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Mr. Karl Kniel	Florida Power & Light Company Miami, Florida Robert E. Uhrig	12/06/77
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DESCRIPTION

(1-P)

ENCLOSURE

Concerns the use of Kerite Insulated Cable for St. Lucie Unit No. 2.....

(5-P)

PLANT NAME: St. Lucie Unit No. 2
RJL 12/12/77

REPRO BALANCE

FOR ACTION/INFORMATION

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FPL
FLORIDA POWER & LIGHT COMPANY

December 6, 1977
L-77-363

Mr. Karl Kniel, Chief
Light Water Reactors, Branch #2
Division of Project Management
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Kniel:

Re: Use of Kerite Insulated Cable for
St. Lucie Unit No. 2
Docket No. 50-389

In Supplement No. 1 to the Safety Evaluation Report for St. Lucie Unit No. 2, your staff determined that the use of cross-linked polyethylene (CPLE) insulated cable identical to that of St. Lucie Unit No. 1 was acceptable in the underground duct banks at St. Lucie 2. The Unit 2 PSAR further states (Section 8.3.1.1.9) that use of any other insulating material will not be implemented without prior NRC staff approval.

Florida Power & Light Company proposes to improve on CLPE cable performance by using Kerite insulated cable for 600 V power and signal cables. Kerite insulation maintains the dry/wet/alternately wet and dry properties of CLPE while offering greatly enhanced fire retardancy capabilities.

Current schedules call for the cable to be on-site by November 1978 with an ordering date of early summer 1978. Bases for staff review and approval of the Kerite cable are contained in the attachment to this letter.

We request your approval of this cable and that you review the attachment as expeditiously as possible to support the above schedule. We will be pleased to meet with your staff to discuss the matter further.

Very truly yours,

Robert E. Uhrig
Vice President

REU/MV:ltm
Attachment

cc: Robert Lowenstein, Esq.

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ATTACHMENT
KERITE INSULATED CABLE

1.0 INTRODUCTION

The Staff in Supplement #1 to its Safety Evaluation Report at Section 8.3.1, dated 3 March 1976, discusses the qualification program for Class IE cable in the underground duct bank system. This program demonstrates the suitability of cable for operation in a wet, dry, and alternately wet and dry environment. Subsequent guidance on cable insulation properties has been provided by the Staff in RG's 1.120 and 1.131. These RG's indicate that cable insulations should comply with the fire retardancy requirements of IEEE-383-1974. To be responsive to the Staff's most recent guidance on cable insulation an evaluation was conducted to determine if a single cable insulation can provide suitable fire retardancy and wet/dry/alternately wet and dry properties. The results indicate that Kerite cables can acceptably accommodate both requirements. Accordingly Kerite insulated cable, in lieu of cross-linked polyethylene, will be utilized for 600V power and signal cable. The bases are provided infra.

2.0 HISTORICAL BACKGROUND

In the 1860's the compound Kerite was developed, which resulted in the first successfully developed insulated wire in this country. By 1868 at least 200 Kerite cable installations had been made in the United States, Canada, Panama and Egypt.

In November 1868, Dr. S. Morse stated with regard to Kerite cable that "It appears to me that you have discovered the most perfect as yet of all insulating substances for submarine cable ..." In 1869, Kerite insulated cable was installed under the Chicago River and by 1871 Kerite insulated cable was furnishing submarine service for the rivers near New York City. A 1,000,000 circular mill Kerite insulated power transmission submarine cable was laid in the Gowanus Canal in 1898.

In 1883 Kerite insulated cables were first installed on the New York City elevated railroads. Insulation tests on cable removed from the 6th Avenue elevated structure after 50 years of service indicated no appreciable electrical deterioration.

In 1908 Kerite insulated cable was placed alongside the Panama Canal and in 1914 30 miles of the cable were submerged in Gatun Lake upon completion of the canal. Part of this cable was still in service 60 years later having survived the severest conditions of the hot humid jungles of the tropics.

A railroad cable has been in continuous service for 70 years and two underground cables in Chicago for around 80 years.

The Kerite Company developed and manufactured 16 new Kerite insulated cable designs for the Manhattan Project at Oak Ridge. More than one million feet of cable were supplied and over ten thousand high-voltage connections made.

Kerite insulated cable has a 100 years plus history of providing reliable service in all types of environmental conditions. A consistent outstanding performance of the insulation is assured by the Kerite Company's quality assurance criteria. Whenever a new ingredient is added to Kerite to achieve an improvement in insulation performance, the insulation is subjected to a qualification test program. Insulation performance must be equal to or exceed the relevant performance in all respects of the original Kerite.

High temperature Kerite was introduced 10 to 12 years ago and fire retardant Kerite about 9 years ago. These cables retain the important properties of Kerite while achieving the ability to comply with IEEE-383 fire retardancy requirements. Power, single and multi-conductor control cables all pass the IEEE-383 ribbon burner test.

History to date indicates that Kerite insulated cable has demonstrated through considerable in situ experience its ability to accommodate all types of environmental conditions and has demonstrated its fire retardancy capability by passing the IEEE-383 test. Specific test data relating to fire retardancy and wet/dry/alternately wet and dry conditions are provided below.

3.0 QUALIFICATION TESTS

Tests were run to insure that the current Kerite formulations are equivalent to the prior Kerite in a wet environment.

In addition, cyclic wet and dry tests were run to compare these insulation formulations in a cyclic wet/dry environment. In all cases, the current formulation exceeded the characteristics of Kerite.

To demonstrate fire retardancy capability, the IEEE-383-1974 ribbon burner test, the IEEE-383-1974 burlap bag test, and the IPCEA S-19-81, NEMA WC-3, or ASTM D-2633 fire resisting tests were run. Cables using the current Kerite formulation successfully passed these tests.

3.1 Dry/Wet/Alternately Wet and Dry

An evaluation technique has been developed by The Kerite Company to compare their current Kerite formulation to the prior Kerite insulation with its time-proven service record.

The data developed demonstrates the newer insulation's superior water performance. Alternate wet and dry cycling tests have been performed which demonstrate that alternately wet and dry cycling is not as severe as continuously wet.

The monitoring to the effect of water on electrical properties showed the insulation resistance was a useful parameter in terms of comparing the later compounds with Kerite insulation. The rate of change of insulation resistance, rather than the absolute value of insulation resistance, is used.

Having identified the relevant aging factors to be time and water temperatures, the relationship between materials was selected to be based on the time to reach one-half of the original insulation resistance level. Other levels or parameters could have been selected; however, the 1/2 IR point was something achievable in reasonable time periods and representative of actual cable performance parameters. (It must be noted that achieving the 1/2 IR point does not constitute loss of cable function, it is merely a convenient test parameter commonly used for this type of comparative testing.)

The tests were performed with the outer jacket of the cable removed in order to eliminate its positive influence on the results. In actual service the cable jacket will aid in the cable's overall water performance.

As stated previously the current Kerite insulation was compared to Kerite, which has had an extended service history encompassing in excess of 100 millions of feet of many construction types in all environments, including wet, dry, and alternately wet and dry.

The attached figure, "Comparison of Prior Kerite Insulation with the Newer Kerite Insulation in Water," demonstrates conclusively that the newer Kerite insulations for power as well as signal cables are far superior to the prior Kerite. The results shown on this figure are very conservative when one considers that the insulation thickness tested on the prior Kerite cable was 78 mils, while that of the newer formulation was only 50 mils.

In addition, to further demonstrate that the alternate wet and dry condition is not a limiting condition, but is bounded by wet and dry performance, 3-1/2 day cycle tests were conducted. The accelerated test consisted on one sample of cable being placed continuously in 90°C water, and another sample cycled 3-1/2 days in 90°C water, followed by 3-1/2 days in room temperature air (approximately 22°C). Once again, the time it took for the cable to reach 1/2 of its insulation resistance was used as a basis for comparison. The results were that for a 30 mil thickness of insulation, the sample continuously in water took thirty days to reach 1/2 IR, while the cycled cable took 58 days to reach 1/2 IR for the signal cable insulation.

From the above tests and field experience, it can be concluded that the 600 volt power and signal cables purchased for St. Lucie 2 will perform their function in wet, dry, and alternately wet and dry conditions, and that cyclic conditions are less demanding on the insulation than the continuously wet condition.

3.2 Fire Retardancy

Kerite cable meets the vertical tray flame test requirements of IEEE 383-1974 for single and multiple conductor cable.

Test samples similar in construction to that to be used on St. Lucie Unit 2 were installed in a 12-inch wide, 3-inch deep, 11-foot high ladder tray and exposed to a flame source of 1500°F placed three inches away from the test samples in accordance with IEEE 383-1974, Paragraph 2.5.4.4. At the end of twenty minutes, the flame source was shut off and the cable was allowed to burn until it self-extinguished. Temperatures were measured by a thermocouple located 2-7/8" from the burner face. The test was repeated three times for reproducibility. Test samples that did not self-extinguish after removal of the flame source were allowed to continue to burn to determine the extent that the sample burned.

Test results for all aged and unaged cable samples demonstrate that all test samples were damaged to a height less than 8 feet, as required by IEEE 383-1974, Paragraph 2.5.4.2 and Paragraph 2.5.5.

A single unjacketed conductor from the signal cable were flame-tested to demonstrate the ability of the insulation to meet the flame-resisting test of IPCEA S-19-81. Test results indicated no burning of the flame indicator, approximately four inches of the insulation was consumed at the point of flame impingement with an additional one inch of charred insulation at each end and there was no persistence of flaming after removal of the burner flame. There was no propagation of the flame.

Flame tests on cable were also conducted, using a 24" x 24" x 9 oz. commercial grade burlap saturated with transformer oil as a fire source. The burlap was folded in accordance with Figure 2 of IEEE 383-1974 and immersed in a container of transformer oil for five minutes. It was allowed to drain in free air until the weight of the oil retained was 160 $\pm$ 5 grams. It was then fastened in place approximately two feet from the bottom of the tray and ignited. The cable showed no evidence of propagating a fire, from the area of the source.

Conclusion

Based on the long standing performance of Kerite insulated cable, comparative tests of current and prior Kerite formulations and the ability to pass industry fire tests, it is concluded that the current Kerite formulation strikes an optimum balance between fire and wet/dry/alternately wet and dry properties.

COMPARISON OF PRIOR KERITE INSULATION WITH

THE [redacted]ER KERITE INSULATIONS IN WATE[redacted]