INSULATION WALL THICKNESS MEASUREMENT

OF SILICONE RUBBER CABLES

AT IDENTIFIED FAILURE POINTS

W. G. Jones

W. G. Jones, Engineer

J. B. Ragsdale, QA/QC

R. L. Morley, Chief, CLSB

INTRODUCTION

On Tuesday, November 17, 1987, Brian Reagan, Division of Nuclear Engineering (DNE) telephoned the Central Laboratories Services Branch (CLSB) and requested support in testing silicone rubber cable. The testing was to be performed on cables manufactured by two vendors, Rockbestos and AIW. All cables tested had been installed , tested and failed at Sequoyah Nuclear Plant.

TEST EQUIPMENT

Von Hi-Pot Test Set, US TVA 259106
Reichert-Jung Optical Microscope, US TVA 502536
Calipers, US TVA 902931

TEST REQUIREMENTS

There were two basic test requirements for this test. The CLSB was to locate the points in each cable where each had failed and remove them. The next step was to mount the fault specimens such that each fault could be examined with the microscope, photograph the failure points and measure the remaining insulation wall thickness.

TEST RESULTS

There were three cables provided to the CLSB for testing. One cable was made up of two separate conductors while the other two cables were single conductors. Due to the removal process from the power plant some of the conductors were cut into pieces. Below is a breakdown of cable number, conductor identification and the number of pieces tested.

Cable Number	Conductor I.D.	Number of Test Pieces	Manufacturer
2V5662B	RHVBN	Two	AIW
2B5682A	RHVA1, RHVA3	Four, 2 separate conductors	AIW
2B1223A	VGM3	One	Rockbestos

The first task was to locate the points where the failures had occurred. Two methods of locating the failures were attempted. The first method failed to locate these points. This method used the hi-pot test set to establish a high voltage potential on the cable sample, in air, and a "glow stick" was used to search for the failure. The glow stick has a special lamp installed in it such that under certain conditions; i.e., a fault in cable insulation, it will sense the leakage at the fault and glow. However, after trying this technique on two samples it was determined that to get the desired results the voltage on the cable would have to be elevated to higher than acceptable levels. This method was discontinued. The voltage applied in this method was never elevated above 10,000 V dc.

The other method utilized was to perform a dc hi-pot test on each sample under water. The maximum voltage applied to all samples was 9,600 V dc. Some samples were able to withstand this voltage while others could not. This method proved to be the best in locating the failure points.

After locating all of the faults in the test specimens each was removed and tagged for identification. Each fault specimen was then photographed under the microscope to record the visual appearance of the fault and to measure the remaining insulation wall thickness around the fault.

Listed below are the results of this method of testing. Table I contains the remaining insulation wall thickness data.

Rockbestos Cable #2V1223A, Conductor #VGM3. This was a single conductor cable and single piece sample. This sample never sustained 9,600 V. At the 2,000 V level the leakage current went to full scale. A single failure was noted, tagged and removed from the cable. It was tagged as microphoto sample #5.

AIW Cable #2V5662B, Conductor RHVBN. This was a single conductor cable and was delivered to the CLSB in 2 pieces. Two points of failure were detected; one on each of the pieces tested. One fault was located between condulets #5 and #6. This fault was removed, tagged and labeled microphoto sample #1. This section of the cable never sustained the 9,600 V before the fault was located. The other piece of this conductor passed the hi-pot test. At 9,600 V dc the 1 and 5 minute leakage current readings were approximately 0-1 microamps. At one end of the cable, labeled condulet #4, a "knicked spot" was noticed. If this spot was put in the water a fault occurred. If it was tested out of the water, and dry, no fault was observed. This fault was removed, tagged and labeled microphoto sample #2.

AIW Cable #2V5682A, Conductor RHVA1. This was the first of two conductors in this cable that was tested. It was delivered to the CLSB in 2 pieces. Each piece passed the 9,600 V dc hi-pot test with the maximum leakage current being 5.5 microamps for the 5 minute reading. It should be noted that a 6-inch piece was removed from one end of one of the pieces and visually examined for possible damage. None was found. This 6-inch piece came from what would have been the middle of the original conductor.

AIW Cable #2V5682A, Conductor RHVA3. This was the second of two conductors in this cable that was tested. It was delivered to the CLSB in 2 pieces. One section of this conductor passed the 9,600 V dc hi-pot test. The leakage current readings at 1 and 5 minutes were 12-13 microamps. The other piece of this conductor failed the hi-pot test. A fault was located, tagged and removed from this piece and labeled microphoto sample #3. On the tagged end of this piece several "nicks or cuts" were observed. These were approximately 3-5 inches from the tagged end of the piece. This was removed, tagged and labeled microphoto sample #4.

The process of measuring the remaining insulation wall thickness was the same as used in previous tests performed by the CLSB on this type cable. The optical microscope used has an option which allows a linear measurement scale to overlay onto the slide being viewed. This allows a direct measurement of thickness to be made by the viewer.

The method of preparing the fault specimens was slightly different for this test. After each fault specimen was removed from the conductor a measurement of the distance from one end of the specimen to the fault point was made. The specimen then was mounted in an epoxy block for handling purposes, and the end that was measured was left exposed on one face of the block. This end was flush with the face of the epoxy block. Through an iterative measurement/grinding process the fault specimen was slowly ground down to the point where the fault was located. At this time photographs were taken and the remaining insulation wall thickness measurement was made.

Summary

All dc hi-pot testing was witnessed by Mr. Reagan of DNE. All fault specimen removal, tagging, and insulation wall thickness measurements were witnessed by Mr. Don Arp of DNE and Mr. Fred Sittason of Wyle Laboratory, Huntsville, Alabama. Table I contains the insulation wall thickness measurement data. A copy of all photographs taken was made available to the DNE staff at the conclusion of the testing.

The CLSB will maintain the cable samples for 90 days at which time, unless otherwise directed, they will be disposed of. If you have any questions regarding this report please telephone Glen Jones, CLSB, extension 4219-C.

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NOTE: All measurements are made along the radial axis from the point on the conductor where the failure initiates.

Manufacturer	Microphoto Sample #1	Conductor Number	Remaining Wall Thickness (mil)
AIW	1	RHVBN	21.2
AIW	2	RHVBN	51.5
AIW	3	RHVA3	53.8
AIW	4	RHVA3	*
Rockbestos	5	VGM3	48.3

*NOTE: No defect located; i.e., complete hole through the insulation.

TABLE I