQ Program Manual (NOTE: The subject cables are not located above Elevation 315' of the drywell).

The power cable in primary containment is for motor-operated valves as described in the Operating Time Section (Tab DO). Motor-operated valves have a motor operating time typically of two minutes or less (see QDR Page DT4 which is written by Limitorque, the Vendor for Vermont Yankee Safety-Related MOVs) and cycle very infrequently, the number of cycles being enveloped by the typical 2,000-cycle qualification used for MOV qualification (QDR Page DT5). Because of the significant thermal inertia of cable insulation which is represented by data in IEEE Standard 242-1975, "Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems," Chapter 11, Part A Cable Protection, Figure 157 (QDR Page DT6), the smallest cable will have an insignificant temperature rise even if we were to consider stroke times of as much as 5 minutes.

Even if each valve were to be "on" for a full 5 minutes for 2,000 cycles for maximum rated cable temperature (ignoring thermal inertia), the total "at-temperature" time would be much less than one percent of plant 40-year life:

(2,000 cyc x 5 min/cyc)/40 yrs x 1 yr/365 days x 1 day/24 hrs x 1 hr/60 min x 100%

$= 10^4$ min/2.1 x 10^7 min x 100%

= 0.048%

DT7
QDR 6.14
REV. 5

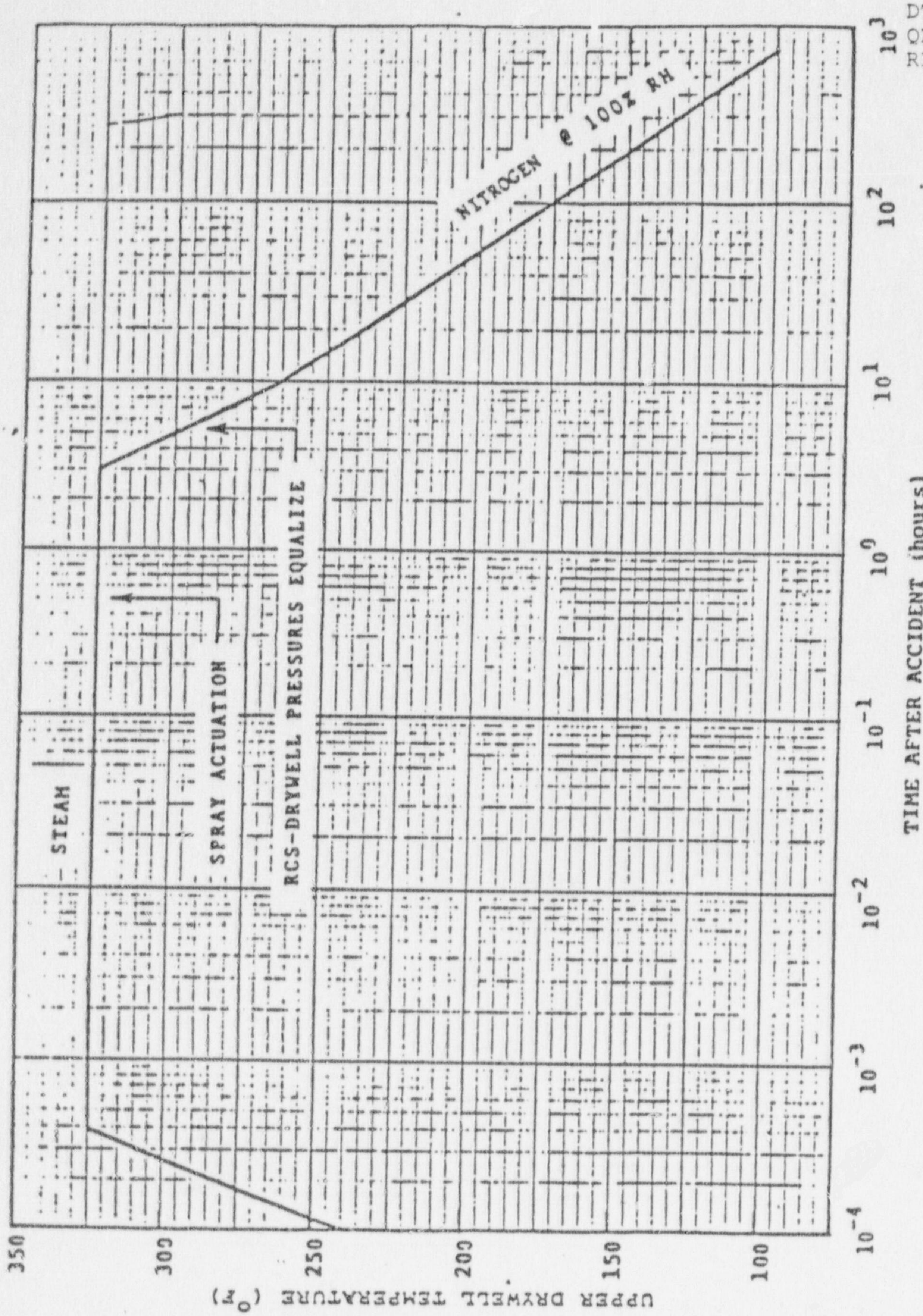


FIG. DWH-T1: UPPER DRYWELL TEMPERATURE PROFILE FOR VY EQUIPMENT QUALIFICATION

WIRE AND CABLE BUSINESS DEPARTMENT

GENERAL ELECTRIC

Product Data

New Generation
VULKENE SUPREME™ POWER AND CONTROL CABLE
Non-Chlorinated Insulation
Qualified to IEEE Stds. 323-74 and 383-74

DT14
ODR 6.14
REV. 5

THE PRODUCT

General Electric's New Generation VULKENE SUPREME flame-resistant, single and multi-conductor power cables and multiconductor control cables are available for use where cables with a non-chlorinated flame-resistant insulation are desired. The new cables rated 90°C, are insulated with VULKENE SUPREME™ a non-chlorinated version of General Electric's flame-resistant, filled, chemically cross-linked polyethylene. The insulating material has excellent thermal and electrical properties and outstanding resistance to moisture and chemicals.

The New Generation VULKENE SUPREME non-chlorinated insulation on individual conductors meets the requirements of IPCEA Publication Number S-66-524, Par. 3.6. The overall jacket, either Hypalon* or GEOPRENE®, a General Electric flame-resistant formulation of Neoprene is also resistant to ozone, oil, acids and alkalis and meets the requirements of IPCEA Publication No. S-19-81, Par. 4.13.3.

Vertical rack flame tests on GE's New Generation VULKENE SUPREME flame-resistant GEOPRENE jacketed 7 conductor No. 12 AWG and 7 conductor No. 16 AWG control cables were conducted at the Underwriters' Laboratory, Inc. facility located in Northbrook, Illinois. The tests conducted were similar to the vertical rack flame test described in IEEE Standard 383-1974, incorporating the ribbon gas burner, except the trays of cable were burned with the flame source rated 210,000 BTU/HR output and 400,000 BTU/HR whereas the IEEE Standard 383-1974 requires a flame source rated 70,000 BTU/HR. Tests were conducted with cables random laid to 40% fill of the cross-sectional area of the cable tray. The flame source was positioned to maximize the destructive impingement of the flame on the cables.

In addition, General Electric has conducted in its Wire and Cable Department test facilities vertical rack flame tests similar to the tests described in IEEE Standards 383-1974 incorporating the ribbon gas burner as the flame source (cables spaced ½ cable's diameter apart) except at 210,000 BTU/HR on single conductor size No. 14 AWG SI-57279 Type SIS switchboard wire, and sizes No. 2 AWG and 500 MCM SI-58812 2kV power cable. The test arrangement and test parameters for each specific flame test and cable construction is shown in Table 6.

Finished cables were subjected to carefully controlled tests suggested in IEEE Standards. The tests were normal life, design basis event, post-design basis event, and flame test. These products satisfactorily passed the normal life qualification tests, the qualification tests under simulated reactor containment service conditions, and the combined BWR-PWR loss-of-coolant accident simulation (LOCA) for a duration of 110 days per IEEE Standards 383-1974 and 323-1974 and are fully qualified to these IEEE Standards. The representative GE cables subjected to these tests were SI-58810 single-conductor No. 12 AWG 600 Volt power cable and SI-58808 7-conductor No. 12 AWG 600 Volt control cable which qualified the GE line in the 0-2000 volt category.

As shown in Table 1, the VULKENE SUPREME cable product line comprises single conductor 600 Volt and 1000 Volt control cables in the most commonly used sizes and conductor strandings. Both the 600 volt and 1000 volt rated control cables are available with two or more conductors. Overall diameters, cable jacket wall thicknesses and weights for cables from two through 37 conductors are shown on pages 11 through 18 of this publication.

Information on control cables with more than 37 conductors can be supplied on request.

TABLE 1
VULKENE SUPREME Power and Control Cables

Voltage Rating	General Electric Specification Number	Type	Available Conductor Size and Stranding
600V	SI-58810	1/C Power	IPCEA Class B #14 AWG thru 1000 MCM
600V	SI-58811	Multi-conductor Power	IPCEA Class B #8 AWG thru 750 MCM
2000V	SI-58812	1/C Power	IPCEA Class B #14 AWG thru 1000 MCM
600V 1000V	SI-58808 SI-58809	Control	#16, 14, 12, 10 AWG in 7 or 19 strands; 19/25 (approx. #13 AWG) 19/22 (approx. #9 AWG)

CONSTRUCTION

Conductors used in General Electric's New Generation, VULKENE SUPREME cables consist of 7 or 19 strands of tinned, soft copper in control cable constructions and bare soft-copper (IPCEA Class B strand) on single-conductor and multi-conductor power cables.

Individual conductors are insulated with VULKENE SUPREME insulation, a non-chlorinated, filled, chemically cross-linked polyethylene. Color coding on control cable is available with solid-color insulation (with tracer-on-color identification for more than 6 conductors) per IPCEA Method 1 or printed coding on black insulation per IPCEA Method 3. Multi-conductor power cable is available with solid-colored insulation or colored hash marks on black insulation for identification. Multi-conductor constructions are assembled with nonchlorinated flame-resistant fillers as required, and tinned soft copper ground wires when appropriate, then covered with a core binding tape and an overall GEOPRENE or Hypalon jacket. Standard jacket color is black with or without hash marks. Two conductor through twelve-conductor control cables are available with solid-color GEOPRENE jackets on special order. Single-conductor power cables are available with solid-color insulation.

*Registered Trademark of General Electric Company
™Trademark of General Electric Company
*DuPont Trademark

Data subject to change without notice.

wcbd

WIRE AND CABLE BUSINESS DEPARTMENT
BRIDGEPORT, CONNECTICUT 06602

PRODUCT DATA

QUALIFICATION TESTING PER IEEE STANDARDS 323-74 and 383-74

The VULKENE SUPREME insulated cables that were subjected to qualification tests were constructed as shown in Table 3. The cables are rated 600V.

TABLE 3

CONSTRUCTION		
Power	Component	Control
#12 AWG, 7 Strands tinned copper	Conductor	#12AWG, 7 Strand tinned copper
.030 Nonchlorinated VULKENE SUPREME	Insulation	.030 Nonchlorinated VULKENE SUPREME
	Assembly	7 Cond. Fillers Polyester Tape
	Overall Jacket	.060 GEOPRENE or HYPALON

Aging Characteristics

To establish the aging characteristics of the New Generation VULKENE SUPREME, slabs of the insulation were aged in an air oven at 136°C, 150°C, and 160°C and percent retention of original elongation was measured. Aging curves were plotted including mean values and 95 per cent confidence limits.

IEEE Standard 383-1974 states that a minimum of 3 data points including 136°C and two or more others at least 10°C apart should be used in developing the aging data. The criteria to establish thermal life was chosen by GE as 65 percent retention of original elongation.

AGING CHARACTERISTICS
Nonchlorinated VULKENE SUPREME

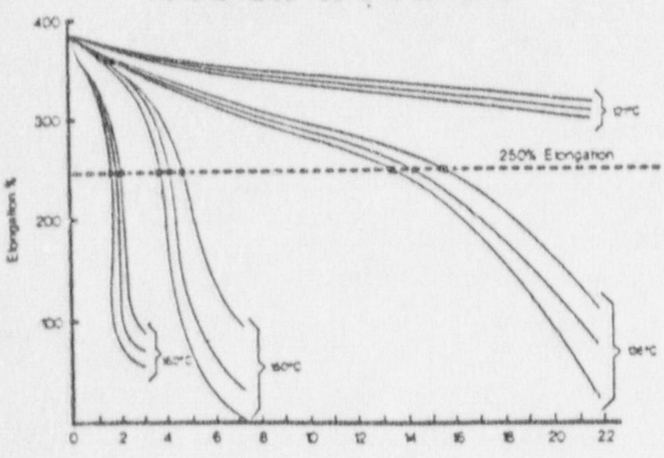


Fig. 6

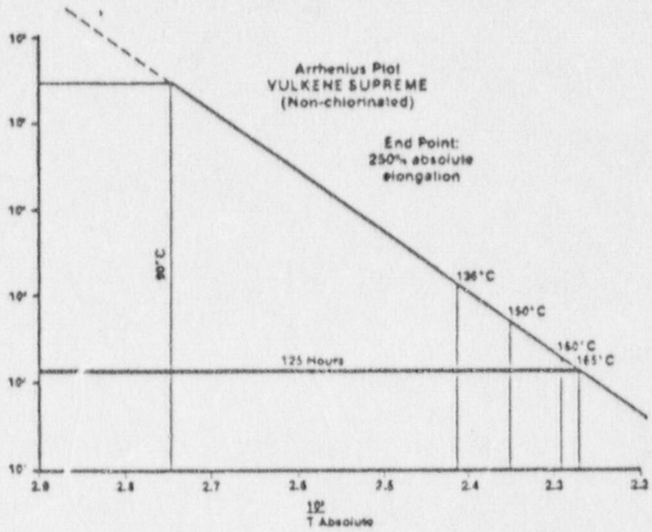


Fig. 7

From the aging curves (Figure 6) at 65 percent retention of original elongation, time in hours at 136°C, 150°C and 160°C, was obtained and these points were used to establish the Arrhenius plot in Figure 7. An extrapolation of the test data shows a time of over 350,000 hours (over 40 years) at 90°C. Thermal aging of samples for qualification testing was selected from the Arrhenius plot. GE selected an aging time of 125 hours and aging temperature of 165°C. This exceeds the requirements of the IEEE Standard which states that the aging time must be 100 hours minimum.

Note that aging at 121°C for 168 hours (7 days) does not come close to the Arrhenius plot. At 121°C, over 3000 hours of aging time would be required to fall on the Arrhenius plot. Aging for 125 hours at 165°C was used for all qualification testing.

Normal Life Qualification

The normal life qualification test is designed to demonstrate that the cables are serviceable for the design life when subjected to the combination of thermal aging and radiation to simulate a 40 years time period.

Four sets of samples were used. (Two sets with thermal aging and two sets unaged.) They were mounted on 20-inch diameter mandrels and exposed to gamma radiation from a cobalt 60 source to an accumulated air-equivalent dose of 220 megarads at an average dose rate of 0.54

PRODUCT DATA

megarads per hour. This radiation dose meets that suggested by IEEE Standard 383 1974 including a 10 percent margin suggested by IEEE Standard 323-1974. The radiation dose is equal to the radiation integrated over the expected plant life plus the radiation dose of a simulated loss of coolant accident.

Design Basis Event

A typical pressure test vessel (Figure 8) was used to test electrically loaded cables. Temperature and pressure were varied in acordance with the temperature pressure profile, Figure 9, as prescribed in IEEE 323-74 for 110 days to qualify for boiling water and pressurized water reactor

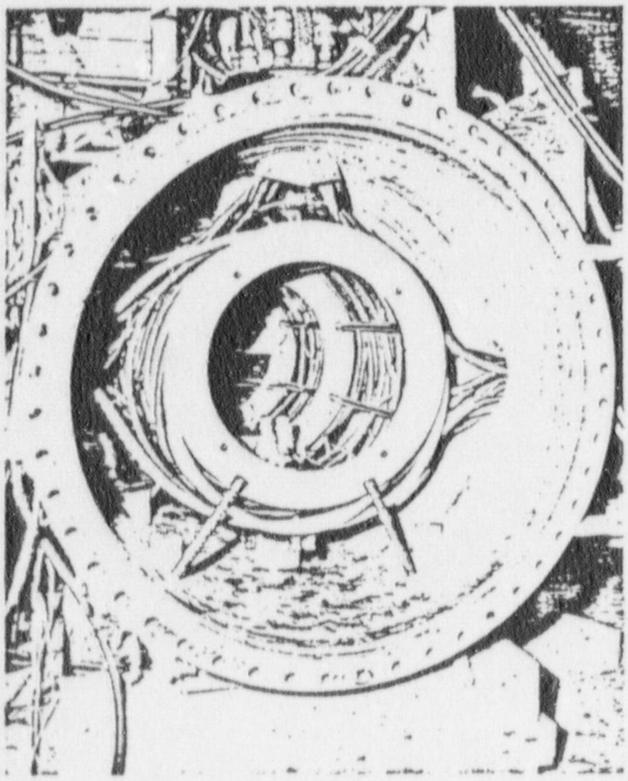


Fig. 8

conditions. Samples were continuously sprayed vertically upward for the first 24 hours with a solution of the following composition at a rate of 0.15 (gal/min)/ft² [6.1 (liters/min)m²] of spray area:

0.28 molar H_3BO_3(3000 parts per million Boron)
0.064 molar $Na_2S_2O_3$
NaOH to make a PH of 9.5 to 11 at 77F (about 0.59 percent)

Insulation resistance was measured periodically as shown on the profile in Figure 9.

Temperature/Pressure Profile for Steam/Chemical-spray with Electrical Loading

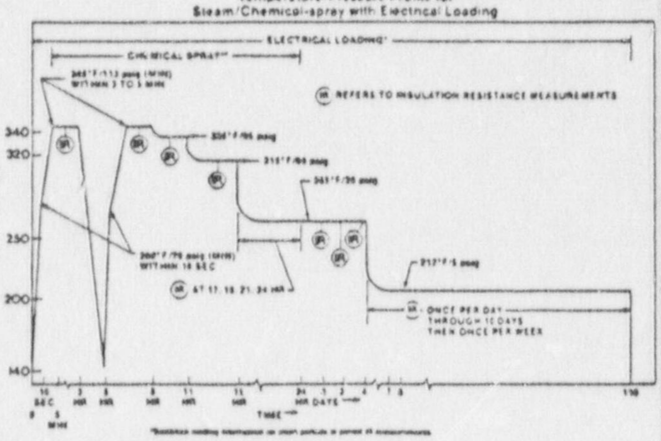


FIG. 9

Post Design Basis Event

After samples had been subjected to the temperature pressure profile, they were removed from the 20x mandrels, straightened, and each sample was reverse wrapped around a mandrel with a diameter 40 times the sample diameter, immersed in water for one hour and then given a high voltage withstand test of 80 volts per mil of insulation thickness for 5 minutes. All GE samples passed the test.

This test is called the Post DBE test and demonstrates that the samples can be handled and bent and still maintain electrical integrity after having gone through the temperature pressure profile.

FACILITY: Vermont Yankee TYPE: BWR

QDR NO.: 6.14, Revision 3	COMPONENT: Power and Control Cable	DESCRIPTION AND SERVICES: Control and Power Service
MANUFACTURER: Rome Cable (Cyprus)	MODEL/SERIAL NO.: XLP/PVC/PVC	
PARAMETER: Radiation	QUALIFICATION STATUS: Qualified	

REMARKS:

For Worksheets ELEC-4, 6, 8, 11, 12, 13

REVIEW

The cables have been tested to a total radiation dosage of 5×10^8 rads, as stated on QDR Page G1-20 of Cyrpus (Rome) Test Report for Qualification. The worst case radiation dose which these cables are subject to is 7×10^8 rads TID as indicated on Worksheet ELEC-4 (QDR Page B1). This value is for cables installed inside primary containment. NOTE: The test value envelops the radiation requirement of 5×10^6 rads for the steam tunnel (Worksheet ELEC-6, QDR Page B4) and 2×10^7 rads for the Reactor Building (Worksheet ELEC-8, QDR Page B7).

The data in Section 7.0 of the EQ Program Manual for worst case drywell is 7×10^8 rads (gamma plus beta) and 8×10^7 rads gamma (beta shielded) as shown in Section 5.0 of the EQ Program Manual. Therefore, beta contributes 6.2×10^8 rads to the total radiation dose. The DOR Guidelines, Paragraph 4.2, appropriately states that, "Beta radiation doses generally are less significant than gamma radiation doses for equipment qualification. This is due to the low penetrating power of beta particles in comparison to gamma rays of equivalent energy." The DOR Guideline goes on to explain that a 30 mil insulation would reduce beta by approximately a factor of 10. Data from the Specification for the subject power cables (QDR Tab G3, QDR Pages G3-3 to G3-4) indicates that the minimum insulation thickness for any cable is 45 mils of insulation and 30 mils of jacket for a total thickness of 75 mils. For review, the major dose reduction factors are determined with a

QDR NO. 6.14
REVISION 4

rather conservative use of only a small fraction of credit available used as described below:

Raceway Credit

As described in Chapter 8 of the Vermont Yankee FSAR, the cable routings of safety-related cabling is in rigid conduit or cable tray. NUREG-0588 allows 50% beta reduction credit as shown in Paragraph 1.5(9), QDR Page DR5.

Jacket Credit

As described in the Technical Specification, the minimum jacket is 30 mils (QDR Page G3-5) with a PVC jacket. Per IEB 79-01B, this thickness allows a reduction to 10% of the total beta dose. As the primary purpose for the jacket is insulation protection during installation with no electrical function, its degradation due to beta is not significant to safety function.

Consequently, the total beta dose of 6.2×10^8 rads can be reduced to 0.31×10^8 rads at the jacket insulation interface as follows:

Total Beta at the Insulation = Total x 0.5 Factor for Raceway x 0.1 Factor for Jacket

$$= (6.2 \times 10^8) \times 0.05$$

$$= 3.1 \times 10^7$$

Consequently, the total insulation radiation dose will be beta plus 8×10^7 rads or 1.11×10^8 rads total integrated dose.

Specific YAEC Beta Reduction Data

Conservative beta reduction data which allows margin in excess of IEEE Standard 323-1974 values is provided on QDR Pages DR5 to DR8. This data which takes no credit for raceways indicates a value for TID of 1.3×10^8 rads (QDR Pages DR7 and DR8) after "self-shielding" of 30 mils (the minimum jacket thickness).

IEB 79-01B Data

Using just a factor of 10 reduction in beta previously described as allowed by IEB 79-01B, a 30 mil jacket reduces the beta shown in Section 5.0 of the Program Manual to 6.2×10^7 rads.

The actual dose experienced by the cable will then be 6.2×10^7 rads (gamma) or 1.42×10^8 rads (beta plus gamma). This is the larger of the three TIDs determined.

DR3

QDR NO. 6.14
REVISION 3

Consequently, based on the above approaches, it is reasonable to take credit for beta reduction to at least 6.2×10^7 rads from 6.2×10^8 rads for a total gamma plus beta dose of 1.42×10^8 rads. It is reasonable to accept these cables as qualified (i.e., as indicated in the DOR Guidelines, Appendix C, substantial doubt does not exist as to the qualification of these cables).

The test value envelops the requirement with the following margin:

Margin = [(Capability - Requirement)/Requirement] x 100%

$= [(5 \times 10^8 - 1.42 \times 10^8)/1.42 \times 10^8] \times 100\%$

= 252%

Conclusion

Qualified.

NUREG-0588
Rev. 1

QDR 6.14
REV 3

DR4

Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment

Including Staff Responses to Public Comments

Resolution of Generic Technical Activity A-24

Manuscript Completed: November 1980
Date Published: July 1981

A. J. Szukiewicz, Task Manager

Division of Safety Technology
Office of Nuclear Reactor Regulation
S. Nuclear Regulatory Commission
Washington, D.C. 20555

QDR 6.14
REV 3

DR5

CATEGORY I Applicable to Equipment Qualified in Accordance with IEEE Std. 323-1974	CATEGORY II Applicable to Equipment Qualified in Accordance with IEEE Std. 323-1971
shielding of the equipment reduces the dose and dose rate. (7) For unshielded equipment, the beta doses at the surface of the equipment should be the sum of the airborne and plate-out sources. The airborne beta dose should be taken as the beta dose calculated for a point at the containment center. (8) Shielded components need be qualified only to the gamma radiation levels required, provided an analysis or test shows that the sensitive portions of the component or equipment are not exposed to beta radiation or that the effects of beta radiation heating and ionization have no deleterious effects on component performance. (9) Cables arranged in cable trays in the containment should be assumed to be exposed to half the beta radiation dose calculated for a point at the center of the containment plus the gamma ray dose calculated in accordance with Section 1.[illegible]. This reduction in beta dose is allowed because of the localized shielding by other cables plus the cable tray itself. (10) Paints and coatings should be assumed to be exposed to both beta and gamma rays in assessing their resistance to radiation. Plate-out activity should be assumed to remain on the equipment surface unless the effects of the removal mechanisms, such as spray wash-off or steam condensate flow, can be justified and quantified by analysis or experiment. (11) Components of the emergency core cooling system (ECCS) located outside containment (e.g., pumps, valves, seals and electrical equipment) should be qualified to withstand the radiation equivalent to that penetrating the containment, plus the exposure from the sump fluid using assumptions consistent with the requirements stated in Appendix K to 10 CFR Part 50. (12) Equipment that may be exposed to radiation doses below 10^4 rads should not be considered to be exempt from radiation qualification, unless analysis supported by test data is provided to verify that these levels will not degrade the operability of the equipment below acceptable values.	

Telephone (617) 872-8100
TWX 710-380-7619

YANKEE ATOMIC ELECTRIC COMPANY

QDR 6.14
REV 3

DR6

YANKEE

1671 Worcester Road, Framingham, Massachusetts 01701

VYE #65/84
W.O. #4440
DCC-VY-ECOTECH-84-12

May 23, 1984

Mr. L. P. Gradin
Ecotech, Inc.
5418 Tonnele Avenue
North Bergen, NJ 07047

Purchase Order Number 103135
Environmental Qualification Consulting Services
Vermont Yankee Nuclear Power Station

Dear Mr. Gradin:

We are transmitting a radiation dose specification model for equipment within the VY drywell. The model provides the equipment qualification dose to cable insulation as a function of insulation or jacket material depth. The model can be used to justify dose reduction due to self-shielding.

Very truly yours,

Paul R. Johnson

P. R. Johnson
Lead Electrical Engineer
Vermont Yankee Project

PRJ/kg

Attachment

cc: A. C. Kadak
S. R. Miller
R. J. January
R. L. Smith
D. M. Thomson
F. Trotto (DCC)

EcoTech, Inc.
MAY 25 1984
RECEIVED

DR7

(plant name) VYNPS

RADIATION DOSE SPECIFICATION WORKSHEET
(From Procedure YA-REG-11, Rev. 0, P.8)

Calc# ________ Section ________
Rev ____ Date ________ P. ________

INPUT

Calculation Applies to Each of the Following Pieces of Equipment

System	ID	Description	Location	Beta Shield	Qual. Dose
ELECTRICAL POWER	ELECT-5	ELECTRICAL PENETRATIONS THAT BREACH PRIMARY CONTAINMENT ELEVATION 252 FT	INSIDE/ OUTSIDE PRIMARY CONTAINMENT	NO	10^8 RAD

QDR-6.14
REV.3

QDR 6.14
REV 3

Design Basis Event (Other Than Normal Operations)

D.B. Accident	Period of Operation	Limiting D.B.A.
LOCA AND ALL HELBS	360 DAYS	LOCA - WORSE TEMP. - PRESS. RADIATION AND HUMIDITY

Input Prepared By ____________________ Date ____________________

CALCULATION

BETA SHIELD (ρ=1 gm/cm³)

	Event, Source, and Type of Radiation	Assumptions	References	Dose (RAD) a: 0.0 mils	Dose (RAD) b: 10 mils
Normal	gamma beta neutron	VYC-193 APPENDIX B.5		7×10^6 1.8×10^4 1.8×10^5	7×10^6 1.8×10^4 1.8×10^5
Limiting Design Basis Accident — Submersion	gamma	VYC-193 APPENDIX B.8		4.5×10^7	4.5×10^7
	beta	VYC-193 APPENDIX B.17		7.9×10^8	2.2×10^8
Limiting Design Basis Accident — External	recirculating systems			—	—
	sump water			—	—
	containment shine			—	—
	other			—	—
Margin	IEEE 323-1974 (6.3.1.5) Margin-10% on Accident Dose			8.35×10^7	2.65×10^7
	Roundup			0.5%	0.4%

RESULT

Limiting Normal Dose Rate (Rad/hour) a: 20, b: 20

Total Dose (Rad to Air) a: 9.3×10^8 b: 3.0×10^8

Prepared Eric B Barthto Date MAY/4/84 Reviewed [signature] Date 5/4/84

DR8

(plant name) VYNPS

RADIATION DOSE SPECIFICATION WORKSHEET

(From Procedure YA-REG-11, Rev. 0, P.8)

Calc# ________ Section ________
Rev ____ Date ________ P. ________

INPUT

Calculation Applies to Each of the Following Pieces of Equipment

System	ID	Description	Location	Beta Shield	Qual. Dose
ELECTRICAL POWER	ELECT-5	ELECTRICAL PENETRATIONS THAT BREACH PRIMARY CONTAINMENT ELEVATION 252 ft	INSIDE/ OUTSIDE PRIMARY CONTAINMENT	NO	10^8 RAD

QDR 6.14
REV 3

Design Basis Event (Other Than Normal Operations)

D.B. Accident	Period of Operation	Limiting D.B.A.

Input Prepared By ____________________ Date ____________

CALCULATION

BETA SHIELD THICKNESS (g=1 ...)

Event, Source, and Type of Radiation		Assumptions	References	Dose (RAD) a: 15 mills	Dose (RAD) b: 30 mills
Normal	gamma, beta, neutron	VYC-193 APPENDIX B.5		7×10^6 1.8×10^4 1.8×10^5	7×10^6 1.8×10^4 1.8×10^5
Limiting Design Basis Accident — Submersion	gamma	VYC-193 APPENDIX B.8		4.5×10^7	4.5×10^7
	beta	VYC-193 APPENDIX B.17		1.5×10^8	6.5×10^7
Limiting Design Basis Accident — External	recirculating systems			—	—
	sump water			—	—
	containment shine			—	—
	other			—	—
Margin	IEEE 323-1974 (6.3.1.5) Margin-10% on Accident Dose			1.95×10^7	1.1×10^7
	Roundup			3.7%	1.4%

RESUL.

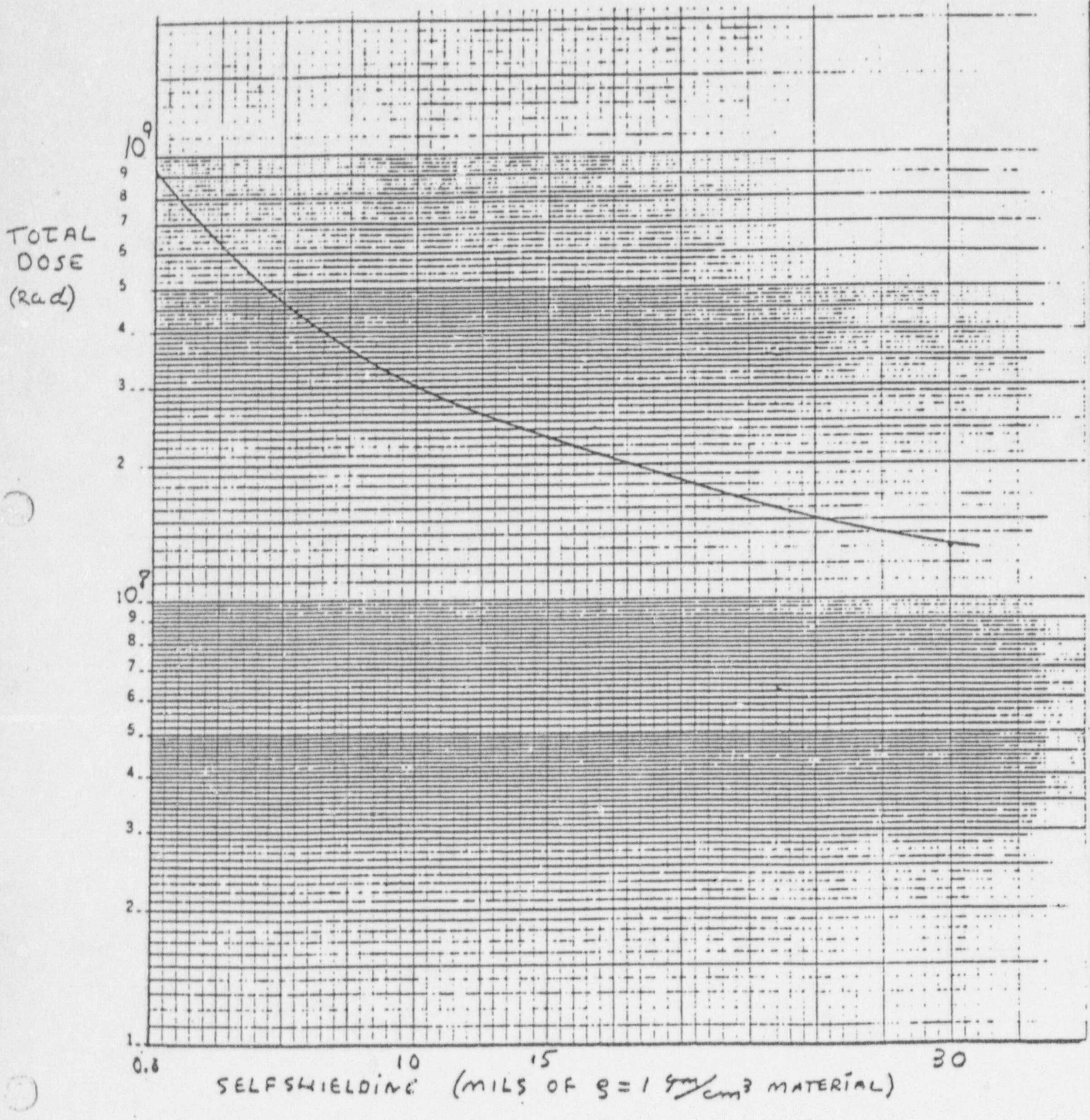
Limiting Normal Dose Rate (Rad/hour): a 20, b 20

Total Dose (Rad to Air): a 2.3×10^8, b 1.3×10^8

Prepared Eric B Bartlett Date MAY/4/84 Reviewed [signature] Date 5/4/84

DR9

QDR 6.14
REV 3



ATTACHMENT E

Lewis Cable

Purpose

The purpose of this review is to document the qualifiability of Lewis PE/PVC electrical cables used at Vermont Yankee. The subject cables are located outside primary containment and serve the loads as described in Appendix (a). The cables require qualification to the DOR Guidelines. The basis of the review is to document the acceptability of a generic material qualification for the cable. Generic material qualification and Vermont Yankee's position of its acceptability has been previously discussed in Attachment D for Rome Cable.

Discussion

The Lewis Cables installed at Vermont Yankee were purchased to the EBASCO Specification for Special Cables (see QDR Section G4). That specification required all cables be in accordance with IPCEA standard. A comparison of the data contained in Appendix (b) (Vermont Yankee Purchase Order Information) and the requirements of IPCEA Standard S-61-402 demonstrates that the PE insulation used in the Lewis Cable meets or exceeds the IPCEA requirements.

Since no type testing of the subject Lewis Cable exists, environmental qualification is documented through similarity with the PE/PVC cable tested by Wyle (Test Report No. 45917-40-1). The cable tested was Simplex PE/PVC Cable with 0.016 inches of PE insulation.

The use of the Wyle test report of Simplex PE insulated cable is acceptable to demonstrate the qualification of the Lewis PE insulated cable because:

A. The Lewis Cable has 56% greater insulation thickness than the Simplex Cable. (25 mils for Lewis versus 16 mils for Simplex.)

B. The demonstrated capabilities of the Simplex Cable exceeds the capabilities required of the Lewis Cable. Specifically:

1. The Simplex Cable was successfully preaged to an equivalent life of 40 years at a temperature of 67°C. The requirement at Vermont Yankee is 40 years at 60°C.

2. The Simplex Cable was successfully subjected to a peak accident temperature of 319°F. The peak temperature was maintained for one minute after which temperature was reduced, slowly over a period of eight minutes, to a value of 210 degrees. As installed at Vermont Yankee the Lewis Cable is subjected to a peak of only 300°F and that peak lasts for less than ten seconds.

3. The Simplex Cable was successfully exposed to a total radiation dose of 7.7×10^6 rads. The worst case exposure for the Lewis Cable at Vermont Yankee is 5×10^6 rads.

Conclusion

In accordance with DOR Guidelines, environment-qualification of the Lewis PE insulated cable installed at Vermont Yankee is demonstrated through similarity with the Simplex PE insulated cable tested in Wyle Report No. 45917-40-1. Because the Simplex Cable was qualified to environmental conditions which were more severe than those the Lewis Cable is exposed to at Vermont Yankee and because the Lewis PE insulation thickness is approximately 56% greater than that of the Simplex Cable, reasonable assurance is provided such that adequate confidence of the environmental qualification of the Lewis Cable exists.

The above review and supporting test reports will be added to QDR 6.27 for Lewis Cable.

TABLE 1

	IPECA STANDARD S-61-402 REQUIREMENTS	LEWIS CABLE REQUIRED	LEWIS CABLE OBSERVED
	PE INSULATION	PE INSULATION	PE INSULATION
MINIMUM TENSILE	1400 psi	1400 psi	2650 psi
MINIMUM ELONGATION %	350 %	350 %	550 %
AGING REQUIREMENT	100 C FOR 48 HOURS	100 C FOR 48 HOURS	OK
POST-AGING TEST			
TENSILE STRENGTH	75% OF UNAGED VALUE	75% OF UNAGED VALUE	93%-99%
ELONGATION	75% OF UNAGED VALUE	75% OF UNAGED VALUE	90%-96%
ENVIRONMENTAL CRACKING	NO CRACKS	NO CRACKS	

Lewis Cable

Functional Review:

The Lewis Cable at Vermont Yankee serves the following instrumentation only:

FT-10-109 A/B RHR System Flow

FT-10-111 A/B RHR Torus Cooling and Containment Spray Flow

DPT- 10-91 A/B RHR Heat Exchanger Differential Pressure

The Flow transmitters (FT-10-109A/B and FT-10-111A/B) were added to our EQ Program as a result of our RG 1.97 evaluation. They were added as a long term operator aid. Since the RHR System has several accident modes that could be shared by one loop (ie. both torus cooling and LPCI modes operating together in one RHR subsystem), the flow indicators provide flexibility to enable better control over system line-up changes during the course of the accident. No automatic action occurs as a result of these instruments. Therefore, these flow instruments are considered an operator aid only for long term accident management.

The differential pressure transmitters (DPT-10-91A/B) are associated with the automatic control of the RHR Heat Exchangers' differential pressure. In the early phase of an HELB, the decay heat from the reactor will be transferred to the Torus. The operating procedures instruct the operators to initiate Torus Cooling upon Torus temperature increase. When the controller is in the automatic mode, this instrument controls the position of the RHRSW outlet valve and thereby controls the flow rate of cooling water through the Heat Exchanger. When the controller is operated in manual mode (which is the usual case) this instrument only provides indication of differential pressure with no control function. The ability to control valve position in manual mode is independant of the transmitters and associated Lewis cable.

Since the controller is normally operated in the manual mode, and since other instrumentation is relied upon to monitor the effectiveness of Torus Cooling (eg. Torus Temperature instruments), the function of the differential pressure instrument can be considered an operator aid for setting up Torus Cooling and long term automatic control as desired. This instrument is not considered essential in early phase of HELB since other instruments can be utilized to insure Torus Cooling is performing properly and remote manual valve position could be readily performed as necessary regardless of differential pressure indications.

EBASCO SERVICES INCORPORATED
MATERIALS ENGINEERING
QUALITY COMPLIANCE REPORT

FORM 110-98

Supplement #3
ORDER NO. NY-706231

CLIENT AND PROJECT: Vermont Yankee Nuclear Power Corporation
Vermont Yankee Nuclear Power Plant

MANUFACTURER: Lewis Engineering Co

MATERIAL: Electric Cable

SPEC NO. VYNP-IV-C-1

PREVIOUS SHIPPING PROMISE: October 1970

NEW PROMISE: Part released bal Oct thru Nov 1970

LOCATION: Naugatuck, Connecticut

REF. NO. 16788

DATE: September 29, 1970

SHOP NO. --

PERSONNEL CONTACTED & TITLE: R Newton, Sales Manager
A Cappiello, Quality Control

The writer visited vendor's Naugatuck, Connecticut plant to witness tests and examine cable being furnished on subject order.

Item #8 - 43,322 ft (5090' - 4955' - 4940' - 4992' - 5115' - 5090' - 4140' - 3900' - 5100') (9 reels) 2/C #16 Awg, 19 strands coated copper condurtor, .025" polyethylene insulation, colored, 1/C black, 1/C white twisted with plastic fillers, cabled round, mylar binder tape, #18 Awg, solid coated copper drain wire, helically wound over mylar and under a .0025" uncoated copper shielding tape, .047" black PVC jacket overall.

Item #9 - 2000 ft 6/C (3 pair) #16 Awg, 19 strands coated copper conductor, .025" polyethylene insulation, color coded by pigmentation, cabled round, mylar binder tape, #18 Awg, solid coated copper drain wire, helically wound over mylar and under a .005" uncoated copper shielding tape, .060" black PVC jacket overall.

Item #10 -2038 ft 8/C (4 pair) #16 Awg, 19 strands coated copper conductor, same construction as Item #9 above, except this has an .065" black PVC jacket overall.

Item #11 -2065 ft 10/C (5 pair) #16 Awg, 19 strands coated copper conductor, same construction as Item #10 above.

Item #13 -20,110 ft (5050' - 5040' - 5020' - 5000') 3/C #16 Awg 19 strands coated copper conductor, .025" polyethylene insulation, colored, 1/C black, 1/C white, 1/C red, twisted with plastic fillers, cabled round, mylar binder tape, tinned copper wire wrapped shield, .042" black PVC jacket overall.

Supplement #3
NY-706231

Item #14 - 2112 ft, 4/C #16 Awg, 19 strands coated copper conductor, .025" polyethylene insulation, color coded by pigmentation, cabled round, mylar binder tape, #18 Awg, solid coated copper drain wire, helically wound over mylar and under a .0025" uncoated copper shielding tape, .047" black PVC jacket overall.

Item #19 - 2085 ft 48/C #20 Awg, 19 strands coated copper conductor, .025" polyethylene insulation, color coded by pigmentation and spiral stripe cabled round, mylar binder tape, #19 Awg, solid coated copper drain wire, helically wound over mylar and under a .005" uncoated copper shielding tape, mylar tape over shield, .060" black PVC jacket overall.

Item #22 - 4115 ft, 27/C #16 Awg, 19 strands coated copper conductor, .025" polyethylene insulation, color coded by pigmentation and spiral stripe, cabled round, mylar binder tape, .060" black PVC jacket overall.

The offered cable was tested and examined in accordance with the wording of subject order requirements, IPCEA, ASTM, and Ebasco Specification #VYNP-IV-C-1 revision one dated October 6, 1969.

Cable was accepted and released for preparation for shipment.

Our engineer accepted excess footage on all items.

On items #14 and #19 a #16 Awg solid coated copper drain wire was used in lieu of #18 Awg. This was also accepted.

The offered cable was subjected to electrical and physical check tests with satisfactory results observed as follows:

Item #	8	9	10	11
Voltage Applied 5 Min. kv ac	2.5	2.5	2.5	2.5
Insulation Resistance, Megs Per M' at 15.6 C				
Min. Permitted	17,600	17,600	17,600	17,600
Obser Min.	100,000+	100,000+	100,000+	100,000+
Conductor Resistance Ohms Per M' at 25 C				
Spec Max.	4.53	4.53	4.53	4.53
Obser Max.	4.36	4.34	4.49	[illegible]

Supplement #3
NY-706231

Item #	8	9	10	11
Insulation Wall				
Spec Avg	.025"	.025"	.025"	.025"
Obser Min Avg	.027"	.027"	.027"	.027"
Min. Wall Permitted	.0225"	.0225"	.0225"	.0225"
Min. Wall Observed	.026"	.025"	.025"	.025"
Jacket Wall				
Spec Avg	.047"	.060"	.065"	.065"
Obser Min. Avg	.060"	.080"	.085"	.070"
Min. Wall Permitted	.038"	.048"	.052"	.052"
Min. Wall Observed	.055"	.069"	.080"	.058"
Conductor Make-Up				
Spec Nominal	.0113"	.0113"	.0113"	.0113"
Observed	.0113"	.0113"	.0113"	.0113"
Overall Diameter, Nominal	--	.570"	.680"	.700"
Overall Diameter, Max. Observed	.380"	.550"	.670"	.690"

Passed jacket integrity test at 2.5 kv.

Drain wire measured .0405" against a nominal of .0403" specified.

The offered cable was subjected to electrical and physical check tests with satisfactory results observed as follows:

Item #	13	16	19	22
Voltage Applied 5 Min. kv ac	2.5	2.5	2.5	2.5
Insulation Resistance, Megs Per M' at 15.6 C				
Min. Permitted	17,600	17,600	17,600	17,600
Obser Min	100,000+	100,000+	100,000+	100,000+
Conductor Resistance, Ohms Per M' at 25 C				
Spec Max.	4.53	4.53	10.08	4.53
Obser Max.	4.42	4.20	9.03	4.30

Supplement #3
NY-706231

Item #	13	14	19	22
Insulation Wall				
Spec Avg	.025"	.025"	.025"	.025"
Obser Min. Avg	.027"	.027"	.026"	.028"
Min. Wall Permitted	.0225"	.0225"	.0225"	.0225"
Min. Wall Observed	.025"	.025"	.023"	.026"
Jacket Wall				
Spec Avg	.047"	.047"	.069"	.060"
Obser Min. Avg	.050"	.065"	.085"	.060"
Min. Wall Permitted	.038"	.038"	.048"	.048"
Min. Wall Observed	.048"	.052"	.063"	.052"
Conductor Make-Up				
Spec Nominal	.0113"	.0113"	.008"	.0113"
Observed	.0113"	.0113"	.008"	.0113"
Overall Diameter, Nominal	--	.450"	--	--
Overall Diameter, Max. Observed	.370"	.430"	.940"	.790"

Passed jacket integrity test at 2.5 kv.

Drain wire on items #14 and #19 exceeded specifications.

Physical properties of insulation and jacket were checked with the following results observed:

Item #	8	9	10	11
Insulation				
Tensile Strength, psi				
Spec Min.	1400	1400	1400	1400
Obser Min.	2650	2600	2600	2600
Elongation %				
Spec Min.	350	350	350	350
Obser Min.	550	550	550	550

Supplement #3
NY-706231

Item #	8	9	10	11
Jacket				
Tensile Strength, psi				
Spec Min	2000	2000	2000	2000
Obser Min.	2025	2008	2008	2008
Elongation %				
Spec Min.	150	150	150	150
Obser Min.	200	200	200	200

Physical properties of insulation and jacket were checked with the following results observed:

Item #	13	14	19	22
Insulation				
Tensile Strength, psi				
Spec Min.	1400	1400	1400	1400
Obser Min.	2650	2600	2760	2600
Elongation %				
Spec Min.	350	350	350	350
Obser Min.	550	550	575	550
Jacket				
Tensile Strength, psi				
Spec Min.	2000	2000	2000	2000
Obser Min.	2025	2008	2037	2008
Elongation %				
Spec Min.	150	150	150	150
Obser Min.	200	200	275	200

The status of balance of subject order is as follows:

Item	Footage	Type	Schedule
6	1800 bal	RG-114A/u (modified)	Nov. 24, 1970
7	5500 bal	RG-59A/u (anti-microphonic)	11-24-70

Supplement #3
NY-706231

-4-

Item	Footage	Type	Schedule
8	37,000 bal (approx)	2/C-#16 Awg (shld)	10-2-70
12	2000	24/C-(12 pair) #16 Awg (shld)	10-2-70
15	2000	12/C-#16 Awg (shld)	10-2-70
16	10,000	19/C-#16 Awg (shld)	10-2-70
17	3000	27/C-#16 Awg (shld)	10-2-70
18	3000	37/C-#20 Awg (shld)	10-2-70
21	2000	29/C-#20 Awg (shld) (chr-al-T/C)	10-2-70
23	4000	37/C-#20 Awg	10-2-70
25	2000	27/C-#20 Awg	10-2-70
26	6000	5/C-#16 Awg	11-26-70

Supplement #4

Item	Footage	Type	Schedule
13A	15,000	3/C-#16 Awg (shld)	Not Scheduled
14A	2000	4/C-#16 Awg (shld)	as of this
21A	2000	29/C-#20 Awg	date

Item #6 and #7 will be fabricated by Times Wire of Wallingford, Connecticut for Lewis Engineering Company.

Close follow will be maintained and developments reported accordingly.

E P Cagle
Q C Representative

EPC/ec

CC: W J Ross/T O Davenport
E P Cagle

FORM #700128

THE LEWIS ENGINEERING COMPANY
NAUGATUCK, CONNECTICUT
TEST REPORT

CUSTOMER VERMONT YANKEE NUCLEAR POWER Co. ITEM 8
R.E. 16788-8
CUST. ORD. NO. VY-706231
DATE 9/29/70
DESTINATION VERNON, VERMONT
TESTED BY A.J.C. & T.L.H.
SPECIFICATION VYNP-IV-C-1 & IPCEA
TEST NO. —
MATERIAL 1/C #16 (19/.0117") TINN. COPP. P.E.
PART NO. 16-PCM-121
CABLE 2/C + F. MYLAR - DRAIN - COPPER
LOT NO. —
TAPE - PVC, BLACK
43,322 FT ; 9 Reels

EXAMINATION OF PRODUCT	REQUIRED	OBSERVED
1. POLYETHYLENE INSULATION-Unaged		
1. TENSILE STRENGTH	1400 PSI	2650 - 3225
2. ELONGATION	350%	550% - 625%
2. AGING TEST (SINGLES)	48 hrs. Air Oven @ 100°C	OK
1. TENSILE STRENGTH, % of Orig	75%	93% - 99%
2. ELONGATION, % of Orig.	75%	90% - 96%
3. JACKET	PVC	PVC
1. TENSILE STRENGTH	2000 PSI (MIN)	2025 - 2550
2. ELONGATION %	150% (MIN)	200% - 325%
4. COLD BEND TEST	-55°C/1 Hr. No cracks	OK No CRACKS
5. MELT INDEX	.20-.40	.22
6. EMF vs TEMP. TEST	N/A	N/A
1.	"	"
2.	"	"
3.	"	"
4.		

These are summarized physical properties of polyethylene insulation, checked as specified above, on previously selected samples.

A. J. Cahill
Q. C. MANAGER, WIRE DIVISION

7

Question No. 18:

MOV-10-15B Splice

For the splices on the motor leads of the dual-voltage motor, MOV-10-15B, please provide evidence to support their qualification.

Although this valve motor is in a relatively mild area, our concern extends to valve motors installed inside the drywell.

Response No. 18:

We have verified, by additional physical inspection, that the splices on the motor leads of this dual-voltage motor consist of a nylon dual-voltage motor connector (similar to those discussed in Question No. 19) covered by additional layers of electrician's tape which has no effect on qualification. From discussions with plant personnel, we have determined that on occasion, the electrician may have added electrician's tape to a nylon splice to provide added assurance that a good insulated connection was made.

Qualifications of nylon dual-voltage motor connectors are discussed in the response to Question No. 19 and No. 14. These responses also discuss the qualifications of other motors including those located within the drywell.

The following discussion is being provided to document the justification of the original qualification of 3M Tape Splices as documented in QDR 16.1.

The Nuclear Regulatory Commission's (NRC's) concern about the 3M Tape Splice QDR is documented below:

1. Page A2 - Discusses worst case 3.2 V/mil.

   Page A11 - Addresses two half-lapped layers Scotch 23.
   Thickness of tape 30 mils (before stretching).
   Max insulation is 4 x 30 x 3.2 = 362.4 volts ?
   How is stretching accounted for ?

2. Type test do not match configuration on Page A11.

3. Overall conclusion on Page DT5 assumes all EPR based splices to be qualified. Explain the Non-3M splices for which this report applies.

The Vermont Yankee initial response is detailed below.

1. 3.2 volts per mil is not the insulating property of the material, but the most conservative application at Vermont Yankee - 600 volts/187.5 mils. The actual dielectric strength of the material is greater than 500 volts per mil. Stretching is not a concern because the material is applied to a thickness of 3/16" (187.5 mils), not to a number of layers. The vendor recommends stretching to eliminate possible voids (QDR Page G2-12).

2. The material used in both the 3M and Okonite tapes is EPR (QDR Pages G2-10, G3-8, and attached product data sheet). The conservative testing of the Okonite configuration bounds the application and requirements at Vermont Yankee.

3. The subject QDR only addresses the EPR based splices as applied to Vermont Yankee requirements. No other applications or qualifications are assumed.

It is Vermont Yankee's contention that the basis of the 3M Tape Splice qualification is a combination of the electrical testing performed by the manufacturer and similarity of the insulated splices to those tested by Okonite Company. As discussed in Attachment D, the demonstration of adequacy in environmental qualification is not completely absolute but rather relates to the "reasonable" concepts established in Title 10 of the Code of Federal Regulations and NRC staff guidance in such appropriate documents as the DOR Guidelines. The Vermont Yankee files provide "reasonable adequate assurance" such that "adequate confidence of environmental qualification exists."

As discussed in Attachment D generic material qualification has been accepted for certain outside containment applications based on the following factors:

1. The severity of the environments relative to commonly known material capability and to normal (nonaccident) environments.

2. The amount of margin between generic test environments and the required environments for the item to be qualified.

3. What similarity data exists (e.g., aging, radiation resistance, information on materials, and processing from manufacturers involved, etc).

4. What type test data does exist for the item to be qualified.

The following analysis which takes into account these four factors documents our contention of the original acceptability of the 3M Tape Splice file.

The splices used at Vermont Yankee are similar to those used for years in the electrical industry in conditions ranging from subzero temperatures to flooded manholes. The material is rated for 90°C continuous duty, short-term duty at 130°C, and relative humidities up to 96%. The peak conditions experienced by these splices at Vermont Yankee are 213°F (100°C) and 100% relative humidity. The specific material (Scotch 23) has been satisfactorily tested to radiation levels of 1×10^8R or five times the Vermont Yankee requirement of 2×10^7R.

The similarity of the Scotch 23 tape to the Okonite T-95 tape is based upon both being manufactured from ethlylenepropylene rubber to produce a high voltage, high temperature splicing material with excellent electrical properties. A review of the electrical properties indicates that the 3M Tape has a higher dielectric strength and greater insulation resistance than the tested Okonite tape. The LOCA testing of the inferior Okonite tape splice far exceeded the Vermont Yankee requirements demonstrating significant margin for the Vermont Yankee 3M Tape Splice applications.

Therefore, it is Vermont Yankee's contention that the files as they were on October 19, 1987 were sufficient to demonstrate reasonable assurance of qualification of the 3M Tape Splices and that no violation existed.

The Nuclear Regulatory Commission (NRC) questions concerning QDR 6.15, Cerro EPR Cables were as follows (Reference Vermont Yankee Audit Question No. 3):

1. Qualification of this cable is based on Rockbestos Test Report QR No. 1804A, Revision 1, dated February 23, 1982. This report is considered invalid because of IE Information Notice 84-44.

2. The test report states that the tested specimen was subjected to 200M rad radiation. Who conducted the radiation test ? Where is the radiation certificate ?

Vermont Yankee is aware of the concerns noted in IE Information Notice 84-44. These concerns question the acceptability of Rockbestos Cable qualification programs. The notice states that users of the subject cable should take steps to ensure that Rockbestos Cable installed in the plant is qualified.

Rockbestos is presently revising all of their qualification reports. Vermont Yankee has closely monitored these efforts. Requalification programs for XLPE and CO-AX Cables are complete. Testing is complete for SR Cable. As of this date retesting of EPR Cable is not scheduled. Each program has successfully re-affirmed that Rockbestos Cable is fully qualified.

As stated in IE Notice 84-44, one of the deficiencies of the Rockbestos test program was control of and documentation of tests performed by "outside" test organizations. The documentation of radiation testing was one of the items not supported by test certification documents.

When originally prepared, Vermont Yankee's environmental qualification package for Cerro EPR Cable was based on the results of FIRL test report F-C3789 (March 1974). This was the package which was found to be acceptable by Franklin in their Equipment Environmental Qualification Review (see QDR 6.15, Tab G5, and Page A1). Subsequent to that review a new test report by Rockbestos of their Firewall EP Cable (EPR insulation) became available (dated February 23, 1982). Vermont Yankee believed that this test superseded the FIRL report and so replaced the FIRL report with the Rockbestos.

As discussed on Page A2 of the QDR, Yankee was made aware of the NRC audit of Rockbestos in 1984, and as instructed in IE 84-44 Yankee reviewed the audit findings and determined that reasonable confidence in the adequacy of the actual test results existed. Further confidence existed due to the existence of the old FIRL report included in the original EPR Cable qualification package still on file at Yankee Atomic Electric Company, and successful tests of similar EPR insulated cable manufactured by Anaconda (QDR 6.25) and Okonite.

Note:

The demonstrated capability of the EPR insulation as shown in the FIRL, the Rockbestos, the Anaconda, and the Okonite reports exceeds the requirements for Vermont Yankee with significant margin. For example the radiation requirement for Vermont Yankee is 2×10^7 rads (QDR Section DR) just 10% of the demonstrated capability of 2×10^8 rads discussed in the test reports.

Yankee committed to remaining current with the ultimate resolutions to the audit findings; specifically to replace the Rockbestos report with the new, revised Rockbestos reports currently being issued. As stated earlier the Rockbestos re-test efforts have successfully affirmed that their cable is fully qualified.

Therefore, per the instructions of IE Information Notice 84-44 Yankee ensured EPR Cable installed at Vermont Yankee was qualified.

ATTACHMENT 1

Additional Information on EQ MOV Walkdowns

1. As requested during the EQ Audit, we are submitting examples of the types of MOV inspections and walkdowns performed at Vermont Yankee.

   During the 1970's, MOV's were inspected many times by plant maintenance personnel and engineering personnel to respond to various issues raised on components supplied by Limitorque. Inspections covered types of torque switch, terminal block, etc. The results of these inspections were provided in responses to the various IE Bulletins and Notices. A typical maintenance record is included as Attachment I, Appendix A, to this response. It also documents the various inspections and walkdowns performed on a typical MOV.

   In 1980 and 1984, Vermont Yankee performed walkdowns of equipment included in the EQ Program. The 1980 walkdown was performed in preparation for our NRC submittal. The 1984 walkdown was performed to obtain final equipment data. An example of the raw data taken during the 1984 walkdown is provided in Attachment I, Appendix B.

   In 1986, while performing the changeout of internal wiring in Limitorque actuators, walkdown information was reverified. Attachment I, Appendix C, provides a sample of this walkdown information.

2. In addition, in response to your question nos. 15 and 16, we have requested Limitorque to reverify that the subject motors are qualified (see attached).

MACHINE REPAIR RECORD

MACHINE	SERIAL NO	PROPERTY NO
CS Gate Valves		V14-5A,B

DEPARTMENT	LOCATION		REVIEW AT →	HOURS DOWN / COST

DATE	P OR E	REFERENCE	WORK PERFORMED	HOURS DOWN	LABOR	MATERIAL	TOTAL	ACCUMULATED COST
10-16-71			Dutchmen installed on both valves					WF
11/18/71			REMOVED HEATER H14 REPLACED WITH H27					JS
9/12/72		MR72-2016	Tightened covers on V14-5A					
9/10/72			Changed torque switch- 5A- open- 13.6 close-13.2 5B-13.4open close-13.6					
11/12/71		V-5A	Inspected worm and brass motor gear- Found OK-Set limits- Ran OK					DA
11/12/71		V-5b	Inspected worm and brass motor gear- Found OK- Set limits- Ran OK					DA
9/10/72		V-5b	Changed torque switch with revided typw of red material½					HFA
7/28/76		V14-5A	Complete inspection of the limitorque operator					Gilmart
8/29/77		V14-5B	Complete limitorque operator inspection					DAT
12/13/79		MR79-1041	repaired pinched wires on 5A					DAT/FAS
10/6/80		MR80-1008	Repaired broken limitorque mounting bolt MI# 10v0076 V14-5B					GW/DD
3/5/86		MR86-0399	V14-5B Replaced thermal reset pushbutton w/ new reset kit. 03B0106					WAC/NF/
2/28/86		MR85-1262	"V-5B" Performed OP 5220 on 10/31/85 - Inspected internals of operator. Inspected spring pack assembly & noted: the plastic stop nut was tight (see MR for details). Replaced grease in main housing of operator with EPO & in limit switch with MOBIL 28. Replaced O rings guard rings & gaskets as required. NOTE: The close setting of the torque sw is now set on 2 & not on the 1½ as found. Completed S.I.S. chg. out of all jumpers in the sw cmpt.. MI 10A0267, 0266, 0207, 0236, 0127, 0206, 11A0152, 11A0137, MR01B0358, MR11A0182					CCR/WAC/JB/MC/M
1/16/86		MR85-1261	"V-5A" Performed OP 5220. Inspected spring pack assem., replaced o rings, quad rings & gaskets, torque sw with new one, all operator grease with NEBULA O, all limit sw gear box grease with MOBIL 28. Chg'd all limit sw compt. wires to S.I.S. Rockbestos. MI 10A235, 10A236, 10A263, 2B160, 2B170, 1B193, 1B322, 10A127, MR02B0170.					JC/JG/AAG/LM
5/10/86		MR86-916	Adjusted packing on V14-5B					CAP/CWK
6/19/86		MR86-1251	"B" Installed spring pack grease relief tubing per Limitorque instr. Also, installed adjustable spring cartridge cap. MI 6B0248, 6B0302, 6B0315,					WJM/NEPSCO "
6/19/86		MR86-1250	"A" Installed spring pack grease relief tubing per Limitorque instr. Also, installed adjustable spring cartridge cap. MI 6B0315, 6B0248, 6B0302					WJM/NEPSCO
*** 2/28/86		MR85-1262	"5B" SAME AS BELOW					
** 1/16/86		MR85-1261	"5A" During 85-86 Recirc Outage changed grease in operator to Exxon Nebula EP-0 Grease PFC per DAT					
9/10/87		MR87-1740	5A Changed wiring per LL&J #87-0053 and set limits to CWD					JAT

SUMMARY OF PREVENTIVE MAINTENANCE DONE

MACHINE: CS Gate Valves

PROPERTY NO.: V14-5A,B

DATE WORK ORDERED	DATE WORK DONE	MISC. FREQ. CODE	LUBE FREQ. CODE	ELEC. FREQ. CODE	MECH. FREQ. CODE	REMARKS	BY
	9/30/80			V14-5A		~~Inspected limitorque operator~~	RDB/R
	10/3/80			V14-5B		~~Inspected limitorque operator~~	JAT/R
	4/29/83			V14-5A		Performed op5220 WAC	DD
	6/28/84			V14-5B		Performed OP 5220.01,.02	JEF/MC/LM/
	2/28/86			V14-5B		One-time PM: Inspected SMB MTR. operator for worm shaft locknut (P/N 83) set screw tightness per info. notice 84-36 dated May 1, 1984. Also, replaced grease in operator with Exxon Nebula EP-0.	MC/JAT/CC
	10/31/85			V14-5B		Performed OP 5220 - see MR85-1262	CCR/JAT/WAC
	1/15/86			V14-5A		Performed OP 5220 - see MR85-1261	LM/?G
	3/25/87			V14-5B		Performed overload reset rod inspection	JAT
	3/25/87			V14-5A		Performed overload reset rod inspection	JAT
	9/10/87			V14-5A		Performed OP 5220	JAT

ATTACHMENT A TO PROCEDURE VYP-EQP-001

EQUIPMENT WALKDOWN WORKSHEET

VERMONT YANKEE NUCLEAR POWER STATION

SIGNATURES [illegible] DATE 6/29

3.1.1 IDENTIFYING DATA

a) COMPONENT DESCRIPTION: MOTOR OPERATED VALVE
b) SERVICE (TAG NO.): MOV- 14-26A
c) MANUFACTURER: LIMITORQUE/
d) MAKE & MODEL: SMB- 1 , SIZE- ___
e) SERIAL NO: 98447A
f) ADDITIONAL NAMEPLATE DATA:
PO# 706124 ORDER # 335268F
VALVE SIZE- 8" IN. VALVE ID#- 33435

3.1.2. INSTALLATION DESCRIPTION

a) BUILDING LOCATION: [illegible] off [illegible] catwalk
b) ELEVATION (FROM FLOOR): 9 ft
c) ORIENTATION (DESCRIBE):
HORIZONTAL/VERTICAL
Valve Horizontal
motor Horizontal
d) MOUNTING: BOLTED TO YOKE
inline with pipe
e) DISTANCE TO PIPING:

3.1.3 CABLE ENTRY

a) CONDUIT TYPE & SIZE: 1-1½ LIQ. & 1- 1" LIQ.
b) CABLE TERMINATION METHOD: L.S. WAS RING TERMINALS AND MOTOR HAS A BUCHANAN TERMINAL BLOCK
c) CABLE TYPE(S), SIZE, NO: 1-7/c & 1-3/c
d) SEALING METHOD, IF ANY: None (or specify)
e) LOCATION WITH RESPECT TO ORIENTATION: Horizontal

3.1.4 ENCLOSURE

a) MATERIAL DESCRIPTION: CAST IRON
b) GASKET/SEALS, IF ANY: GASKET
c) VENTS, IF ANY: NONE FOUND
d) MOISTURE RESISTANCE / NEMA CLASS: N/A

3.1.5 MISCELLANEOUS NOTES

MOTOR - (RELIANCE) / PEERLESS ID# 447074-DU

FRAME	PF56	TYPE	N/A
INSUL	5	H.P.	N/A
RPM	1700	VOLTS	230/460
AMPS	8/4	SERVICE FACTOR	

TORQUE - START 2.5 ftlbs, RUN 5 ftlbs

Buchanan TB for motor leads
EVAL Cable is Rome

NOTE: Circle ✓ if info is correct otherwise cross out and add correct information
Check if sketch is on back ☐

FM Samuels

MEMORANDUM

YANKEE ATOMIC - FRAMINGHAM

To S. R. Miller

From P. R. Johnson

Subject IE INFORMATION NOTICE 86-03: POTENTIAL DEFICIENCIES IN ENVIRONMENTAL QUALIFICATION OF LIMITORQUE MOTOR VALVE OPERATOR WIRING

Date February 10, 1986
Group # VYE #14/86
W.O. # 4440
I.M.S. #

BACKGROUND INFORMATION

IE Information Notice 86-03, dated January 14, 1986, alerts licensees of potential problems regarding the environmental qualification of wiring used in Limitorque MOVs. The notice reports that, during several NRC inspections, licensees were unable to identify the manufacturer of internal wiring used in the MOVs. In addition, when the licensee contacted the manufacturer, Limitorque was unable to certify that the wire installed in the valve operator was environmentally qualified. Limitorque stated that it could provide some environmental qualification information for wiring it provided, however, it could not certify wiring added by the valve manufacturer or the field.

DISCUSSION

As part of our ongoing commitment for Vermont Yankee's (VY's) Equipment Qualification (EQ) Program, VY Project Electrical Engineering (VYE) was asked to evaluate Information Notice 86-03. Because Limitorque actuators are used in nearly every nuclear plant, this notice has significant effect on the EQ Program of every plant and, therefore, it has received industry-wide attention in the past two weeks.

We have learned through other projects at Yankee Atomic Electric Company (YAEC) and through other utilities that Limitorque has not actually tested wire as part of their test program and that in nearly every instance when a licensee has attempted to obtain certification from Limitorque on the wire provided, the information obtained only resulted in finding additional discrepancies. Attempts by utilities to identify the jumper wire installed in the actuator by field walkdown resulted in finding a variety of wires installed, some of which could not be identified.

This notice seriously questions the environmental qualification of MOVs and questions the operability of MOVs for plants which are on-line. The Nuclear Utility Group on Equipment Qualification (NUGEQ) quickly assembled a qualification package entitled "Qualification Data and Reports Associated with Limitorque Motor Operated Valve Control Wiring." Yankee Nuclear Services Division (YNSD) received this package on January 30, 1986, and we have completed a preliminary review of it. The package attempts to qualify wire "generically" and, by a failure modes and effects analysis, attempts to demonstrate that the problems cited in the notice will not create a problem. It is our opinion that this document can only serve to support a justification for continued operation for a limited number of inaccessible valves for plants currently on-line. We believe that this report should not be used as auditable documentation to support qualification and cannot be used as justification for inaction on this notice for any plant currently off-line.

February 10, 1986

We believe the most expeditious method of resolving the concerns of Information Notice 86-03 is to replace all internal wiring on the MOVs listed in Attachment 1 with qualified Rockbestos SIS wire (QDR 6.4-2). The EQ maintenance records, the MOV field walkdown sheets, and SCEW sheets should be updated to document that this wire is used in the MOV circuits. QDR 6.4-2 should be reviewed to determine if any modification of that QDR is required resulting from this change.

In addition, as the rewiring is performed, we request that VY personnel complete Attachment 2. This form will enhance the field walkdown information in QDR 3.1, Limitorque MOV actuators, by adding additional qualification data on MOV internals such as torque switch type.

RECOMMENDATION

VYE recommends that all internal wiring on MOVs listed in Attachment 1 be replaced with qualified Rockbestos wire. In addition, as the work is performed, we request that the information in Attachment 2 be completed.

P. R. Johnson
Lead Electrical Engineer
Vermont Yankee Project

Jay K. Thayer
J. K. Thayer
Engineering Manager
Vermont Yankee Project

PRJ/gms
Attachments
cc: W. D. Hinkle
R. L. Smith
M. J. Cofske
M. Saniuk
J. Thayer

Please return to P. R. Johnson with action taken:

Recommendation accepted: ✓

Recommendation denied: ______

Comments: ______

Date: 2/10/86 Signed: S.R. Miller

ATTACHMENT 2

MOV Walkdown Information

MOV No:________________________________

Order No:______________________________

Serial No:_____________________________

Motor Mfg:_____________________________

Motor Serial No:________________________

Motor Termination Method: Terminal Block or Splice (Circle)

Splice Type: Raychem or Tape (Circle)

Terminal Block Type:____________________

Torque Switch Color:____________________

Limit Switch Color:_____________________

Lubricant Used:________________________

T-drains Used: Yes or No (Circle); if yes, location:______________________

ATTACHMENT 2

MOV Walkdown Information

MOV No: RHRV10-39A

Order No: 3EA730B

Serial No: 328140

Motor Mfg: RELIANCE

Motor Serial No: B77Q0780 m-VK 2

Motor Termination Method: Terminal Block or (Splice) (Circle)

Splice Type: (Raychem) or Tape (Circle)

Terminal Block Type: N/A

Torque Switch Color: Brown

Limit Switch Color: FB Brown Rotors Brown

Lubricant Used: EPO

T-drains Used: Yes or (No) (Circle); if yes, location: ____________

Telephone (617) 872-8100
TWX 710-380-7619

YANKEE ATOMIC ELECTRIC COMPANY

YANKEE

1671 Worcester Road, Framingham, Massachusetts 01701

November 2, 1987
WO 4440
VYE 110/87
DCC VY-87-114

Limitorque Corporation
5114 Woodall Road
P.O. Box 11318
Lynchburg, VA 24506
Attn: Pat McQuillan, QA Manager

Subject: Actuator Motor Lead Insulation

Dear Mr. McQuillan:

During a recent NRC audit at Vermont Yankee Nuclear Power Station, several concerns were identified regarding Limitorque actuator motor lead insulation. The list of affected components and description of NRC concerns are contained in Attachment 1.

Limitorque has previously provided Vermont Yankee with certification of compliance for these two motors to the applicable Limitorque test reports. In light of the NRC concerns, we request that you review your records for the identified motors and verify the applicability of the existing test reports.

If you have any questions or require additional information, please contact me a telephone number (617) 872-8100, Extension 2296. Your cooperation in this matter is appreciated.

Very truly yours,

Paul P. Johnson for

C. J. Nichols
Vermont Yankee Project

CJN/25.226

bcc: P. R. Johnson
M. P. Saniuk
R. N. Moschella
J. K. Thayer
S. R. Miller
R. L. Smith
M. J. Cofske

ATTACHMENT 1

I. MOV's Installed at Vermont Yankee

1. Vermont Yankee Valve Tag No. MOV-70-19A Limitorque Operator

Order No.	391355A
Serial No.	215715
Reliance Motor Serial No.	Y276060A2

2. Vermont Yankee Valve Tag No. MOV-70-19B Limitorque Operator

Order No.	391355A
Serial No.	215714
Reliance Motor Serial No.	Y263461A3

The NRC inspector identified the lead wire insulation on these motors as unique (i.e., not previously seen by the inspector). MOV-70-19A has red nonbraided insulation and MOV-70-19B has grey nonbraided insulation. The inspector questioned whether or not these wire types are covered by Limitorque testing.

II. Motors in the Vermont Yankee Storeroom

1.

Motor Manufacturer	Porter - Peerless
Motor Serial No.	YM73197TN
Limitorque Order No.	3K8763S
Vermont Yankee PO No.	22859, Item 30

2.

Motor Manufacturer	Peerless
Motor Serial No.	TM68900
Limitorque Order No.	3K3150A
Vermont Yankee PO No.	21948

3.

Motor Manufacturer	Porter - Peerless
Motor Serial No.	YM73198TN
Limitorque Order No.	3K8763R
Vermont Yankee PO No.	22859, Item 29

4.

Motor Manufacturer	Peerless - Winsmith
Motor Serial No.	NP87761
Limitorque Order No.	3P3964A
Vermont Yankee PO No.	25578

5.

Motor Manufacturer	Peerless - Winsmith
Motor Serial No.	NP87764
Limitorque Order No.	3P3964B
Vermont Yankee PO No.	22578, Item 2

During the NRC inspectors review of Vermont Yankee's response to IE Information Notice 87-08, he identified several motors which are not directly covered by the notice, but appear (visually) to have the same Nomex/Kapton insulation. The inspector questioned if the lead wire insulation is of the same or a different material and if it is covered by Limitorque testing.