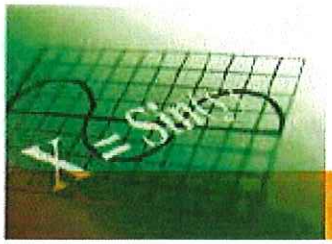

ENERGY DEVELOPMENT REPORT (EDR)

EDR-5626

HELB Qualification Test For 5/8 kV Nuclear Motor Connection Kits

HELB Qualification Test For 5/8 kV Nuclear Motor Connection Kits	136
Title:	Pages:
EDR-5626, Rev. 1	08/28/2019
Report Number:	Date:

Prepared By:
Erik Schaefer
Nuclear Product Specialist — Signature — 8/28/19 Date:

Reviewed By:
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Sr. R&D/Product Dvl Engineer — Signature — 28 August 2019 Date:

Reviewed By:
Jonathan Cornelius
Nuclear Product Manager — Signature — 8/28/2019 Date:

Revision Record

Revision	Page	Paragraph	Description	Date
0			Initial Release	09/19/2018
1	2		Added Revision Record	08/28/2019
1	3		Added Table of Contents	
1	4	1	Modified “Introduction” for clarification	08/28/2019
1	5	2,3	Change actual radiation dose to remove rounding (53.28 Mrads)	08/28/2019
1	1-10		Added page numbers	08/28/2019

Table of Contents

Introduction

The purpose of this report is to provide corrected radiation dose exposure data to the previously issued test report EDR-5037, Rev. 4. Included in this report is the revised information provided to TE Connectivity from Kinectrics (Attachment A), and the complete, original content of EDR-5037, Rev. 4 (Attachment B).

Background

EDR-5037, Rev. 3 is the test report of the Raychem brand class 1E safety related splices and terminations designed for medium voltage 5kV to 15 kV systems. It is used as the basis for Environmental Qualification decisions made by nuclear power stations. The radiation aging dose level quoted in the summary of the EDR-5037, Rev. 3 issued 10/07/1987, states that the product was tested to 50 Mrads. This is supported on the radiation certificate (page 16) which indicates the radiation dose was “50 Mrads, plus 10% within the accuracy of the dosimeters” shown to be +/- 5%. With this tolerance factored in, the minimum possible dose to which the product was exposed according to the Certificate of Irradiation in EDR-5037, Rev. 3 is calculated as follows:

	= (50 MRads + 10%) -5%
	= (55 MRads) - (0.05 *55 MRads)
	= 55 MRads - 2.75 MRads
Minimum Total Possible Dose for Rev. 3	**= 52.25 MRads**

Due to a raw material obsolescence in 2012, there was a formulation change made to the compound used to manufacture the BBIT-N heat shrinkable tubing. This tubing is a component used in splice kits identified as NMCK-8 and NHVT stress control terminations. As a result of this formulation change, an equivalency evaluation was implemented. As part of that evaluation, many analytical material tests were performed in addition to an environmental equipment qualification test. The purpose of the test, which is described in EDR-5037, Rev. 4, was to demonstrate that the new material was equivalent to the previously tested material reported in EDR-5037, Rev. 3. The product environmental qualification levels tested were described in EDR-5037, Rev. 3. The additional information provided in EDR-5037, Rev. 4 is used as supplemental test data to support the equivalency statement which is included on the TE Certificate of Conformance. The radiation dose provided in the radiation certificate included in EDR-5037, Rev. 4 states that there was a “minimum delivered gamma dose of 58.58 MRads”.

In 2014, an NRC inspection of the radiation service provider, Steris, indicated that the applied radiation doses reported by Steris did not account for all the uncertainties involved. As such, the actual radiation dose applied to test specimens may be less than the dose reported by Steris to Kinectrics, and by extension, less than the dose documented in the associated equipment qualification test report provided to TE Connectivity by Kinectrics. Subsequently, information provided by Kinectrics states that they received more accurate dose information from Steris and that the total corrected

variability had been determined to be 9.04% for our 2012 test program. Reducing the original certified minimum delivered dose by 9.04% results in the revised radiation levels as follows:

Minimum Dose Delivered per Original Certification for EDR-5037, Rev. 4	58.58 MRads
Total Variability Provided by Steris of +/- 9.04%to be subtracted from minimum	-5.30
New Corrected Minimum Dose Potentially Received for equivalency	**53.28 MRads**

Although the actual delivered dose of 53.28 MRads is less than previously indicated, it is still greater than the delivered dose of 52.25 MRads reported in EDR-5037, Rev. 3 and therefore, it still supports the purpose of equivalency evaluation. All other test details included in EDR-5037 Rev 4. are still correct and supported by TE Connectivity.

Attachment A, “Steris-Isomedix Position Paper-Follow-Up”

October 9, 2015

Tyco Electonics/Raychem
8000 Purfoy Road, Fuquay-Varina
NC, 27526-9349 USA

Attn: Betty Wilson

Re: Steris-Isomedix Position Paper-Follow-Up

This is a follow-up to the letter dated June 22, 2015 sent by Kinectrics regarding the position paper issued by Steris Isomedix. The purpose of this letter is to provide information to assist Tyco in completing its evaluation.

Since our initial notification to you, Kinectrics has received more accurate dose information from the supplier, Steris Isomedix (Steris), specific to the irradiation performed for your contract.

Steris' final dose variability study determined that total variability (including dosimetry error) is based on the following relationship for irradiations performed after April 1, 2001 on specimens located in hot cell positions other than the ceiling (this is applicable to your contract):

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$$TV = (\sqrt{DE^2 + DV^2} + SD)$$

Where:
TV = Total Variability
DE = Dosimetry Error (0.065)
DV = Density Variability (0.0602)
SD = Source Decay

Dosimetry Error has been analyzed and calculated by Steris as 6.5%. Density Variability was analyzed and calculated by Steris to be as much as 6.02% based upon dose rate studies and historical data. Source decay varies by the time between when the specimen began irradiation and when it was removed from the hot cell. Simply expressed, the source decay variable is determined from the following expression:

$$SD = \frac{days\ of\ exposure}{30} \times 0.00538$$

Thus, the total variability based on the above is summarized in the following table based on the length of exposure:

Days of Exposure	Total Variability (%)	
60	9.94	
40	9.58	
35	9.49	
30	9.40	
25	9.31	
20	9.22	
15	9.13	
10	9.04	**←- This program**
5	8.95	
1	8.88	
0.5	8.87	

The actual dose delivered to the test specimen may have differed from the value reported on the Steris certification. To assist you in evaluating the effects of this reported variability, we have reviewed our contract files to extract what we feel to be the key information which is summarized in the following tables.

Table 1: Radiation Dose Requirements
Kinectrics Test Procedure K-115221-PSWI-0001 R03 & Tyco PO# NL040216

Kinectrics ID	Description	Gamma Dose Requirement TID (MRad) Including 10% Margin	Gamma Dose Requirement TID (Mrad) Including Additional 6.5% Dosimetry Error
K-115005-0001	NMCK8 Nuclear Motor Connection Kits 8 kV	55	58.58
K-115005-0002	NMCK8 Nuclear Motor Connection Kits 8 kV	55	58.58
K-115005-0003	NMCK8 Nuclear Motor Connection Kits 8 kV	55	58.58
K-115005-0004	NMCK8 Nuclear Motor Connection Kits 8 kV	55	58.58
K-115005-0005	NMCK8 Nuclear Motor Connection Kits 8 kV	55	58.58
K-115005-0006	NMCK8 Nuclear Motor Connection Kits 8 kV	55	58.58

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Table 2: Results from Steris Irradiation Including Margin & Variability

Specimen ID	Minimum Dose Required by Table 1 TID (MRad)	Minimum Dose Delivered per Original Certification (MRad)	Maximum Dose Delivered per Original Certification (MRad)	Variability Calculated by Steris Isomedix	Minimum Dose Potentially Received (MRad)*
K-115005-0001	58.575	58.58	70.95	±9.04%	53.3
K-115005-0002	58.575	58.58	70.95	±9.04%	53.3
K-115005-0003	58.575	58.58	70.95	±9.04%	53.3
K-115005-0004	58.575	58.58	70.95	±9.04%	53.3
K-115005-0005	58.575	58.58	70.95	±9.04%	53.3
K-115005-0006	58.575	58.58	70.95	±9.04%	53.3

*Note: The minimum dose is calculated by reducing the value reported on the original certification by 9.04%. It now includes dosimetry error, whereas previously, it did not.

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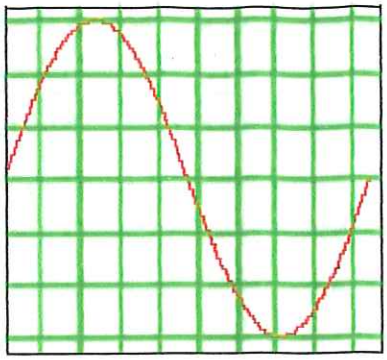
Please provide confirmation to us whether or not this deviation results in the determination that a defect as defined in 10CFR21 exists. Please do not hesitate to contact us if we can assist you in any way to make this determination. Kinectrics is committed to providing the highest level of customer service and will make every effort to work with our customers to reconcile any results affected by this matter.

If you have any questions, or require additional information, please contact me by e-mail at justin.hubbard@kinectrics.com, or by phone at 416-207-6000 ext. 6137.

Justin Hubbard
Kinectrics Inc.
Quality Manager

Attachment B, “EDR-5037, Rev. 4”

Energy Report



EDR-5037

Performance Test of 8 KV In-Line Type Motor Connection Splices Raychem Type NMCK8

Title: Performance Test of 8 KV In-Line Type Motor Connection Splices, Raychem Type NMCK8		Pages: 23 Attachments: 7
Report Number: EDR-5037	Date: August 20, 2012	Revision: 4
Prepared by: Bridget Gilchrist	Signature: Bridget Gilchrist	Date: 8/20/2012
Approved by: Jonathan Cornelius For Product Management	Signature: Jonathan C. Cornelius	Date: 8/20/2012
Approved by: George Pullium For Technical	Signature: George Pullium	Date: 8-20-2012
	Signature:	Date:

Energy Division
8000 Purfoy Road
Fuquay-Varina, NC 2752

REVISION RECORD

REV.	PAGE	PARAGRAPH	DESCRIPTION	DATE	
1			Added Revision Record, page ia and ib		
1	i		Changed page i to page iia and iib		2
1	2	item 4	Changed 323°C to 348°F		
1	5	5.1.1	Added "The test results are summarized in Table 2."		
1	8	2	Changed second sentence to read: (Note: This thermal aging condition corresponds to the Okonite Company's equivalent to 40 years life at 90°C for their cable and does not represent aging conditions equivalent to simulate 40 year life for the Raychem splice materials.)		
1	9	7.2	Changed 382°F to 384°F		
1	9	7.2.1 Para. 3	Changed second sentence to read: "This is equivalent to rated operating voltage phase to ground plus 10 percent margin."		
1	11	item 8, Results	Changed 1 x 10^{10} ohms typical to 8.2 x 10^{10} ohms min.* and added (see Table 2)		
1	11	item 9, Test Reqmt	Changed 23 PSIG to 28 PSIG and 343°F to 348°F		
1	11		Added note* "Sample number 4 insulation resistance value of 6.0 x 10^{7} was attributed to the motor lead/end cap assembly and not to the test sample itself."		2
1	16		RSI Certification of Irradiation added (9) Radiation Source: Cobalt 60		
1	20	Attachment 4	Page 1 of NTS Report 548-9273, para. 2 "Summary" corrected procedure number to NPE-TP-81-02		
1	20	Attachment 4	Page 3 of NTS Report 548-9273 added ohm to meg in table		

REVISION RECORD

REV.	PAGE	PARAGRAPH	DESCRIPTION	DATE
1	20	Attachment 4	Page 3 of NTS Report 548-9273, para. 2 changed 382°F to 384°F, 343°F to 348°F and 28.5 psig to 28 psig.	
1	20	Attachment 4	Page 7 of NTS Report 548-9273, Figure 2, identified test chamber and changed Figure 2 title to HELB Test Setup.	
1	20	Attachment 4	Page 8 of NTS Report 548-9273, Figure 3 changed "LOCA CHAMBER" to read "TEST CHAMBER."	
1	20	Attachment 4	Appendix A, page 8, NTS General Data Sheet changed 343°F to 348°F and 23 PSIG to 28 PSIG.	
1	20	Attachment 4	Appendix A, NTS Report 548-9273, page 11, changed test title to read: POST HELB I.R. and Hypot changed last line to read "cables were at 5000 Va-c during HELB test." NOTE: Revisions to Attachment 4 were made by NTS.	
2	ia	-	Clarification and corrections to revision record description.	
2	11	Note @ bottom of Table 3	Changed 6.7 to 6.0	

APPROVALS

Rev. 2	9-10-82					Corrections
Rev. 1	6-30-82					Incorporate comments and corrections
Rev.	Date	N.P.Engrg.		Prod. Mgt.	Q.A.	

REVISION RECORD

Rev.	Page	Paragraph	Description	Date
3	14	ALL	Reduced reproduction size of appendices	10/7/87
3	17	ALL	Reduced reproduction size off Attachment 1	10/7/87
3	18	ALL	Reduced reproduction size of Attachment 2	10/7/87
3	19	ALL	Reduced reproduction size of Attachment 3	10/7/87
3	Several		Indicated pages which should remain blank to ensure proper format	10/7/87

APPROVALS

Rev.	Date	Tested By	Prepared By	Prod. Mgt.	Tech.Oper
3	10/7/87	NA	Milo Anderson	John Hoffman	Peter Larsson

Rev.	Page	Paragraph	Description	Date
4	Title		Replaced title page with new revision level	8/20/2012
4	1d		Added Revision 4 revision record page 1d	8/20/2012
4	Header		Added Original Issue Date:	8/20/2012
4	iia		Added 2012 NMCK8 Requalification Section 8 to Table of Contents.	8/20/2012
4	iib		Added 2012 Requalification Attachments to Table of Contents.	8/20/2012
4	iib		Added Attachment 5 to Table of Contents - Test Plan	8/20/2012
4	iib		Added Attachment 6 to Table of Contents - Kinectrics Qualification Test Report	8/20/2012
4	iib		Added Attachment 7 to Table of Contents – Certificate of Completion	8/20/2012
4			Removed page number from Appendices was pg. 14	8/20/2012
4	14	Section 8	Added 2012 NMCK8 Requalification	8/20/2012
4	14	Section 8, para 1	Added 2012 NMCK8 Requalification Objective	8/20/2012
4	14	Section 8, para 2	Added 2012 NMCK8 Requalification Summary	8/20/2012
4	14	Section 8, para 3	Added 2012 MNCK8 Requalification Conclusion	8/20/2012
4	21	Attachment 5	TE Connectivity Test Plan No. 20166-20 Rev. 6 and Kinectrics Inc. Test Procedure for Qualification Testing of NMCK8	8/20/2012
4	22	Attachment 6	Kinectrics Inc. Test Report for Qualification Testing of NMCK8	8/20/2012
4	23	Attachment 7	Kinectrics Certificate of Completion	8/20/2012

APPROVALS

4	8/20/2012	Bridget Gilchrist	Jonathan Cornelius	George Pullium	Wilbert Meadows
Rev.	Date	Prepared By	Product Management	Technical	Quality Assurance

CONTENTS

CONTENTS (Cont.)

1.0 OBJECTIVE

To evaluate the performance of the Raychem NMCK8(1), 8kV In-Line Motor Connection kit when subjected to accelerated thermal aging, radiation, electrical stress and a simulated high energy line break in accordance with Raychem Energy Division test plans NPE-TP-81-01 and NPE-TP-81-02.

To establish the qualification of the NMCK8 kit for use on Class IE electrical circuits outside the containment area of nuclear generating stations in accordance with the requirements of IEEE Standards 323-1974 and 383-1974.

2.0 SUMMARY

Twelve test samples consisting of bolted in-line connections were subjected to a test program based on the guidelines of IEEE Standards 323-1974 and 383-1974 to determine their suitability for service outside the containment area of a nuclear generating station. The NMCK8 was required to demonstrate functional operability after simulated 40-year aging conditions and maintain rated voltage during a high energy line break exposure.

The test program consisted of:

1. Thermal aging (504 hours at 150°C)

(1) NOTE: NMCK8 is the product name given to the nuclear grade 8kV motor connection kits. Prior to completion of qualification tests this same product configuration was designated MCK-S-1LX or 2LX to distinguish it from Raychem's commercial MCK-S motor connection kit.

2. Radiation exposure (50 Mrads)

3. Electrical tests (insulation resistances at 500 Vd-c and voltage withstand tests at 11.2kV rms a-c).

4. Simulated high energy line break - HELB (steam for 4 hours at 348°F 28 psig; samples energized at 5kVa-c phase to ground).

The splice system demonstrated satisfactory performance in the test programs and no failures were recorded in any of the 12 splices tested. The test sequence and the results are summarized in Table 3.

All samples demonstrated capability to maintain electrical integrity for their installed life with up to 50 Mrads of radiation including an HELB exposure.

3.0 CONCLUSION

The results of the test programs confirm by type testing the adequacy and suitability of the NMCK8 motor connection assemblies under normal and design basis event conditions for use on Class IE systems in a nuclear power generating station where LOCA considerations are not a requirement.

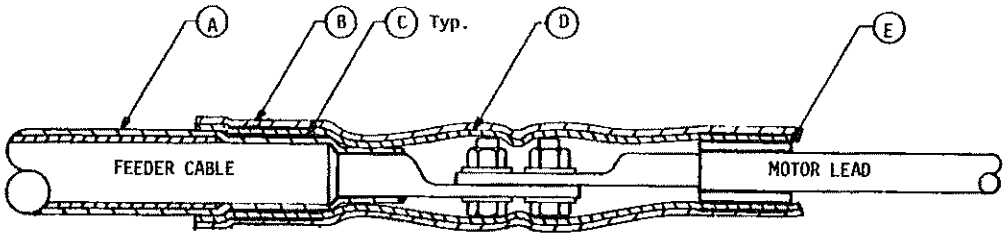
4.0 SAMPLE DESCRIPTION

4.1 Cables and Connections

The feeder cable used was Okonite Company's Okoguarde® 4/0 AWG tape shielded cable. Two types of motor cables were used: (1) 6 AWG glass reinforced silicone rubber insulated cable and (2) 2 AWG silicone rubber.

FIGURE 1

SAMPLE CONSTRUCTION



A - NHVT-I-A-2-00
B - BBIT - 65/25, 14" Long
C - S1024 Adhesive Tape
D - BBIT - 40/16, 14" Long
E - BBIT - 25/10, 3" Long

SAMPLE TEST CONSTRUCTIONS

CONSTRUCTION 1 - Okonite Okoguard® 8kV, 4/0 AWG tape shield feeder cable connected to a 6 AWG glass reinforced silicone rubber insulated motor lead with shim.

CONSTRUCTION 2 - Okonite Okoguard® 8kV, 4/0 AWG tape shield feeder cable connected to a 2 AWG silicone rubber insulated motor lead without shim.

CONNECTORS - Burndy YA6C-2N, YA1C-2N, YA28-2N

TABLE 1

SAMPLE MATRIX

Sample	Construction	Thermal Aging	Radiation Exposure
1	1	X	X
2	1	X	X
3	1	X	X
4	1		X
5	1		X
6	1		X
7	2	X	X
8	2	X	X
9	2	X	X
10	2		X
11	2		X
12	2		X

insulated cable. The feeder cable was terminated on both ends using a standard Raychem 8kV NHVT termination kit.

The following hardware was used: Compression type terminal lug - 2 hole NEMA, manufactured by the Burndy Corporation; 1/2 inch dia. x 1 inch long bolts.

4.2 Sample Construction

The test samples were assembled in accordance with the Raychem installation instructions (as provided in each kit) and as shown in Figure 1. The BBIT insulating tubing was taken at random from manufacturing stock. The test sample matrix is given in Table 1.

5.0 TESTING PROCEDURES

5.1 Functional Tests

Functional tests were conducted in accordance with Raychem Energy Division Test Plans NPE-TP-81-01 and NPE-81-02.

5 .1.1 Insulation Resistance

The insulation resistance was measured in accordance with ASTM D257-78. The insulation resistance measurements were taken after one minute of electrification at 500 Vd-c. The IR requirement for this test was greater than 2.5 megohms (Table 3). The test results are summarized in Table 2.

5.1.2 Voltage Withstand Test

Voltage withstand tests were conducted in water in accordance with IEEE Standard 383-1974, Section 2.3.3.4, using equipment as described in ASTM

TABLE 2

TEST RESULTS

Insulation Resistance at 500 Vd-c for 1 min. in Water at Ambient Temp.

Measurements are in OHMS

Sample	Baseline Result	Post Thermal Aging and Radiation	Post Radiation Only	Post HELB (Engineering data only; not part of test requirements)
1	1.2×10^{11}	3.0×10^{10}	———	———
2	6.2×10^{11}	1.4×10^{12}	———	6.8×10^{7}
3	6.0×10^{11}	1.4×10^{12}	———	6.5×10^{7}
4	5.0×10^{11}	———	6.0×10^{7}	———
5	7.8×10^{11}	———	8.2×10^{10}	6.6×10^{7}
6	6.4×10^{11}	———	1.2×10^{11}	6.6×10^{7}
7	1.6×10^{12}	1.4×10^{12}	———	———
8	1.7×10^{12}	1.9×10^{12}	———	6.8×10^{7}
9	5.0×10^{11}	1.5×10^{12}	———	6.8×10^{7}
10	3.0×10^{10}	———	3.5×10^{11}	———
11	1.7×10^{12}	———	4.0×10^{11}	6.6×10^{7}
12	1.5×10^{12}	———	4.5×10^{11}	6.8×10^{7}

D149-75. The voltage applied was between each sample conductor and the ground plane. The voltage applied was 80 volts per mil of insulation thickness of the feeder cable for five minutes. The actual voltage applied to the samples was 11.2kV rms a-c (80V/mil x 140 mils). Note: 11.2kV rms a-c is the equivalent of 2.25 times the rated voltage phase to ground. The requirement for this test was that there be no breakdown.

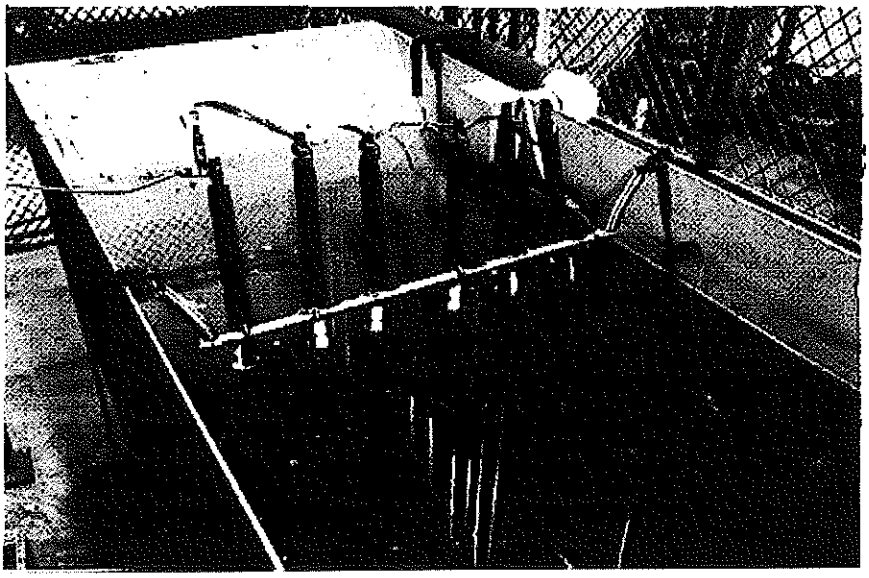
6.0 SAMPLE TESTING

All 12 samples were first subjected to 24 hours water immersion followed by voltage withstand and insulation resistance measurements as described in 5.0 above.

Figure 2 depicts the test set-up.

FIGURE 2

IMMERSION



The samples were then divided into two groups. Group 1 consisted of three samples each of constructions 1 and 2 (Figure 1). Group 1 received both thermal aging and radiation exposure. Group 2 received radiation exposure only.

Sample group 1 received thermal aging for 504 hours at 150°C (302°F) in a circulating air oven (note: This thermal aging condition corresponds to the Okonite Company's equivalent to 40 years life at 90°C for their cable and does not represent aging conditions equivalent to simulate 40 year life for the Raychem splice materials) and radiation exposure of 50 Mrads from a Co^{60} source. Sample group 2 received the same radiation exposure. This sample test matrix was in accordance with Raychem Energy Division Test Plan NPE-TP-81-01. After thermal aging and radiation exposure, the samples were subjected to functional testing as described

After completion of Test Plan NPE-TP-81-01, selected samples from groups

1 and 2 were further subjected to a simulated high energy line break (HELB) in accordance with Raychem Energy Division Test Plan NPE-TP-81-02. This test was conducted at National Technical Services test facility in Chatsworth, California.

7.0 TEST RESULTS

7.1 Results of Test Plan NPE-TP-81-01

All samples met or exceeded the functional test requirements as prescribed in the test plan. The results of these tests are summarized in Table 3. The final functional testing was witnessed and verified by Energy Division Quality Assurance personnel. The results of this test are documented in Raychem laboratory notebook 5750-23.

7.1.1 Inspection

Upon completion of the functional tests, the samples were visually inspected for any abnormalities. None were found.

7.2 Results of Test Plan NPE-TP-81-02, HELB

All samples held rated voltage throughout the course of the HELB environment exposure. At the start-up of the test, the internal chamber temperature was raised from ambient to 384°F as the internal chamber pressure was adjusted to 28 psig within 16 seconds (refer to NTS Report 548-9273 page 6 attached). The chamber temperature then dropped to 280°F for 10 seconds. The temperature and pressure were then adjusted to the requirements of the HELB profile.

The results of this test as performed by National Technical Services are certified in NTS test report 548-9273 attached.

7.2.1 Post HELB Testing

Upon completion of the HELB exposure, the samples were de-energized and the chamber filled with water.

After the chamber was filled with water, insulation resistance measurements were made. IR values ranged from 6.5×10^7 ohms to 6.8×10^7 ohms. Voltage withstand tests were not performed due to test equipment failure at NTS. Voltage withstand tests were completed at Raychem.

The voltage withstand tests were conducted in air at 5.5kVa-c phase to ground. This is equivalent to rated operating voltage phase to ground plus 10 percent margin.

TABLE 3
SUMMARY OF TEST

Test Description	Test Requirement	Results
1. Water Immersion	Samples immersed under 12 inches of water at ambient temp. for 24 hours	N/A
2. AC Withstand (while immersed)	11.2kV rms a-c for 5 minutes	Passed
3. Insulation Resistance (while immersed)	Baseline measurements	3×10^{10} ohms min. (see Table 2)
4. Thermal Aging	504 hours at 150°C (3 samples of each constr.)	No visible defects
5. Radiation Exposure	50 Mrads Co^{60} Source	No visible defects
6. Water Immersion	Samples immersed under 12 inches of water at ambient temp. for 24 hours	N/A
7. AC Withstand (while immersed)	11.2kV rms a-c for 5 minutes	Passed

TABLE 3 (cont.)

Test Description	Test Requirement	Results
8. Insulation Resistances (while immersed)	> 2.5 megohms after 1 min. at 500 Vd-c	8.2×10^{10} ohms min.* (see Table 2)
9. HELB Exposure	Samples exposed to 28 psig and 348°F for 4 hours while energiz to 5kVa-c phase to ground	Passed

*Sample number 4 insulation resistance value of 6.0×10^{7} was attributed to the motor lead/end cap assembly and not to the test sample itself.

The samples were wrapped tightly with copper gauze to constitute a ground plane. All samples maintained 5.5kV phase to ground for five minutes.

Dielectric breakdown tests were conducted in air. The rate of rise was 500 Va-c/second. Breakdown voltages ranged from 18kVa-c to 64kVa-c. Table 4 summarizes the results.

The breakdown tests were conducted for engineering purposes and were not part of the qualification requirements.

TABLE 4
VOLTAGE WITHSTAND AND DIELECTRIC BREAKDOWN
POST HELB

Sample	5.5kVa-c Withstand 5 Minutes	Dielectric Breakdown Voltage, kVa-c 500 Va-c/Sec Rise Time
1	Passed	56
2	Passed(1)	18
3	Passed(1)	40
4	Passed	49
5	Passed(1)	56
6	Passed(1)	58
7	Passed	66
8	Passed(1)	64
9	Passed(1)	42
10	Passed	54
11	Passed(1)(2)	60
12	Passed(1)	60

(1) Denotes samples subjected to HELB test. (2) Tested at 8kVa-c phase to ground.

7.2.2 Inspection

Upon completion of the HELB exposure and insulation resistance measurements as described in 7.2.1, the samples were removed from the chamber and examined for any defects. No visible defects were observed. After the inspection, the samples were returned to Raychem.

Upon arriving at Raychem, the samples were again visually examined. This examination revealed cracks in samples 2 and 3 over the bolted area 0.3 inches long. These samples were subjected to the testing described in 7.2.1. Both samples passed the 5.5kVa-c phase to ground voltage withstand for 5 minutes. Further examination of the cracks were conducted after completion of testing to determine the extent of damage. The cracks in the outer sleeves were carefully cut away to determine if the inner sleeves were affected. The area immediately under the cracked outer sleeve showed no signs of damage. Further examination of the inner sleeve was conducted by removing the remainder of the outer sleeve. The inner sleeve was completely intact and no signs of damage were visible.

8.0 2012 NMCK8 REQUALIFICATION

8.1 Objective

To verify the performance of the NMCK8 kit for use on Class IE electrical circuits outside the containment area of nuclear generating stations in accordance with the requirements of IEEE standards 323-1983 "IEEE Standard for Qualifying Class IE Equipment for Nuclear Power Generating Stations" and 383-1974. "IEEE Standard for Qualification of Class IE Electrical Cables, Field Splices, and Connections for Nuclear Power Generating Stations".

8.2 Summary

The 2012 NMCK8 requalification was performed due to a change made to the compound used to manufacture BBIT-N tubing. BBIT-N tubing is used in NMCK8 kits and other nuclear cable accessories. A raw material used in the BBIT-N compound was discontinued by its supplier and replaced with a comparable alternative. The requalification is intended to validate the performance and demonstrate equivalency of the modified product to the originally qualified product in form, fit and function. The test plan and test results are documented in Attachments 5 "Kinectrics Inc. Test Procedure for Qualification Testing of TE Connectivity NMCK8-Nuclear Motor Connection Kits 8-kV Class 1E Systems" and Section 6 "Kinectrics Inc. Test Report for Qualification Testing of TE Connectivity NMCK8-Nuclear Motor Connection Kits 8-kV Class 1E Systems". The requalification test program was designed to follow the original qualification program. Sample configurations for the requalification were modified to minimize sample numbers. These changes do not impact the HELB test objective to demonstrate equivalent performance of the BBIT-N tubing.

8.3 Conclusion

The NMCK8 motor connection test samples passed the requalification test for use on class 1E electrical circuits outside the containment area of nuclear generating stations in accordance with the requirements of IEEE Standards 323-1974 and 383-1974. Requalification test results are documented in Attachment 6 "Kinectrics Inc. Test Report for Qualification Testing of TE Connectivity NMCK8-Nuclear Motor Connection Kits 8-kV Class 1E Systems"`. Test results demonstrate equivalency of the BBIT-N product manufactured with the modified compound. The necessary changes made to the BBIT-N material have not compromised the NMCK8 products' integrity or adversely affected the products' form, fit, or function.

APPENDICES

Data Acquisition Instruments

Certification of Radiation

APPENDIX A

LIST OF DATA ACQUISITION INSTRUMENTS[1]

The instruments listed below were used to conduct those tests described in Raychem Test Plan NPE-TP-81-01, Rev. 2. Those instruments used to conduct the HELB (Raychem Test Plan NPE-TP-81-02) are listed in National Technical Services report 548-9273 which is attached.

INSTRUMENT	MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CALIBRATED	CALIBRATION FREQUENCY	RANGE
Megohmmeter(1)	General Radio	1864	6571	Before use	6 mos	0 - 1×10^{13} ohms
High Voltage Meter(1)	Jennings	J-1005	323	Before use	6 mos	0 - 100kV
Transformer	General Electric	M296710YET8	----	----	N/A	0 - 20kV
Multi-Point Recorder(1)	Honeywell	16303846/324-162-0000-00000-301-11	08210735001	Before use	6 mos	0 - 300°C

NOTE: 1

All instruments were calibrated by Viking Laboratories of Santa Clara California. All instruments used were calibrated against standards traceable to the National Bureau of Standards or an acceptable natural physical standard, per MIL-I-45208A and MIL-C-45662A requirements. Calibration records are on file at Raychem Corporation, Menlo Park, California.

CERTIFICATION OF IRRADIATION

CUSTOMER: Raychem Corporation

IRRADIATION RUN DATE: July 10,1981

IRRADIATION RUN NUMBER: RAY1001-T

LIST AND DESCRIPTION OF MATERIALS PROCESSED:

Lot Number: None

12 Raychem MCK-5 In Line Motor Connection Kit Specimens #NPE-TP-81-01S

Radiation Sterilizers, Incorporated certifies that this material received a gamma radiation air equivalent dose of 50.0 MRads, plus 10 percent, minus 0 percent, within the accuracy of the dosimetry devices utilized.

(1). Average dose rate 0.2 MRads/hour.

(2). Total hours of irradiation 250 hours.

(3). Samples were positioned vertically in the rack supplied by Raychem.

(4). Halfway through irradiation period the rack was rotated and the inside specimens were rotated to the outside to assure dose uniformity.

(5). Prior to irradiation twenty four dosimeters were utilized to establish the dose map and dose rates for the radiation field.

(6). Dosimeters used were radiachromic dye type supplied by Far West Technology Inc., Goleta, Ca.

(7). Dosimetar calibration is traceable to Standard NBS source. Calibration curve dated November 26, 1980 is attached.

(8). The overall accuracy of the dosimetry system utilized is approximately ± 5%.

(9). Radiation Source: Cobalt 60

Certified By: [signature]

Date: 7-20-81

ATTACHMENT 1

Environmental Test Plan for Raychem
MCK-5 In-Line Motor Connection
NPE-TP-81-01, Rev. 2

Raychem Corporation

ENVIRONMENTAL TEST PLAN FOR
Raychem MCK-5 IN-LINE
MOTOR CONNECTION

1.0 Objective

To evaluate the performance of the Raychem MCK-5, 5-8Kv In-Line Motor Connection Kit when subjected to accelerated thermal aging, radiation and electrical stress in accordance with the requirements of Gibbs L Hill, Inc. Specification 2323-ES-100, Append1x 3, page 7, paragraph 1.4.1a.

2.0 Materials and Sample Construction

2.1 Materials

2.1.1 Raychem test materials shall meet the requirements of Raychem Material Specificat10n PPS 3010/4.

2.1.2 The cable shall be supplied by Comanche Peak Steam Electric Station and shall meet all the requirements set forth by the Comanche Peak Steam Electric Station Quality Assurance Program.

2.2 Sample Construction (figure 1)

2.2.1 Samples shall be constructed per the standard installation instructions for the kits used in this test. Figure 1 illustrates the construction and lists the materials to be tested. There shall be six samples each of two constructions. Three samples of each construction shall be given the full test sequence and the other three of each construction shall be tested to all parts of the sequence except thermal aging (Table 1).

3.0 Test Sequence

3.1 The test program shall consist of the following sequence:

Sequence	Test	Section
1.	Water immersion	4.0
2.	Functional test	5.0
3.	Thermal aging	6.0
4.	Radiation exposure	7.0
5.	Water immersion	4.0
6.	Functional test	5.0
7.	Inspection	8.0

4.0 Water Immersion

4.1 Test samples shall be immersed in tap water at room temperature for 24 hours. All parts of the motor connection assemblies, excluding leads, shall be at least 12 inches below the surface of the water.

5.0 Functional Tests

5.1 Insulation Resistance (ASTM D257-78)
The insulation resistance shall be measured at 500 volts d.c. in water at room temperature after one minute of electrification time.

Requirement: $R > 2.5$ megohms

5.2 Voltage Withstand Tests

The Voltage Withstand Tests shall be conducted in water per IEEE Std. 383-1974, section 2.3.3.4, using equipment as described in ASTM D149-75. The voltage shall be applied between each sample conductor and the ground plane. The voltage applied shall be 80 volts per mil of insulation thickness of the feeder cable for five minutes.

Requirement: No breakdown

6.0 Thermal Aging

Three of each construction shall be thermally aged for 504 hours at 150°C ± 2°C in an air circulating oven (Table 1).

NOTE: This thermal aging condition corresponds to the Okonite Company's equivalent to 40 years of life at 90°C for their cable.

7.0 Radiation Exposure (IEEE 383-1974, 2.3.3.3)

Test samples shall be exposed to an air equivalent dose of 5.0×10^7 rads of gamma radiation from a Co^{60} source at a rate not to exceed 1.0×10^6 rads per hour.

NOTE: This radiation exposure exceeds the Comanche Peak requirement.

8.0 Inspection

Upon completion of the test program, the test samples shall be visually inspected and their condition noted.

9.0 Report

A report shall be issued subsequent to the completion of testing. This report shall contain descriptions of the test samples, test data, a listing of data acquisition instruments, calibration data, radiation certification and conclusions.

Raychem

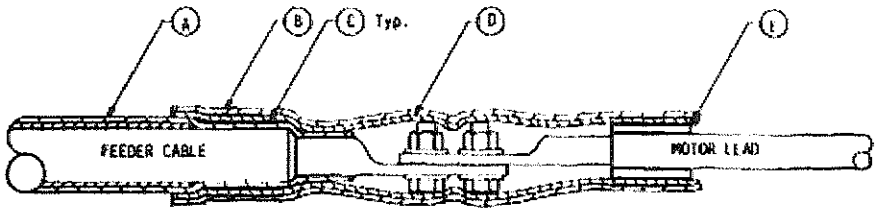
Table 1

TEST MATRIX

SAMPLE	CONSTRUCTION	THERMAL AGING	RADIATION EXPOSURE
1	1	X	X
2	1	X	X
3	1	X	X
4	1		X
5	1		X
6	1		X
7	2	X	X
8	2	X	X
9	2	X	X
10	2		X
11	2		X
12	2		X

FIGURE 1

SAMPLE CONSTRUCTION



NOTES:

1. Motor lead to be:
   A. Construction 1
      1/C-#6 AWG glass reinforced silicone rubber insulation with shim.
   B. Construction 2
      1/C-#2 AWG silicone rubber insulation without shim.
2. Connectors
   Burndy YA-2N, 2-hole NEMA

KEY

A - HVT-1-A-2-00

B - Outer Sleeve, BBIT 65/25, 14" L

C - S1024 Adhesive Tape

D - Inner Sleeve, BBIT 40/16, 14" L

E - Shim, BBIT 25/10, 3" L

PRODUCT APPLICATION DRAWING			
Raychem ENERGY DIVISION-AMPAC		DCR No.	
ENGINEER	DATE:	DESCRIPTION:	
PCN:		DOCUMENT No.	REV.

ATTACHMENT 2

Radiation Requirements for
The Raychem MCK-5 In-Line
Motor Connection Kit
NPE-TP-81-01S

RADIATION REQUIREMENTS
FOR
THE RAYCHEM MCK-S IN-LINE
MOTOR CONNECTION KIT

1.0 Dose and dose rate

Test samples shall be exposed to an air equivalent dose of 5.0×10^7 rads of gamma radiation from a Co^{60} source at a rate not to exceed 1.0×10^6 rads per hour.

2.0 Uniformity

The test samples shall be uniformly irradiated longitudinally and circumferentially to an air equivalent dose of 5.0×10^7 rads, plus 10 percent, minus zero percent.

3.0 Number of dosimeters

The number of dosimeters used to monitor the irradiation of the test samples shall be sufficient to ensure the requirements of paragraphs 1.0 and 2.0.

4.0 Frequency of data acquisition

Dosimetry readings shall be made at a frequency to ensure the requirements of paragraphs 1.0 and 2.0.

5.0 Data acquisition devices

There must be documented measures to assure that data acquisition instruments used for this program are properly controlled, calibrated and adjusted at specified periods to maintain accuracy within established limits. This is in accordance with the requirements of 10CFR50, Appendix B. A record of the calibration dates and accuracies shall be provided with the certification at the conclusion of the program.

6.0 Certification

Upon completion of the irradiation, a letter of certification shall be issued to Raychem Corporation and shall contain the following information:

1. Total dose and dose rate
2. Actual total hours of irradiation
3. Sample positioning
4. How the radiation was measured
5. The types of dosimeters used and calibration information
6. Signature and title of the person issuing the certification

ATTACHMENT 3

Test Plan for HELB Qualification Test of
Raychem MCK-5 In-Line Motor Connection Kit
NPE-TP-81-02

August 12, 1981

TEST PLAN FOR HELB QUALIFICATION TEST OF RAYCHEM MCK-5 IN-LINE MOTOR CONNECTION KIT.

1.0 Objective

To evaluate the performance of the Raychem MCK-5, 5-8kV In-Line Motor Connection Kit when subjected to simulated high energy line break (HELB) environmental conditions, in accordance with the requirements of Comanche Peak Steam Electric Station.

2.0 Sample Construction

Eight samples shall be chosen from the test matrix described in Test Plan NPE-TP-81-01 at the conclusion of the testing. Four samples shall have been exposed to both thermal aging and radiation. Four samples shall have been exposed to radiation only. These samples are representative of the worst case conditions of the product over its installed life. A detailed description of the sample construction is contained in NPE-TP-81-01 Revision 1 and will be documented in the test report. The samples consist of an MCK-5 In-line Motor Connection Kit installed onto an unshielded motor lead and a shielded field cable (terminated with a Raychem N-HVT), both representative of cable used at the Comanche Peak Steam Electric Station.

3.0 Test Program

3.1 General

Following completion of the qualification test program detailed in Test Plan NPE-TP-81-01 Revision 1, eight samples shall be selected -- four of each aging condition. In each group of four, two samples shall be of each construction as outlined in Test Plan NPE-TP-81-01 -- for further testing to the HELB environmental conditions of the Comanche Peak Steam Electric Station.

Test Program, General (contd.)

Successful completion of the previous test qualifies the MCK-5, 5-8kV In-Line Motor Connection Kit for use on Class IE circuits under normal operating conditions. The samples chosen for this test represent two possible end of life conditions. A completely unaged (virgin) sample, representing beginning of life, need not be tested. The testing of conditioned samples is a worst case condition for the Raychem materials.

The required HELB environmental conditions as specified for the Comanche Peak Steam Electric Station are:

Temperature:	328°F
Pressure:	23 psig
Humidity:	100%
Duration:	4 hours

The test sequence shall be as follows:

1. Visual inspection
2. HELB exposure
3. Functional test

3.2 Visual Inspection - a visual inspection shall be performed by Raychem upon receipt of the test samples at the test site location to detect any in-transit damage. Splice and cable shall be inspected for cuts, cracks, scrapes or other signs of physical abuse. Samples revealing indeterminate damage shall be given a voltage withstand test at 11.2kV to ground to determine suitability for further testing.

3.3 HELB Exposure - samples shall be mounted in a pressure vessel capable of exposing the samples to steam at the required temperatures and pressure plus margin. The samples shall be energized

Test Program (HELB Exposure, contd.)

to 5kV a-c phase to ground throughout the test. The required test profile is as follows:

TIME	TEMPERATURE °F (°C)	PRESSURE
0-	Ambient	Ambient
0 to 4 hours	Ambient to 343°F (173°C)	23 psig (minimum)
4 hours +	Cool down to ambient	Ambient

3.4 Acceptance Criteria - the samples shall be capable of maintaining rated voltage throughout the HELB exposure to verify functional operability. In the event that rated voltage is not maintained throughout the HELB exposure, the source of the failure shall be identified. If the failure is not attributed to the splice insulating kit itself, further testing of the splice wrapped with a copper gauze ground plane shall be conducted to determine its functional operability. Subsequent ability of the splice sample itself to pass a voltage withstand test at rated voltage and demonstrate insulation resistances greater than one megohm shall be considered acceptable performance verification.

3.5 Post HELB Electrical Tests - the insulation resistance of each sample shall be measured at 500 V. d-c at ambient temperature after being energized for one minute. Equipment shall conform to ASTM D 257-78. Each sample shall also be given a voltage withstand test at 5.5kV. a-c to ground for five minutes, using equipment in accordance with ASTM D 149-75. Both tests shall be conducted in water. These tests are intended to provide engineering information only on the performance of the splice. They are not required to demonstrate functional operability.

4.0 Report

A report shall be written subsequent to completion of the testing. The report shall include descriptions of the test samples and test set-up, test data, a list of data acquisition instruments with calibration records, and conclusions.

ATTACHMENT 4

HELB Test Certification
National Technical Services
Report No. 548-9273

RAYCHEM CORPORATION
300 Constitution Drive
Menlo Park, CA 94025

Report No. 548-9273

Date: 14 October 1981

TEST SPECIMENS

Eight (8) MCK-5 In-Line Motor Connection Kits; Sample Numbers MCK-5-2, MCK-5-3, MCK-5-5, MCK-5-6, MCK-5-8, MCK-5-9, MCK-5-11, MCK-5-12.

SUMMARY

This report certifies that the Specimens identified above have been subjected to High Energy Line Break (HELB) Testing in accordance with Raychem Test Procedure Number NPE-TP-81-02. An anomaly was reported and is fully documented in the body of this report. [1]

TEST EQUIPMENT

				Calibration	
NTS No.	Equipment	Manufacturer	Model	Cycle	Due Date
ENV672V	Boiler	Parker	16869	--	N/A
--	Super Heater	NTS	--	--	N/A
--	Auto-clave	Kaiser	585 @ 450°	--	N/A
E1219V	Bridge Balance	NTS	--	Before Use	--
E1193V	X-Y Plotter	Linear Inst	285MM	Before Use	--
P1030V	Compound Gauge	Ashcroft	AMP8346	Ind. Only	N/A
P623V	Press Gauge	Ashcroft	AMP7317	Ind. Only	N/A
P456V	Press Gauge	Ashcroft	0-160	Ind. Only	N/A
1062	Press Gauge	Ashcroft	AMP8236	Ind. Only	N/A
P536V	Press Gauge	Ashcroft	0-100	--	11-19-81
P547V	Press Gauge	Ashcroft	AMP7321	Ind. Only	N/A
P582V	Press Gauge	Ashcroft	0-300	Ind. Only	N/A
P561V	Press Gauge	Ashcroft	0-200	Ind. Only	N/A
P1093V	Press Gauge	Helicoid	6W-150-1	Ind. Only	N/A
P1126V	Press Gauge	U.S. Gauge	19042	Ind. Only	N/A

TEST EQUIPMENT (continued)

NTS No.	Equipment	Manufacturer	Model	Calibration Cycle	Calibration Due Date
ENV475V	LED Thermometer	Analogic	AN2572	Ind. Only	N/A
ENV1107V	Transducer	Statham	0-100	Before Use	--
ENV527V	Recorder	Honeywell	Temp	--	3-28-82
G642V	Recorder	Honeywell	Press	Before Use	--
ENV856S	Controller	Honeywell	Temp	Ind. Only	N/A
E698V	Megometer	Gen.Radio	1862C	6 months	2-18-82
P858V	Press Gauge	Ashcroft	0-100	3 months	10-14-81
P846V	Press Gauge	Ashcroft	0-60	3 months	1-6-82
P851V	Press Gauge	Ashcroft	0-200	3 months	12-2-81
E1185V	Variac	Gen.Radio	0-140 ACV	--	N/A
E740V	VOM	Simpson	630NA	6 months	4-7-82
E1192	Transformer	Maloney Elec	7650047	6 months	N/A

NOTE: The equipment specified above was calibrated, as required, in accordance with MIL-C-45662A and is traceable to the National Bureau of Standards (NBS). The NBS traceability records are maintained on file in the NTS Quality Control Office.

NTS

TEST PROCEDURES AND TEST RESULTS

HIGH ENERGY LINE BREAK (HELB) TEST

Date Performed: 8 October 1981

The Specimens were mounted to a NTS-adaptable flange and installed in a test chamber of the High Energy Line Break (HELB) system, as shown in Photograph 1. The Specimens were then energized to 5000 Vac and this condition was maintained throughout the test (refer to Figure 2).

The internal chamber temperature was adjusted from ambient to +384°F as the internal chamber pressure was adjusted from ambient to 28 psig within 16 seconds (refer to Figure 1 and Notice of Deviation 1). The chamber temperature was then adjusted to +348°F and the chamber pressure to 28.0 psig. These conditions were maintained for a period of 4 hours. No other anomalies were reported. | 1 | 1

The chamber environmental conditions were returned to ambient and the Specimens were deenergized. The chamber was filled with water and the Specimens were subjected to insulation resistance (IR) tests. The results of these tests are listed below:

Samples	Reading (meg ohm)
MCK-5-2	68
MCK-5-3	65
MCK-5-5	66
MCK-5-6	66
MCK-5-8	68
MCK-5-9	68
MCK-5-11	66
MCK-5-12	68

| I

The IR test was completed at 500 Vdc and the readings were recorded after 1 minute of energization. A voltage withstanding test was not done due to equipment failure. Per customer instruction, the test shall be completed by the customer at his facility. Following the IR tests, the chamber was drained of water and the Specimens were removed from the chamber. No signs of physical damage were noted following a visual examination. This concluded testing and the Specimens were returned to Raychem Corporation.

DAVID P. BAME Project Manager

HOWARD E. CLARK, Quality Assurance Manager

NOTICE OF DEVIATION

AETL APPROVED ENGINEERING TEST LABORATORIES
A NATIONAL TECHNICAL SERVICES CO.

DATE: 10-8-81

☐ LOS ANGELES DIVISION / 5320 WEST 104TH STREET / LOS ANGELES, CALIFORNIA 90045 / (213) 776-3202
☒ VALLEY DIVISION / 9551 CANOGA AVENUE / CHATSWORTH, CALIFORNIA 91311 / (213) 341-0830
☐ SAUGUS DIVISION / 20988 W. GOLDEN TRIANGLE RD. / SAUGUS, CALIFORNIA 91350 / (805) 259-8184
☐ EL MONTE DIVISION / 1431 POTRERO AVENUE / SO. EL MONTE, CALIFORNIA 91733 / (213) 444-9511
☐ FULLERTON DIVISION / 1536 EAST VALENCIA / FULLERTON, CALIFORNIA 92631 / (714) 879-6110

CUSTOMER: RAYCHEM
MJO NO.: 548-9273
PART NO.:
N.O.D. NO.: 1
SAMPLE SERIAL NO.: MCK-5-2,3,5,6,8,9,11,12
P.O. NO.: A05271-1
TEST PROCEDURE: 4-5412
PARAGRAPH: 6.1.2.3 Fig 3

REQUIREMENT: MAINTAIN SIMULATED ENVIROMENTAL CONDITION OF 343°F @ 23 PSIG FOR 4 HOURS

DEVIATION: SOON AFTER SPIKE TEMP DROPPED TO 280°F FOR 10 SEC.

DISPOSITION: CONTINUE TESTING

APPROVAL _____
(Customer Representative)

CUSTOMER NOTIFICATION:

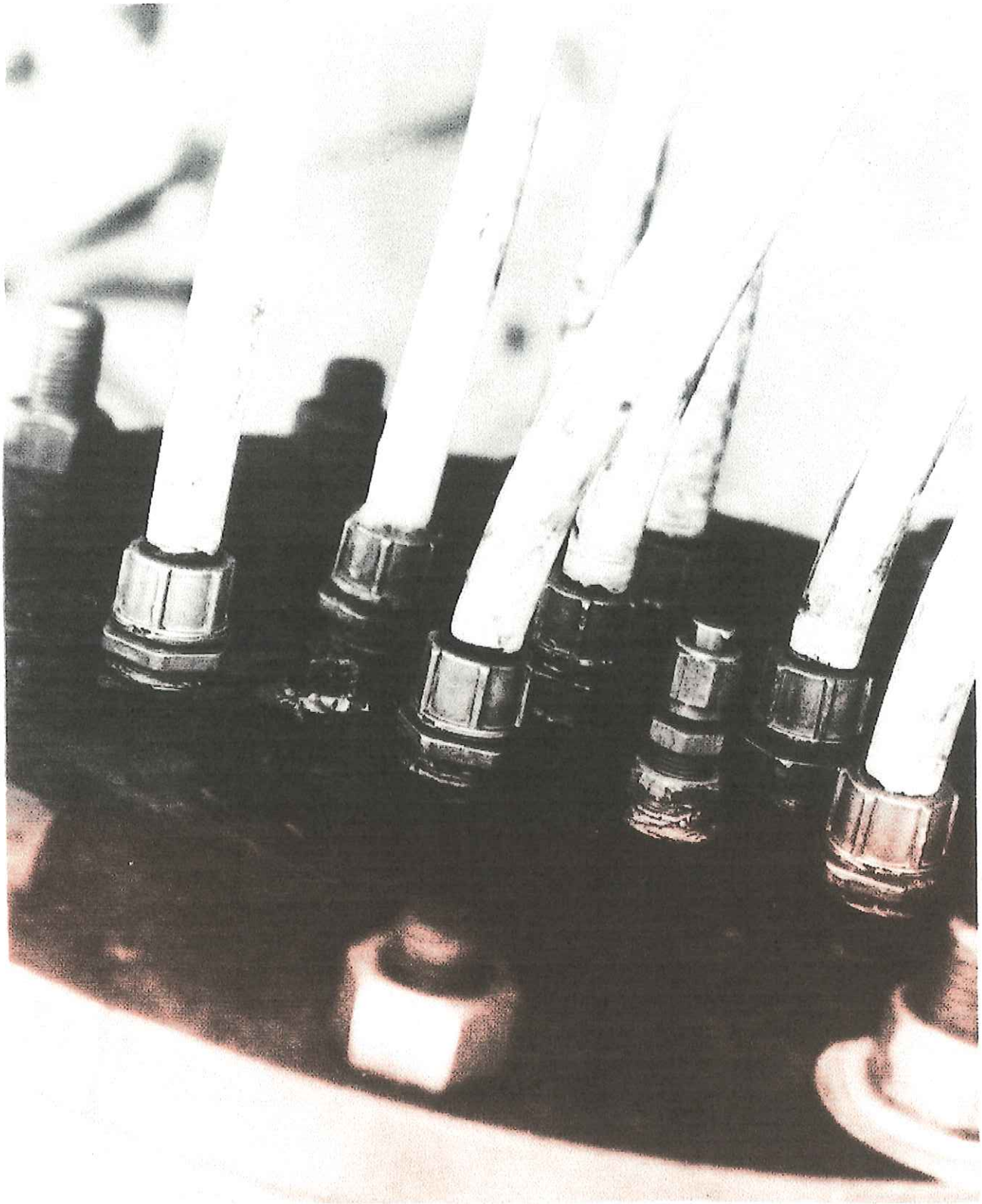
Made to: GARY WILL
How: VERBAL
Date & Time: _____
By: D.P. BAME

DCAS Notified: ☐ YES ☐ NO _____ DATE

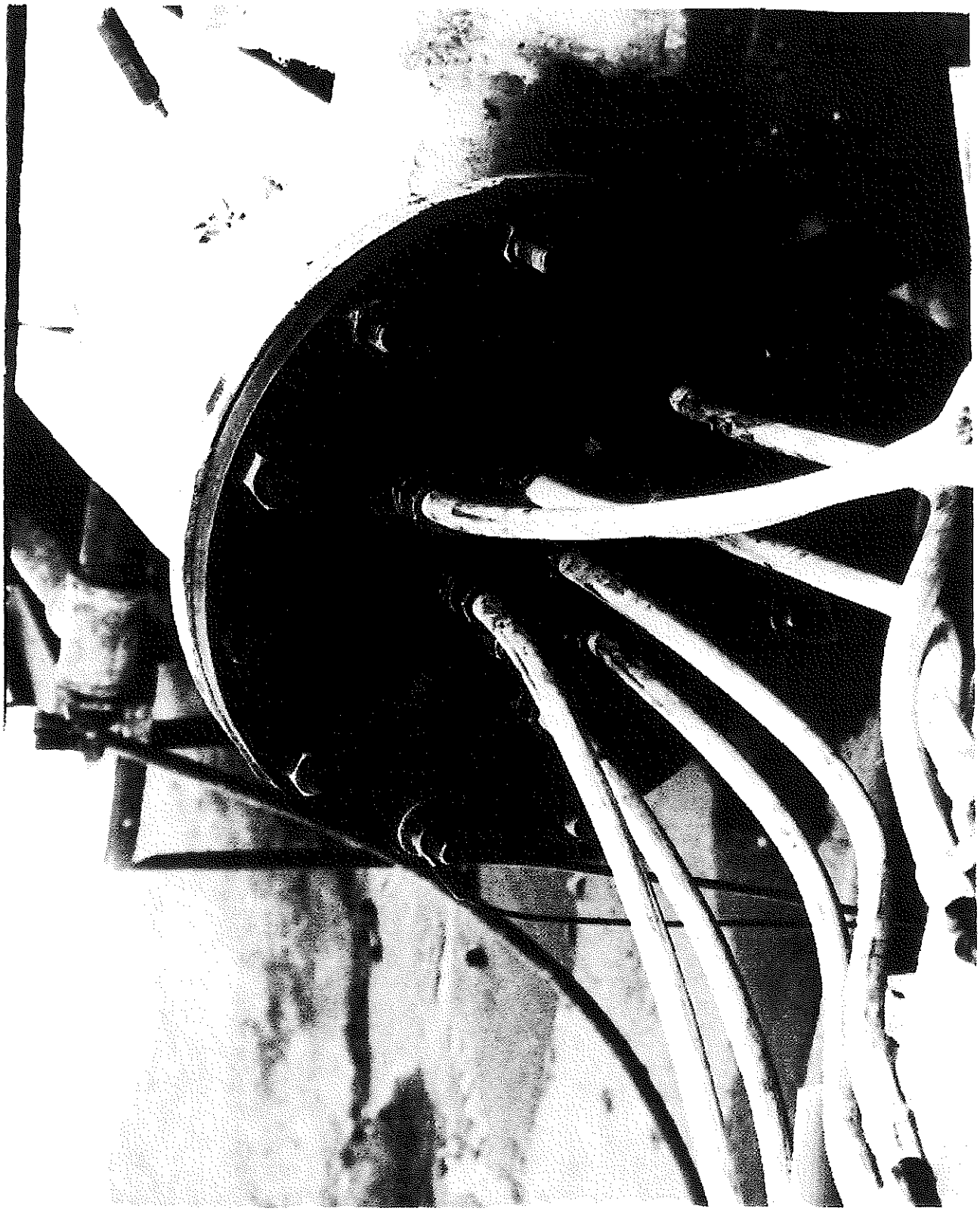
D.P. Bame
A.E.T.L. Dept. Supervisor

PHOTOGRAPH 1
HELB Test Setup

NTS

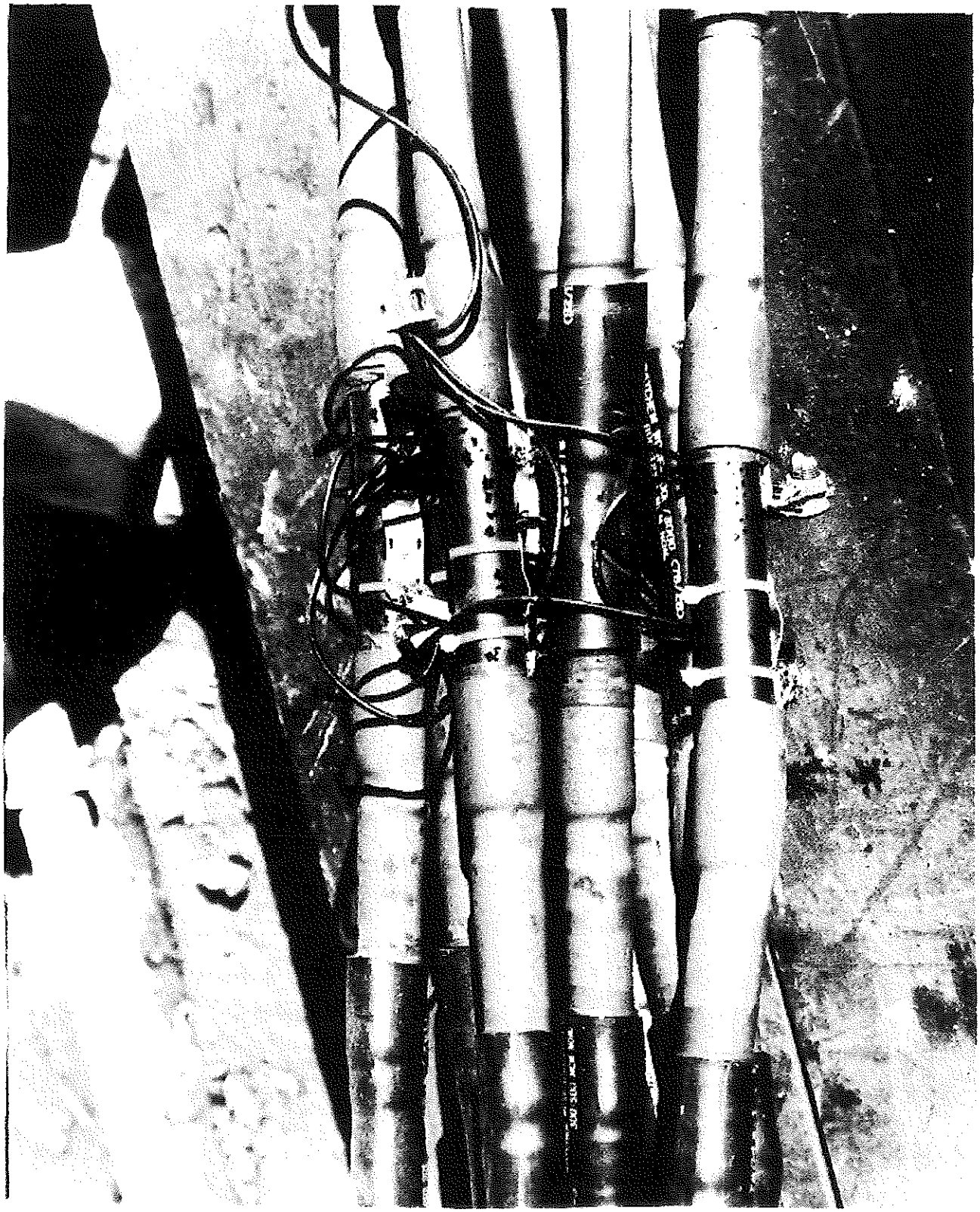


Photograph 2
HELB Test Setup



Photograph 3
Post HELB Examination

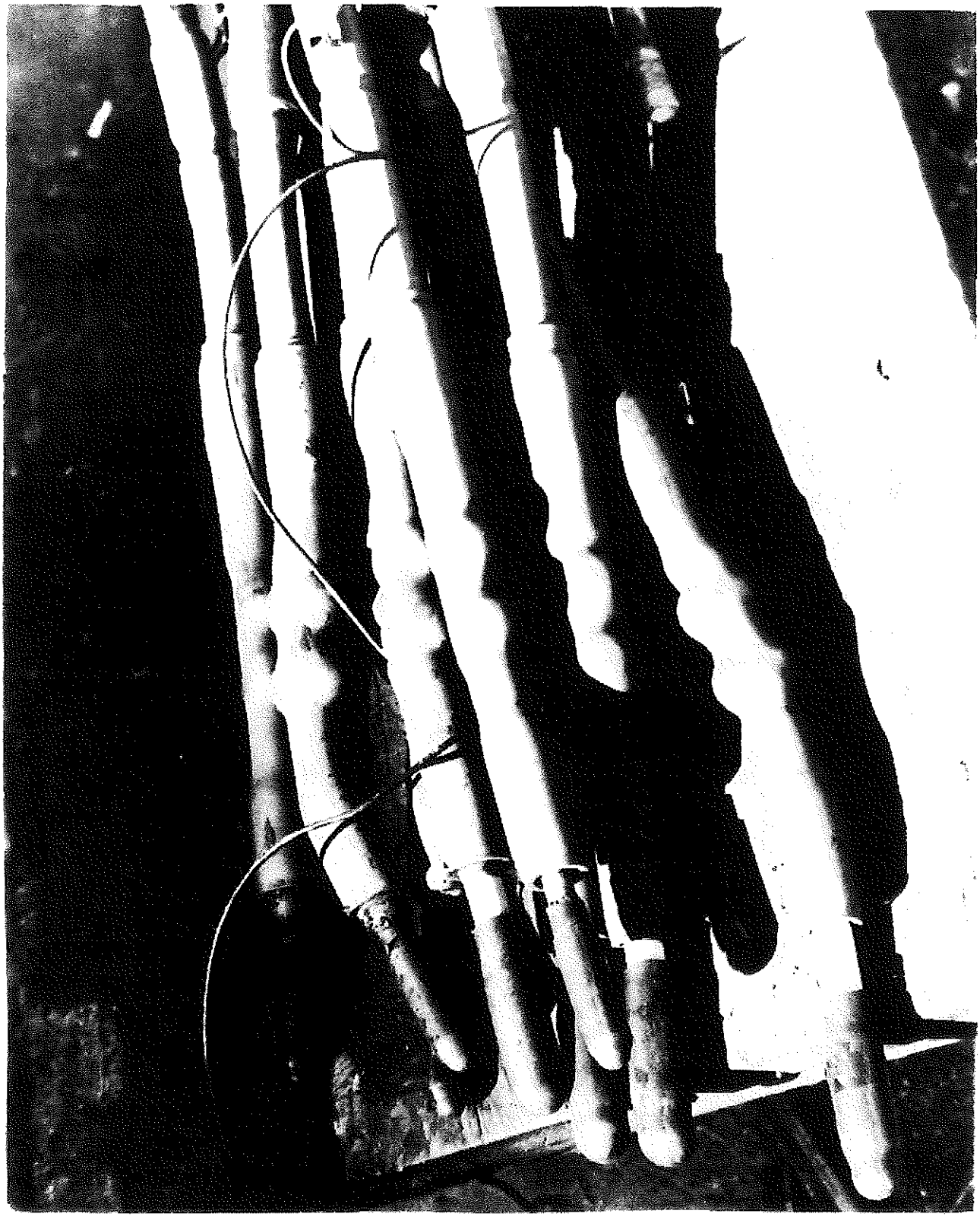
NTS



NTS

Photograph 4
Post HELB Examination

Photograph 5
Post HELB Examination



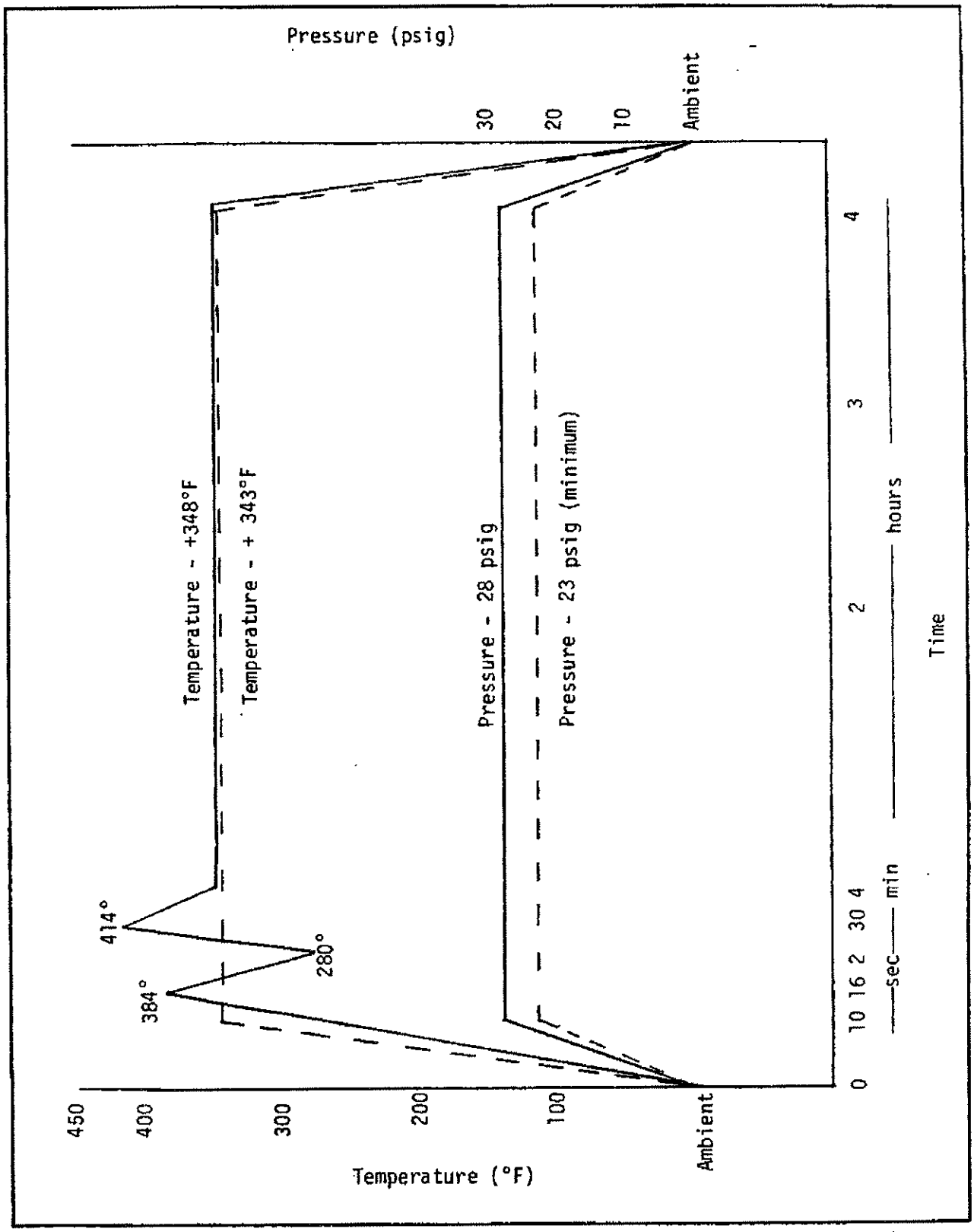


Figure 1 HELB Profile

---------- = Required Levels

———— = Test Levels

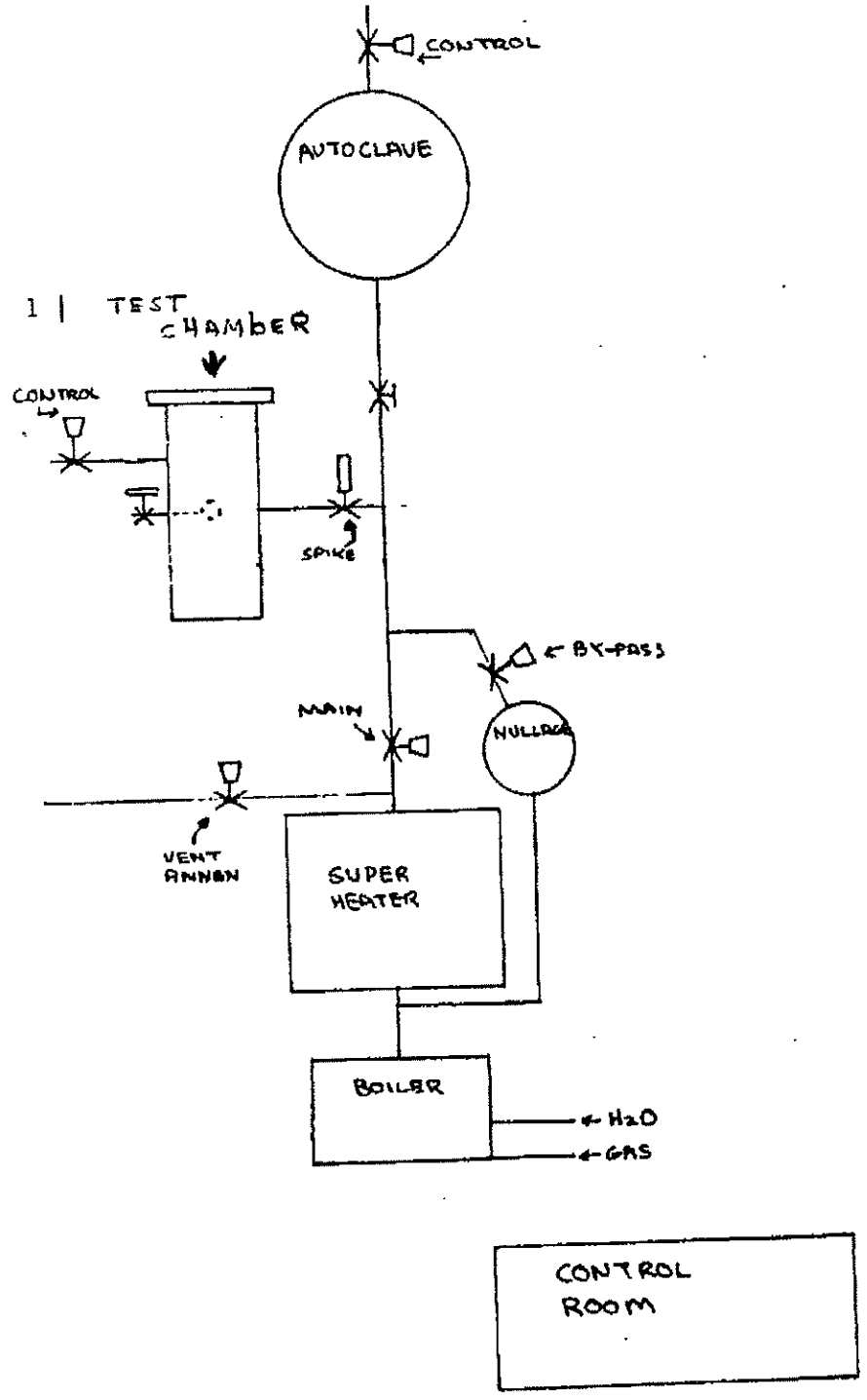


ABB PTC — 207

1 | FIGURE 2 - HELB Test Setup

APPROVED ENGINEERING TEST LABORATORIES
A NATIONAL TECHNICAL SERVICES CO.
NTS

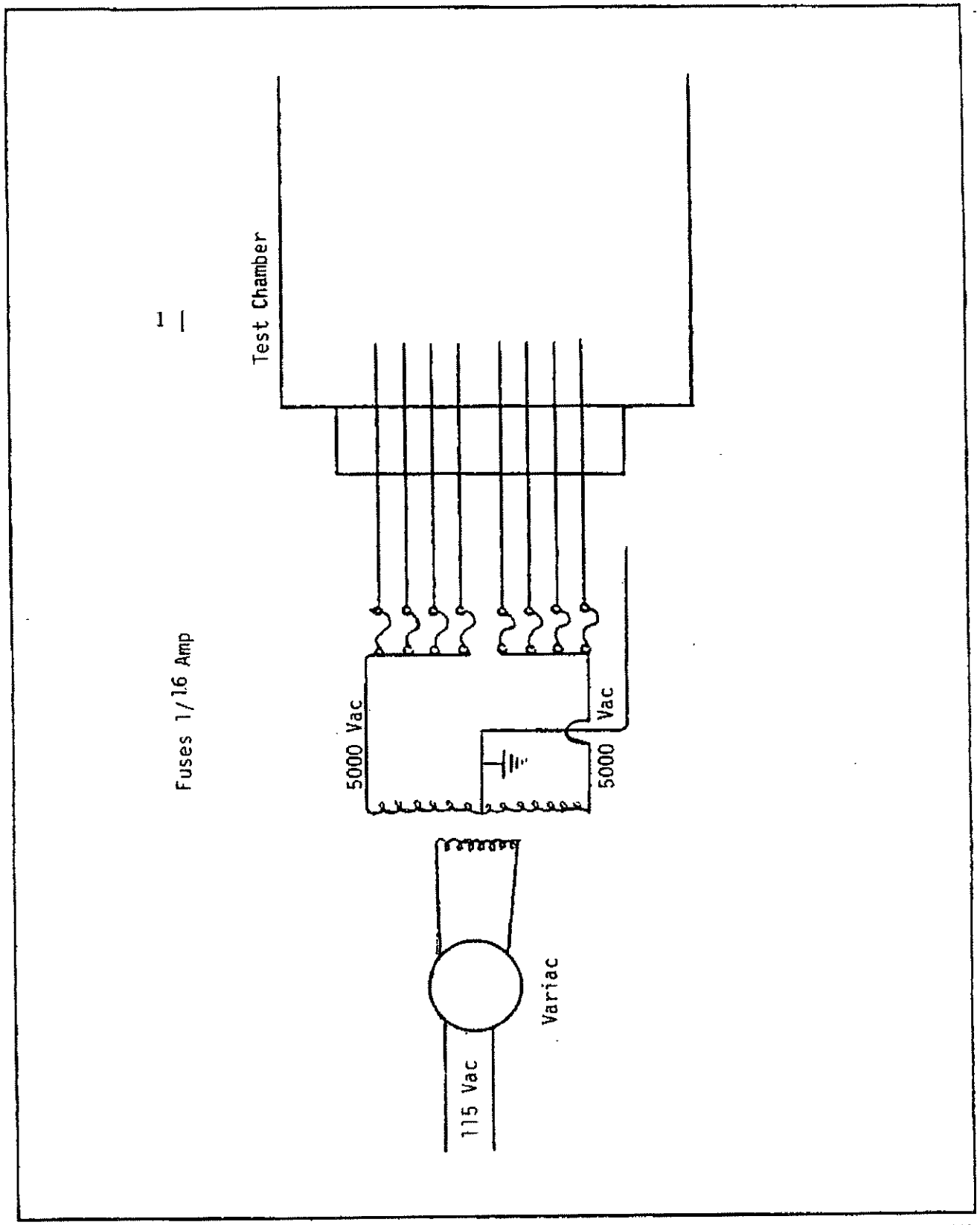


ABB PTG — 207

FIGURE 3 - Energizing Circuitry Schematic

APPROVED ENGINEERING TEST LABORATORIES
A NATIONAL TECHNICAL SERVICES CO.
NTS

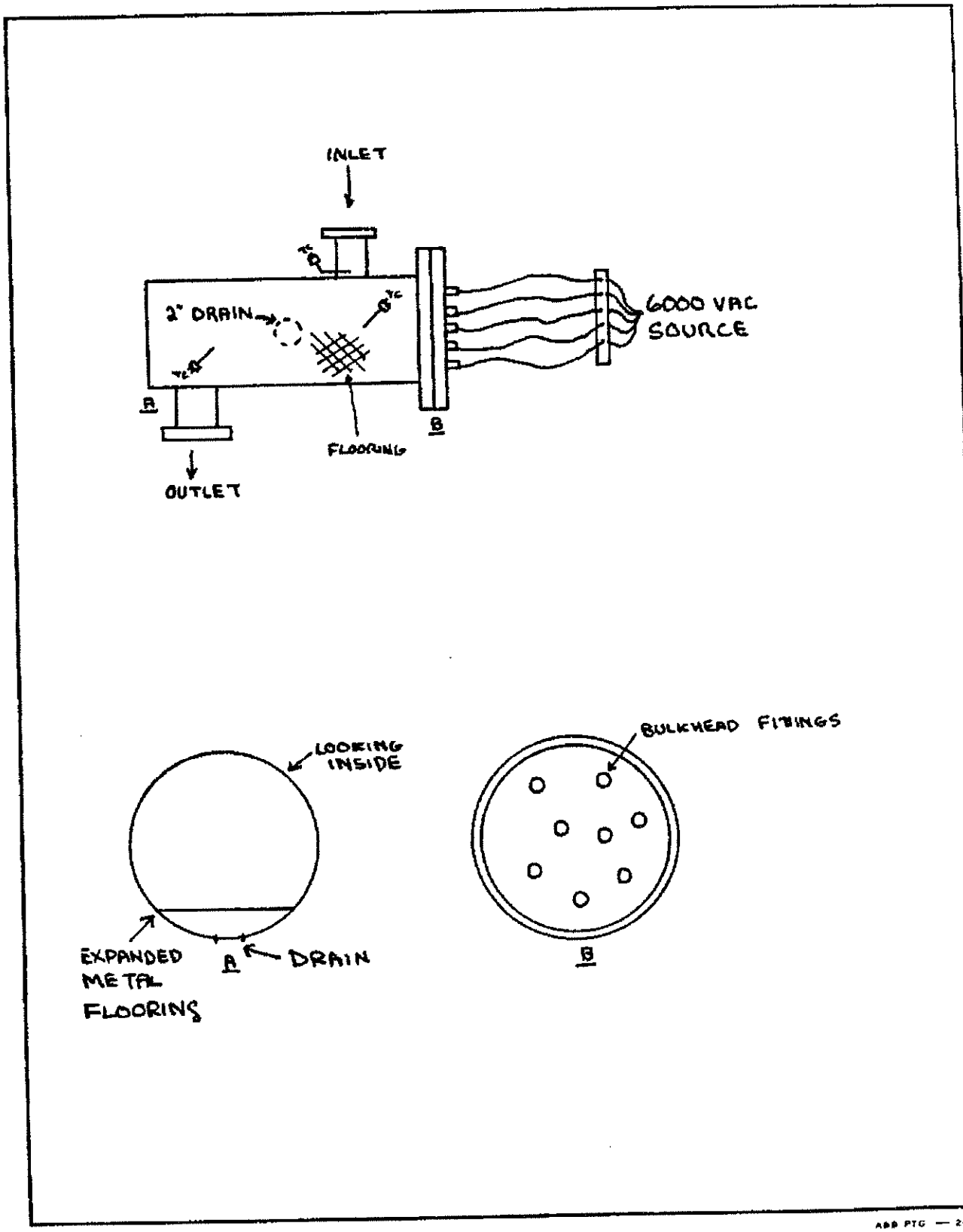


ABB PTG — 207

FIGURE 4: Test Chamber Setup

APPENDIX A

Test Data

APPROVED ENGINEERING TEST LABORATORIES
A NATIONAL TECHNICAL SERVICES CO.
NTS

GENERAL DATA SHEET

TEST HELB DATE 10-8-81 MJO 548-9273
CUSTOMER RAYCHEM
TEST ITEM MOTOR CONN. KITS P/N S/N
SPECIFICATION 4-5412 PAR 6.0

TEST DESCRIPTION

THE SPECIMENS WERE MOUNTED TO A FLANGE THAT ADAPTED THE MOTOR CONNECTION KITS TO THE NTS LOCA SYSTEM. THEY WERE ENERGIZED TO 5 KVAC AS PER FIG 2 OF SPEC. THE SPECIMENS WERE THEN SUBJECTED TO A SIMULATED ENVIROMENTAL HIGH ENERGY LINE BREAK TO THE CONDITIONS OF FIG 3 (348°F AT 28 PSIG). AFTER 4 HOURS OF SIMULATED HELB THE CHAMBER WAS RETURNED TO AMBIENT AND FILLED WITH WATER PER PARA 6.1.3.1, AND AN INSULATION RESISTANCE TEST WAS CONDUCTED. ALL 8 (EIGHT) TEST SPECIMENS PASED INSULATION RESISTANCE TESTING. THE SPECIMENS WERE THEN REMOVED FROM THE CHAMBER AND VISUALY INSPECTED. NO VISUAL DAMAGE WAS NOTED. THE SAMPLES WERE REMOVED FROM THE TEST FLANGE AND REBOXED

AETL ID	CALIB DUE DATE	AETL ID	CALIB DUE DATE	AETL ID	CALIB DUE DATE

PAGE ____ OF ____
TEST BY R. L. Hunt DATE 10-8-81
ENGR. [signature] GOV'T QAR.

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APPROVED ENGINEERING TEST LABORATORIES
A NATIONAL TECHNICAL SERVICES CO.

GENERAL LOG SHEET

TEST Post HELB I.R & HYPOT MJO 548-9273
CUSTOMER RAYCHEM
TEST ITEM MCK CONNECTIONS P/N S/N
SPECIFICATION 548-9273 PAR 6.1.3

DATE	TIME	LOG ENTRIES	INITIAL
10/8/81	14:00 pm	SPECS CALL FOR AN INSULATION RESISTANCE TEST	RWB
		AT 500 VDC. RECORD VALUES AFTER 1 MIN EXCITATION	
		CABLE A READ 68 MEG Ω	
		CABLE B 65 MEG Ω	
		CABLE C 66 MEG Ω	
		CABLE D 66 MEG Ω	
		CABLE E 68 MEG Ω	
		CABLE F 68 MEG Ω	
		CABLE G 66 MEG Ω	
		CABLE H 68 MEG Ω	
10/8/81	14:15	COMPLETED	RWB
		SPECS ALSO CALLED FOR A HYPOT TEST AT	
		5.5 KVAC OR 5 MIN. TEST WAS WAIVED BECAUSE	
		CABLES WERE AT 5000 VDC DURING HELB TEST.	
		TEST EQUIPMENT	
		GENERAL RADIO MODEL # 1862-C	
		ID # E698V CALIBRATION DUE 2/18/82	

PAGE ____ OF ____

TEST BY Randy Baker DATE 10/8/81
ENGR. [signature] GOV'T QAR

ATTACHMENT 5

TE Connectivity Test Plan No. 20166-20 Rev. 6
"NMCK8-Nuclear Motor Connection Kit 8kV Class 1E
Systems Subjected to HELB-High Energy Line
Break Conditions"
And
Kinectrics Inc. Test Procedure for Qualification Testing
of TE Connectivity NMCK8-Nuclear Motor Connection
Kits 8-kV Class 1E Systems

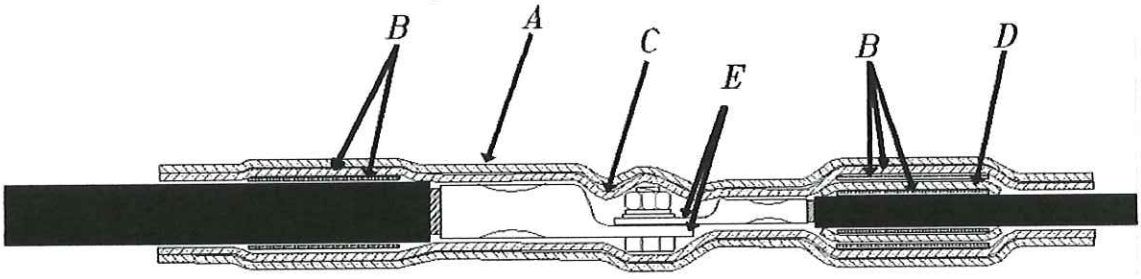
Test Plan No. 20166-20 Rev.6
Date: January 23, 2012
Subject: NMCK8 –Nuclear Motor Connection Kit 8-kv Class 1E Systems Subjected to HELB – High Energy Line Break Conditions

1. Objective: To document the NMCK8 HELB test plan. This re-qualification testing is needed to verify the performance of NMCK8 for use on Class IE electrical circuits outside the containment area of nuclear generating stations in accordance with the requirements of IEEE standards 323-1983 "IEEE Standard for Qualifying Class IE Equipment for Nuclear Power Generating Stations" and 383-1974. "IEEE Standard for Qualification of Class IE Electrical Cables, Field Splices, and Connections for Nuclear Power Generating Stations".
Background: This re-qualification is being performed due to a change made to the compound used to manufacture BBIT-N tubing used in NMCK kits. Changes made to the compound are a result of raw material obsolescence.

2. Sample Test Configurations:
Sample configurations were modified from the original qualification configurations described in the EDR-5037, Dated 1982, to minimize sample numbers. These changes will not impact the HELB test objective to demonstrate equivalent performance of the BBIT-N tubing.
Samples are to be constructed per the standard installation instructions for NMCK8 kits (PII55154). Six samples of the following configuration are to be constructed for test.

8 kV, 4/0 AWG tape shield cable connected to a 6 AWG fiber reinforced silicone rubber insulated motor lead with shim.

Figure 1. Sample Construction



A. BBIT-65/25-280/U
B. S1119 Adhesive Tape
C. BBIT-40/16-280/U
D. BBIT-25/10-75/U
E. Connectors: Burndy YA-6CN 1 hole NEMA and 4/0 Lug Utilux part 1-1099899-0

3. Test Procedure:

Six test samples are to be subjected to test sequence 1-3 outlined in Table 1. Four of the six test samples will be subjected to all of the test sequences 1-5 outlined in Table 1. The procedures used for each test sequence are described in the applicable sections below. The test specimens are to be visually inspected following each test sequence. Result of the visual inspections and functional tests are to be documented.

Table 1. NMCK8 Test Sequence

Test Sequence	Test	Test Plan Section
1	Initial Functional Tests	3.1
2	Sample Preconditioning	3.2
3	Pre-HELB Exposure Functional Tests	3.3
4	HELB Exposure	3.4
5	Post-HELB Exposure Functional Tests	3.5

3.1 Pre-HELB Initial Functional Tests

All six test specimens are to be subjected to the following functional tests prior to pre conditioning:

- Immersed in ambient temperature water for 24 hours. All parts of the motor connection assemblies excluding leads shall be at least 12 inches below the water surface.
- After 24 hours of water immersion, the insulation resistance (IR) is to be measured in accordance with ASTM D257. Measurements are to be taken while the samples are still immersed in water. Resistance is measured after one minute of electrification at a test voltage of 500 Vd-c. IR values are to be recorded. IR values must be greater than 2.5 megohms to pass.
- Following IR measurements, phase to ground voltage withstand tests are to be conducted on all 6 samples while submerged in water in accordance with IEEE Standard 383-1974. Eighty volts per mil of cable insulation thickness is applied between each sample conductor and the ground plane for five minutes. The voltage to be applied is 11.2 kV rms a-c (80 V/mil x 140 mils). No breakdown should occur.

3.2 HELB Sample Pre-Conditioning

Following successful completion of the Pre-HELB functional testing, test specimens are to be pre-conditioned as described in Table 2 below.

Table 2. HELB Pre-Conditioning Sample Matrix:

Sample Number	Thermal Aging 504 hrs at 150°C	Radiation Co^{60} (50 Mrads)
1-3	Yes	Yes
4-6	No	Yes

Test specimens requiring thermal aging are to be aged in a 150°C air circulating oven for 504 hours per Table 2. The 504 hour aging condition corresponds to the Okonite Company's equivalent to 40 years of life at 90°C per EDR 5037 dated 1982. All of the test specimens are to be irradiated to the accident radiation air equivalent dose of 50 megarads at a dose rate not to exceed 1.0 megarad/hour of gamma radiation from a Co^{60} source. Thermal aging is to be done prior to irradiation.

3.3 Pre-HELB Exposure Functional Tests

All of the pre-conditioned test specimens are to be subjected to the following functional tests prior to HELB testing:

- Samples are to be immersed under 12 inches of ambient temperature water for 24 hours.
- After 24 hours of water immersion, the insulation resistance (IR) is to be measured in accordance with ASTM D257. Measurements are to be taken while the samples are still immersed in water. Resistance is measured after one minute of electrification at a test voltage of 500 Vd-c. IR values are to be recorded. IR values must be greater than 2.5 megohms to pass.
- Following IR measurements, phase to ground voltage withstand tests are to be conducted on all 6 samples while submerged in water in accordance with IEEE Standard 383-1974. Eighty volts per mil of cable insulation thickness is applied between each sample conductor and the ground plane for five minutes. The voltage to be applied is 11.2 kV rms a-c (80 V/mil x 140 mils). No breakdown should occur.

3.4 HELB Exposure

Four of the six conditioned samples (representing 2 samples from each pre-conditioned group) are to be mounted in a pressure vessel capable of exposing the samples to steam at the required temperature and pressure plus margin. These four test specimens will be exposed to the HELB conditions. The HELB environmental conditions are:

Temperature:	358°F (343°F +15°F Margin)
Pressure:	25.3 (23 psig + 10% Margin)
Humidity:	100%
Duration:	4.4 hours (4 hours + 10%) at HELB conditions

It is recommended the temperature and pressure be reached with in 15 seconds of the beginning of the HELB simulation. The samples are to be energized throughout the HELB exposure to 5 kV a-c phase to ground. All of the samples must maintain the rated voltage throughout the HELP exposure to verify functional operability. In the event that the rated voltage is not maintained throughout the HELB, the source of the failure shall be indentified. If the failure mode is not attributed to the NMCK8 insulating kit, further testing of the NCMK8 product wrapped with a copper gauze ground plane shall be conducted. Passing the subsequent post-HELB functional tests will be considered acceptable performance verification.

3.5 Post-HELB Functional Tests

The four test specimens are to be subjected to the following functional tests following HELB Exposure:

- Test samples are to be immersed under 12 inches of ambient temperature water for 24 hours.
- After 24 hours of water immersion, the insulation resistance (IR) is to be measured in accordance with ASTM D257. Measurements are to be taken while the samples are still immersed in water. Resistance is measured after one minute of electrification at a test voltage of 500 Vd-c. IR values are to be recorded. IR values must be greater than 2.5 megohms to pass.
- Following IR measurements, phase to ground voltage withstand tests are to be conducted on all 6 samples while submerged in water in accordance with IEEE Standard 383-1974. Eighty volts per mil of cable insulation thickness is applied between each sample conductor and the ground plane for five minutes. The voltage to be applied is 11.2 kV rms a-c (80 V/mil x 140 mils). No breakdown should occur.

4. NMCK8 HELB Test Report:

Following testing an NMCK8 HELB test report shall be written documenting a description of the test specimens and the test set-up. A list of data acquisition equipment and applicable calibration records shall be included. The test procedure and all test data including IR measurements, voltage withstand results and visual inspection results are also to be recorded.

KINECTRICS

KINECTRICS INC.

TEST PROCEDURE FOR QUALIFICATION TESTING OF TE Connectivity NMCK8-Nuclear Motor Connection Kits 8-kV Class 1E systems

May 24, 2012

Kinectrics Test Procedure: K-115005-PSWI-0001 R03
TE Connectivity Purchase Order NL040216

Prepared by: Date: 24-May-2012
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Senior Engineer
Nuclear Parts and Qualification
Kinectrics US Inc.

Reviewed by: Date: 28 May 2012
David Reichert
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QA Reviewed by: Date: 28 May 2012
for Dudley Mowery
Quality Assurance
Nuclear Parts and Qualification
Kinectrics US Inc.

Approved by: Date: 29 May 2012
Garry Chapman
Director-US Nuclear Programs
Nuclear Parts and Qualification
Kinectrics US Inc.

Accepted by: Date: May 29, 2012
TE Connectivity Representative

REVISION LOG

REV NO	ISSUE DATE	PREPARED BY	REVIEWED BY	APPROVED BY
00	February 20, 2012	S.Krause	D. Reichert	G.Chapman
01	March 22, 2012	S.Krause	D. Reichert	G.Chapman
02	May 22, 2012	S. Krause	D. Reichert	G. Chapman
03	May 24, 2012	S. Krause	D. Reichert	G. Chapman

REVISION HISTORY

REVISION NUMBER	SECTION/ PARAGRAPH	PAGE	DESCRIPTION
00	All	All	Initial Issue
01	Section 2	6 - 8	Addition of Details on Test Steps
	Section 2.4.2	8	Clarification radiation dose
	Section 2.6	8	Details on testing
02	Section 2.4.2	8	Changed dosimtery error to comply with irradiator requirement
	Section 2.6	8-9	Clarification for specimens subjected to the HELB simulation
03	Section 2.6	8-9	Corrected paragraph –specimens for HELB incorrectly referenced and clarified set up on cable connectors

TABLE OF CONTENTS

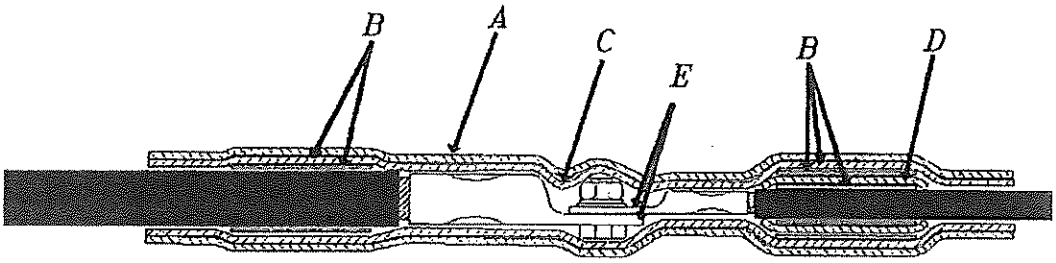
1 SCOPE

This test procedure specifies the requirements and process for qualifying Tyco NMCK8 Nuclear Motor Connection Kits. Kinectrics is responsible for performing Thermal aging and High Energy Line Break (HELB) testing. Radiation aging will be performed by a Kinectrics approved sub-contractor.

1.1 Test Specimen Description

The test samples consist of six (6) samples each of two configurations of connections (prepared by Tyco). Feeder lead and motor lead lengths shall be of sufficient length to accommodate the test process. These samples shall be subjected to initial and intermediate functional tests throughout the program which will include thermal aging, irradiation and a HELB simulation.

Figure 1. Sample Construction



A. BBIT-65/25-280/U
B. S1119 Adhesive Tape
C. BBIT-40/16-280/U
D. BBIT-25/10-75/U
E. Connectors: Burndy YA-6CN 1 hole NEMA and 4/0 Lug Utilux part 1-1099899-0

1.2 Applicable References

i. TE Connectivity LTD Purchase Order NL040216 dated, February 17, 2012
ii. Kinectrics Proposal # K-115005 Rev 1, dated, November 1, 2011
iii. TE Connectivity Test Plan 20166-20 Revision 6
iv. ASTM D257, "Standard Test Methods for DC Resistance or Conductance of Insulating Materials"
v. IEEE 323-1974/1983/2003, "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations"

2 TEST REQUIREMENTS

2.1 Test Sequence

The specimens shall be subjected to the following test sequence. The specimens shall be

split into two groups. Specimens 1-3 shall be subjected to both thermal and radiation aging prior to the HELB exposure and specimens 4-6 shall be subjected to radiation aging prior to the HELB exposure. The overall sequence is listed in in Table 1. The procedures used for each sequence are defined in the sections that follow.

Table 1: Test Program Sequence

Test Sequence
Receipt Inspection
Baseline Functional Test
Sample Preconditioning (thermal and radiation aging)
Pre-HELB exposure Functional Tests
HELB Exposure
Post-HELB Exposure Functional Test

2.2 Receipt Inspection

The test specimens shall be visually inspected for damage and photographed. A tag shall be attached to each specimen indicating the project and ID number.

The results of the receipt inspection, the test specimen descriptions, and their part and serial numbers shall be recorded on Kinectrics form QF10-1 "Record of Inspection of Incoming Items" and shall correspond to the test specimen description in Section 1.1.

TE Connectivity shall be informed if any obvious signs of physical damage are found.

2.3 Baseline Functional Test

The six (6) specimens shall be subjected to the following functional tests prior to the aging sequence of this test program. The purpose of the baseline test is to establish criteria to monitor the specimens for degradation as they complete each segment of testing.

The functional test shall be performed as follows:

1. **Immersion**
    a. The test specimens shall be immersed in ambient temperature water for minimum of 24 hours.
    b. All parts of the motor connection assemblies excluding leads shall be at least 12 inches below the water surface
2. **Insulation Resistance (IR) Test (per ASTM D257)**
    a. IR testing shall commence after the test specimens have been immersed for at least 24 hours. Testing to be performed while the specimens are still submerged in water.
    b. Test setup and connections shall be as shown in Figure 1
    c. The test voltage shall be 500Vdc
    d. The test voltage shall be applied for one minute before taking the resistance reading.
    e. Resistance reading shall be taken between conductor and ground plane

f. Repeat the above for resistance reading taken between the shield and ground plane
g. IR values shall be recorded and must be greater than 2.5 megaohms to pass testing.

3. **Phase-to-Ground Withstand Test (per IEEE 383-1974)**
   a. Testing to be performed while the specimens are still submerged in water.
   b. Test setup and connections shall be as shown in Figure 2
   c. The voltage to be applied is 11.2 kV rms a-c (80 V/mil x 140 mils).
   d. The test voltage is to be applied between conductor and ground plane.
   e. The test voltage shall be applied for 5 minutes.
   f. No breakdown should occur in order to pass testing.

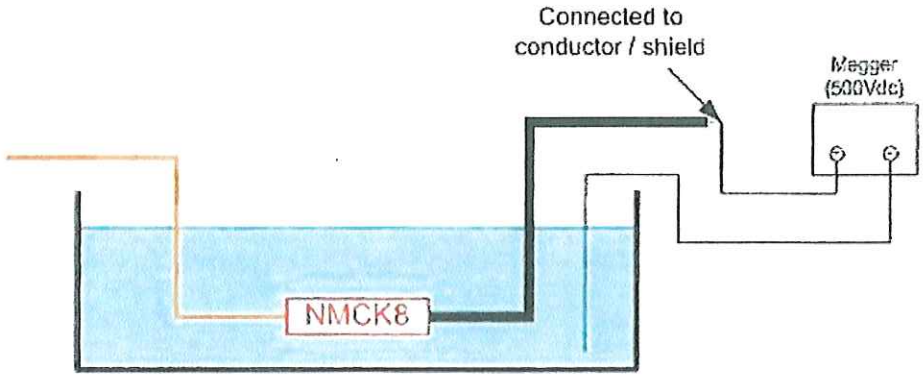


Figure 1 – Test Setup for IR Testing

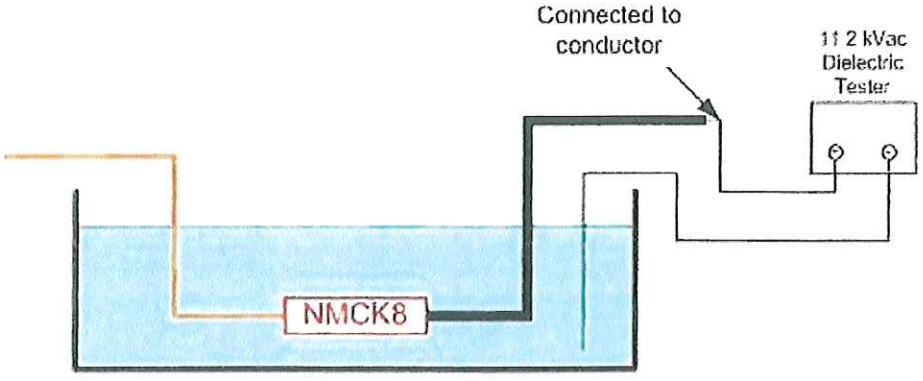


Figure 2 – Test Setup for Phase-to-Ground Withstand Testing

2.4 Sample Preconditioning

Test specimens shall be preconditioned per Table 2 below.

2.4.1 Thermal Aging

Table 2: Sample Pre-Conditioning Matrix

Test Specimen Number	Thermal aging 504 hours at 150°C	Radiation (Co-60 source) 50 Mrads)
1-3	Yes	Yes
4-6	No	Yes

The test specimens requiring thermal aging shall be aged in a 150°C +5/-0°C air circulating oven for a minium of 504 hours per Table 2 above.

2.4.2 Radiation Aging

Test specimens 1-6 shall be exposed to a minimum of 50 Mrads plus 10% margin. Dosimetry error is approximately 6.5% and the TID achieved shall be included in the certification from the Irradiation facility. Dose rate shall not exceed 1 Mrad per hour and shall be rotated mid-way through exposure to ensure uniform dose. The specimens shall be shipped to a Kinectrics approved subcontractor through issuance of a safety related purchase order.

2.5 Pre-HELB Exposure Functional Test

The steps outlined in section 2.3 above shall be repeated in their entirety following radiation aging.

2.6 HELB Exposure

Specimens 2, 3, 5 and 6 (four specimens total of the six conditioned samples) are to be mounted in a pressure vessel capable of exposing the samples to steam at the required temperature and pressure plus margin. These four test specimens (see table 2.1 below) will be exposed to the HELB conditions.

Table 2.1: Samples Subjected to the HELB conditions

Test Specimen Number	Previously subjected to thermal aging 504 hours at 150°C	Previously subjected to radiation (Co-60 source) 50 Mrads)
K-115005-002	Yes	Yes
K-115005-003	Yes	Yes
K-115005-005	No	Yes
K-115005-006	No	Yes

The HELB environmental conditions are:

Temperature: 358°F (343°F +15°F Margin)
Pressure: 25.3 (23 psig + 10% Margin)
Humidity: 100%
Duration: 4.4 hours (4 hours + 10%) at HELB conditions

It is recommended the temperature and pressure be reached within 15 seconds of the beginning of the HELB simulation.
The samples are to be energized throughout the HELB exposure to 5 kV a-c phase to ground. All of the samples must maintain the rated voltage throughout the HELB exposure to verify functional operability.

The positive shall be on the conductor side and the negative shall be on the cable shield. The cable shield shall be electrically connected to the vessel in which HELB testing is being performed. The connector portion of the specimens shall be wrapped with a stainless steel gauze and connected to the shield to ensure that the ground encapsulates this area of the specimens.

In the event that the rated voltage is not maintained throughout the HELB test, the source of the failure shall be indentified and communicated to TE Connectivity. If the failure mode is not attributed to the NMCK8 insulating kit, further testing of the NCMK8 product shall be conducted.

Passing the subsequent post-HELB functional tests will be considered acceptable performance verification.

2.7 Post-HELB Exposure Functional Test

The steps outlined in section 2.3 above shall be repeated in their entirety following the HELB simulation.

2.8 Post-HELB Test Inspection

The test specimens shall be thoroughly checked for any sign of damage induced by the test. Any discoloration, corrosion, deformation, etc. will be reported and photographed.

2.9 Margins

Margins shall be applied to the test parameters in compliance with IEEE 323-1974.

2.10 Acceptance Criteria

Acceptance Criteria applied are as follows:

- The specimens must pass post HELB functional testing
- No breakdown of the insulation shall occur
- IR must be greater than 2.5 MΩ

2.11 Test Specimen Disposal

The test specimens shall be returned to Tyco Electronics (FOB Kinectrics).

3 ACTION ON FAILURE

Any anomalies that may occur will be documented as required by Kinectrics 10CFR50 Appendix B QA Program. Anomalies may include specimen or procedure issues or occurrences not expected in the course of the testing process. TE Connectivity shall provide resolution or concurrence for all anomalies and non-conformances.

4 TEST EQUIPMENT

4.1 Instrument Calibration

Prior to being used in this test program, all measuring and test equipment shall be calibrated in accordance with Kinectrics' quality program. Calibration equipment and standards used in performing all calibrations shall be traceable to National or International measurement bodies (e.g. National Research Council Canada (NRCC) or National Institute of Standards and Technology (NIST)). Calibration certificates shall be made available to the client on request.

4.2 Test Instrument Lists

All instrumentation, measuring and test equipment to be used in the test program shall be recorded on Kinectrics form QF11-1 Instrumentation Sheet, with calibration dates and accuracies.

5 QUALITY ASSURANCE

The test program shall be performed and all reports shall be prepared in accordance with 10CFR 50 Appendix B and Kinectrics QA Program which complies with the requirements of ISO 9001. Forms for this work will be prepared according to Kinectrics QA requirements and used to record all data and will be signed off appropriately.

6 TEST REPORT

The test report will meet the following requirements:

- Title page with signatures and dates
- Name and address of test facility
- Table of Contents
- Statement of test objectives
- Identification, Description and Quantity of Test Specimens
- Test Set-Ups and Interfaces
- Photograph(s) showing sample mounting and orientation
- Service conditions to be simulated
- Test Procedure
- List of all measuring equipment used including calibration dates
- Test data and results
- Conclusions

- Detailed Specimen interface and mounting configurations
- Notices of Anomaly – if required
- Non-Conformance Reports, if required

ATTACHMENT 6

Kinectrics Inc. Test Report for Qualification Testing
of TE Connectivity NMCK8-Nuclear Motor Connection
Kits 8-kV Class 1E Systems

KINECTRICS

KINECTRICS INC.

TEST REPORT FOR QUALIFICATION TESTING OF TE Connectivity NMCK8-Nuclear Motor Connection Kits 8-kV Class 1E systems

09 Aug 2012

Kinectrics Test Procedure: K-115005-RA-0001 R01
TE Connectivity Purchase Order NL040216

Prepared by: Date: 2012-Aug-9
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Kinectrics US Inc.

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QA Reviewed by: Date: August 9, 2012
Dudley Mowery
Quality Assurance
Nuclear Parts and Qualification
Kinectrics US Inc.

Approved by: Date: 9 August 2012
Garry Chapman
Director-US Nuclear Programs
Nuclear Parts and Qualification
Kinectrics US Inc.

Accepted by: Date: Aug. 09, 2012
TE Connectivity Representative

REVISION LOG

REV NO	ISSUE DATE	PREPARED BY	REVIEWED BY	APPROVED BY
00	May 30, 2012	S.Krause	D. Reichert	G.Chapman
01	August 9, 2012	S. Krause	D. Reichert	G. Chapman

REVISION HISTORY

REVISION NUMBER	SECTION/ PARAGRAPH	PAGE	DESCRIPTION
00	All	All	Initial Issue
01	1.1	5	Revised to correct specimen description

TABLE OF CONTENTS

1 SCOPE

This report documents the results of testing for Tyco NMCK8 Nuclear Motor Connection Kits. The specimens were subjected to Thermal aging, Radiation Aging and High Energy Line Break (HELB) testing. Radiation aging was performed by a Kinectrics approved sub-contractor. All other facets of testing were performed at the Kinectrics facility located at 800 Kipling Avenue in Toronto, Ontario CANADA.

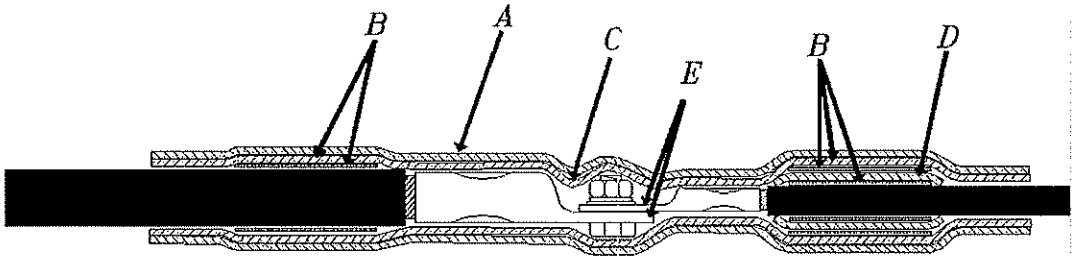
1.1 Test Specimen Description

Per direction of TE Connectivity, sample configurations had to be modified from the original qualification configurations described in the EDR-5037, Dated 1982, to minimize sample numbers. These changes did not impact the HELB test objective to demonstrate equivalent performance of the BBIT-N tubing. The samples were prepared by TE Connectivity and were constructed per the standard installation instructions for NMCK8 kits (PII55154).

Six samples of the following configuration were constructed for the test.

8 kV, 4/0 AWG tape shield cable connected to a 6 AWG fiber reinforced silicone rubber insulated motor lead with shim.

Figure 1. Sample Construction



A. BBIT-65/25-280/U
B. S1119 Adhesive Tape
C. BBIT-40/16-280/U
D. BBIT-25/10-75/U
E. Connectors: Burndy YA-6CN 1 hole NEMA and 4/0 Lug Utilux part 1-1099899-0

1.2 Applicable References

i. TE Connectivity LTD Purchase Order NL040216 dated, February 17, 2012
ii. Kinectrics Proposal # K-115005 Rev 1, dated, November 1, 2011
iii. TE Connectivity Test Plan 20166-20 Revision 6
iv. Kinectrics Test Procedure K-115005-PSWI-0001, latest revision

v. ASTM D257, "Standard Test Methods for DC Resistance or Conductance of Insulating Materials"

vi. IEEE 323-1974/1983/2003, "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations"

2 TEST RESULTS

2.1 Test Sequence

The specimens were subjected to the following test sequence. The specimens were split into two groups. Specimens 1-3 were subjected to both thermal and radiation aging prior to the HELB exposure and specimens 4-6 were subjected to radiation aging only prior to the HELB exposure. The overall sequence is listed in in Table 1. The segments of testing that the specimens were subjected are detailed below.

Table 1: Test Program Sequence

Test Sequence
Receipt Inspection
Baseline Functional Test
Sample Preconditioning (thermal and radiation aging)
Pre-HELB exposure Functional Tests
HELB Exposure
Post-HELB Exposure Functional Test

2.2 Receipt Inspection

The test specimens were visually inspected for damage and photographed. A tag was attached to each specimen indicating the project and ID number.

The results of the receipt inspection, the test specimen descriptions, and part and serial numbers were recorded on a Kinectrics form and is included in Attachment A of this report. There were no discrepancies noted during receipt inspection.

2.3 Baseline Functional Test

The six (6) specimens were subjected to a baseline functional test to establish initial criteria to monitor for degradation following each segment of testing. The specimens were immersed in ambient temperature water for 24 hours where all parts of the motor connection assemblies were at least 12 inches below the water surface. An insulation resistance (IR) test using 500 Vdc applied for one minute before taking the resistance reading. The IR test was performed between the conductor and ground plane and between the shield and ground plane. IR values were recorded on a datasheet and are included in Attachment B of this report. Following IR testing a phase-to-ground withstand test was performed while the specimens were still submerged in water. 11.2 kV rms a-c was applied between the conductor and ground plane for five minutes. No breakdown occurred during phase-to-

ground testing.

2.4 Sample Preconditioning

Upon completion of the baseline functional test, the specimens were subjected to the pre-conditioning portion of the test program (thermal and radiation aging). The test specimens were preconditioned per Table 2 below.

2.5 Thermal Aging and Radiation Aging

Table 2: Sample Pre-Conditioning Matrix

Test Specimen Number	Thermal aging 504 hours at 150°C	Radiation (Co-60 source) 50 Mrads)
1-3	Yes	Yes
4-6	No	Yes

The test specimens requiring thermal aging were aged in a 150°C +5/-0°C air circulating oven for a minium of 504 hours per Table 2 above.

Test specimens 1-6 were exposed to a minimum of 50 Mrads plus 10% margin. The (total integrated dose) TID achieved is included in the certification from the Irradiation facility (included in Attachment B of this report).

2.6 Pre-HELB Exposure Functional Test

A repeat of the baseline test was performed following the pre-conditioning segment of testing following radiation aging. There was no functional test performed inbetween thermal aging and radiation aging on the specimens exposed to both sequences. Results are included in Attachment B of this report.

2.7 HELB Exposure

Specimens 2, 3, 5 and 6 (four specimens total of the six conditioned samples) were mounted in a pressure vessel capable of simulating a High Energy Line Break (HELB) by exposing the samples to steam at the required temperature and pressure plus margin.

The four test specimens (see table 2.1 below) were exposed to the HELB conditions.

Table 2.1: Samples Subjected to the HELB conditions

Test Specimen Number	Previously subjected to thermal aging 504 hours at 150°C	Previously subjected to radiation (Co-60 source) 50 Mrads)
K-115005-002	Yes	yes
K-115005-003	Yes	Yes
K-115005-005	No	Yes

K-115005-006	No	Yes

The HELB environmental conditions simulated are listed below:

Temperature: 358°F (343°F +15°F Margin)
Pressure: 25.3 (23 psig + 10% Margin)
Humidity: 100%
Duration: 4.4 hours (4 hours + 10%) at HELB conditions

Results of the HELB simulation are included in Attachment C of this report. The profile shows temperature and pressure achieved per the requirements listed above. The test specimens were energized throughout the HELB exposure to 5 kV a-c phase to ground. The specimens were required to maintain the rated voltage to verify functionality. The connector portion of the specimens was wrapped with a stainless steel gauze and connected to the shield to ensure that the ground encapsulates that area of the specimens.

2.8 Post-HELB Exposure Functional Test

Upon completion of the HELB simulation the specimens were subjected to a post HELB functional test and passed as required.

2.9 Post-HELB Test Inspection

The test specimens were inspected for any sign of damage induced by the test. All discoloration, corrosion, and deformation was reported to the customer and photographed. Photographs are included in Attachment D of this report.

3 TEST EQUIPMENT

3.1 Instrument Calibration

Prior to being used in this test program, all measuring and test equipment was calibrated in accordance with Kinectrics' quality program. Calibration equipment and standards used in performing all calibrations are traceable to National or International measurement bodies (e.g. National Research Council Canada (NRCC) or National Institute of Standards and Technology (NIST)).

3.2 Test Instrument Lists

All instrumentation, measuring and test equipment used in the test program was recorded and is included in Attachment B of this report.

4 QUALITY ASSURANCE

The test program was performed and in accordance with 10CFR 50 Appendix B and Kinectrics QA Program which complies with the requirements of ISO 9001. Forms for this

work were prepared according to Kinectrics QA requirements and are included in Attachment B of this report.

5 CONCLUSION

The test specimens met the requirements of the TE Connectivity purchase order and the governing customer approved test procedure. The specimens shall be returned to TE Connectivity for final disposition. All results, data, graphs and photographs are included in the attachments that follow.

ATTACHMENT A

INCOMING INSPECTIONS
EQUIPMENT AND INSTRUMENT LISTS

Kinectrics
Quality Form:
QF10-1
rev 10-12
page 1 of 4

RECORD OF INSPECTION OF INCOMING ITEMS

Section 1 (To be completed by Project Manager or Delegate)			
Inspection Record No.	**K-115005 - II - 0001 R 00** **(Project No. K-XXXXXX) -II - (Sequential Number XXXX) R (Rev No. XX)**		
Item Description	**TE Connectivity Connection Kits**		
Part No./Serial No.	NMCK8		**Quantity 6**
☒ **Customer Supplied Samples / Mat'ls** **Received From: TE Connectivity**	☐ **Purchased Items** **Kinectrics P.O. No.:** **Line Number**	☐ **Other Source** **Explain:**	
Customer P.O. Number	NL040216	**Line Number 1**	
Customer's Item Id Number			

Fraudulent Inspection is Required for all Purchased Items (Inspector completes page 3)
If not required, check here ☒ and state reason: Supplied by customer

Documentation To be supplied: (check all that apply)	☒ **Packing List**	☐ **Manuals, Instructions**	☐ **Specifications, Drawings**
	☐ **MSDS**	☐ **Cert. of Conformance**	☐ **Cert. of Compliance**
	☐ **Certificate of Material Test Report**		☐ **Material Test Report**
	☐ **Certificate of Quality Program Registration, Authorization, Accreditation**		
	☐ **Other**		

Item Labeling Instructions:
TE Connectivity
NMCK8 Nuclear Motor Connection Kit
Kinectrics ID: K-115005-CKIT-0001 to -00006
Date Received: 23-Feb-2012

Lot/Batch Identification Required? ☒ **No** ☐ **Yes: document details on page 2**

Section 2 (To be completed by Inspector, Reviewed by Project Manager or Delegate)

Acceptance Criteria

Correct item(s) received?	☑ **Yes** ☐ **No**	**NCR No.**
Correct quantity?	☑ **Yes** ☐ **No**	**NCR No.**
Correct packaging?	☑ **Yes** ☐ **No**	**NCR No.**
Packaging Intact (free of damage)?	☑ **Yes** ☐ **No**	**NCR No.**
Correct documentation received?	☑ **Yes** ☐ **No**	**NCR No.**

Remarks:

Inspected by		☐ **Check When Labels Complete**	**Date:** Feb 27/2012
Reviewed by			**Date:** 29 Feb 2012

Kinectrics
Quality Form:
QF10-1
rev 10-12
page 2 of 4

RECORD OF INSPECTION OF INCOMING ITEMS

To be completed by Project Manager or Delegate	To be completed by Inspector	
Tests for Acceptance and Acceptance Criteria	**Test Equipment / IM&TE Used**	**Acceptance Test Results (Pass/Fail)**
No Shipping Damage	Visual	BSS
Take Photographs to note original colour and condition	Camera	BSS
Cables are in Good Condition	Visual	BSS
Terminal Connection is sound	Visual	BSS

Item Accepted for Use: ☑ **Item Rejected for Use (complete NCR):** ☐

Inspected by		**Date:** Feb 27, 2012
Reviewed by		**Date:** 29 Feb 2012

Kinectrics
Quality Form:
QF10-1
rev 10-12
page 3 of 4

RECORD OF INSPECTION OF INCOMING ITEMS

FRAUDULENT PART INSPECTION CHECKLIST	PART ID: N/A Customer Supplied

INSPECTION RESULTS

	Requirement	Result		If yes, describe deficiency
		No	Yes	
1	Is there evidence of alteration of manufacturer's name, logo, serial number or manufacturing date	☐	☐	
2	Configuration, dimensions, fit, finish, colour or other attributes different than spec?	☐	☐	
3	Markings on items or documentation missing, unusual, altered, inconsistent across the lot compared with that expected?	☐	☐	
4	Markings or documentation from a country other than that of the supplier?	☐	☐	
5	New items exhibit evidence of prior use?	☐	☐	
6	Performance inconsistent with supplied specifications, certification, or test data? *(May not be relevant at incoming inspection)*	☐	☐	
7	Documentation appears altered, incomplete, lacks expected traceability, Safety Authority (CSA, UL) or manufacturers markings?	☐	☐	

Based on the above examination, the part is considered to be authentic.

Yes, Item Accepted for Use: ☐ No, Item Rejected for Use (complete NCR): ☐

Remarks:

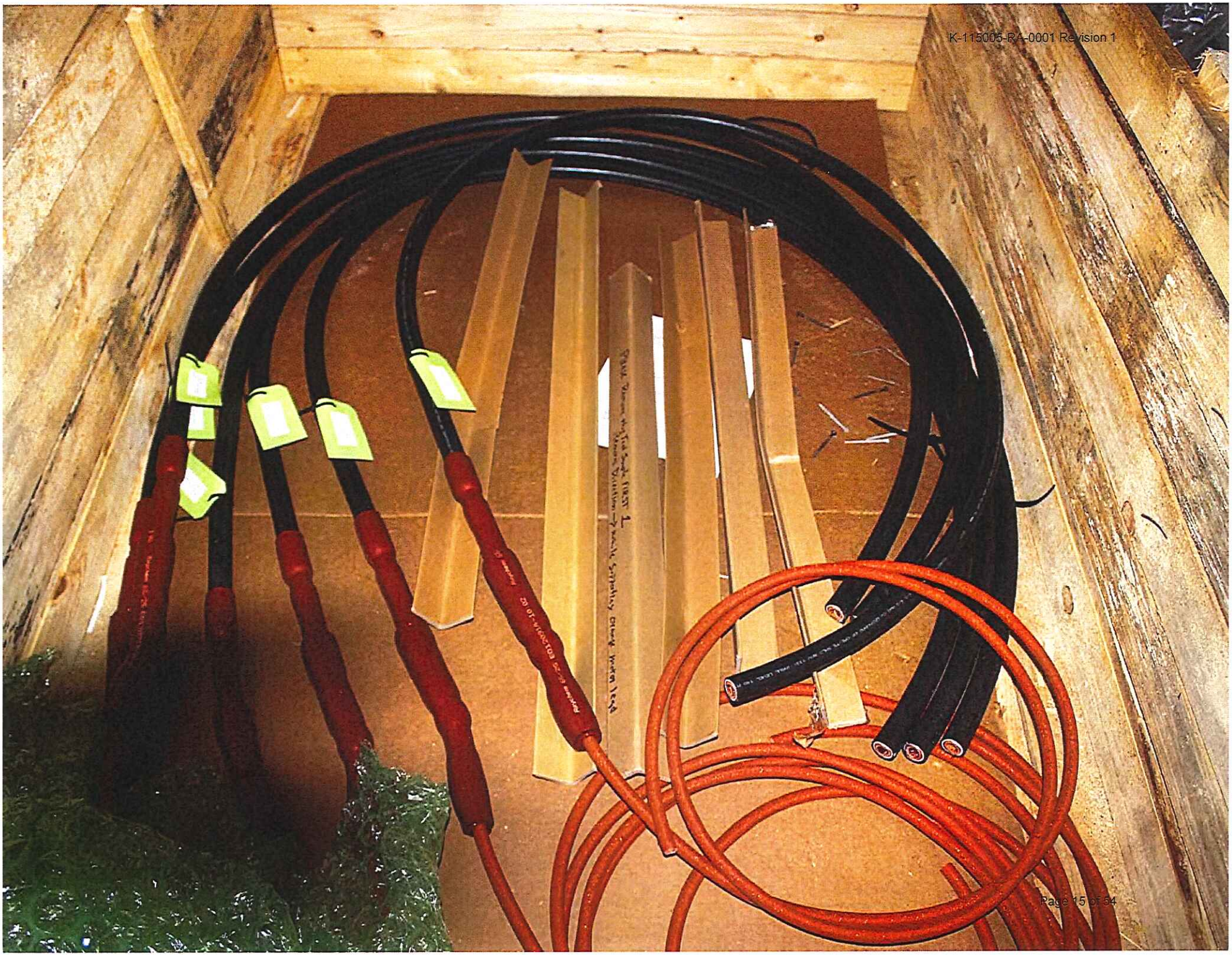
Inspected by		**Date:**
Reviewed by		**Date:**

Kinectrics
Quality Form:
QF10-1
rev 10-12
page 4 of 4

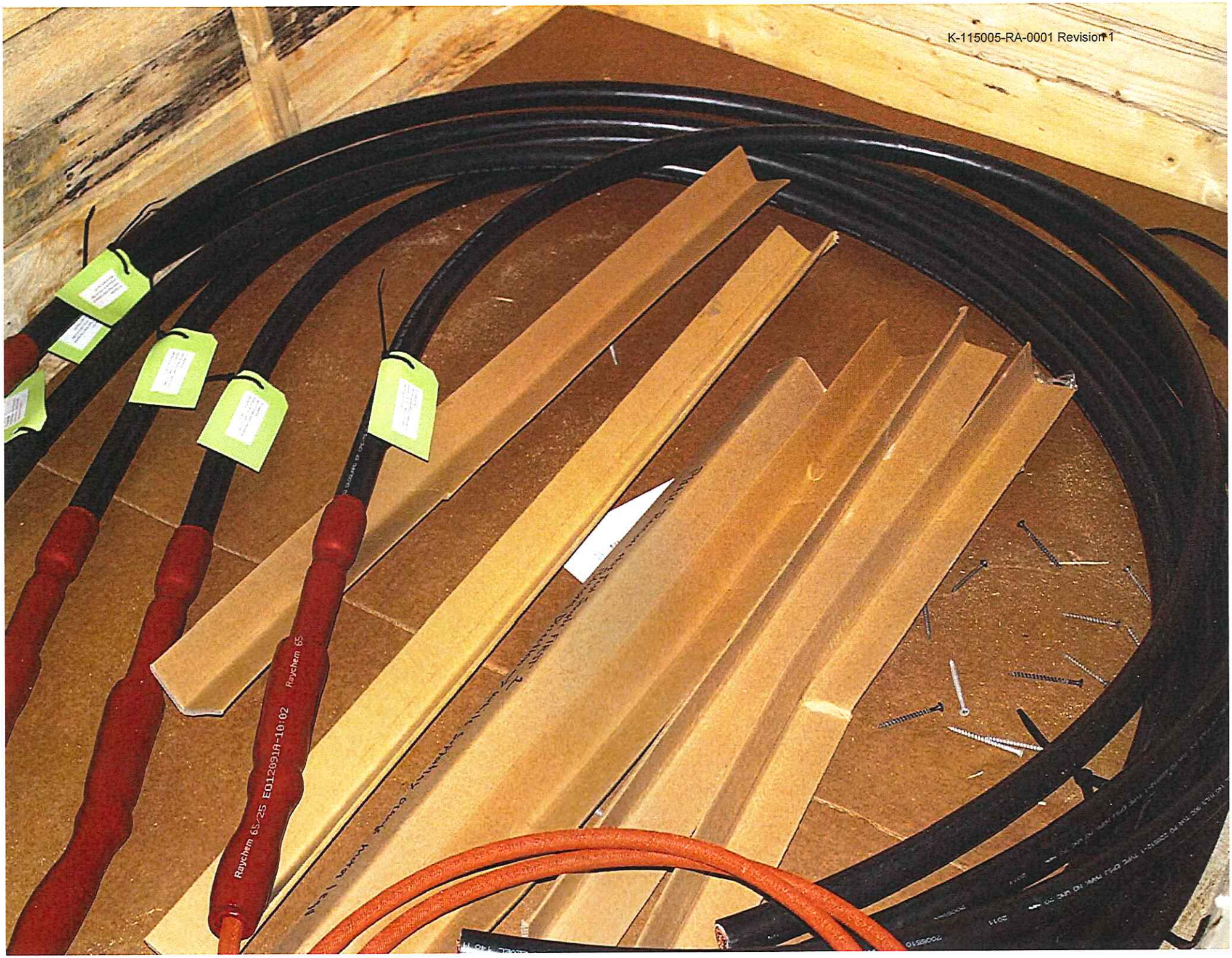
RECORD OF INSPECTION OF INCOMING ITEMS

Attachments:

Photographs of items at time of receiving




Please Remove this Test Sample FIRST 1
Removal Direction → while supporting Orange Motor lead
Raychem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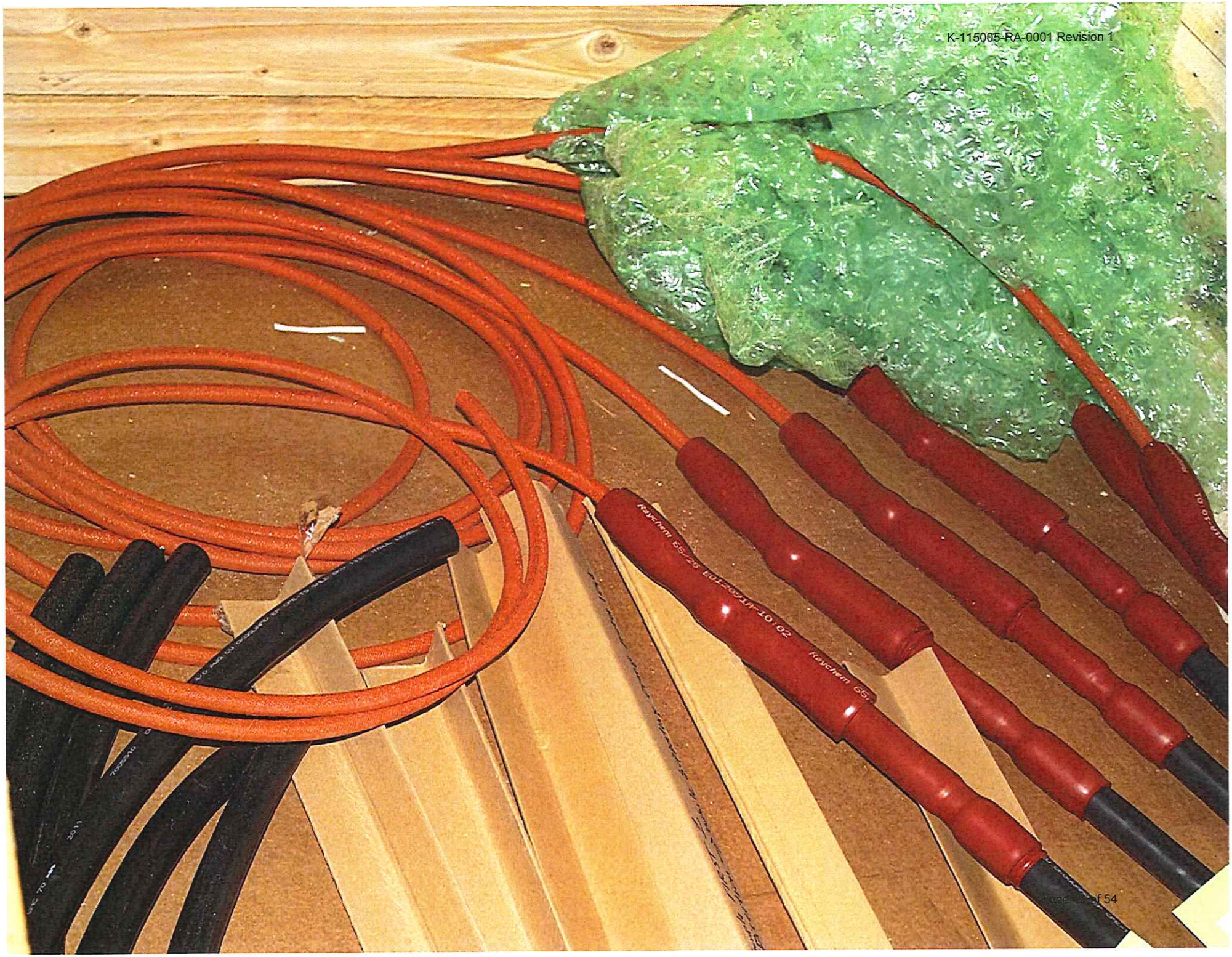

Raychem 65-25 EOI2-0XIF-10:02
Raychem 65-


Raychem 65/25 E012091A-10:02
Raychem 65/25 E012091A-10:02

ATTACHMENT B

TEST DATA

K-115005-DATA-0001 R00	Kinectrics Inc. Functional Test Results		Sheet 1 of 1
Part #	NMCK8 Nuclear Motor Connection Kit	Manufacturer:	TE Connectivity
TE Connectivity P.O. Number	NL040216	Test Stage (Check one):	☑ Baseline ☐ Pre-HELB ☐ Post-HELB

Reference: K-115005-PSWI-0001 R00, Section 2.3

Sample Number	Time Immersed and Depth Minimum Time: 24h Minimum Depth: 12in	Insulation Resistance (Conductor)* Applied Voltage: 500Vdc (Requirement: >2.5 MΩ)	Insulation Resistance (Shield)* Applied Voltage: 500Vdc (Requirement: >2.5 MΩ)	Phase to Ground Withstand* Apply 11.2kVac (rms) (Requirement: No Breakdown)	Pass / Fail
K-115005-CKIT-0001	25.50h / 13in	60.76GΩ	74.96GΩ	NO VISIBLE BREAKDOWN	PASS
K-115005-CKIT-0002	24.25h / 13in	58.84GΩ	80.14GΩ	NO VISIBLE BREAKDOWN	PASS
K-115005-CKIT-0003	25.25h / 13in	71.96GΩ	86.16GΩ	NO VISIBLE BREAKDOWN	PASS
K-115005-CKIT-0004	25.00h / 13in	198GΩ	346GΩ	NO VISIBLE BREAKDOWN	PASS
K-115005-CKIT-0005	25.75h / 13in	68.96GΩ	85.16GΩ	NO VISIBLE BREAKDOWN	PASS
K-115005-CKIT-0006	26.00h / 13in	38.34GΩ	73.56GΩ	NO VISIBLE BREAKDOWN	PASS

*** measuring to be performed while specimen is still immersed in water**

Record all test equipment used on QF11-1

Performed by: [signature] Date: March 13 2012

Reviewed by: [signature] Date: 13-Mar-2012

Kinectrics
ISO-9001
Form: QF11-1
rev 00-08

INSTRUMENT SHEET

Test Description: Baseline Functional Test
Project Number: K-115005
Test Start Date: 13 Mar 2011
Test Finish Date: 13 Mar 2011

Instrument	Equipment Number	Value Measured	Accuracy Claimed	Cal. Date	Cal. Due Date	Comment
MEGGER MIT520/2	KIN-01715	Insulation Resistance	+/- 0.05 GΩ	07-Sep-2011	07-Sep-2012	
AC/DC HIGH V Test set E-37387-	KIN-221	Dielectric Withstand	+/- 0.25 KV	21-Sep-2011	21-Sep-2012	

STERIS
Isomedix Services
Committed to Customer Satisfaction

COMPONENT IRRADIATION CERTIFICATION

Prepared for Kinectrics Inc.

Source Type: Cobalt 60 Gamma P.O. # 280027339

Air Equiv. Required Dose (MRADS)	58.58
Rate Not to Exceed (MRADS / Hr.)	1.00

SPECIMENS:

Qty	Part No.	Serial No.	Description
6	Model # NMCK-8	N/A	TE Connectivity Motor Connection Kits

DATA:

Total Delivered Dose (Air) MRADS:			Min	58.58	Max	70.95
Dose Rate (Air) MRADS / Hr:			Min	.502	Max	.608
Total Exposure Hours:			116.70			
Static Rotation	2 - WAY:	√	Turntable Rotation		None:	
Date In:	04/28/12		Date Out:		05/05/12	

DOSIMETRY:

Dosimeter Type	Harwell Red 4034 Red Perspex	Batch	LT
Calibration Date	11/14/2011	Calibration Due Date	11/14/2012
Readout Instrument:	Beckman DU-640	Serial No.:	4324039
Calibration Date	08/16/11	Calibration Due Date	08/16/12

Comments: Process Run ID 51117A

ATTACHMENTS:

Worksheets:	N/A	Drawings:	N/A
Notice of Anomaly:		N/A	

Approved By: _____ **Title:** Sr. QS/RC Analyst **Date:** 05/07/12

Processing Location: STERIS Isomedix Services 9 Apollo Drive. Whippany, NJ 07981 Phone: 973-887-2754 Fax: 973-887-6591

The product run described above was processed in accordance with STERIS Isomedix Services Quality System requirements and the approved process parameters. STERIS Isomedix Services facilities are in compliance with applicable state and federal regulations (FDA, NRC, EPA, and OSHA). STERIS Isomedix Services operates under a quality system which meets the requirements of the FDA QSR and ISO 13485: 2003. STERIS Isomedix Services adheres to requirements provided through ANSI/AAMI/ISO 11137 and EN 552.

K-115005-DATA-0001 R00	Kinectrics Inc. Functional Test Results		Sheet 1 of 1
Part #	NMCK8 Nuclear Motor Connection Kit	Manufacturer:	TE Connectivity
TE Connectivity P.O. Number	NL040216	Test Stage (Check one):	☐ Baseline ☒ Pre-HELB ☐ Post-HELB

Reference: K-115005-PSWI-0001 R01, Section 2.3

Sample Number	Time Immersed and Depth Minimum Time: 24h Minimum Depth: 12in	Insulation Resistance (Conductor)* Applied Voltage: 500Vdc (Requirement: >2.5 MΩ)	Insulation Resistance (Shield)* Applied Voltage: 500Vdc (Requirement: >2.5 MΩ)	Phase to Ground Withstand* Apply 11.2kVac (rms) (Requirement: No Breakdown)	Pass / Fail
K-115005-CKIT-0001	13" 45 hr	99.2 GΩ	57.6 GΩ	No Breakdown	PASS
K-115005-CKIT-0002	14.75" 45.75hr	161 GΩ	38.7 GΩ	No Breakdown	PASS
K-115005-CKIT-0003	14" 45.25hr	223 GΩ	41.4 GΩ	No Breakdown	PASS
K-115005-CKIT-0004	13.25" 43.75hr	101 GΩ	14.7 GΩ	No Breakdown	Pass
K-115005-CKIT-0005	13.75" 45.5hr	113 GΩ	7.51 GΩ	No Breakdown	PASS
K-115005-CKIT-0006	13" 44.75hr	155 GΩ	17.8 GΩ	No Breakdown	PASS

*** measuring to be performed while specimen is still immersed in water**

Record all test equipment used on QF11-1

Performed by: Derek Sim Derek Sim Date: May 16, 2012

Reviewed by: Date: 16 May 2012

Kinectrics
ISO-9001
Form: QF11-1
rev 00-08

INSTRUMENT SHEET

Test Description: Pre Helb Functional Test
Project Number: K-115005

Test Start Date: 14 May 2012
Test Finish Date: 16 May 2012

Instrument	Equipment Number	Value Measured	Accuracy Claimed	Cal. Date	Cal. Due Date	Comment
Megger MIT520/2	KIN-017515	Insulation Resistance	+/- 0.05 GΩ	07 Sep 2011	07 Sep 2012	
AC/DC HIGH V Test Set E-37337	KIN 221	Dielectric V Withstand	+/- 0.25 kV	21 Sep 2011	21 Sep 2012	
Stopwatch	KIN-01570	Test time	+/- 0.005s	23 Apr 2012	23 Apr 2014	
Measuring tape	KIN-01825	Specimen Depth	+/- 1/64"	03 Jan 2012	03 Jan 2014	

K-115005-DATA-0001 R00	Kinectrics Inc. Functional Test Results		Sheet 1 of 1
Part #	NMCK8 Nuclear Motor Connection Kit	Manufacturer:	TE Connectivity
TE Connectivity P.O. Number	NL040216	Test Stage (Check one):	☐ Baseline ☐ Pre-HELB ☒ Post-HELB

Reference: K-115005-PSWI-0001 R03, Section 2.3

Sample Number	Time Immersed and Depth Minimum Time: 24h Minimum Depth: 12in	Insulation Resistance (Conductor)* Applied Voltage: 500Vdc (Requirement: >2.5 MΩ)	Insulation Resistance (Shield)* Applied Voltage: 500Vdc (Requirement: >2.5 MΩ)	Phase to Ground Withstand* Apply 11.2kVac (rms) (Requirement: No Breakdown)	Pass / Fail
K-115005-CKIT-0001	14.75" 25h 30 min	65.1 GΩ	27.4 GΩ	No Breakdown	Pass
K-115005-CKIT-0002	15" 26h 15 min	1.68 GΩ	2.27 GΩ	No Breakdown	Pass
K-115005-CKIT-0003	14.5" 25h 30 min	1.04 GΩ	5.86 GΩ	No Breakdown	Pass
K-115005-CKIT-0004	15" 26h 0 min	58.4 GΩ	6.32 GΩ	No Breakdown	Pass
K-115005-CKIT-0005	15" 26h 0 min	1.04 GΩ	2.83 GΩ	No Breakdown	Pass
K-115005-CKIT-0006	14.75" 25h 15 min	1.05 GΩ	6.35 GΩ	No Breakdown	Pass

*** measuring to be performed while specimen is still immersed in water**

Record all test equipment used on QF11-1

Performed by: Derek Sim Derek Sim Date: May 29, 2012

Reviewed by: [signature] Date: 29 May 2012

Kinectrics
ISO-9001
Form: QF11-1
rev 00-08

INSTRUMENT SHEET

Test Description: Post-HELB Functional Test

Test Start Date: 29 May, 2012

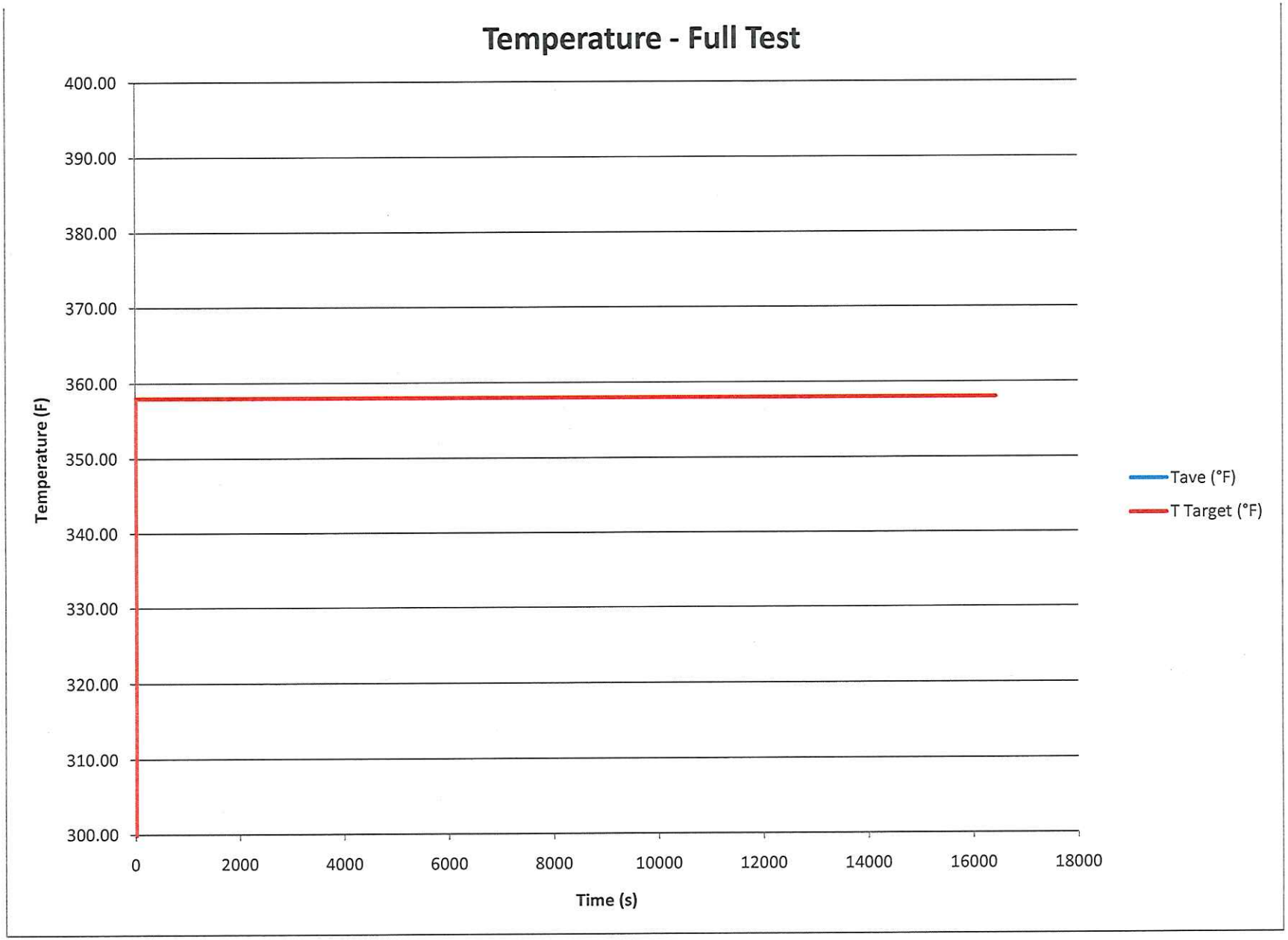
Project Number: K-115005

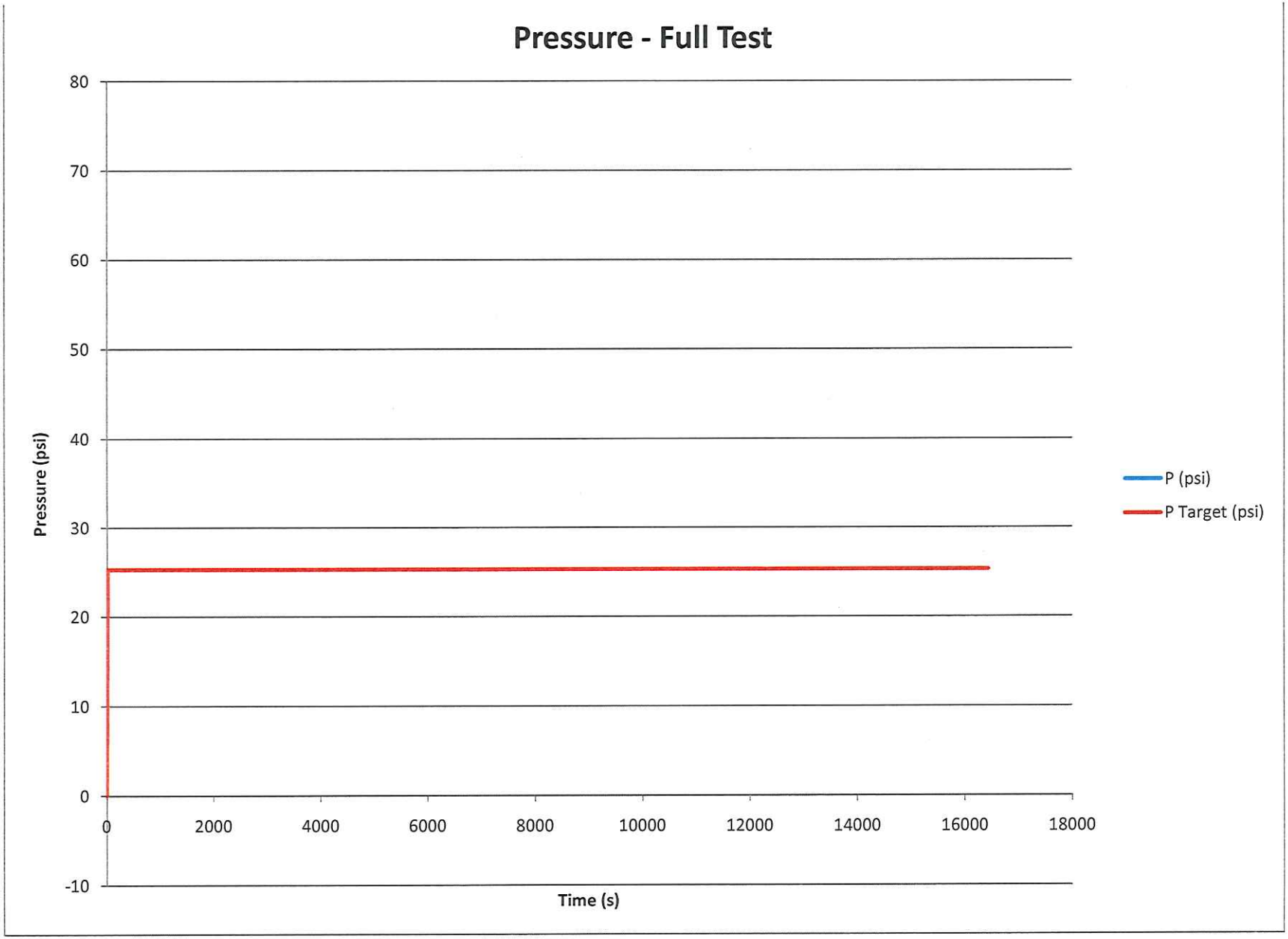
Test Finish Date: 29 May, 2012

Instrument	Equipment Number	Value Measured	Accuracy Claimed	Cal. Date	Cal. Due Date	Comment
AC/DC Tester	KIN-10332-0	Withstand Test Voltage	0.25 kV	21-Sep-2011	21 Sep 2012	
Megger	KIN-01715	Insulation Resistance	0.05 GΩ	07-Sep-2011	07 Sep 2012	
Stopwatch	KIN-01520	Withstand Test Time	0.01 s	23 Apr 2012	23 Apr 2014	
Tape measure	KIN-01825	Depth of water Cover	1/64"	03 Jan 2012	03 Jan 2014	

ATTACHMENT C

HELB SIMULATION DATA

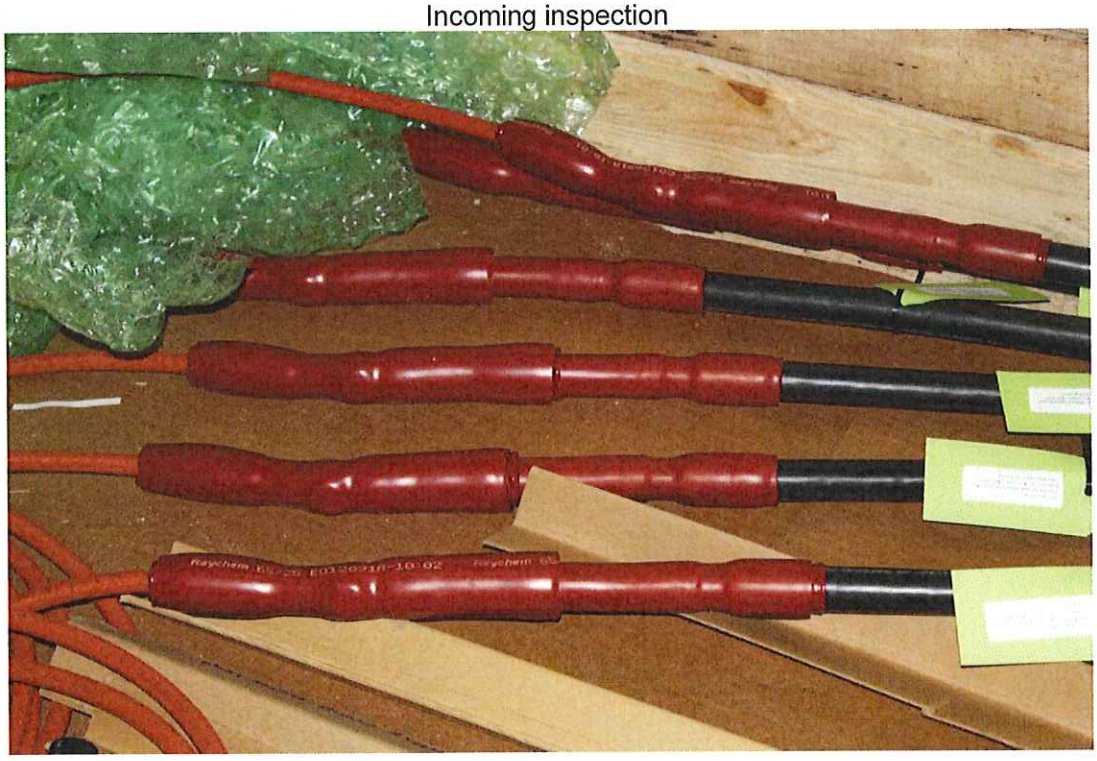

Temperature - Full Test
400.00
390.00
380.00
370.00
360.00
350.00
340.00
330.00
320.00
310.00
300.00
Temperature (F)
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
Time (s)
Tave (°F)
T Target (°F)


Pressure - Full Test
80
70
60
50
40
30
20
10
0
-10
Pressure (psi)
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
Time (s)
P (psi)
P Target (psi)

ATTACHMENT D

PHOTOGRAPHS

Incoming inspection



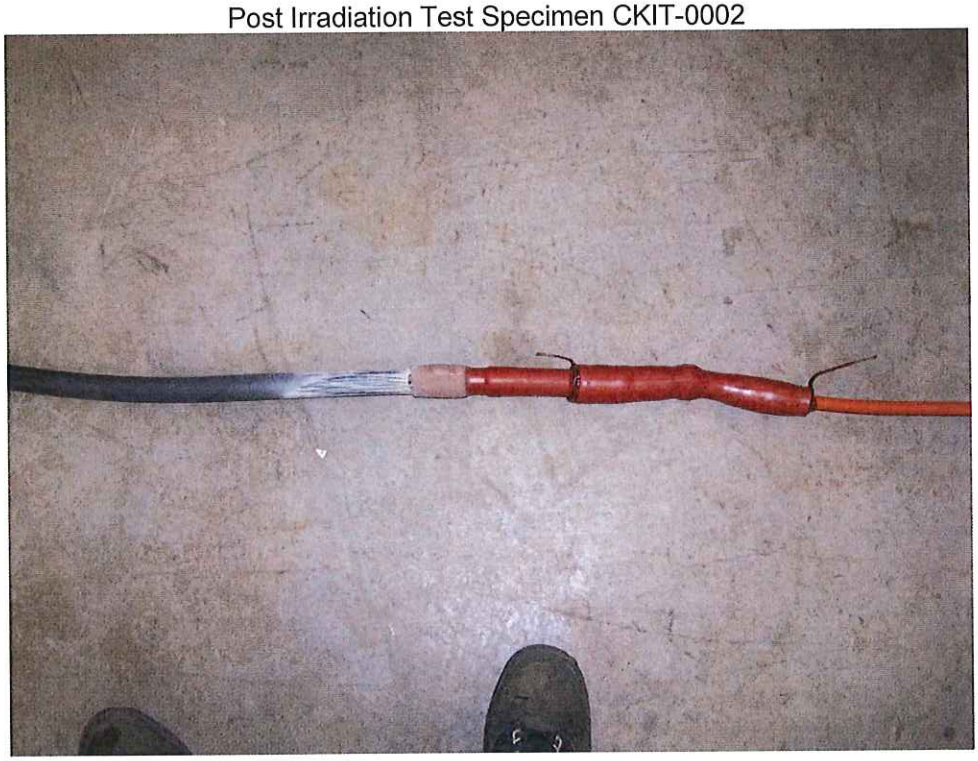
Baseline Functional Testing

Baseline Functional Testing

Thermal Aging (specimens 1-3 only)

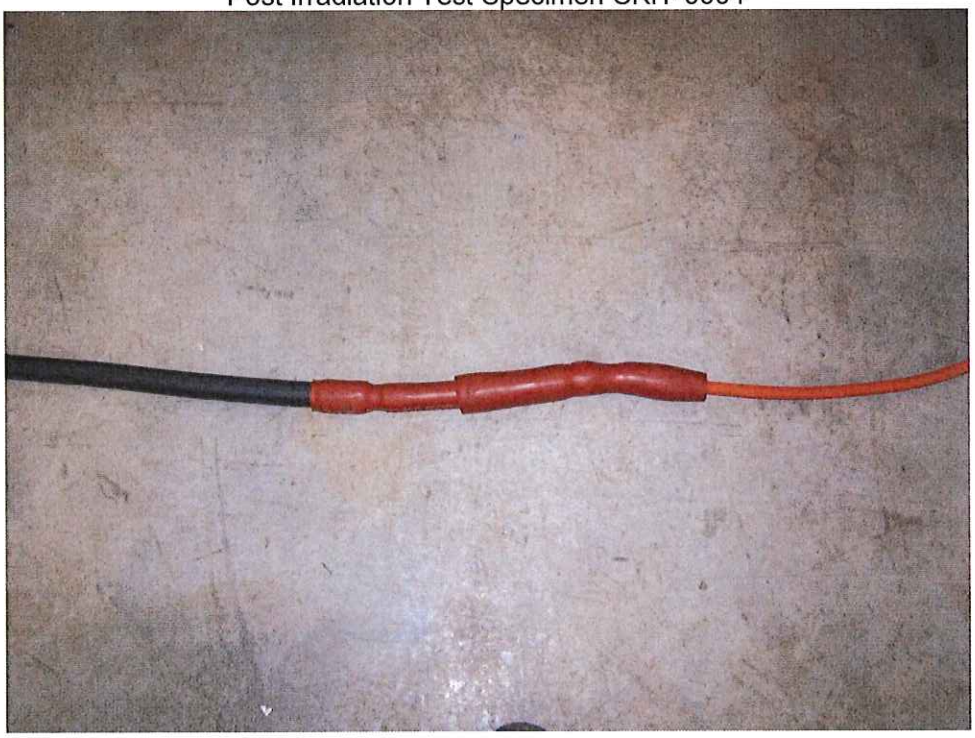
Post Irradiation Test Specimen CKIT-0001

Post Irradiation Test Specimen CKIT-0002



Post Irradiation Test Specimen CKIT-0003

Post Irradiation Test Specimen CKIT-0004



Post Irradiation Test Specimen CKIT-0005

Post Irradiation Test Specimen CKIT-0006

Pre-HELB Functional Testing

ATTACHMENT E

Kinectrics Procedure K-115005-PSWI-0001 Revision 3

KINECTRICS

KINECTRICS INC.

TEST PROCEDURE FOR QUALIFICATION TESTING OF TE Connectivity NMCK8-Nuclear Motor Connection Kits 8-kV Class 1E systems

May 24, 2012

Kinectrics Test Procedure: K-115005-PSWI-0001 R03
TE Connectivity Purchase Order NL040216

Prepared by: Serena Krause **Date:** 24-May-2012
Serena Krause
Senior Engineer
Nuclear Parts and Qualification
Kinectrics US Inc.

Reviewed by: _____ **Date:** _____
David Reichert
Engineer
Nuclear Parts and Qualification
Kinectrics Inc.

QA Reviewed by: _____ **Date:** _____
Dudley Mowery
Quality Assurance
Nuclear Parts and Qualification
Kinectrics US Inc.

Approved by: _____ **Date:** _____
Garry Chapman
Director-US Nuclear Programs
Nuclear Parts and Qualification
Kinectrics US Inc.

Accepted by: _____ **Date:** _____
TE Connectivity Representative

KINECTRICS

KINECTRICS INC.

TEST PROCEDURE FOR QUALIFICATION TESTING OF TE Connectivity NMCK8-Nuclear Motor Connection Kits 8-kV Class 1E systems

May 24, 2012

Kinectrics Test Procedure: K-115005-PSWI-0001 R03
TE Connectivity Purchase Order NL040216

Prepared by: _____ **Date:** _____
Serena Krause
Senior Engineer
Nuclear Parts and Qualification
Kinectrics US Inc.

Reviewed by: _____ **Date:** 28 May 2012
David Reichert
Engineer
Nuclear Parts and Qualification
Kinectrics Inc.

QA Reviewed by: _____ **Date:** 28 May 2012
for Dudley Mowery
Quality Assurance
Nuclear Parts and Qualification
Kinectrics US Inc.

Approved by: _____ **Date:** _____
Garry Chapman
Director-US Nuclear Programs
Nuclear Parts and Qualification
Kinectrics US Inc.

Accepted by: _____ **Date:** May 29, 2012
TE Connectivity Representative

KINECTRICS INC.

TEST PROCEDURE FOR QUALIFICATION TESTING OF TE Connectivity NMCK8-Nuclear Motor Connection Kits 8-kV Class 1E systems

May 24, 2012

Kinectrics Test Procedure: K-115005-PSWI-0001 R03
TE Connectivity Purchase Order NL040216

Prepared by: _____ **Date:** _____
Serena Krause
Senior Engineer
Nuclear Parts and Qualification
Kinectrics US Inc.

Reviewed by: _____ **Date:** 28 May 2012
David Reichert
Engineer
Nuclear Parts and Qualification
Kinectrics Inc.

QA Reviewed by: _____ **Date:** 28 May 2012
for Dudley Mowery
Quality Assurance
Nuclear Parts and Qualification
Kinectrics US Inc.

Approved by: _____ **Date:** 29 May 2012
Garry Chapman
Director-US Nuclear Programs
Nuclear Parts and Qualification
Kinectrics US Inc.

Accepted by: _____ **Date:** _____
TE Connectivity Representative

REVISION LOG

REV NO	ISSUE DATE	PREPARED BY	REVIEWED BY	APPROVED BY
00	February 20, 2012	S.Krause	D. Reichert	G.Chapman
01	March 22, 2012	S.Krause	D. Reichert	G.Chapman
02	May 22, 2012	S. Krause	D. Reichert	G. Chapman
03	May 24, 2012	S. Krause	D. Reichert	G. Chapman

REVISION HISTORY

REVISION NUMBER	SECTION/ PARAGRAPH	PAGE	DESCRIPTION
00	All	All	Initial Issue
01	Section 2	6 - 8	Addition of Details on Test Steps
	Section 2.4.2	8	Clarification radiation dose
	Section 2.6	8	Details on testing
02	Section 2.4.2	8	Changed dosimtery error to comply with irradiator requirement
	Section 2.6	8-9	Clarification for specimens subjected to the HELB simulation
03	Section 2.6	8-9	Corrected paragraph –specimens for HELB incorrectly referenced and clarified set up on cable connectors

TABLE OF CONTENTS

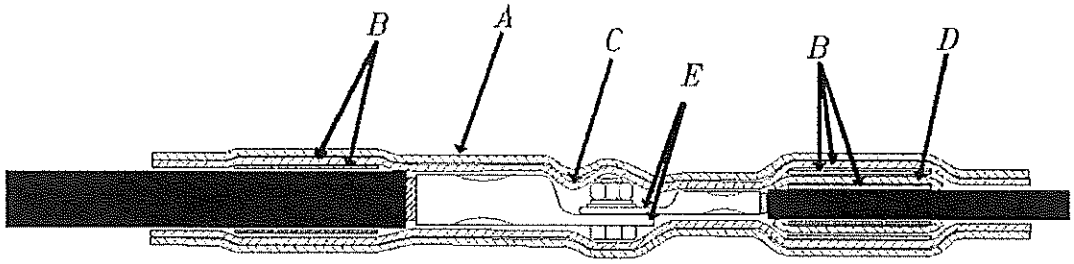
1 SCOPE

This test procedure specifies the requirements and process for qualifying Tyco NMCK8 Nuclear Motor Connection Kits. Kinectrics is responsible for performing Thermal aging and High Energy Line Break (HELB) testing. Radiation aging will be performed by a Kinectrics approved sub-contractor.

1.1 Test Specimen Description

The test samples consist of six (6) samples each of two configurations of connections (prepared by Tyco). Feeder lead and motor lead lengths shall be of sufficient length to accommodate the test process. These samples shall be subjected to initial and intermediate functional tests throughout the program which will include thermal aging, irradiation and a HELB simulation.

Figure 1. Sample Construction



A. BBIT-65/25-280/U
B. S1119 Adhesive Tape
C. BBIT-40/16-280/U
D. BBIT-25/10-75/U
E. Connectors: Burndy YA-6CN 1 hole NEMA and 4/0 Lug Utilux part 1-1099899-0

1.2 Applicable References

i. TE Connectivity LTD Purchase Order NL040216 dated, February 17, 2012
ii. Kinectrics Proposal # K-115005 Rev 1, dated, November 1, 2011
iii. TE Connectivity Test Plan 20166-20 Revision 6
iv. ASTM D257, "Standard Test Methods for DC Resistance or Conductance of Insulating Materials"
v. IEEE 323-1974/1983/2003, "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations"

2 TEST REQUIREMENTS

2.1 Test Sequence

The specimens shall be subjected to the following test sequence. The specimens shall be

split into two groups. Specimens 1-3 shall be subjected to both thermal and radiation aging prior to the HELB exposure and specimens 4-6 shall be subjected to radiation aging prior to the HELB exposure. The overall sequence is listed in in Table 1. The procedures used for each sequence are defined in the sections that follow.

Table 1: Test Program Sequence

Test Sequence
Receipt Inspection
Baseline Functional Test
Sample Preconditioning (thermal and radiation aging)
Pre-HELB exposure Functional Tests
HELB Exposure
Post-HELB Exposure Functional Test

2.2 Receipt Inspection

The test specimens shall be visually inspected for damage and photographed. A tag shall be attached to each specimen indicating the project and ID number.

The results of the receipt inspection, the test specimen descriptions, and their part and serial numbers shall be recorded on Kinectrics form QF10-1 "Record of Inspection of Incoming Items" and shall correspond to the test specimen description in Section 1.1.

TE Connectivity shall be informed if any obvious signs of physical damage are found.

2.3 Baseline Functional Test

The six (6) specimens shall be subjected to the following functional tests prior to the aging sequence of this test program. The purpose of the baseline test is to establish criteria to monitor the specimens for degradation as they complete each segment of testing.

The functional test shall be performed as follows:

1. **Immersion**
    a. The test specimens shall be immersed in ambient temperature water for minimum of 24 hours.
    b. All parts of the motor connection assemblies excluding leads shall be at least 12 inches below the water surface
2. **Insulation Resistance (IR) Test (per ASTM D257)**
    a. IR testing shall commence after the test specimens have been immersed for at least 24 hours. Testing to be performed while the specimens are still submerged in water.
    b. Test setup and connections shall be as shown in Figure 1
    c. The test voltage shall be 500Vdc
    d. The test voltage shall be applied for one minute before taking the resistance reading.
    e. Resistance reading shall be taken between conductor and ground plane

f. Repeat the above for resistance reading taken between the shield and ground plane
g. IR values shall be recorded and must be greater than 2.5 megaohms to pass testing.

3. Phase-to-Ground Withstand Test (per IEEE 383-1974)

a. Testing to be performed while the specimens are still submerged in water.
b. Test setup and connections shall be as shown in Figure 2
c. The voltage to be applied is 11.2 kV rms a-c (80 V/mil x 140 mils).
d. The test voltage is to be applied between conductor and ground plane.
e. The test voltage shall be applied for 5 minutes.
f. No breakdown should occur in order to pass testing.

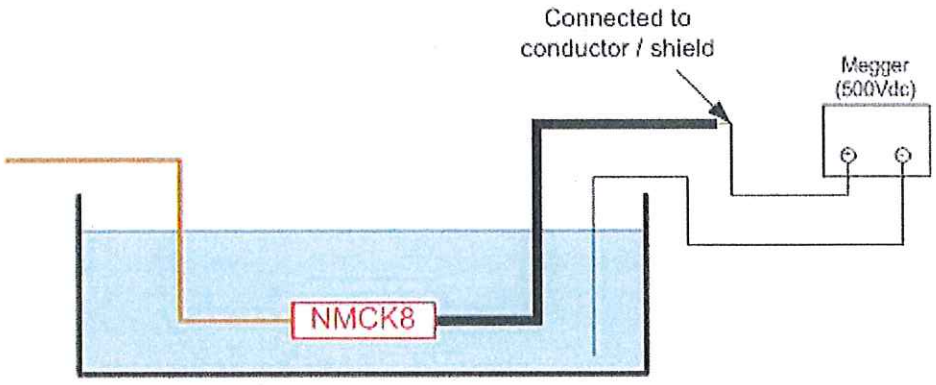


Figure 1 – Test Setup for IR Testing

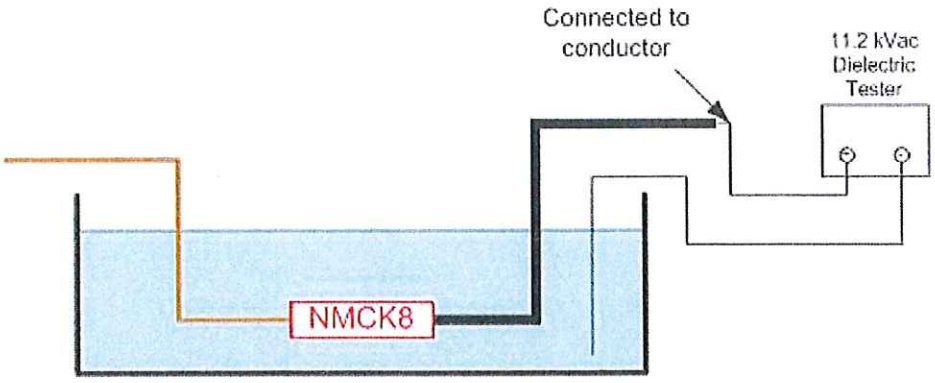


Figure 2 – Test Setup for Phase-to-Ground Withstand Testing

2.4 Sample Preconditioning

Test specimens shall be preconditioned per Table 2 below.

2.4.1 Thermal Aging

Table 2: Sample Pre-Conditioning Matrix

Test Specimen Number	Thermal aging 504 hours at 150°C	Radiation (Co-60 source) 50 Mrads)
1-3	Yes	Yes
4-6	No	Yes

The test specimens requiring thermal aging shall be aged in a 150°C +5/-0°C air circulating oven for a minium of 504 hours per Table 2 above.

2.4.2 Radiation Aging

Test specimens 1-6 shall be exposed to a minimum of 50 Mrads plus 10% margin. Dosimetry error is approximately 6.5% and the TID achieved shall be included in the certification from the Irradiation facility. Dose rate shall not exceed 1 Mrad per hour and shall be rotated mid-way through exposure to ensure uniform dose. The specimens shall be shipped to a Kinectrics approved subcontractor through issuance of a safety related purchase order.

2.5 Pre-HELB Exposure Functional Test

The steps outlined in section 2.3 above shall be repeated in their entirety following radiation aging.

2.6 HELB Exposure

Specimens 2, 3, 5 and 6 (four specimens total of the six conditioned samples) are to be mounted in a pressure vessel capable of exposing the samples to steam at the required temperature and pressure plus margin. These four test specimens (see table 2.1 below) will be exposed to the HELB conditions.

Table 2.1: Samples Subjected to the HELB conditions

Test Specimen Number	Previously subjected to thermal aging 504 hours at 150°C	Previously subjected to radiation (Co-60 source) 50 Mrads)
K-115005-002	Yes	Yes
K-115005-003	Yes	Yes
K-115005-005	No	Yes
K-115005-006	No	Yes

The HELB environmental conditions are:

Temperature: 358°F (343°F +15°F Margin)
Pressure: 25.3 (23 psig + 10% Margin)
Humidity: 100%
Duration: 4.4 hours (4 hours + 10%) at HELB conditions

It is recommended the temperature and pressure be reached within 15 seconds of the beginning of the HELB simulation.
The samples are to be energized throughout the HELB exposure to 5 kV a-c phase to ground. All of the samples must maintain the rated voltage throughout the HELB exposure to verify functional operability.

The positive shall be on the conductor side and the negative shall be on the cable shield. The cable shield shall be electrically connected to the vessel in which HELB testing is being performed. The connector portion of the specimens shall be wrapped with a stainless steel gauze and connected to the shield to ensure that the ground encapsulates this area of the specimens.

In the event that the rated voltage is not maintained throughout the HELB test, the source of the failure shall be indentified and communicated to TE Connectivity. If the failure mode is not attributed to the NMCK8 insulating kit, further testing of the NCMK8 product shall be conducted.

Passing the subsequent post-HELB functional tests will be considered acceptable performance verification.

2.7 Post-HELB Exposure Functional Test

The steps outlined in section 2.3 above shall be repeated in their entirety following the HELB simulation.

2.8 Post-HELB Test Inspection

The test specimens shall be thoroughly checked for any sign of damage induced by the test. Any discoloration, corrosion, deformation, etc. will be reported and photographed.

2.9 Margins

Margins shall be applied to the test parameters in compliance with IEEE 323-1974.

2.10 Acceptance Criteria

Acceptance Criteria applied are as follows:

- The specimens must pass post HELB functional testing
- No breakdown of the insulation shall occur
- IR must be greater than 2.5 MΩ

2.11 Test Specimen Disposal

The test specimens shall be returned to Tyco Electronics (FOB Kinectrics).

3 ACTION ON FAILURE

Any anomalies that may occur will be documented as required by Kinectrics 10CFR50 Appendix B QA Program. Anomalies may include specimen or procedure issues or occurrences not expected in the course of the testing process. TE Connectivity shall provide resolution or concurrence for all anomalies and non-conformances.

4 TEST EQUIPMENT

4.1 Instrument Calibration

Prior to being used in this test program, all measuring and test equipment shall be calibrated in accordance with Kinectrics' quality program. Calibration equipment and standards used in performing all calibrations shall be traceable to National or International measurement bodies (e.g. National Research Council Canada (NRCC) or National Institute of Standards and Technology (NIST)). Calibration certificates shall be made available to the client on request.

4.2 Test Instrument Lists

All instrumentation, measuring and test equipment to be used in the test program shall be recorded on Kinectrics form QF11-1 Instrumentation Sheet, with calibration dates and accuracies.

5 QUALITY ASSURANCE

The test program shall be performed and all reports shall be prepared in accordance with 10CFR 50 Appendix B and Kinectrics QA Program which complies with the requirements of ISO 9001. Forms for this work will be prepared according to Kinectrics QA requirements and used to record all data and will be signed off appropriately.

6 TEST REPORT

The test report will meet the following requirements:

- Title page with signatures and dates
- Name and address of test facility
- Table of Contents
- Statement of test objectives
- Identification, Description and Quantity of Test Specimens
- Test Set-Ups and Interfaces
- Photograph(s) showing sample mounting and orientation
- Service conditions to be simulated
- Test Procedure
- List of all measuring equipment used including calibration dates
- Test data and results
- Conclusions

- Detailed Specimen Interface and mounting configurations
- Notices of Anomaly – if required
- Non-Conformance Reports, if required

ATTACHMENT 7

Kinectrics Certificate of Completion

KINECTRICS

Certificate of Completion

Kinectrics herby certifies that Testing of TE Connectivity NMCK8-Nuclear Motor Connection Kits 8-kV was subjected to thermal aging, radiation aging and a HELB test simulation per the approved Project Specific Work Instructions (PSWI) K-115005-PSWI-0001 R03.The PSWI required that:

- The specimens pass post-HELB functional testing
- No breakdown of the insulation occurred
- IR must be greater than 2.5 MΩ

The test samples met all the acceptance criteria and may be considered to be qualified to the requirements of the governing test procedure and TE Connectivity Purchase Order NL040216.

There were no Non Conformances Reports were generated during the testing.

A full qualification report has been submitted to the customer (reference K-115005-RA-0001).

Test Sample Identification:

Manufacturer: TE Connectivity
Description: NMCK8-Nuclear Motor Connection Kits 8-kV

Kinectrics Test Procedure:

K-115005-PSWI-0001 R03

TE Connectivity Specification

TE Connectivity Test Plan 20166-20 Revision 6

Quality Programs:

10CFR50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Processing Plants"

10 CFR Part 21 "Reporting of Defects and Non-Compliance

Serena Krause
Senior Engineer
Kinectrics US Inc.

2012-Jun-11
Date

15 June 2012