UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

AUG 11 1982

AEOD/E234

MEMORANDUM FOR: Carlyle Michelson, Director
Office for Analysis and Evaluation
of Operational Data

THRU: Karl V. Seyfrit, Chief
Reactor Operations Analysis Branch
Office for Analysis and Evaluation
of Operational Data

Matthew Chiramal, Lead Engineer
Plant Systems Unit
Reactor Operations Analysis Branch

FROM: Frank Ashe
Plant Systems Unit
Reactor Operations Analysis Branch

SUBJECT: FAILURE IN A SECTION OF 4KV BUS CABLE MANUFACTURED BY OKONITE

References: (1) Duquesne Light Company, "Licensee Event Report: 82-004/03L-0 dated February 26, 1982," Plant Unit: Beaver Valley Power Station Unit No. 1, Docket No. 50-334.

(2) Okonite Engineering Report No. 358, Subject: Failure of Cable at Beaver Valley Nuclear Plant, dated March 26, 1982.

Reference 1 is a licensee event report for an event involving the failure of a 4KV bus cable which was manufactured by the Okonite Cable Company and installed approximately ten years ago in the Beaver Valley Power Station. The failure, as reported, occurred in a bus cable section between the 1C unit station service transformer secondary and the 1A bus supply circuit breaker. The 12 Okonite cables (four per phase) in the bus are routed through a Husky Cable Bus System supported in insulating clamping blocks in a covered cable tray type arrangement. Visual observations of the cables revealed that two were damaged to the extent of melting the aluminum conductor and that only two of the 12 cables appeared free of visible effects. In addition, there was some burning and melting of the cable tray side and bottom covers. As a result of this occurrence, ten three-foot lengths of cable in the area of the fault were provided to the manufacturer for testing and evaluation purposes.

Reference 2 is an engineering report written by the cable manufacturer which provides the test conducted, the results of the test conducted, and a statement concerning why this failure occurred. Since in two of the sections of cable severe burning had occurred which partially destroyed the conductor, electrical testing was only performed on the other remaining samples.

Five electrical tests were conducted on the remaining eight samples of cables. These tests consisted of a dc field proof test (20KV applied for five minutes), ac factory withstand test (13KV applied for five minutes), dc factory withstand test (35KV applied for 15 minutes), ac rapid rise to failure of 1KV/second, and a dc rapid rise to failure of 1KV/second. Test results for all eight samples were acceptable and dissection of the cable samples resulted in the finding that these samples were in excellent condition with no evidence of any general deterioration. However, the cause of failure was stated as unknown. The licensee has conducted a review of this occurrence which included the test and evaluation provided by the cable manufacturer and based on this review, does not plan to replace all of the associated cables but rather splice in similar cables only in the area of the section of fault cables.

Based on our review of this occurrence, the following information is provided. First, if the samples of cable tested are representative of the remaining cables installed in the station, this would suggest that the failure may have been due to external causes or a random failure rather than an inherent problem with the cable itself. Further, if an inherent problem existed with this type of cable, it seems reasonable to expect such a problem to be identified within the approximate ten year period which the cable has been installed. Also, in a broader context, it should be noted that this item was reported because the emergency diesel generator for the associated emergency bus was inoperable at the time due to modifications, and the corresponding alternate supply was unavailable because of the operation of the transformer differential current protection due to the faulted cable. Finally, based on our review of this occurrence, we believe that the actions to be taken by the licensee are appropriate.

Accordingly, we recommend that AEOD place this item on our "watch" list and if other similar type cables fail in safety-related applications, further followup, supplemented with appropriate recommendations, should be provided.

Frank Ashe

Frank Ashe
Plant Systems Unit
Reactor Operations Analysis Branch

Enclosures:
References 1 & 2

cc w/enclosures:
RHaynes, RI GWalton, IE
WTroskoski, IE PTam, NRR

Reference 1

Duquesne Light
435 Sixth Avenue
Pittsburgh, Pa.
15219

(412) 456-6000

DUQUESNE LIGHT COMPANY
Beaver Valley Power Station
Post Office Box 4
Shippingport, PA 15077

February 26, 1982
NDISS1:517

Beaver Valley Power Station, Unit No. 1
Docket No. 50-334, License No. DPR-66
LER 82-004/03L

Mr. R. C. Haynes, Regional Administrator
United States Nuclear Regulatory Commission
Region 1
631 Park Avenue
King of Prussia, Pennsylvania 19406

Dear Mr. Haynes:

In accordance with Appendix A, Beaver Valley Technical Specifications, the following Licensee Event Report is submitted:

LER 82-004/03L, Technical Specification 3.4.1.3, Reactor Coolant System-Shutdown.

Very truly yours,

H P Williams

H. P. Williams
Superintendent

Attachment

IE22
S1/1

cc: Director Of Management & Program Analysis
United States Nuclear Regulatory Commission
Washington, D. C. 20555

J. Hultz, Ohio Edison

Director, Office of Inspection and Enforcement Headquarters
United States Nuclear Regulatory Commission
Washington, D. C. 20555

D. A. Chaney, BVPS Licensing Project Manager
United States Nuclear Regulatory Commission
Washington, D. C. 20555

D. A. Beckman, Nuclear Regulatory Commission, BVPS Site Inspector

Mr. Alex Timme, CAPCO Nuclear Projects Coordinator, Toledo Edison

Records Center, Institute of Nuclear Power Operations, Atlanta, Georgia

G. E. Muckle, Factory Mutual Engineering, Pittsburgh

Arthur Alford, Stone & Webster/Boston

NRC FORM 366
(7-77)

LICENSEE EVENT REPORT

CONTROL BLOCK: | | | | | | | (1) (PLEASE PRINT OR TYPE ALL REQUIRED INFORMATION)

0 1	LICENSEE CODE: P A B V S 1 (2)	LICENSE NUMBER: 0 0 - 0 0 0 0 0 - 0 0 (3)	LICENSE TYPE: 4 1 1 1 1 (4) CAT: (5)

CON'T

0 1	REPORT SOURCE: L (6)	DOCKET NUMBER: 0 5 0 0 0 3 3 4 (7)	EVENT DATE: 0 1 2 7 8 2 (8)	REPORT DATE: 0 2 2 6 8 2 (9)

EVENT DESCRIPTION AND PROBABLE CONSEQUENCES (10)

0 2 On 1/27/82 at 1415 hours the backup RHR pump, [RH-P-1A], became unavail-
0 3 able when its normal AC power source was lost due to a fault in a section
0 4 of 4KV bus cable. The faulted area was between the 1C Unit Station Ser-
0 5 vice Transformer secondary and the 1A bus supply breaker. The No. 1 Emer-
0 6 gency Diesel Generator was also inoperable at this time for modifications.
0 7 Public health and safety was not jeopardized since the running pump,
0 8 [RH-P-1B], remained in service for core decay heat removal.

	SYSTEM CODE	CAUSE CODE	CAUSE SUBCODE	COMPONENT CODE	COMP. SUBCODE	VALVE SUBCODE
0 9	E B (11)	E (12)	A (13)	E L E C O N (14)	Z (15)	Z (16)

(17) LER/RO REPORT NUMBER	EVENT YEAR		SEQUENTIAL REPORT NO.		OCCURRENCE CODE	REPORT TYPE		REVISION NO.
	8 2	—	0 0 4	/	0 3	L	—	0

ACTION TAKEN	FUTURE ACTION	EFFECT ON PLANT	SHUTDOWN METHOD	HOURS (22)	ATTACHMENT SUBMITTED	NPRD-4 FORM SUB.	PRIME COMP. SUPPLIER	COMPONENT MANUFACTURER
X (18)	A (19)	Z (20)	Z (21)	0 0 0 0	Y (23)	N (24)	A (25)	0 0 4 0 (26)

CAUSE DESCRIPTION AND CORRECTIVE ACTIONS (27)

1 0 The cause for the cable failure is unknown. Okonite, the cable vendor,
1 1 has been sent samples of the damaged section for analysis. Any defini-
1 2 tive conclusions about the failure mode from this examination will be
1 3 submitted as part of a follow-up report. Power to [RH-P-1A] was re-
1 4 stored on 1/28/82 at approx. 0400 hours using temporary cable at the switchgear.

	FACILITY STATUS	% POWER	OTHER STATUS (30)	METHOD OF DISCOVERY	DISCOVERY DESCRIPTION (32)
1 5	G (28)	0 0 0 (29)	Design Modification Outage	A (31)	Alarm indication

	ACTIVITY RELEASED	CONTENT OF RELEASE	AMOUNT OF ACTIVITY (35)	LOCATION OF RELEASE (36)
1 6	Z (33)	Z (34)	N/A	N/A

PERSONNEL EXPOSURES

	NUMBER	TYPE	DESCRIPTION (39)
1 7	0 0 0 (37)	Z (38)	N/A

PERSONNEL INJURIES

	NUMBER	DESCRIPTION (41)
1 8	0 0 0 (40)	N/A

LOSS OF OR DAMAGE TO FACILITY (43)

	TYPE	DESCRIPTION
1 9	Z (42)	N/A

PUBLICITY

	ISSUED	DESCRIPTION (45)	NRC USE ONLY
2 0	N (44)	N/A	

8203080456 820226

NAME OF PREPARER W. S. Lacey PHONE 412-643-5525

Attachment to LER 82-004/03L
Beaver Valley Power Station
Duquesne Light Company
Docket No. 50-334

On 1/27/82 at 1415 hours a fire alarm was received in the switchgear area. Thirty seconds later the 1C Unit Station Service Transformer supply breaker tripped on transformer differential current, the result of a fault in a 4KV bus cable. Both the 1A normal and 1AE emergency busses were deenergized. Emergency Diesel Generator No. 1, which is the backup power supply for the 1AE emergency bus, was out of service for modifications. The loss of the 1AE emergency bus resulted in the loss of the backup residual heat removal pump [RH-P-1A]. Due to single failure considerations this pump was required operable by Tech. Spec. 3.4.1.3. RHR pump [RH-P-1B] was the in-service pump for core decay heat removal at the time.

The Okonite bus cable section that faulted was between the 1C Unit Station Service Transformer secondary and the 1A bus supply circuit breaker. The 12 Okonite cables (4 per phase) in the bus are routed through a Husky Cabl-Bus System supported in insulating clamping blocks in a covered cable tray type arrangement. Visual observations of the cables revealed two damaged to the extent of melting the aluminum conductor. Other cables in the cable tray had varying degrees of charred jacketing. Only two cables appeared free of visible effects. There was also some burning and melting of the cable tray side and bottom cover. It was concluded as part of the on-site inspection made by an Okonite representative that it would be difficult to reconstruct the mechanism of failure or determine which cable failed first due to the extent of damage. Samples of the faulted area were taken, however, and given to their representative for testing purposes. If the failure mode can be determined from their tests, the results of their examination will be submitted as a follow-up report.

Possible repair methods have also been discussed. Both the splicing in of identical cable which exists in stock and the replacement of the damaged section with equivalent cable are being considered.

Reference 2

March 26, 1982

ENGINEERING REPORT NO. 358

FAILURE OF CABLE AT BEAVER VALLEY NUCLEAR PLANT

SUBJECT:

Husky Products - Duquesne Light Company - Complaint No. 07-021682.

CONSTRUCTION:

1/C - 1000 MCM, 61 strand aluminum, extruded strand screen, .090 X-Olene, semicon tape, .005 bare copper tape, .080 Okoprene, 5kV. The cable is not a Class 1E cable.

DISCUSSION:

The above construction was installed approximately ten years ago and failed recently while under load, phase to phase and phase to ground. At a meeting at Duquesne (JSL) on March 25, 1982, it was determined that the two faulted cables were next to each other in the bus and that one cable failed phase to ground and that the arc burned the second cable resulting in the phase to phase fault. Ten three foot lengths were returned by the customer as shown below.

(1) Two lengths from section A1 (TS7 and TS9). There was no fault in either length.

(2) Three lengths from section A3 (TS1, TS3 and TS5). Only sample TS3 contained fault.

(3) Three lengths from section B3 (TS6, TS8 and TS10). Only sample TS8 contained fault.

(4) Two lengths from section A1 (TS7 and TS9). There was no fault in either length.

Both samples TS8 and TS3 contained what appeared to be typical ac service faults. In each sample severe burning had occurred which partially destroyed the conductor. Due to the condition of these two lengths, the following electrical tests could only be done on the ~~either~~ other remaining samples.

Sample (Section)	DC Field Proof Test 20kV-5 min.	AC Factory Withstand 13kV-5 min.	DC Factory Withstand 35kV-15 min.	AC Rapid Rise to Failure 1kV/sec	DC Rapid Rise to Failure 1kV/sec
TS1 (A3)	Passed	Passed	Passed	---	Terminal Flashover 160kV
TS2 (C3)	Passed	Passed	Passed	Terminal Flashover 92kV	---
TS4 (C3)	Passed	Passed	Passed	---	Terminal Flashover 152kV
TS5 (A3)	Passed	Passed	Passed	Terminal Failure 107kV	---
TS6 ((B3)	Passed	Passed	Passed	Terminal Flashover 99kV	---
TS7 (A1)	Passed	Passed	Passed	Terminal Flashover 96kV	---
TS9 (A1)	Passed	Passed	Passed	---	Terminal Flashover 162kV
TS10 (B3)	Passed	Passed	Passed	---	Terminal Flashover 150kV

DISSECTION:

After all electrical testing was completed, all ten samples were dissected. The semicon tape of samples TS8 and TS3 retained its conductive properties even though it had lost much of its mechanical strength from the severe burning. The semicon tape on all other samples was normal. A one inch section was then taken from each sample and sliced longitudinally to inspect for any voids or contaminants which may have been present. No abnormalities could be seen in the insulation. The strand screens on all the samples were found to be conducting. In addition measurements were taken from all lengths of the dielectric wall thickness (Actual: min.119 mils, max. 123 mils) and of strand screen thickness (Actual: min. 19 mils - max. 23 mils). Both the insulation wall and strand screen dimensions are well within minimum specification.

Thirty 25 mil thick radial wafers (three from each sample) were sliced to more closely examine the insulation and to inspect for evidence of electrochemical treeing. After the wafers were dyed no evidence of treeing could be found and again no abnormalities were seen in the insulation or the strand screen. Four 8" samples were subjected to a solvent extraction test, to check for percent cure. Data appears below.

Sample Designation	% Solvent Extraction
TS7 (A1)	18.4
TS3 (A3)	18.5
TS8 (B3)	18.8
TS4 (C3)	18.7

The solvent extraction test is per AEIC 5. All results are well within the AEIC maximum limit of 30%.

CONCLUSION:

Based on the tests performed at both the Engineering and Research facilities, the electrical and cure properties of this cable appear to be normal. In our evaluation one sample (TS5) had a terminal failure at 107kV, but this does not constitute any reason for the fault which occurred as this is more than 35 times the operating voltage. The cure properties are well within the AEIC maximum limit of 30% therefore, the cable is well cured.

Since we found the cable examined to be in excellent condition with no evidence of any general deterioration, and if the eight no faulted samples examined are representative of the remaining cable of this type in the bus at Beaver Valley, we recommend that the cables be left in service. We see no need to replace cable.

We suggest that the jackets on cables near the faulted cables be examined for charring. If 2/3 of the jacket thickness remains uncharred, we see no reason to take any action. If charring is extensive and no shield damage is involved, a jacket repair with neoprene jacketing tape (Okonite No. 35) will serve.

Since the severe burning that occurred destroyed all possible evidence, the cause of the failure is unknown.

J. S. DiMeglio / row

J. S. Lasky

JSD/JSL/row

DISTRIBUTION:

R. C. Agnelly (10)
R. G. Feller
F. J. Krajick
D. F. Randall
J. S. DiMeglio

102 | 01 | 002 | 001 | 82 2 1 | 101 | 44398

ENGINEERING MEMORANDUM
DUQUESNE LIGHT COMPANY
BEAVER VALLEY POWER STATION UNIT 1

015 N/A D.C.P. | CHARGEABLE? | CHARGED TO:
102 II CAT. ☐ YES
103 N/A C.O. ☐ NO

TO: J. STARR | RESPONSE DUE: 2-4-82

TITLE: I.C. SS1 TRANSFORMER 4KV FEEDER FAILURE

SUBJECT:

VISIBLE FAULT DAMAGE CAN BE SEEN ON THE 4KV FEEDERS FROM IC SS TRANSFORMER. REQUEST ENGINEERING GIVE DIRECTION FOR THE NEEDED TESTS AND REPAIRS.

CC: NELSON TONET

REFERENCES: MWR 826082

PREPARED BY: Frank S. Curl | EXTENSION: 5169

APPROVED BY: R Shine | DATE: 2/1/82

TO: R.J. Swiderski | ASSIGNED TO: HJ Kahl 2/2/82 | DEPARTMENT:

RESPONSE:

Per telecon with Roger Agnelli of Okonite they recommend the following:

1. Repair all visibly damaged cable by splicing. They recommend using their splice kit No. 604-91-1370 except use a Burndy compression connector.
2. High-pot test all cables in the tray at 20 KVDC for 5 minutes. The tray covers should be in place during this test.
3. Use identical cable left over from original installation for repair. This should still be good cable. High-pot cable before installation if desired. If there is any moisture in the cable, it can be purged with nitrogen.
4. If sufficient spare cable is available, make one splice per cable to be (cont.)

REFERENCES: Telecon w/R Agnelli (Okonite) 2/4/82
Husky Bus Instr. Book 1.32-90A

FEB 05 1982

PREPARED BY: H J Kahl | EXTENSION: 5231

ENGR. CHG. NOTICE: | APPROVED BY: James F. Shaw 2/5/82 | DATE:

KEY CODE 14

DISTRIBUTION

X F.S. Curl ✓

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						X		N.R. Tonet
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FOR INFORMATION ONLY

FORM DLR-A264 (2-81)

repaired and replaced from point of damage to the 1A switchgear compartment. Otherwise, replace only the damaged section of cable using two splices per cable.

5. Stagger splices to avoid overcrowding in the tray.

6. Cut out the failed section of cable for analysis by Okonite.