SECTION VI

VOLTAGE WITHSTAND TEST AND POST-TEST INSPECTION

SECTION VI

VOLTAGE WITHSTAND TEST AND POST-TEST INSPECTION

1.0 REQUIREMENTS

1.1 Voltage Withstand Test

The test specimens shall be subjected to a Voltage Withstand Test as specified in Paragraph 3.12 of Section VII. The Voltage Withstand Test shall be performed for margin assessment.

1.2 Post-Test Inspection

The test specimens shall be subjected to a Post-Test Inspection upon completion of the Voltage Withstand Test. The Post-Test Inspection shall be performed as specified in Paragraph 3.13 of Section VII.

2.0 PROCEDURES

2.1 Voltage Withstand Test

The test specimens of Cable Trays A and E were removed from the perforated steel bottoms of the cable trays by cutting the Tefzel cable ties. The curved section of each test specimen was individually straightened prior to wrapping the test specimens around metal mandrels. The test specimens were secured to the metal mandrels in a configuration which allowed the lead ends to remain elevated above the middle sections of each specimen. Photographs are presented in the Appendices of this Section. The test specimens were grouped and mounted to the metal mandrels as follows:

Test Specimen	Mandrel Size (outer diameter)
RWC-S-A.40, RWC-S-B.40, and RWC-S-C.40	8.63 inches
RWC-S-D.40 and RWC-S-E.40	8.63 inches
ANA-S-A.40 and ANA-S-B.40	8.88 inches
ANA-S-C.40, ANA-S-D.40, and ANA-S-E.40	9.0 inches

The test specimens, as mounted to the metal mandrels, were immersed in tap water for performance of the Voltage Withstand Tests. The lead ends of each test specimen were suspended out of the tap water. One lead end of each test specimen was individually connected to the DC Hi-Pot device and the test voltage was increased at a constant rate to 6600 VDC. Each test specimen was held at 6600 VDC and the leakage current between each specimen and ground was recorded every minute for five minutes. Test specimens that would not maintain 6600 VDC were held at the maximum current of the DC Hi-Pot device (10 milliAmps) and the applied DC voltage was recorded every minute for five minutes.

2.0 PROCEDURES (Continued)

2.2 Post-Test Inspection

Upon completion of the Voltage Withstand Test, the test specimens were subjected to a Post-Test Inspection. The test specimens were visually inspected and photographed. Test specimen conditions were noted and recorded.

3.0 RESULTS

The test specimens were subjected to the Voltage Withstand Tests and Post-Test Inspection of Paragraph 2.0 and met the requirements of Paragraph 1.0. During the application of each test specimen to the metal mandrels, cracking and popping sounds were heard as the test specimens were physically bent around the mandrel. A determination could not be made as to whether the audible sounds were a result of silicone rubber insulation breaking or braided jacket material separating from the silicone rubber insulation. During the Voltage Withstand Test, the following abnormal conditions were noted:

> RWC-S-A.40 developed breakdowns at the lead end of the test specimen that was connected to the DC Hi-Pot device (positive lead). The breakdowns occurred at the water level and at two inches below the water level. The breakdowns occurred as the voltage was being raised from 0 VDC to 6600 VDC. The test specimen was able to maintain a maximum of 750 VDC over the five-minute period of the test.
>
> RWC-S-B.40 was noted to have severe voltage fluctuations while raising the voltage to, and holding at, 6600 VDC. The voltage fluctuations were intermittent and were not attributable to excessive leakage currents.
>
> RWC-S-C.40 exhibited arcing and smoke residue at a point approximately three inches from the Raychem tubing splice connection (out of the water). The area of arcing was on the lead end away from the DC Hi-Pot connection and self-extinguished after approximately three minutes. The 6600 VDC applied voltage was maintained throughout the test.
>
> RWC-S-D.40 developed a breakdown as the applied voltage reached 4000 VDC. From the time of breakdown, the test specimen maintained a maximum of 700 VDC during the five minute test. The breakdown occurred in the area of TVA applied identification tape and was situated approximately one inch below the surface of the water.
>
> RWC-S-E.40 developed a breakdown as the applied voltage reached 5000 VDC. From the time of breakdown, the test specimen maintained a maximum of 1000 VDC during the five-minute test. The breakdown occurred in the area of TVA applied identification tape and was situated approximately eight inches below the surface of the water.

3.0 RESULTS (Continued)

Observations recorded during the Post-Test Inspection are presented in the following paragraphs.

RWC-S-A.40 was noted to have rust on what was the bottom side of the test specimen when mounted on the cable tray. The rust had impregnated the jacket material and left permanent marks in every area where the test specimen had made contact with the perforated steel bottom of the cable tray. The rust that had migrated onto the braided asbestos jacket material left the appearance of a flattened semi-smooth surface in the area where contact had been made with the metal cable tray.

RWC-S-B.40 and RWC-S-C.40 were noted to exhibit the same rust markings as those described in the previous paragraph. The braided jacket material of RWC-S-B.40 was a lighter shade of gray than the RWC-S-A.40 test specimen. The braided jacket material of RWC-S-C.40 exhibited a dark green-gray color. Both test specimens exhibited the same worn appearance as discussed in the previous paragraph.

RWC-S-D.40 and RWC-S-E.40 were noted to exhibit the same rust markings as those described for Test Specimen RWC-S-A.40. The appearance of both test specimens was worn as described in the previous paragraphs. RWC-S-D.40 jacket material exhibited a darker shade of green-gray color than RWC-S-C.40, whereas RWC-S-E.40 jacket material was a dark black color.

ANA-S-A.40 was noted to have significantly less rust deposits on the braided jacket material than the corresponding Rockbestos test specimens. The braided jacket seemed to have "shed" a very thin layer of material that was ash colored. Sections of the test specimen jacket material that were not ash colored were very black.

ANA-S-B.40, ANA-S-C.40, ANA-S-D.40, and ANA-S-E.40 were noted to have exhibited the same resistance to rust as discussed in the previous paragraph. All of the specimens maintained an ash coloring over the majority of the cable lengths. The physical condition of the specimens appeared to be very good.

The approximate outer diameters of each test specimen were measured and are as listed below:

RWC-S-A.40	0.252"	ANA-S-A.40	0.310"
RWC-S-B.40	0.239"	ANA-S-B.40	0.273"
RWC-S-C.40	0.245"	ANA-S-C.40	0.293"
RWC-S-D.40	0.241"	ANA-S-D.40	0.286"
RWC-S-E.40	0.262"	ANA-S-E.40	0.300"

Photographs and data recorded during this phase of the test program are presented in Appendices I through III of this Section as noted below:

- Appendix I contains Photographs VI-1 through VI-8 which show the test specimens during the Voltage Withstand Test and the Post-Test Inspection.

3.0 RESULTS (Continued)

- Appendix II contains the Data Sheets generated during the Voltage Withstand Tests.
- Appendix III contains the Instrumentation Equipment Sheet generated for the Voltage Withstand Test.

APPENDIX I

PHOTOGRAPHS

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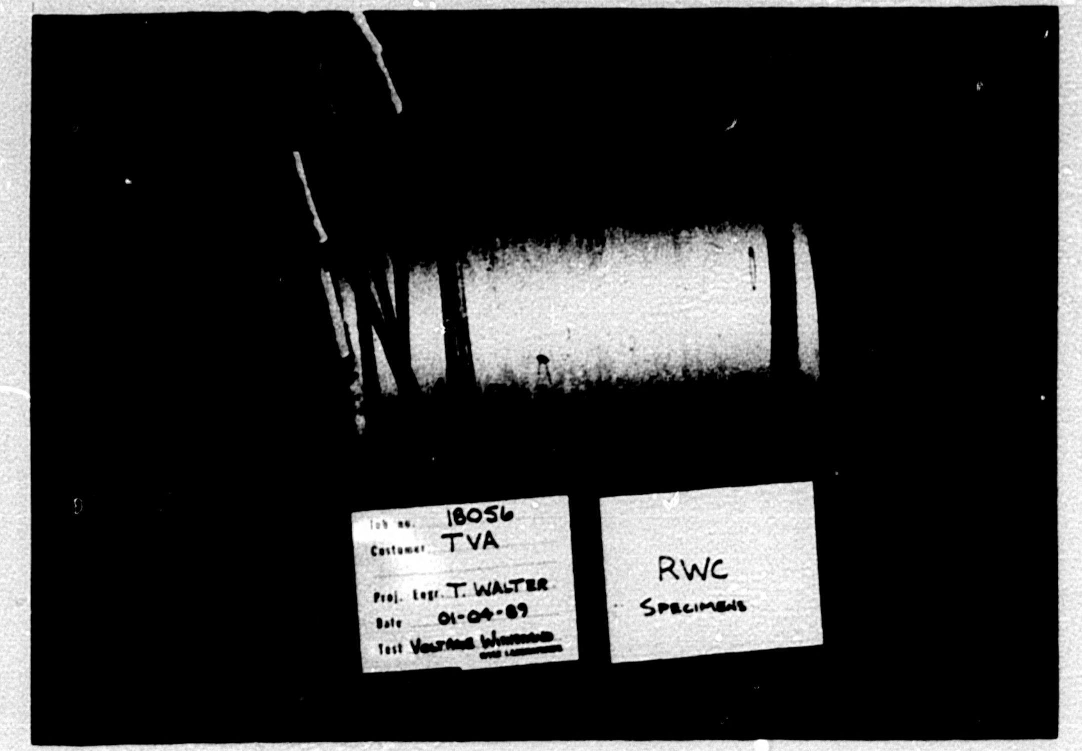
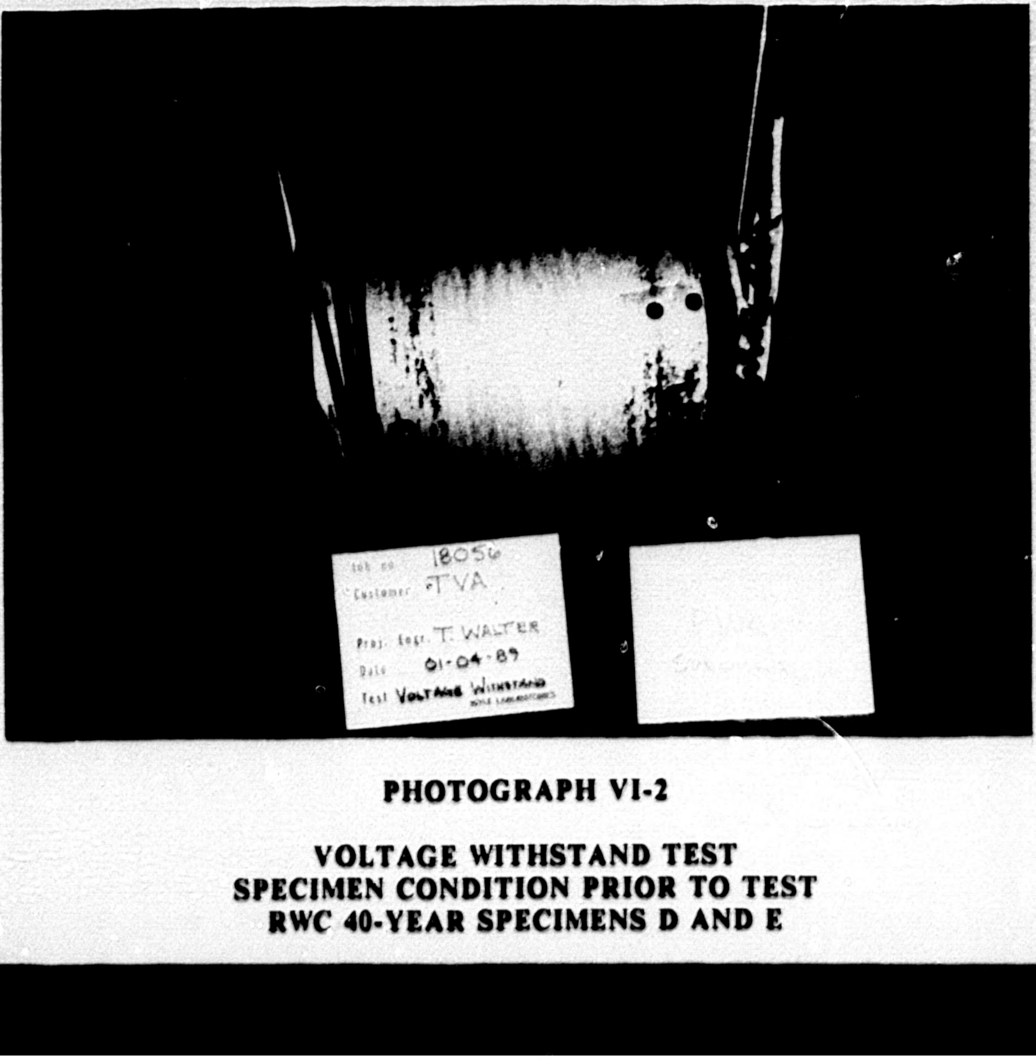


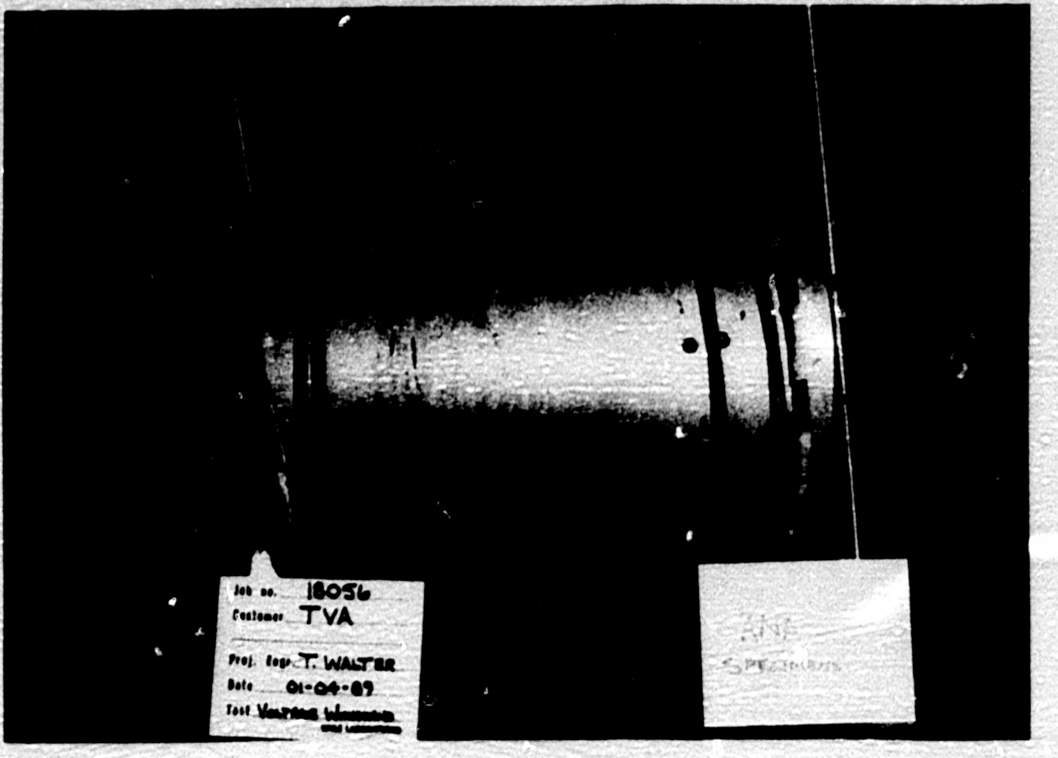
PHOTOGRAPH VI-1

VOLTAGE WITHSTAND TEST
SPECIMEN CONDITION PRIOR TO TEST
RWC 40-YEAR SPECIMENS A, B, AND C



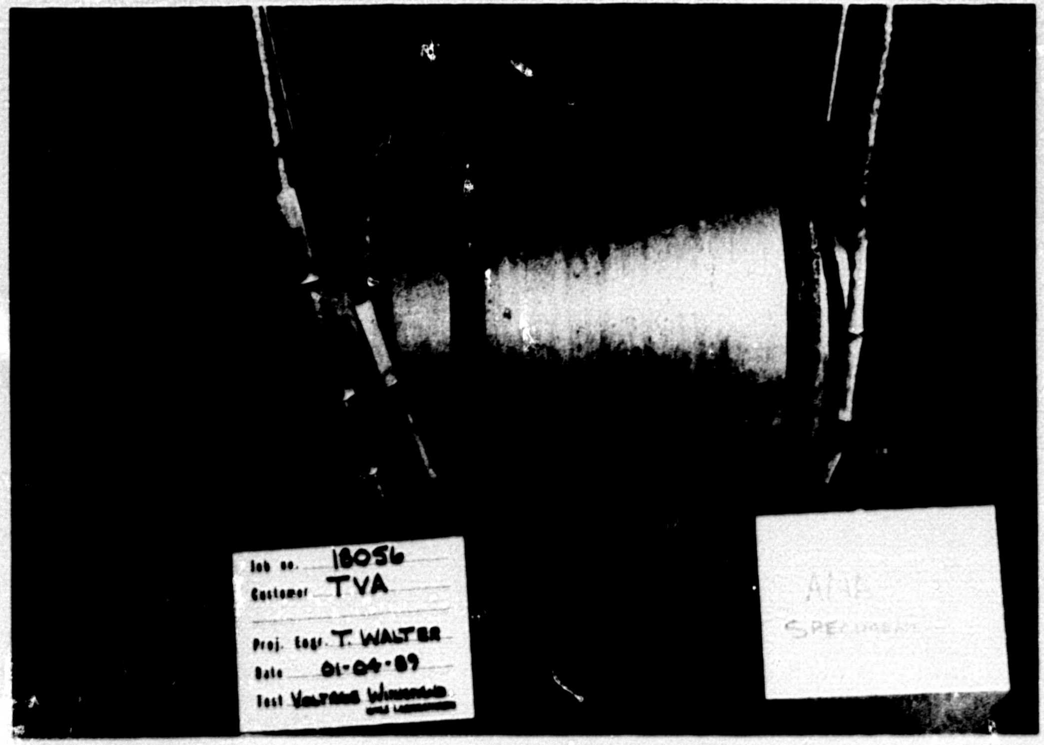
PHOTOGRAPH VI-2

VOLTAGE WITHSTAND TEST
SPECIMEN CONDITION PRIOR TO TEST
RWC 40-YEAR SPECIMENS D AND E



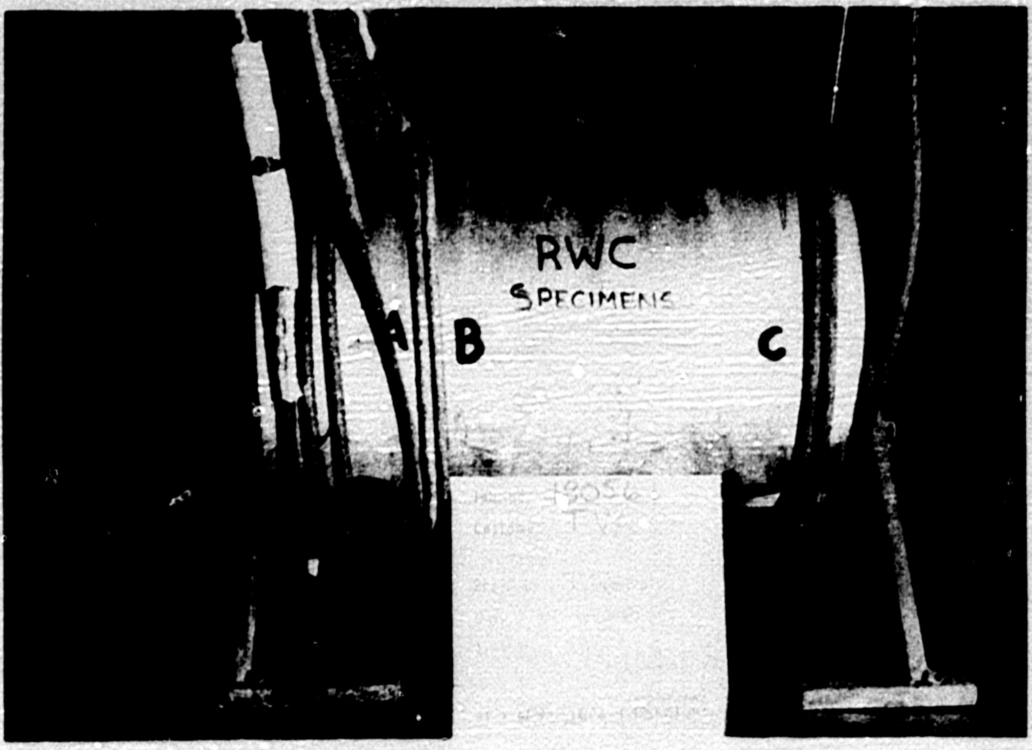
PHOTOGRAPH VI-3

VOLTAGE WITHSTAND TEST
SPECIMEN CONDITION PRIOR TO TEST
ANA 40-YEAR SPECIMENS A AND B



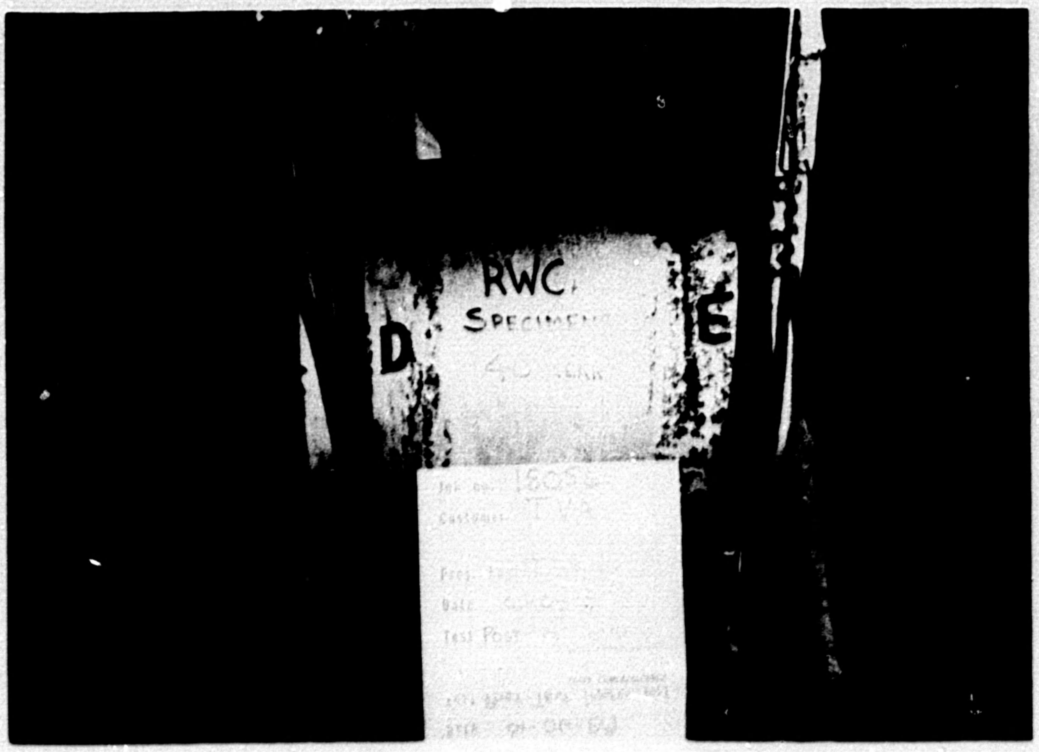
PHOTOGRAPH VI-4

VOLTAGE WITHSTAND TEST
SPECIMEN CONDITION PRIOR TO TEST
ANA 40-YEAR SPECIMENS C, D, AND E



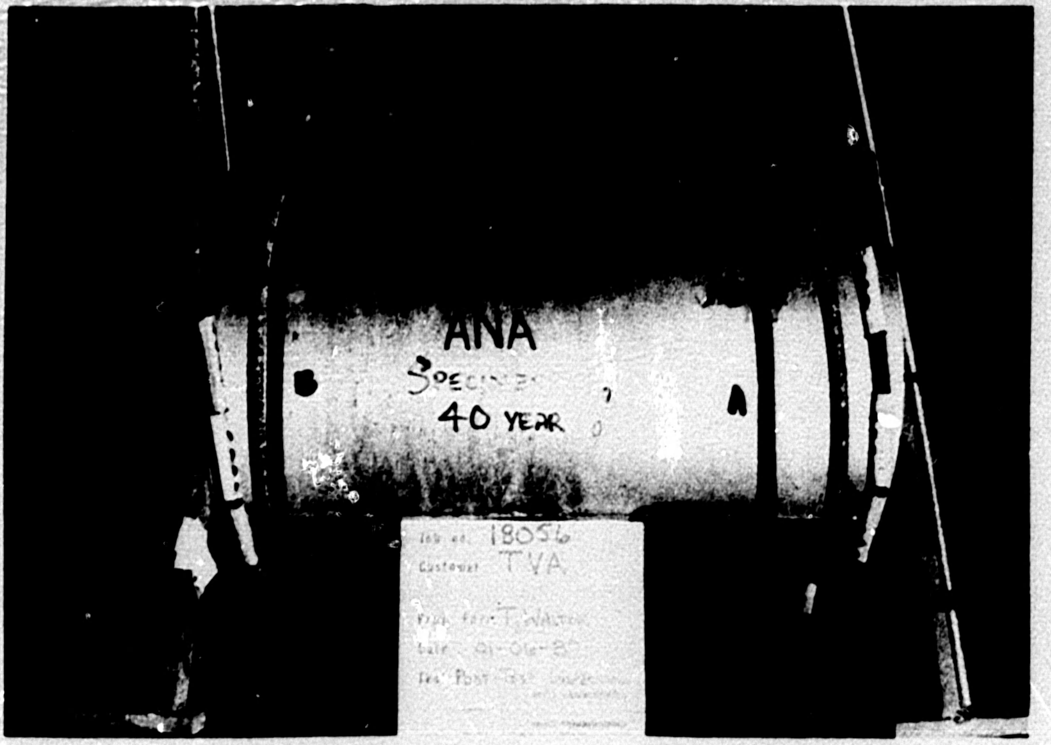
PHOTOGRAPH VI-5

POST-TEST INSPECTION
RWC 40-YEAR SPECIMENS A, B, AND C



PHOTOGRAPH VI-6

POST-TEST INSPECTION
RWC 40-YEAR SPECIMENS D AND E



PHOTOGRAPH VI-7

POST-TEST INSPECTION
ANA 40-YEAR SPECIMENS A AND B

PHOTOGRAPH VI-8

POST-TEST INSPECTION
ANA 40-YEAR SPECIMENS C, D, AND E

APPENDIX II

DATA SHEETS

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DATA SHEET

WYLE LABORATORIES

Customer Tennessee Valley Authority
Specimen Silicone Rubber Insulated Cables
Part No. Various
Spec. WLQP 18057-00, IPR 01
Para. 3.12
S/N Listed
GSI N/A

Amb. Temp. 64°F
Photo No
Test Med. Water
Specimen Temp. Ambient

Job No. 18056
Report No. 18056-1
Start Date 01-04-89

Test Title Voltage Withstand Test

Specimen	Applied Voltage	Time (minutes)	Leakage Current
RWC-S-A.40	600 VDC	1	10mA
	600 VDC	2	10mA
	750 VDC	3	10mA
	750 VDC	4	10mA
	750 VDC	5	10mA
RWC-S-B.40	6.6 KVDC	1	.5mA
	6.6 KVDC	2	.43mA
	6.6 KVDC	3	.41mA
	6.6 KVDC	4	.38mA
	6.6 KVDC	5	.38mA
RWC-S-C.40	6.6 KVDC	1	.34mA
	6.6 KVDC	2	.28mA
	6.6 KVDC	3	.22mA
	6.6 KVDC	4	.34mA
	6.6 KVDC	5	.16mA

Tested By D. Compton Date: 1/4/89
Witness N/A Date:
Sheet No. 1 of 4
Approved Robert [illegible] White 01-04-89

Notice of Anomaly NONE

Wyle Form WH 614A, Rev. APR 84

DATA SHEET

WYLE LABORATORIES

Customer Tennessee Valley Authority
Specimen Silicone Rubber Insulated Cables
Part No. Various
Spec. WLQP 18057-00, IPR 01
Para. 3.12
S/N Listed
GSI N/A
Amb. Temp. 64°F
Photo No
Test Med. Water
Specimen Temp. Ambient
Job No. 18056
Report No. 18056-1
Start Date 1/4/89

Test Title Voltage Withstand Test

Specimen	Applied Voltage	Time (minutes)	Leakage Current
RWC-S-~~D~~E.40 DC	750VDC	1	10mA
	1.0KVDC	2	10mA
	1.0KVDC	3	10mA
	1.0KVDC	4	10mA
	1.0KVDC	5	10mA
RWC-S-~~E~~D.40	500VDC	1	10mA
	600VDC	2	10mA
	700VDC	3	10mA
	600VDC	4	10mA
	600VDC	5	10mA
ANA-S-A.40	6.6KVDC	1	.1mA
	6.6KVDC	2	.08mA
	6.6KVDC	3	.06mA
	6.6KVDC	4	.08mA
	6.6KVDC	5	.08mA

Tested By D Compton Date: 1/4/89
Witness N/A Date:
Sheet No. 2 of 4
Approved Robert W.O Walton 01-04-89

Notice of Anomaly NONE

DATA SHEET

WYLE LABORATORIES

Customer Tennessee Valley Authority

Specimen Silicone Rubber Insulated Cables

Part No. Various

Spec. WLQP 18057-00, IPR 01

Para. 3.12

S/N Listed

GSI N/A

Amb. Temp. 64°F

Photo No

Test Med. Water

Specimen Temp. Ambient

Job No. 18056

Report No. 18056-1

Start Date 1/4/89

Test Title Voltage Withstand Test

Specimen	Applied Voltage	Time (minutes)	Leakage Current
ANA-S-B.40	6.6~~KVAC~~ DC KVDC	1	.1mA
	6.6KVDC	2	.08mA
	6.6KVDC	3	.06mA
	6.6KVDC	4	.06mA
	6.6KVDC	5	.06mA
ANA-S-C.40	6.6 KVDC	1	.04mA
	6.6KVDC	2	.06mA
	6.6KVDC	3	.05mA
	6.6KVDC	4	.04mA
	6.6KVDC	5	.04mA
ANA-S-D.40	6.6KVDC	1	~~.07mA~~ DC .04mA
	6.6KVDC	2	.04mA
	6.6KVDC	3	.04mA
	6.6KVDC	4	.04mA
	6.6KVDC	5	.04mA

Tested By Date: 1/4/89

Witness N/A Date:

Sheet No. 3 of 4

Approved 01-04-89

Notice of Anomaly NONE

DATA SHEET

WYLE LABORATORIES

Customer Tennessee Valley Authority
Specimen Silicone Rubber Insulated Cables
Part No. Various
Spec. WLQP 18057-00, IPR 01
Para. 3.12
S/N Listed
GSI N/A
Amb. Temp. 64°F
Photo No
Test Med. Water
Specimen Temp. Ambient
Job No. 18056
Report No. 18056-1
Start Date 1/4/89

Test Title Voltage Withstand Test

Specimen	Applied Voltage	Time (minutes)	Leakage Current
ANA-S-E.40	6.6KVDC	1	.02mA
	6.6KVDC	2	.02mA
	6.6KVDC	3	<.01mA
	6.6KVDC	4	<.01mA
	6.6KVDC	5	<.01mA

Tested By D. Compton Date: 1/4/89
Witness N/A Date:
Sheet No. 4 of 4
Approved Robert Walker 01-04-89

Notice of Anomaly None

Wyle Form WH 614A, Rev. APR '84

APPENDIX III

INSTRUMENTATION EQUIPMENT SHEET

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INSTRUMENTATION EQUIPMENT SHEET

PAGE 1 OF 1

DATE: 01/04/89
TECHNICIAN: D. COMPTON

JOB NUMBER: 18056-00
CUSTOMER: T. V. A.

TEST AREA: LOCA
TYPE TEST: VOLTAGE WITHSTAND

NO.	INSTRUMENT	MANUFACTURER	MODEL#	SERIAL #	WYLE #	RANGE 1	ACCURACY 1	CALDATE	CALDUE
1	PWR SUPPLY	SORENSEN	1061	283	098745	0-60KV	MFG	01/04/89	07/03/89

THIS IS TO CERTIFY THAT THE ABOVE INSTRUMENTS WERE CALIBRATED USING STATE-OF-THE-ART TECHNIQUES WITH STANDARDS WHOSE CALIBRATION IS TRACEABLE TO THE NATIONAL ~~BUREAU OF~~ STANDARDS.

INSTRUMENTATION

CHECKED & RECEIVED BY 01-04-89

Q.A. 1-4-89

5
Wyle
A

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WYLE LABORATORIES' QUALIFICATION PLAN NO. 18057-00, REVISION A

WYLE LABORATORIES
SCIENTIFIC SERVICES & SYSTEMS GROUP
P. O. BOX 1008 • HUNTSVILLE, ALABAMA 35807
TWX (810) 726-2225 • TELEPHONE (205) 837-4411

QUALIFICATION PLAN

QUAL. PLAN 18057-00
DATE: October 18, 1988
Revision A 1/17/89

ENVIRONMENTAL QUALIFICATION FOR SILICONE RUBBER INSULATED CABLES FOR USE IN TENNESSEE VALLEY AUTHORITY'S SEQUOYAH AND WATTS BAR NUCLEAR PLANTS

APPROVED BY: F M Sittason 10-21-88
PROJECT MANAGER: F. M. Sittason

APPROVED BY: Robert W Walter 10-20-88
FOR: ENVIRONMENTAL QUALIFICATION
R. T. Walter

APPROVED BY: TR Hamilton 10-21-88
QUALITY ASSURANCE: for G. W. Hight

APPROVED BY: Janice K Smith 10-21-88
FOR: QUALIFICATION PLAN DEVELOPMENT
Jan Smith

PREPARED BY: Nipon T. Boonarkat 10/20/88
PROJECT ENGINEER: N. T. Boonarkat

REVISIONS

FORM 1109-1/8-81

REV. NO.	DATE	PAGE OR PARAGRAPH AFFECTED	BY	APP'L	DESCRIPTION OF CHANGES
A	1/17/89	Page 14, Para 3.10.7, Fourth	NTB	SGS 1/17/89	Revised the last sentence to read
		Subparagraph	RTW 01-17-89		"...flow rate. pH shall be
					verified and recorded each hour."
A	1/17/89	Page III-2	NTB	SGS 1/17/89	Added a note under Paragraph 5.0.
			RTW 01-17-89		
		NOTE: The above changes are to incorporate IPR No. 18057-IPR-1 dated			
		11/21/88 to document.			

FOREWORD

This document is divided into three (3) major sections:

- Scope
- Qualification Requirements
- Qualification Program

The section on Scope defines the objectives, tasks, applicable qualification standards and specifications, and an equipment description. The equipment description includes performance and functional specifications, along with the number of each to be tested. This section also includes a test sequence listing.

The section on Qualification Requirements defines all the parameters to which the equipment is to be qualified. These parameters are based on the equipment's location and application in the nuclear power generating station. Descriptions of the equipment's safety-related functions and acceptance criteria are provided.

The section entitled Qualification Program defines necessary test programs which meet the scope and qualification requirements defined in the first two sections. Any assumptions, basis for design basis event simulations, are explained in this section.

Table of Contents

1.0 SCOPE

This document has been prepared by Wyle Laboratories for the Tennessee Valley Authority (TVA), hereinafter referred to as customer, for nuclear environmental qualification of Class 1E silicone rubber insulated cables for use inside containment at TVA's Sequoyah (SQN) and Watts Bar (WBN) Nuclear Plants.

1.1 Objectives

The purpose of this qualification plan is to present the approach, methods, philosophies, and procedures for establishing 15-year and 40-year qualified lives of silicone rubber insulated cables (as specified in Paragraph 1.3) for use on 120 VAC and 125 VDC control circuits and 480 VAC power circuits at SQN and WBN.

Nuclear environmental qualification of any safety-related device to meet the requirements of 10 CFR 50.49 is usually a three-step process: 1) radiation exposure (including accident dose), 2) aging, and 3) design basis event qualification (accident). The purpose of the first two steps is to put the sample equipment to be used for qualification into a condition that represents the worst state of deterioration that a plant operator will permit prior to taking corrective action, i.e., its end-of-qualified-life condition. The next step demonstrates that it still has adequate integrity remaining to withstand the added environmental stresses of specified design basis events and still perform its safety-related functions.

It is incumbent on TVA to assure that the components and materials in the equipment actually placed into service are the same as those qualified.

1.2 Applicable Qualification Standards, Specifications, and Documents

- IEEE STD 323-1974, "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations."
- IEEE STD 383-1974, "IEEE Standard for Type Test of Class 1E Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations."
- 10 CFR 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," U.S. Nuclear Regulatory Commission, 1973.
- 10 CFR 50.49, "Environmental Qualification of Electrical Equipment Important to Safety for Nuclear Power Plants," U.S. Nuclear Regulatory Commission, January 21, 1983.
- 10 CFR 21, "Reporting of Defects and Noncompliances," 1977.
- TVA Engineering Services Scope of Work ESSOW-SQN-E01, "Environmental Testing of Silicone Rubber Cable," Revision 4, dated August 22, 1988.
- TVA Contract No. TV-73743A.
- Wyle Laboratories Test Report No. 17905-1, "Qualification Test Program for Silicone Rubber Cables with Reduced Insulation Thicknesses for use in Tennessee Valley Authority's Sequoyah Nuclear Plant, Unit 2," dated November 19, 1987.
- Wyle Laboratories' (Eastern Operations) Quality Assurance Program Manual.

1.0 SCOPE (Continued)

1.3 Equipment Description

The equipment to be qualified consists of thirty Nos. 12 and 14 AWG, 1/C silicone rubber insulated cables as described below.

Specimen No.	Cable No.	RWC Mark No.*
RWC-S-A.40	1V4450A/CBBN	WPA
RWC-S-B.40	1V9841B/5SVN	WPA
RWC-S-C.40	1V3111B/9DG	WPA
RWC-S-D.40	1V3091A/9DG	WPA
RWC-S-E.40	1V2811B/6D1	WPA
RWC-S-A.15	1V4450A/CBB3	WPA
RWC-S-B.15	1V9841B/5SVG	WPA
RWC-S-C.15	1V3111B/9DR	WPA
RWC-S-D.15	1V3091A/9DR	WPA
RWC-S-E.15	1V2811B/6DG	WPA
RWC-W-A.40	1V4450A/CBB8	WPA
RWC-W-B.40	1V9841B/5SVR	WPA
RWC-W-C.40	1V3111B/9DX	WPA
RWC-W-D.40	1V3091A/9DX	WPA
RWC-W-E.40	1V2811B/6DR	WPA
RWC-W-A.15	1V4450A/CBB9	WPA
RWC-W-B.15	1V9841B/5SV1	WPA
RWC-W-C.15	1V3111B/9DY	WPA
RWC-W-D.15	1V3091A/9DY	WPA
RWC-W-E.15	1V2811B/6DC1	WPA

Specimen No.	Cable No.	ANA Mark No. **
ANA-S-A.40	1V1362B/VFL11	WPB
ANA-S-B.40	1V7168A/VBL1	WPA
ANA-S-C.40	2V1362B/VFL3	WPB
ANA-S-D.40	2PL4830A/A27AC3	WPA
ANA-S-E.40	2V2855B/T1	WPB
ANA-S-A.15	1V1362B/VFL3	WPB
ANA-S-B.15	1V7168A/VBLN	WPA
ANA-S-C.15	2V1362B/VFLN	WPB
ANA-S-D.15	2PL4830A/A27AA1	WPA
ANA-S-E.15	2V2855B/T2	WPB

*Note: RWC MARK NO. WPA: Single conductor, No. 14 AWG Class B stranded copper conductor, 45 mil (nominal), silicone rubber insulation (KS-500), Asbestos jacket, Mfg: Rockbestos. During LOCA testing, the cable shall be energized to the equivalent of 528 VAC (phase to phase) and loaded to 15 amps.

1.0 SCOPE (Continued)

1.3 Equipment Description (Continued)

**Note:ANA MARK NO. WPA: Single conductor, No. 14 AWG Class B stranded copper conductor, 45 mil (nominal), silicone rubber insulation (CC-2193 Nuclesil), Asbestos jacket, Mfg: Anaconda-Continental. During LOCA testing, the cable shall be energized to the equivalent of 528 VAC (phase to phase) and loaded to 15 amps.

ANA MARK NO. WPB: Same as WPA except No. 12 AWG and loaded to 21 amps during the LOCA test.

1.4 Qualification Sequence

As specified by TVA, the qualification program shall be performed in the following sequence:

- Handling Procedure and Specimen Identification
- Specimen Preparation
- Baseline Functional Test
- Normal Radiation Exposure
- Functional Test
- Thermal Aging
- Functional Test
- Accident Radiation Exposure
- Functional Test
- Accident Simulation (LOCA)
- Functional Test
- Voltage Withstand Test (For Margin Assessment)
- Post-Test Inspection

2.0 QUALIFICATION REQUIREMENTS

2.1 Definition of Service Requirements

2.1.1 Margin

The normal and design basis event (DBE) conditions specified do not include margin. Therefore, to account for normal variations in commercial production of equipment and variations in service conditions, margin as per Paragraph 6.3.1.5 of IEEE 323-1974 shall be added as noted.

o	Temperature	+15 deg. F on accident transient
o	Pressure	+10% of gauge
o	Time	+10% of post-DBE operation
o	Voltage	+10% of nominal operating voltage
o	Radiation	+10% on accident dose

2.1.2 Inside Containment Service Conditions

The following service conditions are specified by TVA for the subject equipment.

	Normal	Abnormal	Accident (LOCA)
Temp.(°F)*	120 (99% of time)	130 (1% of time)	327
RH (%)	80	100	100
Press. (psia)	14.7	14.7	27.0
Chem. Spray	N/A	N/A	2000 ppm boron, pH 8.35

*Note: A 60°C conductor operating temperature (50°C ambient plus 10°C heat rise) shall be used to establish an aging program as specified by TVA.

The following radiation requirements are specified by TVA.

Mfr.	15-Year TID (rads)	40-Year TID (rads)	Accident Dose TID (rads) w/ a 10% margin included
RWC (for SQN)	3.0E7	8.0E7	7.15E7
RWC (for WBN)	3.0E7	8.0E7	1.76E8
ANA (for SQN)	7.5E6	2.0E7	7.15E7

2.1.3 Design Basis Event Conditions

Design Basis Event (DBE) conditions, as specified by TVA, are presented as follows:

The accident conditions are documented in Paragraph 2.1.2. The LOCA/HELB combined accident profile for SQN and WBN is shown in Figure 1. This profile does not include margin.

2.0 QUALIFICATION REQUIREMENTS (Continued)

2.1.4 Other Service Conditions

o	Voltage	120 VAC (60Hz) and 125 VDC for control circuits 480 VAC (60Hz), 3 phase, for power circuits

2.2 Safety-Related Function

The subject cables are installed in various Class 1E electrical circuits at SQN and WBN. Therefore, the safety classification of this equipment is Class 1E. The subject equipment provides essential services in support of emergency reactor shutdown, containment isolation, reactor core cooling, and containment and reactor heat removal, or is otherwise essential in providing support to prevent significant release of radioactive material to the environment.

2.3 Acceptance Criteria

The acceptance criteria, as specified by TVA, is for the cables to maintain the following voltage while electrically loaded during the LOCA simulation. Blowing circuit fuses does not constitute failing of the specimens since the fuses are designed to protect measuring equipment.

Mfr./Mark No.	Applied Voltage (VAC) (+10, -0 VAC)*	Test Current (Amps) (+10, -0%)
RWC/Mark No. WPA	305	15
ANA/Mark No. WPA	305	15
ANA/Mark No. WPB	305	21

*Note: A single phase 305 VAC (phase to ground) is equivalent to a 3-phase 528 VAC (phase to phase).

2.4 Safety-Related Component

For the purposes of this test program, only the silicone rubber insulation (excluding the first six inches on both ends) is considered to be the test specimen and serves a safety-related function. The first six inches on both ends of the specimens are handled, bent, and spliced for testing and are not to be considered part of the test specimens.

3.0 QUALIFICATION PROGRAM

3.1 Handling Procedure and Specimen Identification

Caution: Since the specimens have asbestos jacketing material, the safety procedure presented in Appendix III shall be followed in handling the specimens.

An inspection shall be performed upon receipt of the test specimens at Wyle. This inspection shall ensure that the specimens have no obvious physical damage. The specimens shall be labeled to facilitate identification, provided by TVA, of the specimens during all phases of the qualification program. The results of the inspection (manufacturer, type, etc.) shall be recorded.

3.2 Specimen Preparation

The test specimens shall be mounted in six open cable trays, as specified below, where adequate contacts between the specimens and the ground plane are provided.

Specimen No.	Cable Tray Designation
RWC-S-A.40	A
RWC-S-B.40	
RWC-S-C.40	
RWC-S-D.40	
RWC-S-E.40	
RWC-S-A.15	B
RWC-S-B.15	
RWC-S-C.15	
RWC-S-D.15	
RWC-S-E.15	
RWC-W-A.40	C
RWC-W-B.40	
RWC-W-C.40	
RWC-W-D.40	
RWC-W-E.40	
RWC-W-A.15	D
RWC-W-B.15	
RWC-W-C.15	
RWC-W-D.15	
RWC-W-E.15	
ANA-S-A.40	E
ANA-S-B.40	
ANA-S-C.40	
ANA-S-D.40	
ANA-S-E.40	

3.0 QUALIFICATION PROGRAM (Continued)

3.2 Specimen Preparation (Continued)

Specimen No.	Cable Tray Designation
ANA-S-A.15	F
ANA-S-B.15	
ANA-S-C.15	
ANA-S-D.15	
ANA-S-E.15	

If it is necessary to bend the specimens during mounting in the trays, the specimens shall not be bent to a radius less than forty times the specimen diameter. An approximately 1/2" specimen spacing shall be provided so that the specimens will not heat the others when powered. Provisions shall be provided for mounting both ends of each specimen approximately four inches above the bottom of the cable tray. This is to facilitate testing during wet insulation resistance measurements. Tefzel tie wraps shall be used to secure the specimens to the cable trays. No additional specimen preparation is required except for preparing the ends of the specimens to a proper length for electrical wiring during functional test and LOCA testing. Cable jacket shall be stripped approximately five inches.

Upon completion of the specimen preparation, photographs of the specimens on the cable trays shall be taken.

3.3 Baseline Functional Test

3.3.1 Visual Inspection

All test specimens shall undergo visual inspections at each step in the test program. All visual observations shall be recorded. Any damage shall be photographed and reported to TVA.

3.3.2 Wet Insulation Resistance Measurements (For Information Only)

The specimens mounted in the cable trays shall be immersed in tap water. Both leads of each specimen shall be suspended out of the water. While still immersed, the insulation resistance shall be measured by applying 500 VDC for a minimum of 1 minute prior to the reading of the resistance between conductor and ground (the cable tray). If a reading cannot be obtained at 500 VDC, the voltage shall be reduced until the insulation resistance is measurable. All results shall be recorded for information only.

3.4 Normal Radiation Exposure

3.4.1 Radiation Exposure Prior to Thermal Aging (Synergistic Effects)

Testing sponsored by the Nuclear Regulatory Commission (NRC) and reported by Sandia Laboratories (Library Code 0271-80) has shown radiation prior to thermal aging causes some polymers to degrade to a greater extent than when irradiated following thermal aging. The report states:

3.0 QUALIFICATION PROGRAM (Continued)

3.4.1 Radiation Exposure Prior to Thermal Aging (Synergistic Effects) (Continued)

> "The mechanistic postulate is that radiation cleaved bonds, in the form of radicals, react with oxygen to give degradation products, including peroxides. The peroxides are chemically weak links, which are susceptible to thermal cleavage. This thermal peroxide cleavage gives more radicals which, in the presence of oxygen lead to more degradation and more peroxides. Thermal aging prior to irradiation does not substantially disrupt the polymer's original molecular structure over the normal elevated temperature ranges which, in turn, results in a lesser degree of degradation than may be expected in actual plant applications. Thus, the amplification of the degradation process caused by thermal peroxide cleavage must be accounted for by performing radiation exposure prior to thermal aging."

Subsequent testing sponsored by Sandia Laboratories, as reported in SAND-80-2149C (Library Code 0474-81A), establishes performing thermal aging after irradiation as the only method in which to account for the strong synergism due to radiation found in some polymers.

> "The joint effect of gamma radiation and elevated temperature was also found to occur when the two environments were applied in sequential fashion, but only when the experiments were performed in that order, radiation at room temperature followed by elevated temperature."

Other NRC sponsored testing by Sandia Laboratories (Library Code 0474-81A) indicates that the mechanical damage resulting from a given total dose is dependent on dose rate for some polymers. Testing was performed at 1.0E3 and 1.0E6 rads/hour. For the polymers tested, more degradation occurred at the lower dose rate. However, no known synergistic effects and dose rate effects exist for the materials under consideration.

Therefore, the application of the radiation dose prior to thermal aging is conservative and accounts for any synergistic effects which may be applicable to the materials of the test specimens.

3.4.2 Irradiation

The test specimens (unpowered) shall be irradiated to normal radiation doses as described below.

Specimen No.	15-Year TID (rads)	40-Year TID (rads)
RWC-S-A.40, RWC-S-B.40, RWC-S-C.40, RWC-S-D.40, RWC-S-E.40	N/A	8.0E7
RWC-S-A.15, RWC-S-B.15, RWC-S-C.15, RWC-S-D.15, RWC-S-E.15	3.0E7	N/A

3.0 QUALIFICATION PROGRAM (Continued)

3.4.2 Irradiation (Continued)

Specimen No.	15-Year TID (rads)	40-Year TID (rads)
RWC-W-A.40, RWC-W-B.40, RWC-W-C.40, RWC-W-D.40, RWC-W-E.40	N/A	8.0E7
RWC-W-A.15, RWC-W-B.15, RWC-W-C.15, RWC-W-D.15, RWC-W-E.15	3.0E7	N/A
ANA-S-A.40, ANA-S-B.40, ANA-S-C.40, ANA-S-D.40, ANA-S-E.40	N/A	2.0E7
ANA-S-A.15, ANA-S-B.15, ANA-S-C.15, ANA-S-D.15, ANA-S-E.15	7.5E6	N/A

The radiation exposure shall be measured as air equivalent gamma using a Cobolt-60 source at a dose rate not to exceed 1.0E6 rads per hour. The dose rate shall be measured at the geometric centerline of the specimens. The specimens shall be rotated as necessary during the radiation exposure to ensure a uniform dose distribution.

Dosimetry utilized during the radiation exposure shall be traceable to the National Bureau of Standards.

3.5 Functional Test

Photographs of the specimens shall be taken upon completion of the normal radiation exposure and the functional test of Paragraph 3.3 shall be repeated.

3.6 Thermal Aging

The specimens (unpowered) shall be subjected to thermal aging as follows. Thermal aging calculations presented in Appendix I are based on the 60°C conductor operating temperature (ambient plus heat rise) and the activation energies of 1.63 eV (for the Anaconda specimens) and 1.73 eV (for the Rockbestos specimens) as specified by TVA.

3.0 QUALIFICATION PROGRAM (Continued)

3.6 Thermal Aging (Continued)

Specimen No.	Qualified Life	Aging Temperature/Time (+5, -0 deg C/+2, -0 hrs)
RWC-S-A.15,	15 years	105°C for 101 hours
RWC-S-B.15,		
RWC-S-C.15,		
RWC-S-D.15,		
RWC-S-E.15,		
RWC-W-A.15,		
RWC-W-B.15,		
RWC-W-C.15,		
RWC-W-D.15,		
RWC-W-E.15		
ANA-S-A.15,	15 years	105°C for 101 hours, then 112°C for 21 hours
ANA-S-B.15,		
ANA-S-C.15,		
ANA-S-D.15,		
ANA-S-E.15		
RWC-S-A.40,	40 years	112°C for 102 hours
RWC-S-B.40,		
RWC-S-C.40,		
RWC-S-D.40,		
RWC-S-E.40,		
RWC-W-A.40,		
RWC-W-B.40,		
RWC-W-C.40,		
RWC-W-D.40,		
RWC-W-E.40		
ANA-S-A.40,	40 years	112°C for 102 hours, then 120°C for 23 hours
ANA-S-B.40,		
ANA-S-C.40,		
ANA-S-D.40,		
ANA-S-E.40		

3.7 Functional Test

Photographs of the specimens, while still in the aging chambers, shall be taken upon completion of the thermal aging program and the functional test of Paragraph 3.3 shall be repeated.

3.0 QUALIFICATION PROGRAM (Continued)

3.8 Accident Radiation Exposure

The test specimens (unpowered) shall be irradiated to accident radiation doses as described below.

Specimen No.	Accident Dose TID (rads) with a 10% margin included
RWC-S-A.40,	7.15E7
RWC-S-B.40,	
RWC-S-C.40,	
RWC-S-D.40,	
RWC-S-E.40,	
RWC-S-A.15,	
RWC-S-B.15,	
RWC-S-C.15,	
RWC-S-D.15,	
RWC-S-E.15,	
ANA-S-A.40,	
ANA-S-B.40,	
ANA-S-C.40,	
ANA-S-D.40,	
ANA-S-E.40,	
ANA-S-A.15,	
ANA-S-B.15,	
ANA-S-C.15,	
ANA-S-D.15,	
ANA-S-E.15	
RWC-W-A.40,	1.76E8
RWC-W-B.40,	
RWC-W-C.40,	
RWC-W-D.40,	
RWC-W-E.40,	
RWC-W-A.15,	
RWC-W-B.15,	
RWC-W-C.15,	
RWC-W-D.15,	
RWC-W-E.15	

The radiation exposure shall be measured as air equivalent gamma using a Cobolt-60 source at a dose rate not to exceed 1.0E6 rads per hour. The dose rate shall be measured at the geometric centerline of the specimens. The specimens shall be rotated as necessary during the radiation exposure to ensure a uniform dose distribution.

Dosimetry utilized during the radiation exposure shall be traceable to the National Bureau of Standards.

3.0 QUALIFICATION PROGRAM (Continued)

3.9 Functional Test

Photographs of the specimens shall be taken upon completion of the accident radiation exposure and the functional test of Paragraph 3.3 shall be repeated.

Upon completion of the post-accident radiation functional test, the 15-year specimens shall be stored in an area to protect them from potential damage. These specimens are to be saved for possible future testing.

3.10 Accident Simulation (LOCA)

3.10.1 Requirements

The LOCA/HELB combined accident profile is shown in Figure 1. The test profile, which contains margins as specified in Paragraph 2.1.1, is shown in Figure 2.

Post-accident operation is considered to be from the 24-hour point at 165°F through 1,000 hours at 110°F (as extrapolated linearly on the log time scale of Figure 1) and through 100 days during which the temperature remains constant at 110°F. The pressure requirement is approximately 8.1 psig at 24 hours, 3.5 psig at 290.18 hours, and 2.5 psig at 550.18 hours (the end point of the LOCA test).

3.10.2 Chamber Calibration

The ramp rate requirement of peak temperature and pressure is within 30 seconds. Therefore, prior to the accident simulation, a trial run shall be performed to simulate the first 4 hours of the test profile in Figure 2. This is to determine the actual temperature and pressure ramps of which the chamber is capable. Dummy loads designed to simulate the test specimens (volume and mass) shall be placed in the test chamber to simulate the actual test configuration. A best-effort basis shall be given to meet the ramp requirement.

3.10.3 Test Setup and Preparation

New Tefzel tie wraps shall be used to secure the specimens to the cable trays. The specimens, mounted in their respective cable trays, shall be securely placed inside a Wyle Accident Simulation Chamber in a manner such that the specimens shall not be submerged in chemical solution during the chemical spray. TVA-supplied test leads shall be mounted through chamber penetrations and connected to the test specimens through uninsulated butt splices covered with Raychem WCSF-N heat shrink tubing. The chamber penetrations shall be sealed per Wyle Laboratories' standard practice.

3.10.4 Electrical Powering

The test specimens shall be connected in individual circuits. Typical specimen powering setup is shown in Figure 3. The following electrical powering, as specified by TVA, shall be provided for performance verification of the test specimens. The specimens shall be powered continuously throughout the accident simulation.

3.0 QUALIFICATION PROGRAM (Continued)

3.10.4 Electrical Powering (Continued)

Mfr/Mark No.	Applied Voltage (VAC)	Test Current (Amps)
RWC/Mark No. WPA	305	15
ANA/Mark No. WPA	305	15
ANA/Mark No. WPB	305	21

Allowable tolerances are as follows:

o	Voltage	+10, -0 VAC
o	Current	+10%, -0% of the specified value

3.10.5 Monitoring

The following parameters shall be monitored and recorded:

- Applied Voltage
- Circuit Current
- Leakage Current to Ground (for information only)
- Chamber Pressure
- Chamber Temperature
- Average Temperature
- Chem. Spray Flow Rate
- Chem. Spray pH

Chamber pressure shall be measured using an appropriate range pressure transducer. Chamber temperature shall be recorded using three thermocouples which shall be located in the environmental chamber within two inches of the surface of the test specimens. The chamber temperature, for control purposes, shall be the average of the values recorded by the three thermocouples. The average value shall also be recorded.

From initiation of the test until the first 5 minutes, the data acquisition system (DAS) shall print out all channels at maximum line printer speed. The data acquisition system shall be programmed to record all data at one-minute intervals during the first 8 hours, then at ten-minute intervals through twenty-four hours, and finally at one-hour intervals thereafter for the duration of the test. A pen chart recorder shall be used to continuously monitor the chamber temperature.

3.10.6 Wet Insulation Resistance Measurements

After interconnection of the test specimens to the TVA-supplied test leads, the wet insulation resistance measurements of Paragraph 3.3.2 shall be performed while the specimens are inside the chamber at ambient temperature.

3.0 QUALIFICATION PROGRAM (Continued)

3.10.7 Accident Exposure

Prior to initiation of the accident test, the test chamber shall be stabilized at 104°F for a minimum of 30 minutes using steam with the specimens energized. The specimens shall be subjected to the accident profile specified in Figure 2 which includes the appropriate margins.

Beginning at the initial conditions of 104°F and atmospheric pressure, the energized cables shall be subjected to the initial temperature and pressure transient of 30 seconds (on a best-effort basis) to the minimum peak conditions of 342°F and 15 psig. The temperature and pressure shall follow the Figure 2 profile after achieving peak conditions.

The post-DBE period is after the 24-hour point through 110 days (a 10% margin included). From the 24-hour point at 165°F, the temperature shall linearly decrease to 150°F at the 290.18-hour point. The post-DBE temperature ramp requirement of 150°F at 290.18 hours to 110°F at 1,000 hours (assume a linear decrease on the log time scale) and then 110°F from 1,000 hours through 110 days can be shortened by using the Arrhenius equation and elevating the temperature. The post-DBE accelerated aging time shall be 260 hours at 150°F based on an activation energy of 1.63 eV for the ANA specimens and a 10 deg C heat rise (18 deg F) as specified in Wyle Laboratories Test Report No. 17905-1, Page No. V-17. The post-DBE accelerated aging calculations are presented in Appendix I.

The chemical spray shall be initiated at the saturated condition point (250°F/15 psig) and shall continue for a duration of 24 hours. The spray rate shall be 0.30 gpm/ft^2. DAS shall be used to record flow rate. pH shall be verified and recorded each hour. A

The chemical spray requirement for SQN and WBN is as follows.

o	Boron:	2,000 ppm
o	pH:	8.35 at 25°C
o	Concentration:	0.1847 molar H_3BO_3 0.033 molar NaOH

Accident simulation tolerances are:

- o +9, -0 deg. F on temperature (after steady state conditions have been achieved)
- o +5, -0 psi on pressure (after steady state conditions have been achieved)
- o +2, -0 hours on total test time
- o +20%, -0% on flow rate
- o +1, -0 on pH

3.11 Functional Test

Photographs of the specimens shall be taken upon completion of the accident simulation. The wet insulation resistance measurements of Paragraph 3.3.2 shall be performed at room ambient conditions while the specimens are inside the chamber.

Upon removal of the specimens from the chamber, the visual inspection of Paragraph 3.3.1 shall be performed.

3.0 QUALIFICATION PROGRAM (Continued)

3.12 Voltage Withstand Test (For Margin Assessment)

The specimens shall be subjected to the Voltage Withstand Tests (Wet Hi-Pots) for information only as described below.

1. The specimens shall be removed from the cable trays, straightened, and wound around mandrels whose outer diameters (OD) are approximately equal to 40 times the actual specimen OD.
2. The specimens shall be immersed in tap water. Both leads of each specimen shall be suspended out of the water.
3. While still immersed, the specimens shall be subjected to Voltage Withstand/Hi-Pots at 6600 VDC (twice the rated voltage plus 1000 volts) for five minutes as specified by TVA. Leakage current between each specimen and ground shall be measured and recorded every minute.

3.13 Post-Test Inspection

Upon completion of testing, the cables shall be visually inspected, photographed, and cable conditions shall be recorded.

3.14 In-Process Inspection

The cables shall be examined for possible damage following all tests. All important test effects shall be logged.

If any noticeable physical damage occurs, TVA shall be notified and photographs shall be taken.

3.15 Anomalies

Any test anomaly shall be reported to TVA within 24 hours after discovering the anomaly.

3.16 Quality Assurance

The qualification program shall be performed in accordance with Wyle Laboratories' (Eastern Operations) Quality Assurance Program which complies with the applicable portions of ANSI N-45.2, 10 CFR 50/Appendix B, 10 CFR 21, and Military Specification MIL-STD-45662.

All instrumentation to be used in the performance of this qualification program shall be calibrated in accordance with this manual. Standards used in performing all calibrations are traceable to the National Bureau of Standards. Instrumentation used during the qualification shall be listed in the test report.

3.17 Report

The final test report shall describe the qualification requirements, procedures, and results. The report shall also include rationale and justification required for the qualification. The report shall be prepared in accordance with the requirements of IEEE Standard 323-1974. TVA shall receive ten bound copies and one reproducible copy of the test report.

Figures

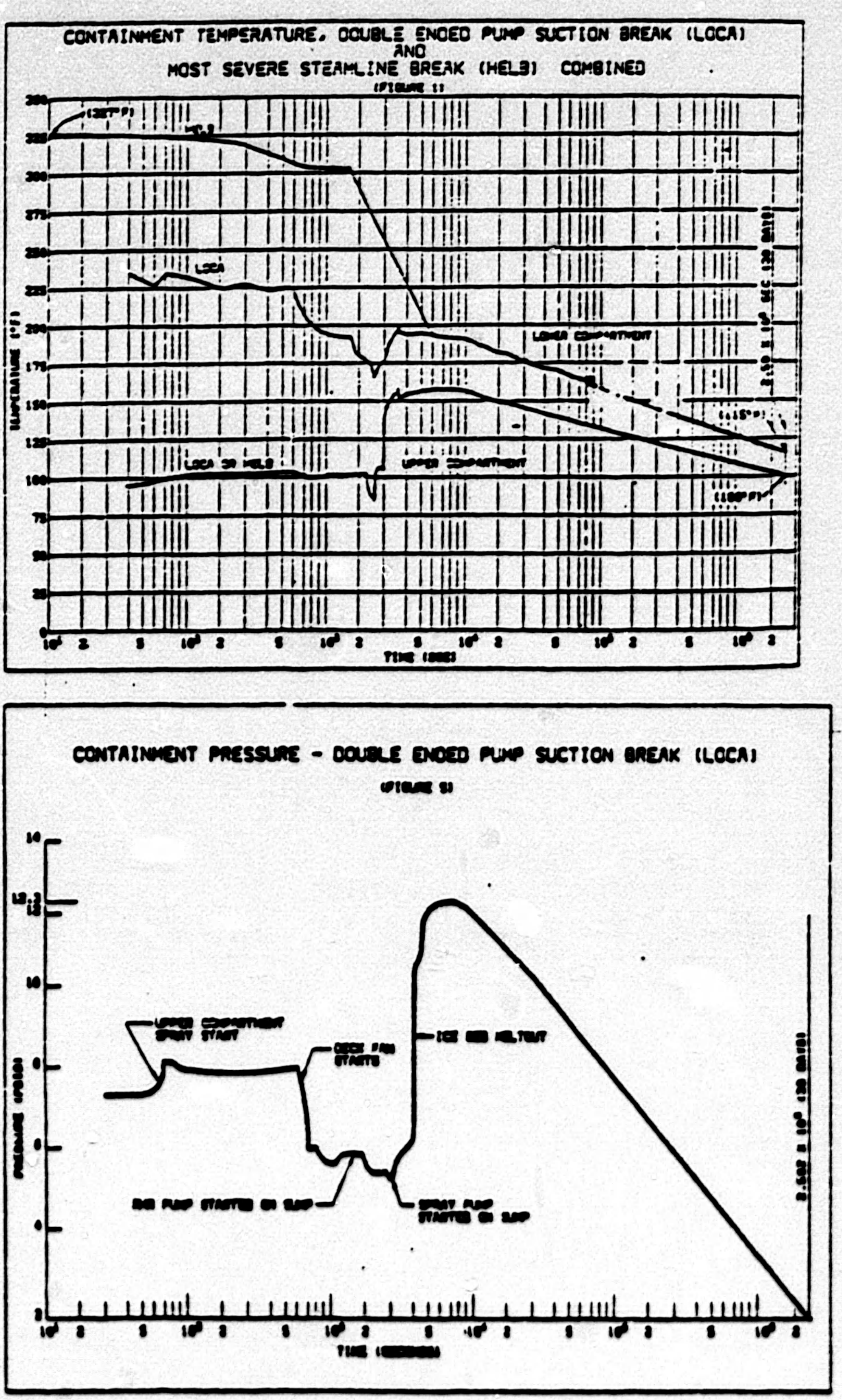
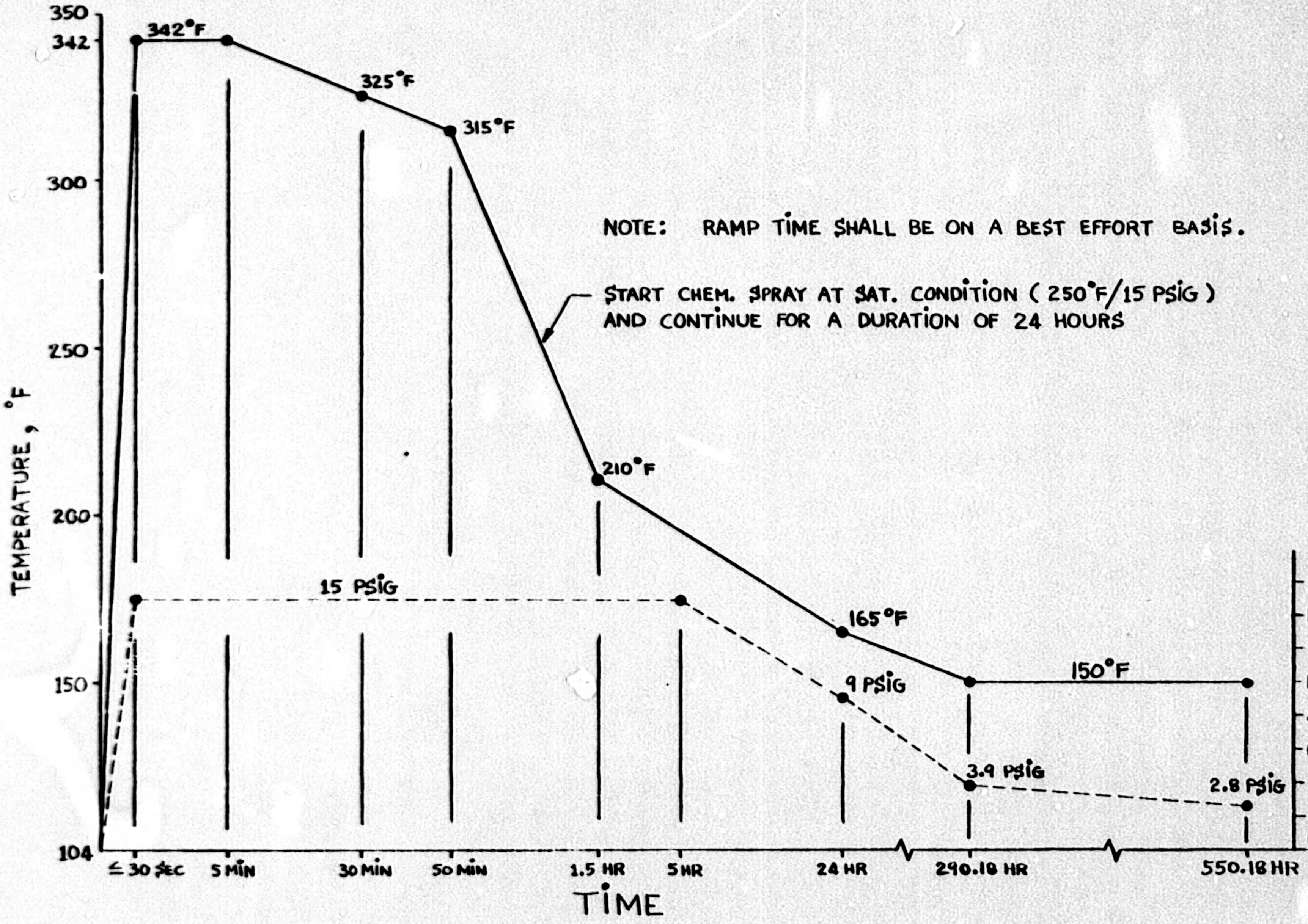


FIGURE 1: LOCA/HELB COMBINED ACCIDENT PROFILE
FOR SQN AND WBN



NOTE: RAMP TIME SHALL BE ON A BEST EFFORT BASIS.

START CHEM. SPRAY AT SAT. CONDITION (250°F/15 PSIG) AND CONTINUE FOR A DURATION OF 24 HOURS

FIGURE 2: TEST PROFILE WITH MARGINS

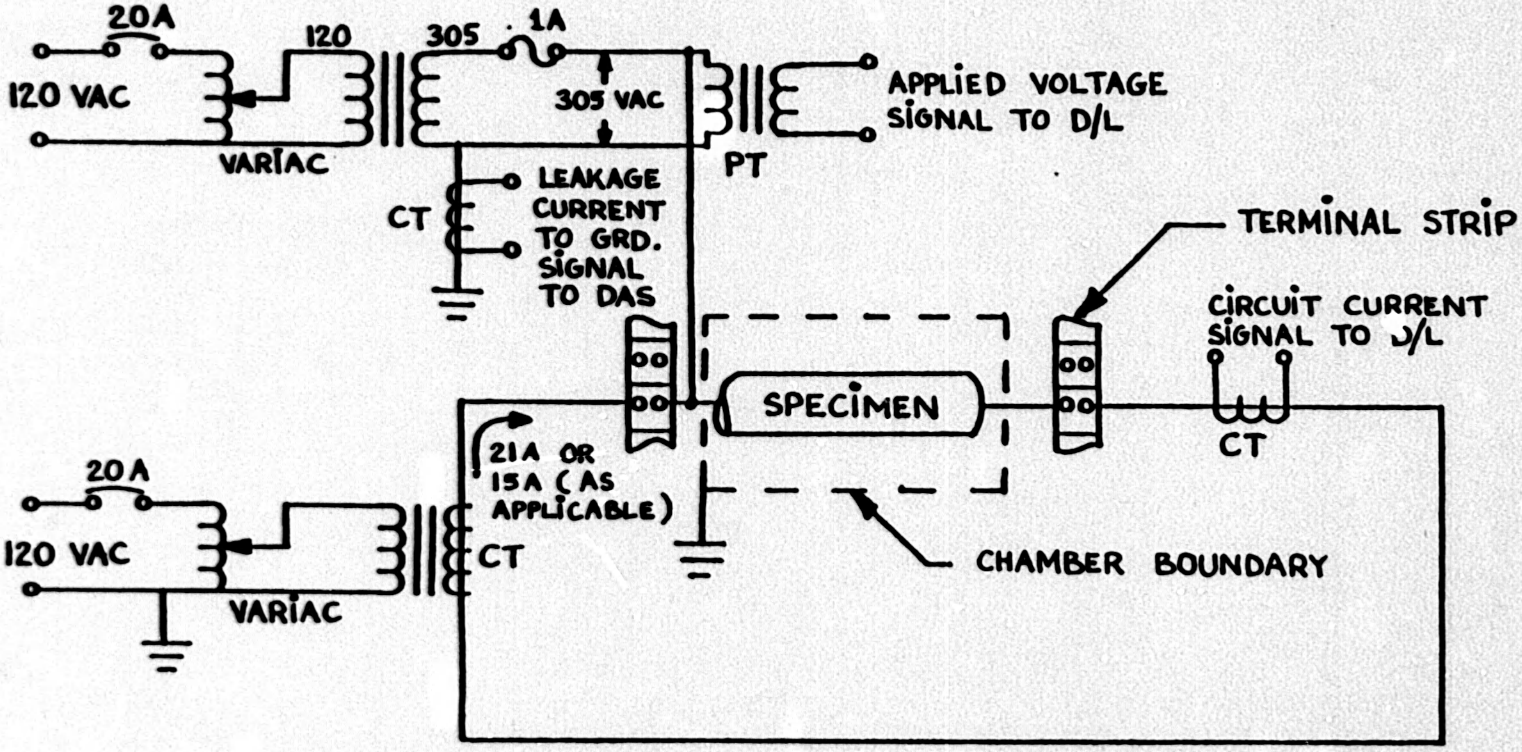


FIGURE 3: TYPICAL SPECIMEN POWERING

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APPENDIX I
Calculations

"THERMAL AGING PROGRAM"

WYLE LABORATORIES
NUCLEAR ENGINEERING SERVICES
ACCELERATED AGING

10/18/88

GENERIC NAME: 15-YEAR ROCKBESTOS SPECIMENS

ACTIVATION ENERGY 1.73

AGING TEMPERATURE (C) 105

TEMPERATURE (C)	TIME (H)
60	131400

TOTAL TIME= 131400.00 HOURS

ACCELERATED AGING TIME AT 105 C=
100.344 HOURS
4.18 DAYS

The 15-year Rockbestos specimens shall be thermally aged at 105°C for 101 hours to simulate a 15-year qualified life based on the activation energy of 1.73 eV.

"THERMAL AGING PROGRAM"

```
                         WYLE LABORATORIES
                    NUCLEAR ENGINEERING SERVICES
                          QUALIFIED LIFE                      10/18/88

MATERIAL NAME: 15-YEAR ANACONDA SPECIMENS       TEST AGING TEMP (C):  105.00
ACTIVATION ENERGY: 1.63                         TEST AGING TIME:         101

    TEMPERATURE (C)         TIME (H)
      60                    131400
                                             QUALIFIED LIFE =
  TOTAL TIME=    131400.00  HOURS                    87345.00 HOURS
                                                          9.9 YEARS



                         WYLE LABORATORIES
                    NUCLEAR ENGINEERING SERVICES
                        ACCELERATED AGING                     10/18/88

GENERIC NAME: 15-YEAR ANACONDA SPECIMENS

   ACTIVATION ENERGY  1.63               AGING TEMPERATURE (C) 112
   TEMPERATURE [C]          TIME [H]
      60                    44676

  TOTAL TIME=        44676.00  HOURS
                                          ACCELERATED AGING TIME AT 112 C=
                                                       20.797 HOURS
                                                         0.86 DAYS
```

The 15-year Anaconda specimens shall be thermally aged with the 15-year Rockbestos specimens at 105°C for 101 hours which is equivalent to 9.9-year qualified life based on the activation energy of 1.63 eV. Therefore, upon removal of the 15-year Rockbestos specimens from the chamber, the 15-year Anaconda specimens shall be subjected to an additional thermal aging at 112°C for 21 hours to simulate an additional 5.1-year qualified life.

"THERMAL AGING PROGRAM"

WYLE LABORATORIES
NUCLEAR ENGINEERING SERVICES
ACCELERATED AGING 10/18/88

GENERIC NAME: 40-YEAR ROCKBESTOS SPECIMENS

ACTIVATION ENERGY 1.73 AGING TEMPERATURE (C) 112

TEMPERATURE (C)	TIME (H)
60	350400

TOTAL TIME= 350400.00 HOURS

ACCELERATED AGING TIME AT 112 C=
101.876 HOURS
4.24 DAYS

The 40-year Rockbestos specimens shall be thermally aged at 112°C for 102 hours to simulate a 40-year qualified life based on the activation energy of 1.73 eV.

" THERMAL AGING PROGRAM "

```
                                   WYLE LABORATORIES
                              NUCLEAR ENGINEERING SERVICES
                                     QUALIFIED LIFE                      10/18/88

MATERIAL NAME: 40-YEAR ANACONDA SPECIMENS            TEST AGING TEMP (C):  112.00
ACTIVATION ENERGY: 1.63                              TEST AGING TIME:         102

     TEMPERATURE (C)          TIME (H)
       60                     350400
                                                  QUALIFIED LIFE =
   TOTAL TIME=     350400.00   HOURS                       219114.00 HOURS
                                                                25.0 YEARS
```

```
                                   WYLE LABORATORIES
                              NUCLEAR ENGINEERING SERVICES
                                   ACCELERATED AGING                     10/18/88

GENERIC NAME: 40-YEAR ANACONDA SPECIMENS


    ACTIVATION ENERGY   1.63                    AGING TEMPERATURE (C) 120
    TEMPERATURE [C]           TIME [H]
       60                     131400

   TOTAL TIME=         131400.00   HOURS
                                                  ACCELERATED AGING TIME AT 120 C=
                                                              22.498 HOURS
                                                                0.93 DAYS
```

The 40-year Anaconda specimens shall be thermally aged with the 40-year Rockbestos specimens at 112°C for 102 hours which is equivalent to 25-year qualified life based on the activation energy of 1.63 eV. Therefore, upon removal of the 40-year Rockbestos specimens from the chamber, the 40-year Anaconda specimens shall be subjected to an additional thermal aging at 120°C for 23 hours to simulate an additional 15-year qualified life.

"POST-DBE ACCELERATED AGING CALC"

```
                              WYLE LABORATORIES
                        NUCLEAR ENGINEERING SERVICES
                           LINEAR SLOPE EQUIVALENT             10/20/88
REF TEMP & SCALE    128.00 F              ACTIVATION ENERGY   1.63  eV
NUMBER OF SLOPES    2                     TEMPERATURE SCALE   F
         INITIAL TEMP    FINAL TEMP      HOURS            EQUIVALENT HOURS
          168.00          128.00           709.8200          7938.90
          128.00          128.00          1640.0000          1640.00
                             TOTALS:      2349.8200          9578.90
```

```
                              WYLE LABORATORIES
                        NUCLEAR ENGINEERING SERVICES
                              ACCELERATED AGING                     10/20/88

GENERIC NAME: SR INSULATED CABLES (ANACONDA)

   ACTIVATION ENERGY  1.63              AGING TEMPERATURE (C) 75
   TEMPERATURE [F]          TIME [H]
      128                   9578.90

  TOTAL TIME=          9578.90  HOURS
                                          ACCELERATED AGING TIME AT   75 C=
                                                    259.394 HOURS
                                                    10.80 DAYS
```

APPENDIX II
References

TABLE II-REFERENCE LIST 10/19/88

CODE	TITLE
027180	"A STUDY OF STRONG SYNERGISM IN POLYMER DEGRADATION," R.L. CLOUGH, K.T. GILLEN, AND E.A. SALAZAR, SANDIA LABORATORIES, NO. SAND-79-092-CK, AUGUST 8, 1979.
047481A	"RADIATION-THERMAL DEGRADATION OF PE AND PVC: MECHANISM OF SYNERGISM AND DOSE RATE EFFECTS," R.L. CLOUGH AND K.T. GILLEN, SANDIA NATIONAL LABORATORIES, SAND 80-2149C.

APPENDIX III
Procedure for Handling Asbestos Material

Procedure for Handling Asbestos Material During Specimen Preparation

1.0 Coveralls, gloves, and footwear shall be worn that afford full protection to the individual performing the material handling. The coveralls and gloves recommended are those that may be disposed of upon completion of the material handling. A full face respirator which utilizes filter cartridges shall be used by the individual performing the material handling. All clothing and other safety equipment shall be approved by the responsible Test Engineer prior to initiation of specimen preparation. The area around where the specimens are to be unpacked and prepared for testing shall be barricaded and signs placed around the area that state: Danger; Asbestos; Cancer and Lung Disease Hazard; Authorized Personnel Only; Respirators and Protective Clothing are Required in This Area.

2.0 The specimen enclosure shall be opened by carefully removing the outer wrapping, warning indications, and enclosure cover. Prior to removal of the test specimens, the enclosure shall be vacuumed clean using a machine equipped with a HEPA filter or equivalent.

3.0 The test specimens shall be removed from the enclosure on an individual basis and after identification and tagging by the Test Engineer, the specimens shall be mounted to the cable trays as specified in Paragraph 3.2 of this qualification plan.

4.0 Both ends of each test specimen shall be cut to remove the silicone insulation and asbestos jacket, as directed by the Test Engineer. Prior to cutting the specimen material, the asbestos jacket shall be sprayed with water to keep release of asbestos material to a minimum.

5.0 All asbestos and silicone materials that remain as a result of preparation of the test specimen lead ends shall be placed in a sealable plastic container for disposal according to health and safety requirements. All containers containing asbestos materials shall be labeled and shall include the following information: Danger; Contains Asbestos Fibers; Avoid Creating Dust; Cancer and Lung Disease Hazard. The Test Engineer shall be responsible for enforcing all safety precautions and measures during preparation of the test specimens.

Note: Based on test results of the asbestos monitoring and analysis documented in Environmental Test Report No. 108075 by Technical Micronics Control, Inc., the asbestos levels described below in the work area were well below the threshold limit value of 0.2 fibers/cc. Therefore, it is concluded that personnel protection from asbestos fibers is not required in handling the test specimens after the initial Specimen Identification and Preparation of Paragraphs 3.1 and 3.2, respectively. A

Specimen Handling Related to Asbestos Exposure	Fibers of Asbestos (fibers/cc)
Before	0.027
During	0.055
After	0.014

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WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP

Reference No. 18056X-007

3 March 1989

Tennessee Valley Authority
J. D. Hutson (Chief Electrical Engineer)
400 West Summit Hill Drive
WT11C 126
Knoxville, TN 37902

Attention: Mr. Kent Brown

Subject: Nuclear Qualification of Cables

Reference: Contract TV-73743A
Task 0011-391159

Enclosed is Technical Inquiry Response Document No. TR18056-1 dated March 3, 1989 regarding test envelope requirements. If you have any further questions regarding this subject please call Fred Sittason (205) 837-4411.

Sincerely,

WYLE LABORATORIES
Eastern Operations

Joanne F. Kelly

Joanne F. Kelly
Senior Contracts Administrator

JFK/drl