VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

W. L. STEWART
VICE PRESIDENT
NUCLEAR OPERATIONS

March 9, 1983

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
Attention: Steven A. Varga, Chief
Operating Reactors Branch No. 1
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Serial No. 085C
PSE/JEW:nh

Docket Nos.: 50-280
50-281

License Nos.: DPR-32
DPR-37

Gentlemen:

TECHNICAL EVALUATION REPORTS
ENVIRONMENTAL QUALIFICATION OF SAFETY RELATED ELECTRICAL EQUIPMENT
SURRY POWER STATION UNITS 1 AND 2

In a letter dated January 26, 1983, the NRC transmitted to Vepco the Safety Evaluation Report for the Environment Qualification of Safety-Related Electrical Equipment at Surry Power Station, Unit Nos. 1 and 2. This letter requested that Vepco reaffirm the justification for continued operation within thirty (30) days of receipt of the letter and submit information for NRC Categories I.B, II.A, and II.B (as presented in the Franklin Research Center Technical Evaluation Report - TER) for which justification for continued operation was not previously submitted.

Attachments 1 through 6 provide the Vepco response to the January 26, 1983 letter. The response for each equipment type will contain any data required to support that response, or refer to another applicable equipment response which contains the required data. Also enclosed in the appropriate attachment are equipment qualification files (Qualification Documentation Reports - QDR's) which provide information with regard to equipment not previously submitted. These will be referenced by the applicable equipment response sheet.

Additionally, during the search of Surry site records in preparation of this response, it was discovered that certain items listed as Category IIIA, "Exempt from Qualification", were, in fact, used in safety-related systems. Attachment 7 provides the Vepco review of these equipment items. These equipment items should be reclassified as Category I.A, "Equipment Qualified."

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P PDR

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
Page Two

Attachments 8 through 15 are equipment file packages (QDR's) which are submitted in support of specific equipment items identified in Attachments 2 and 5. These QDR's have not been previously submitted to the NRC. Please note that only one (1) copy of Attachments 8 through 15 is forwarded. Additional copies will be issued with the Vepco 90-day response to the January 26, 1983 letter.

This completes the thirty (30) day response requirements of the January 26, 1983 letter. A response to the letter with regard to plans for qualification or replacement, and the schedule for accomplishing proposed corrective actions, will be provided by May 6, 1983.

Very truly yours,

J. M. Allgood, Jr.

for W. L. Stewart

Attachments

cc: Mr. James P. O'Reilly, w/attachments 1 through 7
Regional Administrator
Region II
101 Maretta Street, Suite 2900
Atlanta, Georgia 30303

ATTACHMENTS

Attachment 1: Unit 1: Response to NRC Category I.B
Equipment Qualification Pending Modification

Attachment 2: Unit 1: Response to NRC Category II.A
Equipment Qualification Not Established

Attachment 3: Unit 1: Response to NRC Category II.B
Equipment Not Qualified

Attachment 4: Unit 1: Response to NRC Category I.B
Equipment Qualification Pending Modification

Attachment 5: Unit 2: Response to NRC Category II.A
Equipment Qualification Not Established

Attachment 6: Unit 2: Response to NRC Category II.B
Equipment Not Qualified

Attachment 7: Unit 1 and 2: Category III.A
Equipment Re-Reviewed

Attachment 8: QDR-5437-205-01: Valcor Valves and Gordos Limit Switches, Unit 1

Attachment 9: QDR-5437-245-01: Valcor Valves and Gordos Limit Switches, Unit 2

Attachment 10: QDR-5437-241-01: Rosemount Transmitters Models
1152DP & 1152AP, Unit 2

Attachment 11: QDR-5437-201-01: Rosemount Transmitters Models
1152DP & 1152AP, Unit 1

Attachment 12: QDR-5437-78-01; Cutter Hammer 480V
Motor Control Centers; Unit 2

Attachment 13: QDR-5437-17-01; Cutter Hammer 480V
Motor Control Centers; Unit 1

Attachment 14: QDR-5437-131-01; Continental Wire & Cable Company
600V & 1000V Cables; Unit 2

Attachment 15: QDR-5437-47-01; Continental Wire & Cable Company
600V & 1000V Cables; Unit 1

DOCKET NO. 50-280/281 ..VEPCO ..SURRY 1&2

TECHNICAL EVALUATION REPORTS
ENVIRONMENTAL QUALIFICATION OF SAFETY
RELATED ELECTRICAL EQUIPMENT

Rec'd w/ltr 3/9/83...8303110282

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DEADLINE RETURN DATE 50-280/281

3/9/83

8303110282

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TECHNICAL EVALUATION REPORTS
ENVIRONMENTAL QUALIFICATION OF SAFETY-RELATED ELECTRICAL EQUIPMENT
SURRY POWER STATION UNITS 1 AND 2

30-DAY RESPONSE TO
NRC LETTER OF JANUARY 26, 1983

MARCH 9, 1983

ATTACHMENT 1
UNIT 1: RESPONSE TO NRC CATEGORY I.B
EQUIPMENT QUALIFICATION PENDING MODIFICATION

TER ITEMS

81
84
88
109
110
111

Except for those items addressed in this attachment, the replacement commitment and Justification for Continued Operation provided in Sections 7.1 and 7.2 of the 90-day Response Rev. 4 remain valid. This attachment addresses all changes that resulted from a complete review and updating of replacement plans.

With respect to the terminal blocks listed in Section 7.1.11 of the 90-day Response, all terminal blocks in safety related circuits inside containment have been replaced with qualified Raychem splices as stated in Section 7.1.11.1. We have completed review of terminal blocks outside containment and have scheduled replacement of all unqualified blocks in safety related circuits with qualified blocks.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 1

COMPONENT

TER Item No.: 81

TER Category: Ib

Description: SOV FOR PRESSURIZER RELIEF VALVE ACTUATION

Manufacturer, Model: Laurence, 330WA742DC

Tag No(s).: SOV 1456-3, 1455C-3

Worksheet No(s).: 6-195 and 92

QDR No.: None

Location: RC-47A

DISCREPANCY

The 90-day response did not provide justification for continued operation for Laurence SOVs.

RESPONSE

The February 1982 plant inspection determined these valves to be ASCO type 831654E, for which justification of continued operation was provided in Section 7.2.2 of the 90-day Review. Replacement is still intended.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 1

COMPONENT

TER Item No.: 84

TER Category: Ib

Description: SOVs FOR RADIATION MONITORING AND PRIMARY GRADE WATER TO PRESSURIZER RELIEF TANK

Manufacturer, Model: Not determined

Tag No(s).: SOV-RM-100A, SOV-1519A

Worksheet No(s).: 6-170 and 189

QDR No.: None

Location: AB-2B

DISCREPANCY

The 90-day response did not provide identification of these SOVs.

RESPONSE

The February 1982 plant inspection determined these valves to be ASCO types 8320A12 and 8320A102, for which justification of continued operation was provided in Section 7.2.2 of the 90-day Review. Replacement is still intended.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 1

COMPONENT

TER Item No.: 88

TER Category: Ib

Description: SOV FOR PRIMARY PLANT VENT AND DRAIN ISOLATION

Manufacturer, Model: ASCO, Model NP8320A175E

Tag No(s).: SOV-DA-100A

Worksheet No(s).: 6-162

QDR No.: 5437-01-01

Location: RC-3B

DISCREPANCY

TER reviewed this component as an unqualified valve to be replaced. In the Rev. 4 worksheet the specified model number erroneously contained an H instead of the 8.

RESPONSE

This is a qualified NP-series replacement valve as identified on the worksheet. Other valves of this series were assigned to Category IIc in the TER. Replacement is not planned.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 1

COMPONENT

TER Item No.: 109

TER Category: Ib

Description: ACCELEROMETER FOR ACCIDENT MITIGATION (TMI ITEM)

Manufacturer, Model: ENDEVCO, Model 2273AM20

Tag No(s).: YE100A1,2; B1,2; C1,2 and YE-101A1,2; B1,2

Worksheet No(s).: TMI 10.3-9 thru 10.3-18

QDR No.: future

Location: RC-47A

DISCREPANCY

This is a new equipment item for TMI purposes. Qualification testing has not been completed.

RESPONSE

The qualification test report for this equipment is not yet available. We continue to believe that the equipment is the best available for the purpose, and have no knowledge of type test failures that would compromise its capability for qualification.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 1

COMPONENT

TER Item No.: 110

TER Category: Ib

Description: HARDLINE COAXIAL CABLE FOR ACCIDENT MITIGATION (TMI ITEM)

Manufacturer, Model: ENDEVCO Model 3075M6

Tag No(s).: Low Noise Cable

Worksheet No(s).: TMI 10.3-19

QDR No.: future

Location: RC-47A

DISCREPANCY

This is a new equipment item for TMI purposes. Qualification testing has not been completed.

RESPONSE

The qualification test report for this equipment is not yet available. We continue to believe that the equipment is the best available for the purpose, and have no knowledge of type test failures that would compromise its capability for qualification.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 1

COMPONENT

TER Item No.: 111

TER Category: Ib

Description: CHARGE PREAMPLIFIER FOR ACCIDENT MITIGATION (TMI ITEM)

Manufacturer, Model: UNHOLTZ-DICKIE Model 22CA-2TR

Tag No(s).: YY-UMS-100A1,2; B1,2; C1,2; 101A1,2; B1,2

Worksheet No(s).: TMI 10.3-20 thru 10.3-29

QDR No.: future

Location: RC-47A

DISCREPANCY

This is a new equipment item for TMI purposes. Qualification testing has not been completed.

RESPONSE

The qualification test report for this equipment is not yet available. We continue to believe that the equipment is the best available for the purpose, and have no knowledge of type test failures that would compromise its capability for qualification.

TECHNICAL EVALUATION REPORTS
ENVIRONMENTAL QUALIFICATION OF SAFETY-RELATED ELECTRICAL EQUIPMENT
SURRY POWER STATION UNITS 1 AND 2

30-DAY RESPONSE TO
NRC LETTER OF JANUARY 26, 1983

MARCH 9, 1983

ATTACHMENT 2
UNIT 1: RESPONSE TO NRC CATEGORY II.A EQUIPMENT
QUALIFICATION NOT ESTABLISHED

TER ITEMS

3	42
8	46
9	47
10	51
13	55
14	57
20	104
32	106
34	107
36	115
38	116
41	117

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 1

COMPONENT

TER Item No.: 3

TER Category: IIa

Description: PRESSURE TRANSMITTER FOR R.S. PUMP DISCHARGE (PAM)

Manufacturer, Model: FISHER-PORTER, Model 50EP1031BCXA

Tag No(s).: PT-RS-156A,B

Worksheet No(s).: 6-272, 6-273

QDR No.: None

Location: SFGD-1

DISCREPANCY

This is PAM equipment which was under review at the time of the 90-day Rev. 4 submittal. Qualification was not established.

RESPONSE

This equipment will be replaced by qualified equipment within the schedule established in 10CFR50.49. In the interim, due to equipment type similarity, justification for continued operation is provided in the 90-day conclusions section 7.2.4 for this equipment type. The TER classifies other equipment of this sort in Category Ib, Equipment Qualification Pending Modification.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 1

COMPONENT

TER Item No.: 8

TER Category: IIa

Description: ELECTRICAL PENETRATION

Manufacturer, Model: Amphenol Type IA, IB, and IC, Spec. NUS-41

Tag No(s).:

Worksheet No(s).: 6-43, 44, and 45

QDR No.: 5437-59-01

Location: RC-18B

DISCREPANCY

The TER identifies concerns in the following areas:

A. Similarity between equipment and test specimens
B. Aging and qualified life
C. Temperature/pressure test profile
D. Spray
E. Radiation

RESPONSE

The attached pages discuss these concerns in detail. It is concluded that all of these concerns are resolved except Aging and Qualified Life. As recommended in the QDR, the penetrations should be included in a surveillance program. The TER assigns other equipment of this sort to Category IIc.

ATTACHMENT TO SURRY 1 ITEM 8
AMPHENOL PENETRATIONS

A. CONCERN: (1) Similarity Between Equipment and Test Specimens (page 2 of TER)
(2) It is not clear why the manufacturer was not contacted to determine the applicability of the test reports. It is noted that Amphenol has provided test documentation to other plants, i.e., Calvert Cliffs, Trojan, San Onofre, Davis Besse and ANO (page 5f of TER)

RESOLUTION:

The Amphenol penetrations used at Surry are of the canister type, rather than the unitized header design supplied for later plants such as Davis Besse and ANO-2. Copies of ten references are attached documenting contacts with Amphenol to obtain copies of suitable test reports for the canister design (which they could not provide) or for the unitized header design (which were ultimately obtained directly from Toledo Edison and Arkansas Power & Light).

Additionally, the referenced QDR contains substantial documentation relating the canister and unitized header designs. In particular, the "Design Evolution" report included with the original Amphenol proposal in Section 2b of the QDR provides a detailed description of Amphenol's penetration design evolution from canister to unitized header. The photographs and drawings in this report, together with the drawings in the Proposal, clearly establish that at the time Surry penetrations were fabricated the two designs employed the the same connector modules, insulation materials, potting compounds, and sealants; only the structural metallic components in which these items are mounted and related welds differ.

Amphenol's Design Verification Test Report, included in Section 3d of the QDR, summarizes the reasons for evolving from the canister to the unitized header design (page 1): "The unitized header assembly (UHA) offers the advantages of a lighter, more compact unit than the canisters which have been used heretofore and also provides for versatility and interchangeability of components. In addition, the UHA promises to considerably reduce the required field installation effort."

Sheet 10 of the QDR, reproduced on page 5f of the TER, documents additional comparisons performed by NUS to verify the similarity between Surry equipment and the test specimens used for the test reports employed by the QDR.

Summarizing, the manufacturer was contacted repeatedly to obtain applicable test reports. In the absence of complete test reports for the canister design used at Surry, design similarity to the tested unitized header penetrations was established using information provided by the manufacturer. Test reports for the unitized header penetrations were obtained and used to establish the qualification of the Surry penetrations. This effort adequately determines similarity between the plant equipment and test specimens in conformance to the DOR Guidelines.

B. CONCERN: (1) Aging Degradation Evaluation (page 2 of TER)
(2) Qualified Life or Replacement Schedule Established (page 2 of TER)
(3) No aging evaluation has been conducted (page 5h of TER)

RESOLUTION:

Sheet 11 of the QDR, reproduced on page 5i of the TER, summarizes the thermal cycle test in Amphenol report 123-1275 but does not provide an Arrhenius calculation to predict a qualified life. Clearly such a calculation would predict a very long life: for example, using the conservative activation energy of 0.7 ev developed on sheet 13 of the QDR, the one hour of thermal testing at 400°F corresponds to over 1,000 years at the compartment ambient of 105°F.

The QDR concluded that the evidence is not sufficient to justify a 40 year qualified life, and an Ongoing Aging Surveillance Program should be performed. This deficiency by itself would not cause the penetrations to be classified in TER Category IIa. Category IIc, "Qualified Life Deficiency," would be appropriate.

C. CONCERN: (1) Temperature/Pressure Test Duration (TER page 2)
(2) Temperature/Pressure Required Profile Enveloped by Test Profile (TER page 2)
(3) Note 5 states that two referenced tests envelop neither the peak temperature nor entire duration, while a third referenced test which exceeds the peak temperature does not have adequate duration. (TER page 5j; test and plant profiles reproduced on pages 5k through 5n).

RESOLUTION:

This concern primarily reflects the fact that in 1972 the industry did not conduct 120-day LOCA tests; secondarily, the peak temperature in the Davis Besse LOCA test (the most closely related test to Surry LOCA conditions) is slightly lower than for Surry. This concern is not considered significant for the reasons that follow.

The Surry peak LOCA temperature for the penetrations is 280°F for 30 minutes. It decays to 150°F in the next 30 minutes, then to 120°F by the end of two days and remains at 120°F for the balance of the 120 day post-LOCA required operating period.

Attachment No. 2 of the QDR presents a series of Arrhenius calculations to show that the Davis Besse LOCA test is more severe than the Surry LOCA. This is shown by converting both profiles to equivalent time at 120°F, using a conservative actiation energy of 0.7 ev. The calculations show that the Davis Besse test corresponds to an additional two months of post-LOCA operation at Surry after the required 120 day operating time. The two LOCA profiles, shown in Figure 13 of the QDR, do not differ significantly, and this approach is not considered to represent an abusive use of the Arrhenius technique.

Since the Davis Besse test did not bound the Surry peak temperature, the QDR also referred to Amphenol's "Maximum Credible Accident" test. In this test the penetrations experienced 300°F for 15 minutes dropping to 250°F for the balance of 24 hours. The thermal aging test discussed under the aging concern exposed the penetrations to seven hours at or above 300°F; this test was performed in dry air rather than steam. These two tests provide substantial evidence that threshold effects or other adverse behavior will not occur in the small portion of the Surry LOCA peak not enveloped by the Davis Besse test.

With respect to the concern that Arrhenius calculations should not be used to extrapolate high-temperature, saturated steam exposure to low temperature, oxygen-rich operation, two points are noted: First, in Attachment No. 2 of the QDR it is evident that most of the "credit" for post-LOCA operating time derives from testing at or below 180°F, which does not reflect a steam environment. Second, the aging justifies many years operation at ambient temperature, based on the oxygen-rich thermal aging test.

It is noted that the QDR contains an error in presenting LOCA test results. For the Davis Besse test both temperature and duration values used are incorrect because the test procedure rather than the test report was used. The TER presents correct conditions. In spite of the error the results of the calculation in Attachment No. 2 of the QDR remain valid (lower temperature and longer time tend to offset), but the QDR will be corrected.

Summarizing, the justification for LOCA qualification of the penetrations is considered valid.

D. CONCERN: (1) Spray (page 2 of TER)
(2) "Boric acid was mixed and boiled to make steam. No spray was used." (page 5j of TER)

RESOLUTION:

The direct impingement forces of droplets from containment spray nozzles become insignificant relative to LOCA pressures beyond one or two feet from the nozzle. The Surry penetrations are located no closer than several feet from spray nozzles. Thus the spray test is considered to have adequately simulated the Surry LOCA environment even though the solution was not directly sprayed through a nozzle into the test chamber.

E. CONCERN: (1) Radiation (TER page 2)
(2) Note 4 challenges the qualified radiation dose of 1.03×10^8 rads claimed in the QDR (TER page 5i)

RESPONSE:

The TER presents (on page 5h) documentation from the Hanford laboratory showing that, although portions of the test container received 1.03×10^8 R, other portions received as little as 1.22×10^7 R. The TER further presents on page 5h a caution that radiation exposure was quoted in Roentgens and would have to be converted to rads to reflect absorbed dose.

The required radiation dose for the Surry penetrations is 7.44×10^6 rads (40 years plus LOCA). The conversion from Roentgens to rads for the organic materials of concern is unlikely to vary from 1.0 by more than ten to twenty percent, so the qualified dose is at least 1×10^7 rads. This exceeds the plant environment.

VEPCo - SURRY
ATTN. MR. W.C. SPENCER

AMPHENOL
SPACE AND MISSILE
SYSTEMS DIVISION

9201 INDEPENDENCE AVENUE • CHATSWORTH, CALIFORNIA 91311 • TEL: 213-341-0710 • TWX 910-494-1211

Electrical Penetration
4.10-1

HF:4:1:603

April 12, 1971

TELECOPIED
TIME 245 P
DATE 4/14/71

Stone & Webster
225 Franklin Street
Boston, Massachusetts 02107

Attention: A. W. Goldman, Consultant
Electrical Division

Subject: Qualificaiton Test of Connector in Type IA, IIA & III Penetration Assemblies

Reference: Your TWX of 4-8-71

Gentlemen:

In answer to Stone & Webster's question, the connectors provided have not been qualification tested. However, the design of these connectors is based upon the requirements of military specification No. MIL-C-5015 which includes environmental testing. Connector design is such that at least one and in some cases, two silastic components are provided in the connector to feedthru interface. This type of interface has been proven adequate to meet the environmental requirements of MIL-C-5015. Also, additional capability to withstand elevated temperatures, is provided in the silicone material used for the sealing members.

A copy of MIL-C-5015 is attached for your review. Obviously, the tests outlined in the spec are not based on the "accident" condition in question, but I think a useful comparison can be made.

Should you require verification testing, it can be performed at additional cost.

Sincerely,

Harry J. Flock
Sales Correspondent

HJF:fp

cc: E. Stadler
W. Sullivan
D. Sorenson
R. Purinton
K. Rabe

SK

TELECON NOTE

Date: 4/15/81 Time: 11:45 A.M File: 5437-4.10

Between: H HILBEIG of: DG O'BRIEN

And: J Solano (NUS)

DISCUSSION:

I CALLED DG O'BRIEN CO. AND TALKED TO MR. H. HILBEIG ABOUT SENDING US SOME PENETRATION REPORTS ON EQUIP TESTED FOR SURRY 1+2. MR. HILBEIG SAID THAT THEY MAY HAVE SUCH REPORTS ON FILE AND HE WOULD BE VERY GLAD TO SEND THEM TO US.

ACTION ITEMS:

MR. HILBEIG NEEDS A REQUEST LETTER FROM US IN ORDER TO RELEASE SUCH REPORTS.

ENGINEERING DIVISION
~~Equipment Qualification~~

APR 23 1981

TELECON NOTE

No.

Date: 4/23/81 Time: 9-40 AM File: 5437-4.10 8

Between: H. Hilbeig (602-474-5576) D.G. O'brien

And: Nick Garg (NUS)

DISCUSSION:

HILBEIG told me that he did not recieve our letter yet. He will dig into his files for the following types of penetration and will try to send available reports on them by 4/24/81.

Pent. — Amphenol type IA, IB, IC, III & IV

In case he doesn't find any thing on these penetrations he will call me back

I asked them to send report # 123-1268, 123-1269, 123-2045 Rev A and the report prepared on Aging. These reports were prepared for Davis Besse.

ACTION ITEMS:

cc. J. Salano
S. Kastivi.

~~Mont~~ Mano - Avon
EX-377

ENGINEERING DIVISION
Equipment Qualification

APR 23 1981

No.

TELECON NOTE

Date: 4/23/81 Time: 1-10 PM File: 5437-4108

Between: Amphenol. of: Amphenol.

And: Nick Garg (NUS)

DISCUSSION:

Called and talked to the servicing dept. They told me Mr. Mano-Avon is looking after penetrations. He was not in the office. A message is left in his office to call me as soon as possible.

His Telephone No is 213-341-0710 Ext-377

cc: Salamo
Kashim

N. Garg

ACTION ITEMS:

NUS CORPORATION
4 RESEARCH PLACE
ROCKVILLE, MARYLAND 20850
301 948-7010

SK

ENGINEERING DIVISION
Equipment Qualification
APR 27 1981
No.

April 24, 1981
5437-4.10

Amphenol Sams-Bunker Ramos Corporation
9201 Independent Avenue
Chatsworth, California 91311

ATTN: Mano Aaron

Subject: Penetration Qualification Documentation

Gentlemen:

Confirming our telecon of April 24, 1981, please send me a complete set of qualification documentation for Nuclear Applications on Power, Thermocouples, Instruments and Tri-axial Penetrations.

Thank you for your kind assistance.

Very truly yours,

J. R. Solano
Staff Engineer

5437-TL-046

TELECON NOTE

Date: 5/5/81 Time: ________ File: 5437 ~~4.10~~

Between: R. J. Crowell of: D. G. O'brien

And: J. Solano (NUS)

DISCUSSION:

I told Mr. Crowell that the report #C19QA061 on Amphenol penetration does not include the test on Rad. and chemical spray exposures. He told me that this report was prepared a long time ago and at that time they did not have the facility to do rad. and spray test.

He will find out if some tests were conducted on radiation and spray tests and will call me back.

cc: Nick Garg
S. Kasturi

5437-TL-049

TELECON NOTE

Date: 5/6/81 Time: 12. PM. File: 5437- Hilas

Between: J O Armstrong. (213-341-0710) of: Amphenol.

And: N. K. GARG / J Solano. (NUS)

DISCUSSION:

Mrs. Armstrong told me that the requested reports can be sent to us only after getting a authorization letter from either Stones & Webster or VEPCO. After getting a authorization letter she will work on the cost of these reports for which VEPCO has to issue a Purchase order.

At this time she doesnot have any idea of what kind of information they can supply to us.

N. Garg

ACTION ITEMS:

CC: S. Kasturi.

J. Solano.

N. GARG.

TELECON NOTE 5437-TL-050

Date: 5/6/81 Time: 12-50 PM File: 5437 - 1.0 /4.10

Between: Rip Newcomb of: VEPCO.

And: Nick GARG (NUS)

DISCUSSION:

1. Asked about DCP No - Rip told me that DCP # shall be given by VEPCO. He will find out the person who will assign these numbers and let me know. He also told me that NUS' other departments are preparing DCP for Vepco. Same procedure can be followed.

2. I told him about the conversation with Amphenol comp. Amphenol company can issue the reports to NUS only after getting a authorization either from VEPCO or Stones & Webster. After getting the authorization

ACTION ITEMS:

Amphenol shall submit the cost for these reports etc and after getting a P.O from Vepco they will issue the reports.

Rip is going to check on it and will call me back.

N. Garg

CC: ~~S - KASTURI~~
B - Golenbiki
J - Solano.
N - GARG.

5437-TL-053

TELECON NOTE

Date: 5/7/81 Time: 10:30 AM File: 5437 ~~-410~~

Between: D HOWARD of: ARKANSAS POWER & LIGHT

And: I SOLANO (NUS)

DISCUSSION:

ASKED MR. HOWARD FOR COPIES OF AMPHENOL PENETRATION REPORTS NOS. 123-2045. 123-1268 & 123-1269. MR HOWARD referred me TO MR. TONY EMAN IN FLOrida. HE SAID THAT IN CASE MR. INMAN does NOT have them, he'll send them TO US.

CC: N GARG
S KASTURI

ACTION ITEMS:

AMPHENOL NORTH AMERICA

Bunker Ramo Corporation
9201 Independence Ave • Chatsworth, California 91311 • 213/341-0710

S. KASTURI
N. GARG. — NG
file.

May 29, 1981

BJA:5:1:049

4.10

NUS Corporation
4 Research Place
Rockville, MD 20850

Attention: J. R. Solano, Staff Engineer

Reference: Your request for Qualification Documentation for Nuclear Applications on Power, Thermocouples, Instruments and Triaxial Penetrations. Technical Reports 123-2045, 123-1268 and 123-1269

BUNKER RAMO

Dear Mr. Solano:

Because the referenced reports were prepared for Toledo Edison and Arkansas Power and Light Company, it is necessary for you to obtain their permission prior to our releasing the reports. The documents are available and will be sent to you after approval has been received.

As previously quoted to you, our minimum order value is $250.00.

Upon receipt of the releases from the Utilities and your P.O. for $250.00, the reports will sent immediately.

Thank you for your interest in Bunker Ramo. We look forward to hearing from you.

Sincerely,

BUNKER RAMO CORPORATION
Amphenol North America Division
SAMS Operation

Jo Armstrong

(Mrs.) Jo Armstrong
Nuclear Product Manager

BJA:bln

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 1

COMPONENT

TER Item No.: 10

TER Category: IIa

Description: ELECTRICAL PENETRATION (THERMOCOUPLES)

Manufacturer, Model: Amphenol Type IV, Spec. NUS-41

Tag No(s).:

Worksheet No(s).: 6-47

QDR No.: 5437-59-01

Location: RC-18B

DISCREPANCY

(Refer to Surry 1 Item 8)

RESPONSE

(Refer to Surry 1 Item 8)

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 1

COMPONENT

TER Item No.: 13

TER Category: IIa

Description: FLOW TRANSMITTER FOR LOW HEAD INJECTION HEADER (PAM)

Manufacturer, Model: ROSEMOUNT Model 1152 DP5

Tag No(s).: FT-1945, 1946

Worksheet No(s).: 6-277, 6-278

QDR No.: 5437-201-01

Location: SFGD-1

DISCREPANCY

Qualification was not established for this item because the review package (QDR) was not provided.

RESPONSE

The QDR listed under COMPONENT was prepared subsequent to submittal of the SER and 90-day Rev. 4 responses. The QDR establishes qualification, and is being submitted at this time.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 1

COMPONENT

TER Item No.: 14

TER Category: IIa

Description: FLOW TRANSMITTER FOR COLDLEG SI (PAM)

Manufacturer, Model: BARTON, Model 386

Tag No(s).: FT-1961, FT-1962, FT-1963

Worksheet No(s).: 6-276, 6-275, 6-274

QDR No.: None

Location: RC-27B

DISCREPANCY

This is PAM equipment which was under review at the time of the 90-day Rev. 4 submittal. Qualification was not established.

RESPONSE

This equipment will be replaced by qualified equipment within the schedule established in 10CFR50.49. In the interim, due to equipment type similarity, justification for continued operation is provided in the 90-day conclusions section 7.2.5 for this equipment type. The TER classifies other equipment of this sort in Category Ib, Equipment Qualification Pending Modification.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 1

COMPONENT

TER Item No.: 20

TER Category: IIa

Description: LEVEL TRANSMITTER FOR CONTAINMENT SUMP (TMI ITEM)

Manufacturer, Model: GEMS Models XM54853, XM54854

Tag No(s).: LT-RS-151A, LT-RS-151B

Worksheet No(s).: 6-265, 6-266

QDR No.: future

Location: RC-27B

DISCREPANCY

This is a new equipment item for TMI purposes. Qualification testing has not been completed.

RESPONSE

This equipment item duplicates item 106; 90-day worksheets 6-271 and 6-272 cover the same equipment as TMI worksheets 10.3-30 and 10.3-31, respectively.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 1

COMPONENT

TER Item No.: 32

TER Category: IIa

Description: 600 VOLT, CERRO CROSS LINKED POLYETHYLENE INSULATED CABLES

Manufacturer, Model: Cerro Wire and Cable Company

Tag No(s).: Spec. Nos: NAS-120, NA-312/1312, and NAS-3187, NA-3187/4183

Worksheet No(s).: 6-32, 6-33

QDR No.: 5437-50-01 and 5437-51-01

Location: RC-3A

DISCREPANCY

(See TER Item No. 36)

RESPONSE

(See TER Item No. 36)

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 1

COMPONENT

TER Item No.: 34

TER Category: IIa

Description: 300 VOLT, CERRO CROSS LINKED POLYETHYLENE INSULATED CABLES

Manufacturer, Model: Cerro Wire and Cable Company

Tag No(s).: Spec. No. NAS-430, NA-392/1392

Worksheet No(s).: 6-35

QDR No.: 5437-53-01

Location: RC-3A

DISCREPANCY

(See TER Item No. 36)

RESPONSE

(See TER Item No. 36)

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 1

COMPONENT

TER Item No.: 36

TER Category: IIa

Description: 1000 VOLT, CROSS LINKED POLYETHYLENE INSULATED CABLES

Manufacturer, Model: Cerro Wire & Cable Company

Tag No(s).: Spec. Nos: NUS-325, SN-246, NUS-362, SN-1246, NUS-381C, SN-446 and NUS-381E, SN-1447

Worksheet No(s).: 6-37, 6-42a, 6-38, 6-39

QDR No.: 5437-55-01

Location: RC-3A

DISCREPANCY

Licensee qualified the subject cables but did not furnish the manufacturer's certification regarding: 1) cable construction methods (chemically cross linked or irradiationally cross-linked) used and 2) applicability of the test reports to the subject cables.

RESPONSE

Cerro Wire and Cable Company correspondence included in the referenced QDR, were re-reviewed and the applicability of the test reports to various cables is established in the attachment of this TER ITE No. 36.

Per IEEE Paper dated May, 1969 "Insulation and Jackets for Control and Power Cables in Thermal Reactor Nuclear Generating Stations" the XLPE insulated are designated in radiation class 3 (8.8×10^8 Rads) and recommended for nuclear use for safety related equipment.

This equipment should be classified in Category Ia, "Equipment Qualified" as was done for item 45 and 35 in Surry Unit #1.

ATTACHMENT TO TER ITEM NO. 36
OF VEPCO SURRY UNIT #1

Qualification of Cerro XLPE Cables

Following is the summary on Cerro XLPE cable qualification in regard to FRC evaluation:

1. 1000V, XLPE Cables: (TER ITEM #36 for Unit #1 & 73 for Unit #2)

   1000V, XLPE cables were bought under the following 4-different specifications:

   i) Specification No. NUS-325, (P.O. #SN-246), dated July 30,69.
   ii) Specification No. NUS-362, (P.O. #SN-1246), dated Feb. 17,70.
   iii) Specification No. NUS-381C, (P.O. #SN-446), dated Jan. 22, March 22 -71.
   iv) Specification No. NUS-381E, (P.O. #SN-1447/1246), dated April 13, June 10 - 1971

All the above cables were covered in QDR-5437-55-01 for Unit No. 1 and 5437-134-01 for Unit No. 2.

Qualification is established as follows:

i) Per Stone and Webster letter, dated Dec. 12, 1980, to Rockbestos (attached) and the purchase order, the cables under

   Spec. NUS-325, P.O. SN-246 were bought from Dec. 15, 69 thru July, 23, 70
   Spec. NUS-381C, P.O. SN-446 were bought from July 19, 1971 thru Aug. 23, 1971
   Spec. NUS-381E, P.O. SN-1447 were bought from Aug. 18, 1971 thru Sept. 7, 1971
   Spec. NUS-362, P.O. SN-1246 were bought from June 19, 1970 thru March 8, 1971

   Therefore, all the above cables were shipped from Dec. 15, 1969 thru Sept. 1971.

ii) Cerro letter dated Aug. 1, 1969 (included on page 3b of the referenced QDR) indicates that all the 1000V XLPE cables will be "Pyro Trol-III" control cables in accordance with the VEPCO specifications. These were manufactured by Cerro Company per their Specification No. RSS-3-701 of 11/1/68 (page 3b of the of the QDR) with the exception of thickness. Thickness was in accordance with IPCEA Standard.

   The Specification No. RSS-3-701 indicates that the insulating compound used was flame-retardant, chemically cross-linked polyethylene.

iii) Cerro Wire & Cable Comp. letter dated Aug. 20, 1969 (Page 20 of the referenced QDR) indicates that the cables manufactured were "Pyro-Trol III" cables which were tested by FRC Report No. F-C2404-01, dated June 1969.

iv) Franklin Report No. F-C2404-01 was prepared in June 1969. It included only radiation testing upto 2.5×10^7 rads, humidity testing of 6 hrs, and steam pressure test @ 62 psig for 15 min., and cooled down to 150°F in 30 min. Four samples were tested from product code <u>644N30</u> and 655N30 - series (four diff. batches).

v) We procured one more Franklin Report #F-C2857 dated Sept. 1970 in which they tested 8 different types of Cerro cable. They included one sample of "Pyro-Trol III" cable also with the same product code 655N30 series (30 mils of flame retardant cross-linked polyethylene insulation thickness). This report addressed radiation (from 55 Mrad thru 179 Mrad), humidity, steam press. & chemical spray test for 7 days.

The spray test of seven days is quite severe to justify the LOCA requirement of the plant (see the attached analysis).

Our QDR will be revised to reflect the review of the subject cables per these reports and the Franklin Report #F-C3798 which is used to qualify these cables will be deleted.

2. <u>300V & 600V, XLPE Cables:</u> (QDRs-5437-50-01,51-01,53-01 for Unit #1&
QDRs-5437-118-01,119-01,121-01--Unit #2

Originally these 300V & 600V, XLPE cables were bought for N. Anna power plant but later were transferred to Surry power plant for the required use.

These were bought under the following 2 different specifications:

i) Specification No. NAS-120, (P.O. #NA-312/1312), dated Oct. 1969 thru March, 1972.
ii) Specification No. NAS-3187, (P.O. #NA-3187/4183), dated Oct. 11, 1973.
iii) Specification No. NAS-430, (P.O. #NA-392/1392), dated June, 1974.

Qualification of cables in Spec. NAS-120, NAS-3187, & NAS-430 is addressed in QDR #s. 5437-50-01, 5437-51-01 & 5437-53-01 respectively for Unit #1 (QDR #5437-118-01, 5437-119-01, 5437-121-01 for Unit #2).

Qualification is established as follows:

i) Per Stone & Webster letter, dated Dec. 12, 1980, to Rockbestos and the purchase orders the cables were supplied during the following period:

Cables under Spec. NAS-120, P.O. NA-312/1312 - June 23, 1972 thru March, 1978.
Cables under Spec. NAS-3187, P.O. NA-3187/4187 - May 21, 1976 thru Nov. 1976.
Cables under Spec. NAS-430, P.O. NA-392/1392 - June 24, 1974 thru Aug. 1978.

ii) Rockbestos Comp. wrote a letter to S&W on Feb. 21, 1979 which indicates that the cross-linked polyethylene cables supplied under P.O. NA-392 were certified Class IE which are qualified to LOCA. They also enclose the qualification report for Firewall III cables, dated July 7, 1977 which covers these cables.

Although the letter indicated P.O. #392 (spec. no. NAS-430) because all the cables were bought in the same time frame it has been concluded that all the cables in all the three specifications were covered by this report.

Cerro Cable Company revised the same qualification report in Nov. 26, 1979, Dec. 8, 1980 and Dec. 23, 1980. (Ref. 27A) and called the same samples with the same name Firewall III cables with the insulation description as chemically cross-linked polyolefin instead of cross-linked polyethylene. They also provided their specification of Firewall III cables #RSS-3-021. In Pkg. # 5437-51-01 we used one report for XLPE cables which was also prepared by Rockbestos in May, 1976 for the same Firewall III cable.

From a detailed review of all the above mentioned reports it has been concluded that Cerro Cable Co. prepared all cables prior to 1978 by using chemically cross-linked polyethylene.

NRC Concerns

1) In reviewing the qualification cables FRC reviewed the various QDRs for the cables. The following table reveals the discrepancy:

S. No.	Cable Spec. No.	FRC REVIEW SHEETS				Right Applicable QDR #s	
		ITEM #		QDR #s			
		Unit #1	Unit #2	Unit #1	Unit #2	Unit #1	Unit #2
1	NUS-325, 362, 381C, 381E	36	73	5437-53-01	5437-118-01	5437-55-01	5437-134-01
2	NAS-120	32	46	5437-53-01	5437-119-01	5437-50-01	5437-118-01
3	NAS-3187	32	46	5437-53-01	5437-119-01*	5437-51-01	5437-119-01
4	NAS-430	34	44	5437-55-01	5437-55-01	5437-53-01	5437-121-01

* - This is the only right QDR FRC reviewed for the right cable.

2) FRC's general comment is to get the applicability of the specific test report from the vendor.

In this regard as discussed in Sec. 1 & 2 above we found the letters from the vendor which describe the material used for the subject cables and applicability of the test report.

Conclusion:

By reviewing various test reports on Rockbestos XLPE cables from 1969 thru 1981 we found that all the cables manufactured by them, have successfully passed the radiation and LOCA test, irrespective whether it was chemically or irradiationally cross-linked. Based on this finding we have no discrepancies in the qualifications of the cables used in Surry Power Station.

This clarification of cable qualification should preclude FRC concerns regarding the construction method used for the test cables, and the applicability of the test reports as referenced.

COPY

Folder 50
4.8-2

Copy to:
SCBrown, Jr.
Attn: EGLifrage-2
(VEPCO INTERNAL DIST. TO BE MADE BY VEPCO IN ACCORDANCE WITH NOPPS MANUAL)

SCRossier
HWDurkin
DAPiccione
CECole
ESherwood
JMcCann
GJBurroughs
JHBarnhart
JFinnimore
WBDodson

CWilbur
ABanerjee
PReilly
WPC/12
LWBrown-Surry-3
EBroderick/C Files
EBroderick/Job Bk
General Files
PBienick
ISMacFarlane

Mr. J. R. Kushner
Vice President/Technical Director
The Rockbestos Company
195 Church Street
New Haven, CT 06510

December 12,1980
J.O. No. 12846.44

Dear Sir:

IE BULLETIN 79-01B
ENVIRONMENTAL QUALIFICATION OF EQUIPMENT
SURRY POWER STATION - UNITS 1 & 2
VIRGINIA ELECTRIC AND POWER COMPANY

NRC IE Bulletin 79-01B, "Environmental Qualification of Class IE Equipment," issued to operating plants on January 14, 1980, outlines the qualification parameters for the environmental qualification of Class IE instrumentation and electrical equipment operating within these plants. With reference to your telephone conversation with our Mr. I. S. MacFarlane on December 5, 1980, we request any and all qualification test reports you can furnish on the following cables you supplied for VEPCO's Surry Power Station Units 1 and 2.

1. 600 volt control cable supplied to North Anna but utilized at Surry.

   a. Cable purchased under Stone & Webster P.O. No. NA-3187/4187 with a Specification No. NAS-3187 (Reference Mr. P. Reilly's letter to Mr. W. J. Patterson dated October 6, 1980). The following additional information is provided:

      (1) Cable supplied under NA-3187 originally had a Cerro order number of 80805 which was subsequently changed to 52313. The order addressed 16 items, which were shipped between May 21, 1976, and November 4, 1976.

      (2) Cable supplied under NA-4187 originally had a Cerro order number of 80806 which was subsequently changed to 52314. The order addressed 16 items, which were shipped between May 21, 1976, and November 4, 1976.

   b. Cable purchased under Stone & Webster P.O. No. NA-312/1312 with Specification No. NAS-120.

      (1) The items purchased under NA-312 were shipped between June 23, 1972, and September 14, 1977, and consisted of the following Cerro order numbers:

COPY

Cerro Order No.	Change to P.O. No. NA-312	Items Involved
21522	Original	1-19
22950	CH 3	20-23
24640	CH 5	21A
25231	CH 6	1
72655	CH 7	1
73555	CH 8	1,2,4,9, 12,18,19
80330	CH 9	1-15
50411	CH 14	5A
51816	CH 18	9
60741	CH 24	1-4
63603	CH 27	11
63904	CH 28	2,4,5,7,9
70511	CH 33	5,9
72107	CH 36	1,2,11,18

(2) The items purchased under NA-1312 were shipped between June 23, 1972, and March 9, 1978, and consisted of the following Cerro Order Numbers:

Cerro Order No.	Change to P.O. No. NA-1319	Items Involved
21522	Original	1-19
22949	CH 3	20-22
25320	CH 4	1
72654	CH 5	21B
73554	CH 6	1,2,4,9, 12,18,19

Cerro Order No.	Change to P.O. No. NA-1319	Items Involved
80331	CH 7	1-15
50412	CH 13	5A
51815	CH 17	9
60742	CH 23	1-4
63604	CH 26	11
63904	CH 27	2,4,5,7,9
70511	CH 32	5,9,12
71205	CH 36	1,2,11,18
71205	CH 39	2,3,4,6,7,9

2. 1000 volt control cable supplied to Surry.

a. Cable purchased under Stone & Webster P.O. No. SN-246 with Specification No. NUS-325 (Reference Mr. P. Reilly's letter to Mr. W. J. Patterson dated October 6, 1980). The cables were shipped between December 15, 1969, and July 23, 1970, and consisted of the following Cerro order numbers:

Cerro Order No.	Change to P.O. No. SN-246	Items Involved
EG 93609	Original	1-17
70820	CH 1	18,19

b. Cable purchased under Stone & Webster P.O. No. SN-446 with Specification No. NUS-381C (Reference Mr. P. Reilly's letter to Mr. W. J. Patterson dated October 6, 1980). The order, shipped under Cerro Order No. 11529 between July 19, 1971, and August 23, 1971, consisted of two items.

c. Cable purchased under Stone & Webster P.O. No. SN-1447 with Specification No. NUS-381E (Reference Mr. P. Reilly's letter to Mr. W. J. Patterson dated October 6, 1980). The order, shipped under Cerro Order No. 12328 between August 18, 1971, and September 7, 1971, consisted of one item.

d. Cables purchased under Stone & Webster P.O. No. SN-1246, which were shipped between June 19, 1970, and March 8, 1971, consisted of the following Cerro order numbers:

COPY

Cerro Order No.	Change to P.O. No. SN-1246	Spec. No.	Items Involved
71611	Original	NUS-362	1-17
71917	CH 1	NUS-362	3,4,10,12, 15,16,17
71917	CH 1	NUS-325	18
72406	CH 2	NUS-362	19,20,21
74329	CH 3	NUS-362	3
74521	CH 4	NUS-381	3,4,6,20
12423	CH 7	NUS-325	18
20946	Field Ordered	NUS-362	2 new items

All of the cables discussed above must be proven to be operable before, during, and after exposure to the following environments:

40 Year Life Conditions:

Conductor Temperature: 90°C

Integrated Radiation (Gamma): 1.3×10^7 Rads

Accident Conditions:

Duration: 120 days

Temperature: 275°F, 0-30 Minutes

275-150°F, 30-60 Minutes

150-120°F, 1-48 Hours

120°F, 2-120 Days

Pressure (PSIA): 58.7, 0-30 Minutes

58.7-12.7, 30 Minutes - 48 Hours

12.7, 2-120 Days

Relative Humidity: 100 percent

Chemical Spray: H_3BO_3 (2,000-2,200 ppm B)

Buffered to pH of

8.5-11 NaOH, 4 Hours

Integrated Radiation (Gamma): 2.4×10^7 Rads

COPY

We appreciate your cooperation in this matter, and request receipt of this material by January 5, 1981. If you have any question regarding this information, please contact Mr I. S. MacFarlane at (617) 973-0013.

Very truly yours,

JHB

J. H. Barnhart
Principal Electrical Engineer

ISM:PBF

ANALYSIS OF LOCA TEST

Verification of 7 days LOCA Test (Described in FRC - Report No. F-C2857 dated September 1970) Equivalent to the required operating time of 120 day LOCA

As shown on Fig. No. 10 the test profile ABCDEF envelops the plant LOCA profile AGCHIJ for 7 days. The following analysis shows that the effect of test profile is more severe than the required plant profile.

As evident from the Fig. 10 the plant ambient temperature falls to 150°F after one hour and to 120°F after 48 hours. For conservatism we assumed 150°F LOCA temperature for all the 120 days of LOCA.

The object of this analysis is to show that the effect of the test profile CDEF is equivalent or more to the required 120 days at 150°F (assumed for conservatism).

The first hour of the test profile which envelops the required profile of the plant is neglected and only 11 hours of the test (profile CD) is converted to 150°F by using Arrhenius extrapolation.

a) Profile CD (Referring to Fig. 10)

Arrhenius equations:

$$T_x = T_L \, e^{-\frac{\emptyset}{K} \frac{(T_2 - T_1)}{T_1 T_2}}$$

where

T_x = time at an accelerated temperature = 11 hours

T_{La} = equivalent time at lower temperature = to be calculated

$\emptyset$ = Activation energy, EV (1.13 for XLPE per EPRI NP-1558 Final Report, Sept. 1980, Appendix B)

K = Boltzmann's Constant = $8.617\text{x}10^{5}$ EV/°K

T_2 = Elevated temperature = 276°F = 135°C + 273 = 408°K

T_1 = Required temperature = 150°F = 65°C + 273 = 338°K

Substituting all the values

$$11 = T_L \, e^{-\frac{1.13\ (408-338)}{8.617\text{x}10^{-5}\text{x}408\text{x}338}}$$

Solving:

T_{La} = 343 days

b) <u>Profile EF</u> (Referring to Fig. 10)

T_x = 7 days at 160°F

T_{Lb} = 7 days (assumed same for conservatism)

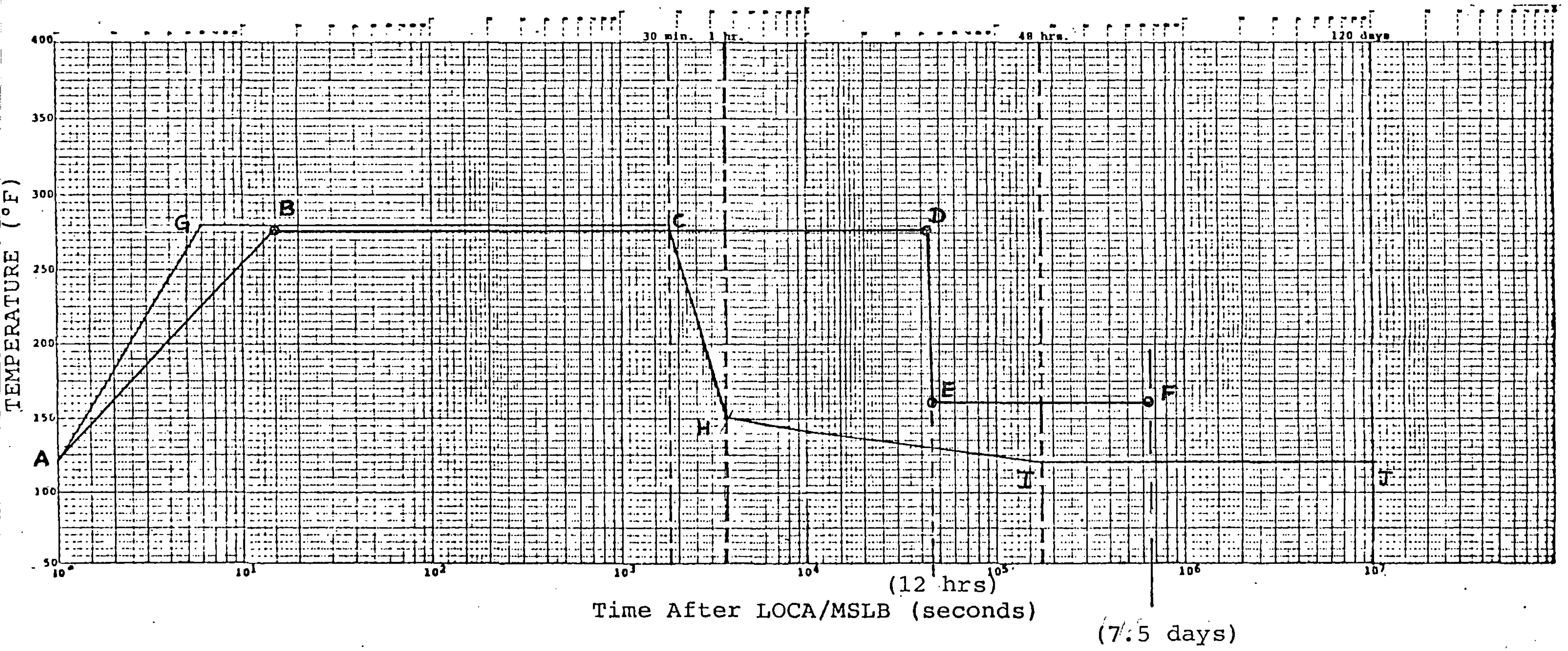
Total Profile CDEF = T_L = 343 + 7 = 350 days > 120 days

<u>Conclusion</u>:

i) As analyzed in above calculations it is obvious that the conducted test is equivalent to 350 days of LOCA at 150°F which is about 3 times the required operating time of 120 days after LOCA at 120°F.

ii) A solution of Borated water (1720 ppm of boron as boric acid) was sprayed throughout the test.

Considering the above it is concluded that the conducted test is more severe than the required conditions of the plant.



——— LOCA PROFILE [Ref.: S&W Calculation No. 12846.44-US(B)-052-1 for Zone RC-3A]

o———o ACTUAL TEST PROFILE (Report No. F-C2857, dated Sept. 1970, Page 5 thru 9)

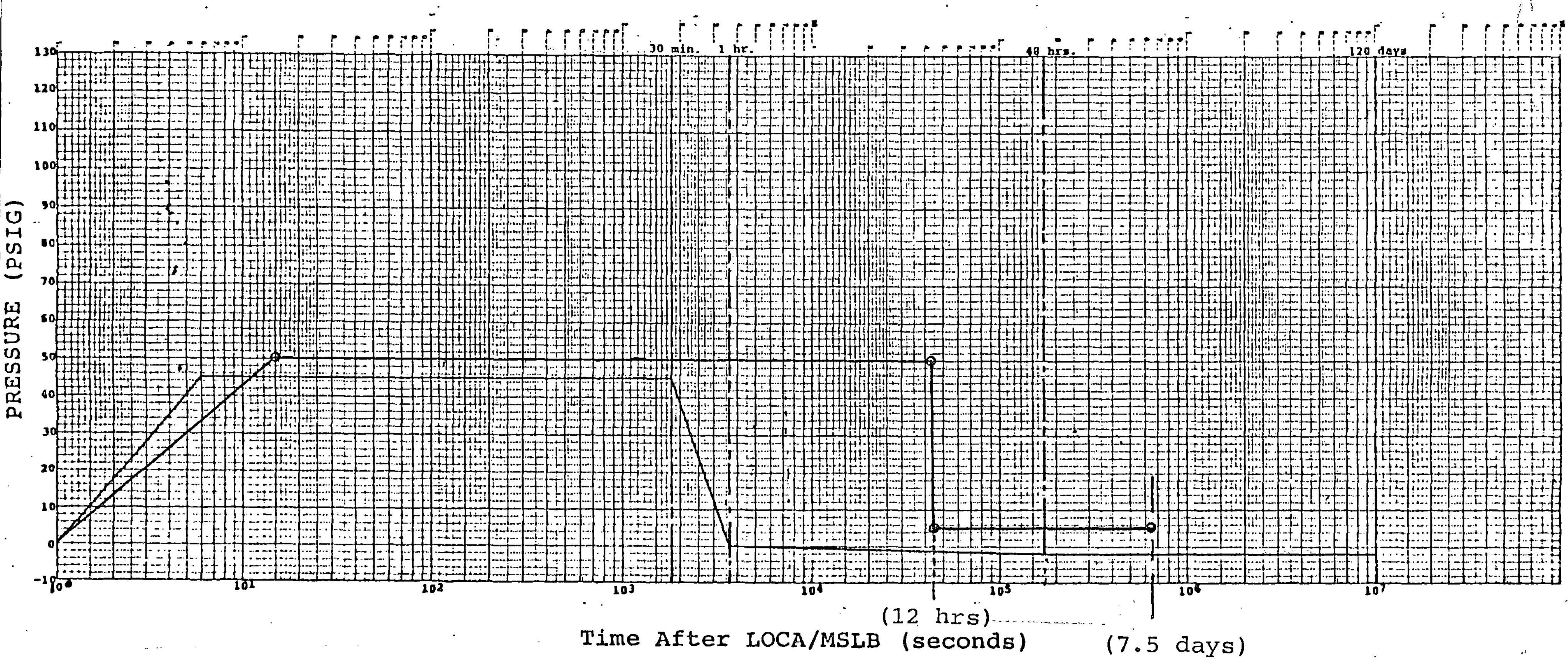
NOTE: The seven day conducted LOCA test is equivalent to 360 days at 150°F (see analysis). Hence it is more severe than the required LOCA period.

LOCA/MSLB TEMPERATURE TRANSIENT

FIGURE 10

(CERRO 1000V XLPE INSULATED CABLES)

Rev. 2



LOCA PROFILE [Ref.: S&W Calculation No. 12846.44-US(B)-052-1 for Zone RC-3A]

o———o ACTUAL TEST PROFILE (Report No. F-C2857, dated Sept. 1970, Page 5 thru 9)

Rev. 2

LOCA/MSLB PRESSURE TRANSIENT

FIGURE 10A

(CERRO 1000V XLPE INSULATED CABLES)

Sheet 17
QDR-5437-55-01
Surry Unit 1

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 1

COMPONENT

TER Item No.: 38

TER Category: IIa

Description: 1000 VOLT CONTINENTAL CROSS LINKED POLYETHYLENE INSULATED CABLE

Manufacturer, Model: Continental Wire & Cable

Tag No(s).: Spec. No. NUS-420, SN-1463

Worksheet No(s).: 6-42

QDR No.: 5437-60-01

Location: RC-3A

DISCREPANCY

Licensee qualified the subject cables but did not furnish the manufacturer's certification regarding: 1) cable construction methods (chemically cross linked or irradiationally cross-linked) used and 2) applicability of the test reports to the subject cables.

RESPONSE

Continental Wire & Cable (Anaconda) correspondence letters included in the referenced QDR (included in attachment to this TER item also) were re-reviewed and the applicability of the test reports to various cables is established in the attachment of this TER Item No. 38.

Per IEEE Paper dated May, 1969 "Insulation and Jackets for Control and Power Cables in Thermal Reactor Nuclear Generating Stations" the XLPE insulated are designated in radiation class 3 (8.8×10^8 Rads) and recommended for nuclear use for safety related equipment.

This equipment should be classified in Category Ia, "Equipment Qualified".

ATTACHMENT TO TER ITEM NO. 38
VEPCO SURRY UNIT #1

QUALIFICATION OF 1000V, XLPE Continental Cables

The qualification of 1000V, Continental cross linked polyethylene insulated cable is established in QDR-5437-60-01.

1) These cables were bought under specification no. NUS-420 (SN-1463) in November 1971.

2) Attached Anaconda (same as Continental) letters dated July 14, 1978 and July 11, 1978 (also included in referenced QDR on page 3a) indicate that they used CC-2210 FR-XLP compound for all their cross linked polyethylene cables which they supplied to VEPCO for Surry Power Plants.

3) Anaconda supplied the physical properties of CC-2210 cross linked polyethylene (used for Surry order) after various environmental conditioning, simulating a LOCA incident. They also provided the radiation resistance curve vs the tensile strength and elongation which are good for 600V cables thicknesses listed in Table I of Attach. 3 for section 3a of referenced QDR.

4) In attachment no. 3 of page 3a of the referenced QDR 5437-60-01 for Unit #1 (5437-130-01 for Unit #2) per Table I they supply 600V XLPE cables from 25 mil's thickness to 78 mils of the same compound, qualified under the same curves which they provided with their July 11, 1978 letter.

5) As stated on page 11 of Section No. 1 of QDR-5437-60-01 (QDR-5437-130-01 for Unit #2) the insulation thickness of the compound used for the subject cables is 45 mils, which is in between the values listed above in item 4. This indicates that the radiation curves and other physical property curves are applicable to this cable also.

Conclusion:

By considering the above facts we conclude that, because the same compound is used for the thicknesses listed in Anaconda's specification, the same qualification reports are applicable to these cables as to those which qualified 600 volt XLPE Continental in the same QDR-5437-60-01 (5437-130-01 for Unit #2)

This clarification of the cable qualification should preclude FRC concerns regarding the construction methods used for the test cables and the applicability of the test reports as referenced.

ANACONDA

July 11, 1978

Stone & Webster Engineering Co.
P.O. Box 2325
Boston, MA 02107

Attn: Howard Redgate

Re: VEPCO/Surry Generating Station;
Continental Wire and Cable PO's SN-265 and SN-1458.

Dear Mr. Redgate:

In response to your request for additional information on CC-2210 FR-XLP please find attached our data sheet of August, 1971 entitled "Physical Properties of CC-2210 Cross-linked PE After Various Environmental Conditioning, Simulating a L.O.C.A. Incident in a Nuclear Generating Station". We further state that a FR-XLP insulation material designated CC-2210 was used on the above referenced orders.

Very truly yours,

CONTINENTAL WIRE & CABLE

Paul S Cardello

Paul S. Cardello
Chief Engineer

PSC:ts
cc: File
Attachments-2

an Anaconda Company Continental Wire & Cable Corp. Wire and Cable Division P.O Box 1553 York, Pennsylvania 17405 717/792-25-

ANACONDA

July 14, 1978

Stone & Webster Engineering Co.
P.O. Box 2325
Boston, MA 02107

Attn: Howard Redgate

Re: VEPCO/Surry Generating Station

Dear Mr. Redgate:

In response to your request, we have checked our files and find that all instrumentation cable manufactured for the referenced project, of the FR-XLP and Hypalon variety, which was ordered in the time period of 1969 through 1971, was manufactured with a cross-linked polyethylene insulation material designated as CC-2210.

Very truly yours,

CONTINENTAL WIRE & CABLE

Paul S. Cardello

Paul S. Cardello
Chief Engineer

PSC:ts
cc: File

This drawing or document and information set forth herein are the property of Continental Wire & Cable Corp. and shall not be used or disclosed, except in accordance with its written permission.

PHYSICAL PROPERTIES OF CC-2210 CROSS-LINKED PE AFTER VARIOUS ENVIRONMENTAL CONDITIONINGS, SIMULATING A L.O.C.A. INCIDENT IN A NUCLEAR GENERATING STATION.

CONDITIONING	TENSILE (PSI)	ELONGATION (%)
NONE	2440	550
STEAM/BORIC ACID[1]	2390	450
RADIATION ONLY		
1X10[7] RADS (GAMMA)[2]	2540	425
5X10[7] RADS "	2230	238
1X10[8] RADS "	1710	100
RADIATION AFTER STEAM/BORIC ACID[1]		
1X10[7] RADS (GAMMA)[2]	2580	393
5X10[7] RADS (GAMMA)[2]	2200	200
1X10[8] RADS (GAMMA)[2]	1600	69

WIRE SAMPLE #16 (7) AWG, .030" WALL CC-2210

(1) 120 HOURS, 50 PSIG at 298°F STEAM, FOLLOWED BY 120 HOUR IMMERSION IN 0.5% BORIC ACID SOLUTION @ 160°F.

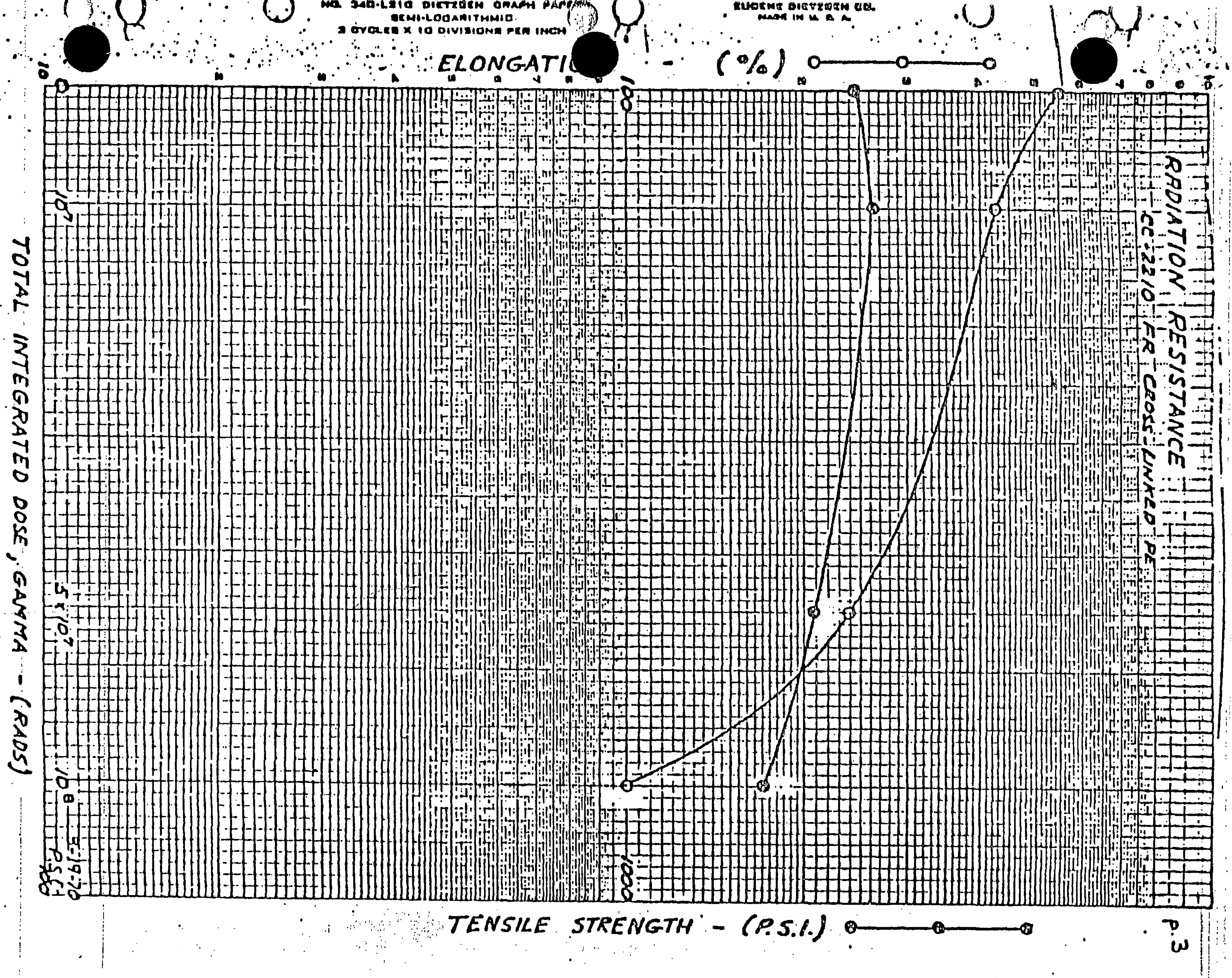
(2) COBALT 60 SOURCE (NEUTRON PRODUCTS, MD.).

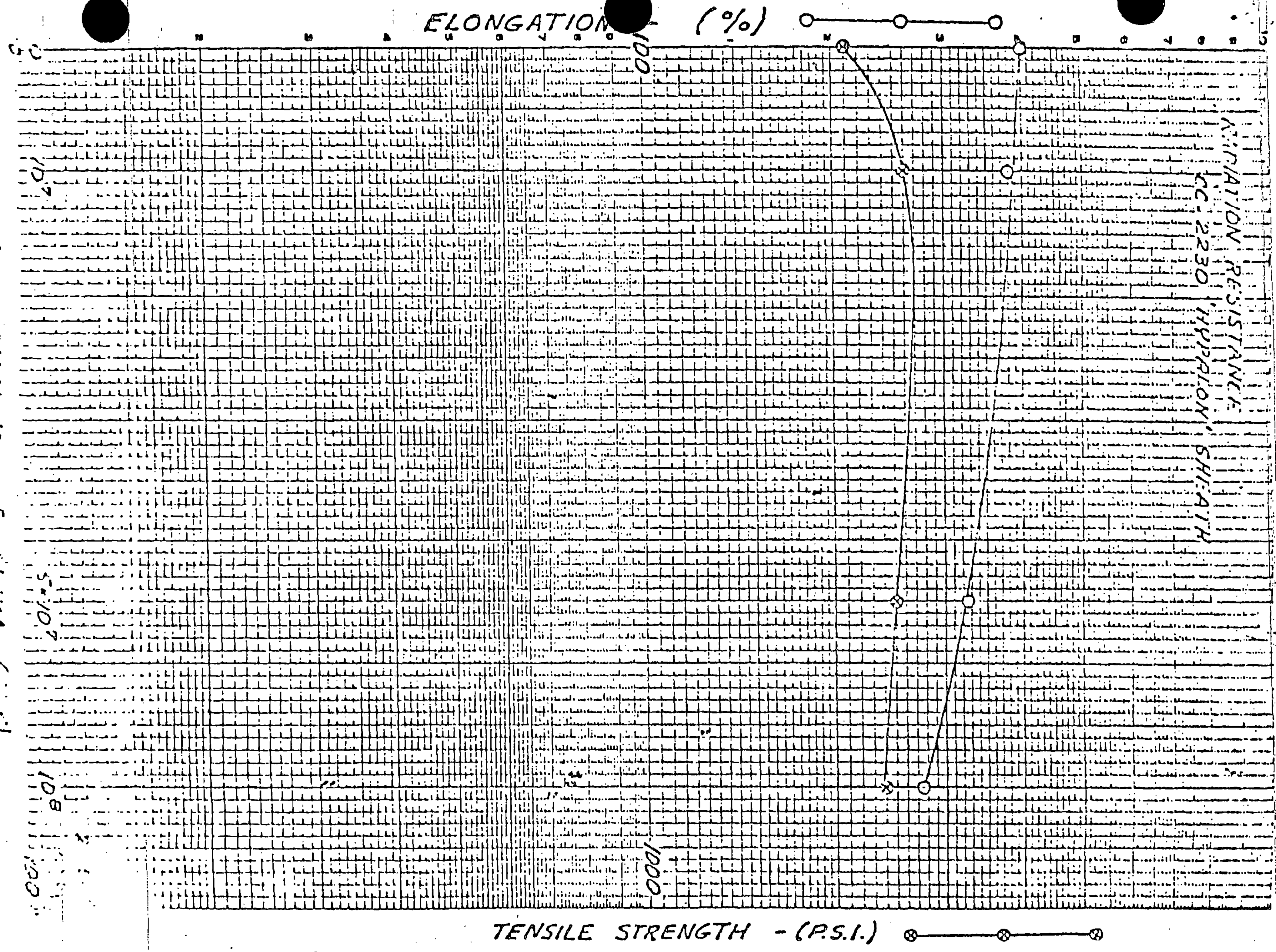
NO.	CHANGE	DATE	BY

REVISIONS

CONTINENTAL WIRE & CABLE CORP.

DRN. M.Q.A. DATE
CKD. DATE
APP. [initials] DATE 8/71


NO. 340-L210 DIETZGEN GRAPH PAPER
SEMI-LOGARITHMIC
3 CYCLES X 10 DIVISIONS PER INCH
EUGENE DIETZGEN CO.
MADE IN U.S.A.
ELONGATI - (%)
100
1000
RADIATION RESISTANCE
CC-2210 FR CROSS-LINKED PE
TOTAL INTEGRATED DOSE, GAMMA - (RADS)
10^7
5x10^7
10^8
5-19-70
P.S.C.
TENSILE STRENGTH - (P.S.I.)



ELONGATION - (%)
100
1000
10^7
5×10^7
10^8
CC-2230 HYPALON SHEATH
TENSILE STRENGTH - (P.S.I.)

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 1

COMPONENT

TER Item No.: 41

TER Category: IIa

Description: 600 VOLT CABLE

Manufacturer, Model: The Okonite Company

Tag No(s).: Spec. Nos. NUS-365B, 365C, 365D, and 374, and 375

Worksheet No(s).: 6-50, 51, 52, and 53

QDR No.: 5437-56-01 and 5437-62-01

Location: RC-3A

DISCREPANCY

The TER combined cables with three different constructions -- ERP and two types of cross-linked polyethylene insulation -- into a single item.

RESPONSE

Three different responses are provided, following for the three types of cable. In each case the response justifies classification in TER Category Ia, Equipment Qualified.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 1

COMPONENT

TER Item No.: 41a

TER Category: IIa

Description: 600 VOLT OKONITE CROSS LINKED POLYETHYLENE INSULATED CABLES

Manufacturer, Model: The Okonite Company

Tag No(s).: Spec. No. NUS-365B, SN-1380 and NUS-365C, SN-1392

Worksheet No(s).: 6-50 and 6-51

QDR No.: 5437- 56-01

Location: RC-3A

DISCREPANCY

Licensee qualified the subject cables but did not furnish the manufacturer's certification regarding: 1) cable construction methods (chemically cross linked or irradiationally cross-linked) used and 2) applicability of the test reports to the subject cables.

RESPONSE

Attached copy of Okonite letter, dated Oct. 15, 1980 indicates that cables supplied under P.O. No. SN-1380 (Spec. NUS-365B) and SN-1392 (Spec. NUS-365C) were CB-XLPE (carbon filled cross-linked polyethylene) insulated cable and the qualification is described by IEEE-paper dated May, 1969.

Per IEEE Paper dated May, 1969 "Insulation and Jackets for Control and Power Cables in Thermal Reactor Nuclear Generating Stations" the XLPE insulated are designated in radiation class 3 (8.8×10^8 Rads) and recommended for nuclear use for safety related equipment.

This equipment should be classified in Category Ia, "Equipment Qualified".

THE OKONITE COMPANY

Post Office Box 340
Ramsey, New Jersey 07446
201-825-0300/Cable. Okonite

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October 15, 1980

Mr. John Bonner
Stone & Webster Engineering Corporation
Post Office Box 2325
Boston, Massachusetts 02107

Dear Mr. Bonner:

J. O. No. 12846. 44
Surry Power Station — VEPCO

Mr. P. Reilly's letter of September 24, 1980 has been referred to me.

Our records indicate that the cables of your letter were as follows:

No.	VEPCO P.O.#	Okonite Factory Order #	
1	SN-1380	03-0186	← spec # NUS-365B
2	SN-1392	03-0469	← spec # NUS-365C
3	SN-1417	01-3662	← spec # NUS-365D
4	SN-375	01-3336 / 07-0033	← spec. # NUS-374
5	SN-1446 -	01-4136	

#1 - 3 x 1/C XLPE/Okoprene

#2 - 3/C - 250 kcmil, Al – X-Olene - Aluminum Armor

#3 - 3/C - 4/0 Okonite EP/Okoprene - Steel Armor
3 x 1/C, 1/0 Okonite EP/Okoprene - Triplex

#4 - 3 x 1/C, 3/0 Okonite EP/Okoprene - Triplex
3 x 1/C, #4 Okonite EP/Okoprene - Triplex

#5 - 2/C, #12 Okonite EP/Okoprene - Okoprene Overall Jacket
7/C, #12 Okonite EP/Okoprene - Okoprene Overall Jacket
1/C, # 6 Okonite EP/Okoprene
2/C, #14 Okonite EP/Okoprene - Okoprene Overall Jacket

Note that although you indicate that the cables are crosslinked polyethylene (XLPE), our records show that only two of the items were XLPE with the others insulated with Okonite EP/Okoprene.

We enclose a recent qualification report (NQRN-1) which covers the Okonite insulation, and has included in the test a chemical spray exposure. The test profile of the report accommodates the profile of your letter with margin.

The Okonite insulation covered by this document is only very slightly modified from that which was supplied to the Surry Station.

The modifications in the compound are not generic in nature and, in our view, do not effect the applicability of the document to your cables.

We point out that the Okoprene on your cables is present for the purpose of imparting flame retardancy to the cable construction, and that it is the insulation alone that must perform through the simulated design basis event. This performance is reported in the document.

The wall thickness of the samples tested were 30 mils which is equal or less than wall thicknesses of Okonite insulation supplied on the cables of the Surry Station so that the test is applicable to all the cables.

Regarding the cables with crosslinked polyethylene, we enclose an IEEE paper which gives information and data on the material. The insulation on the cables is a carbon black filled XLPE, and in the paper this is referred to as CB-XLPE.

I hope the information provided will serve your purposes. If there is anything further we can do, please call me.

Very truly yours,

THE OKONITE COMPANY

J. S. Lasky, Vice President
Research and Engineering

JSL/row
Enclosures

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 1

COMPONENT

TER Item No.: 41b

TER Category: IIa

Description: 600 VOLT OKONITE EPR INSULATED CABLE

Manufacturer, Model: The Okonite Company

Tag No(s).: Spec. No. NUS-365D, SN-1417

Worksheet No(s).: 6-52

QDR No.: 5437-62-01

Location: RC-3A

DISCREPANCY

Licensee qualified the subject cables but did not furnish the manufacturer's certification regarding: 1) cable construction methods (chemically cross linked or irradiationally cross-linked) used and 2) applicability of the test reports to the subject cables.

RESPONSE

Attached copy of Okonite letter, dated Oct. 15, 1980 (also included in QDR-5437-62-01) and worksheet no. 6-52 of 90-day review, Rev. 4 indicate that the cable supplied under P.O. #SN-1417 (spec. no. NUS-365D) is EPR insulated and qualification of this cable is addressed in their report no. NQRN-1.

Qualification of this cable, addressed in QDR-5437-60-01, is based on the same Okonite Report #NQRN-1.

This equipment should be classified in Category Ia, "Equipment Qualified".

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THE OKONITE COMPANY

Post Office Box 340
Ramsey, New Jersey 07446
201-825-0300/Cable Okonite

October 15, 1980

Mr. John Bonner
Stone & Webster Engineering Corporation
Post Office Box 2325
Boston, Massachusetts 02107

Dear Mr. Bonner:

J. O. No. 12846.~~44~~
Surry Power Station — VEPCO

Mr. P. Reilly's letter of September 24, 1980 has been referred to me.

Our records indicate that the cables of your letter were as follows:

No.	VEPCO P.O.#	Okonite Factory Order #	
1	SN-1380	03-0186	← spec # NUS-365B
2	SN-1392	03-0469	← spec # NUS-365C
3	SN-1417	01-3662	← spec # NUS-365D
4	SN-375	01-3336 / 07-0033	← spec. # NUS-374
5	SN-1446 -	01-4136	

#1 - 3 x 1/C XLPE/Okoprene

#2 - 3/C - 250 kcmil, Al – X-Olene - Aluminum Armor

#3 - 3/C - 4/0 Okonite EP/Okoprene - Steel Armor
3 x 1/C, 1/0 Okonite EP/Okoprene - Triplex

#4 - 3 x 1/C, 3/0 Okonite EP/Okoprene - Triplex
3 x 1/C, #4 Okonite EP/Okoprene - Triplex

#5 - 2/C, #12 Okonite EP/Okoprene - Okoprene Overall Jacket
7/C, #12 Okonite EP/Okoprene - Okoprene Overall Jacket
1/C, # 6 Okonite EP/Okoprene
2/C, #14 Okonite EP/Okoprene - Okoprene Overall Jacket

Note that although you indicate that the cables are crosslinked polyethylene (XLPE), our records show that only two of the items were XLPE with the others insulated with Okonite EP/Okoprene.

We enclose a recent qualification report (NQRN-1) which covers the Okonite insulation, and has included in the test a chemical spray exposure. The test profile of the report accommodates the profile of your letter with margin.

The Okonite insulation covered by this document is only very slightly modified from that which was supplied to the Surry Station.

The modifications in the compound are not generic in nature and, in our view, do not effect the applicability of the document to your cables.

We point out that the Okoprene on your cables is present for the purpose of imparting flame retardancy to the cable construction, and that it is the insulation alone that must perform through the simulated design basis event. This performance is reported in the document.

The wall thickness of the samples tested were 30 mils which is equal or less than wall thicknesses of Okonite insulation supplied on the cables of the Surry Station so that the test is applicable to all the cables.

Regarding the cables with crosslinked polyethylene, we enclose an IEEE paper which gives information and data on the material. The insulation on the cables is a carbon black filled XLPE, and in the paper this is referred to as CB-XLPE.

I hope the information provided will serve your purposes. If there is anything further we can do, please call me.

Very truly yours,

THE OKONITE COMPANY

J. S. Lasky, Vice President
Research and Engineering

JSL/row
Enclosures

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 1

COMPONENT

TER Item No.: 41c

TER Category: IIa

Description: 600 VOLT OKONITE XLPE INSULATED CABLE

Manufacturer, Model: The Okonite Company

Tag No(s).: Spec. No. NUS-374, SN-375

Worksheet No(s).: 6-53

QDR No.: 5437-56-01

Location: RC-3A

DISCREPANCY

Licensee qualified the subject cables but did not furnish the manufacturer's certification regarding: 1) cable construction methods (chemically cross linked or irradiationally cross-linked) used and 2) applicability of the test reports to the subject cables.

RESPONSE

Attached copy of Okonite letter, dated Oct. 15, 1980 indicates that the cables supplied under P.O. #SN-375 (spec. no. NUS-374) were EPR insulated not cross-linked polyethylene and the applicable qualification report is Okonite #NQRN-1.

Worksheet no. 6-53 will be revised and included in QDR-5437-62-01 (FRC TER No. 44) which addresses the qualification of Okonite EPR cables based on the Okonite Report #NQRN-1.

This equipment should be classified in Category Ia, "Equipment Qualified".

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THE OKONITE COMPANY

Post Office Box 340
Ramsey, New Jersey 07446
201-825-0300/Cable Okonite

October 15, 1980

Mr. John Bonner
Stone & Webster Engineering Corporation
Post Office Box 2325
Boston, Massachusetts 02107

Dear Mr. Bonner:

J. O. No. 12846. ~~44~~
Surry Power Station — VEPCO

Mr. P. Reilly's letter of September 24, 1980 has been referred to me.

Our records indicate that the cables of your letter were as follows:

No.	VEPCO P.O.#	Okonite Factory Order #	
1	SN-1380	03-0186	← spec # NUS-365B
2	SN-1392	03-0469	← spec # NUS-365C
3	SN-1417	01-3662	← spec# NUS-365D
4	SN-375	01-3336 / 07-0033	← spec. # NUS-374
5	SN-1446 -	01-4136	

#1 - 3 x 1/C XLPE/Okoprene

#2 - 3/C - 250 kcmil, Al — X-Olene - Aluminum Armor

#3 - 3/C - 4/0 Okonite EP/Okoprene - Steel Armor
3 x 1/C, 1/0 Okonite EP/Okoprene - Triplex

#4 - 3 x 1/C, 3/0 Okonite EP/Okoprene - Triplex
3 x 1/C, #4 Okonite EP/Okoprene - Triplex

#5 - 2/C, #12 Okonite EP/Okoprene - Okoprene Overall Jacket
7/C, #12 Okonite EP/Okoprene - Okoprene Overall Jacket
1/C, # 6 Okonite EP/Okoprene
2/C, #14 Okonite EP/Okoprene - Okoprene Overall Jacket

Note that although you indicate that the cables are crosslinked polyethylene (XLPE), our records show that only two of the items were XLPE with the others insulated with Okonite EP/Okoprene.

We enclose a recent qualification report (NQRN-1) which covers the Okonite insulation, and has included in the test a chemical spray exposure. The test profile of the report accommodates the profile of your letter with margin.

The Okonite insulation covered by this document is only very slightly modified from that which was supplied to the Surry Station.

The modifications in the compound are not generic in nature and, in our view, do not effect the applicability of the document to your cables.

We point out that the Okoprene on your cables is present for the purpose of imparting flame retardancy to the cable construction, and that it is the insulation alone that must perform through the simulated design basis event. This performance is reported in the document.

The wall thickness of the samples tested were 30 mils which is equal or less than wall thicknesses of Okonite insulation supplied on the cables of the Surry Station so that the test is applicable to all the cables.

Regarding the cables with crosslinked polyethylene, we enclose an IEEE paper which gives information and data on the material. The insulation on the cables is a carbon black filled XLPE, and in the paper this is referred to as CB-XLPE.

I hope the information provided will serve your purposes. If there is anything further we can do, please call me.

Very truly yours,

THE OKONITE COMPANY

J. S. Lasky, Vice President
Research and Engineering

JSL/row
Enclosures

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 1

COMPONENT

TER Item No.: 42

TER Category: IIa

Description: 600 VOLT, COLLYER CROSS LINKED POLYETHYLENE INSULATED CABLE

Manufacturer, Model: Collyer Insulated Wire Co.

Tag No(s).: Spec. No. NUS-365E, SN-457

Worksheet No(s).: 6-54

QDR No.: 5437-44-01

Location: RC-3A

DISCREPANCY

Licensee qualified the subject cables but did not furnish the manufacturer's certification regarding: 1) cable construction methods (chemically cross linked or irradiationally cross linked) used and 2) applicability of the test reports to the subject cables.

RESPONSE

Per Collyer correspondence letter dated Sept. 10, 1971 (included in the referenced QDR page 2a, in the end) the Purchase Order No. SN-457 (Spec. NUS-365E) was cancelled in its entirety.

Also the review of the plant records reveals that the Collyer, XLPE cables are not used for any safety-related equipment which is located in the harsh environment and listed on the Master List.

This equipment should be classified in Category IIIa "Equipment Exempt from Qualification".

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 1

COMPONENT

TER Item No.: 46

TER Category: IIa

Description: HIGH TEMPERATURE CABLE FOR SUPPLY POWER TO SAFETY SYS.

Manufacturer, Model: CONTINENTAL WIRE & CABLE - SILICONE RUBBER

Tag No(s).: NUS-326

Worksheet No(s).: 6-60

QDR No.: 5437-47-01

Location: RC-3A

DISCREPANCY

Qualification was not established for this item because the review package (QDR) was not provided.

RESPONSE

The QDR listed under COMPONENT was prepared subsequent to submittal of the SER and 90-day Rev. 4 responses. The QDR establishes qualification, and is being submitted at this time.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 1

COMPONENT

TER Item No.: 47

TER Category: IIa

Description: 5KV COLLYER CROSS LINKED POLYETHYLENE INSULATED CABLES

Manufacturer, Model: Collyer Insulated Wire Co.

Tag No(s).: Spec. No. NUS-364, SN-1250

Worksheet No(s).: 6-60a

QDR No.: 5437-46-01

Location: AB-27

DISCREPANCY

Licensee qualified the subject cables but did not furnish the manufacturer's certification regarding: 1) cable construction methods (chemically cross linked or irradiationally cross linked) used and 2) applicability of the test reports to the subject cables.

RESPONSE

The review of the plant records reveals that the Collyer cables are not used for any safety-related equipment which is located in harsh environment.

This equipment should be classified in Category IIIa "Equipment Exempt from Qualification".

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 1

COMPONENT

TER Item No.: 51

TER Category: IIa

Description: LOW HEAD SAFETY INJECTION PUMP MOTOR

Manufacturer, Model: Westinghouse ABDP

Tag No(s).: 1-SI-P-1A,1B

Worksheet No(s).: 6-198, 6-199

QDR No.: 5437-43-01

Location: SFGD-1

DISCREPANCY

Licensee qualified the equipment, but did not furnish sufficient documentation to support (1) the similarity between test specimen and the equipment, (2) radiation resistance of the lube oil and bearing grease and (3) aging surveillance and replacement schedule.

RESPONSE

Westinghouse correspondence letters, included in the referenced QDR, were re-reviewed and we conclude that the similarity between the test specimen and the equipment is established.

This equipment should be classified in Category IIc. "Equipment Satisfies all Requirements Except Qualified Life or Replacement Schedule Justified".

The attached discussion and clarification of the low head safety injection motors should preclude FRC concerns regarding the similarity between the test specimen and the equipment, radiation capabilities and aging qualification.

ATTACHMENT TO TER ITEM #51
(VEPCO SURRY UNIT #1)

LOW HEAD SAFETY INJECTION PUMP MOTORS (Tag Nos. 1-SI-P-1A,1B)

Tag Nos: 1-SI-P-1A,1B & 2-SI-P-1A,1B
QDR Nos: 5437-43-01 for Unit #1 and 5437-105-01 for Unit #2

1. Similarity Between Test Motors and Plant Equipment:

   i) Westinghouse letter dated 4/9/81 in reference to letter NCW-1317/NAW-3615 (page 2d of QDR) indicates that:

      a) The subject low head safety injection pump motors were rewound in accordance with their insulation specification, LIT-Spec-711306 (Page 26 of QDR-5437-105-01*). Since this specification was in use for several years before and after these motors were rewound, the probability for the use of other materials or procedures is minimal.

      b) The thermal endurance test of this thermalastic epoxy system was in accordance with IEEE Standard 275-1966 which describes the complete procedure (like cycle of oven aging, temperatures, aging time, mechanical, vibration, humidification, etc.).

      c) Test results show that this insulation system performed as well as the latest Class B thermalastic epoxy system.

   ii) Westinghouse letter no. NAW-3601 dated Aug. 19, 1980 (page 2c of QDR) indicates successful qualification testing of motors with thermalastic epoxy insulation systems, documented in WCAP-8754, including all organic insulating materials. Therefore wedges and cabling need not be addressed separately. The results of actual tests are available in Westinghouse files.

   iii) Review of the insulation specification LIT-711306 (page 2c of QDR-5437-105-01) indicates that the insulation system consists of sheets of Mica embedded in a solvent-less epoxy resin which is the same as that described in Westinghouse WCAP-8754, Para. 4.2.

   iv) Westinghouse discussed thermalastic epoxy insulation in their application data 3170 (copy attached). Review of the insulation specification LIT-711306 used for the subject motors indicates that the insulation materials, listed in the questioned specification are the same as discussed in their application date 3170.

*Page 2c of Unit #1 QDR-5437-43-01 does not contain specification LIT-711306.

Considering the above it is concluded that the insulation system of the subject motor is the same thermalastic epoxy insulation as that of the test specimen of Westinghouse WCAP-8754. This conclusion is further supported by the fact that all Westinghouse motors with thermalastic epoxy insulation system were wound in accordance with only one insulation specification no. LIT-711306.

2. Lubrication Radiation Resistance and Aging

Review of the plant maintenance records confirms that for low head safety injection motor lubrication chevron SRI #2 has been used. The radiation resistance capabilities of Chevron SRI #2 is 1.8×10^8 Rads per Westinghouse letter NAW-3620 dated Nov. 18, 1980 (included in the Ref. QDR).

Because this qualification value of 1.8×10^8 Rads envelops the plant required dose of 8.0×10^6 Rads, the subject motor lubrication are considered qualified for the radiation.

3. Although an aging analysis was performed (see the attached analysis) a detailed maintenance, aging surveillance and replacement schedule will be submitted.

QUALIFIED LIFE OF WESTINGHOUSE LOW HEAD SAFETY INJECTION MOTORS

1) Westinghouse letter #VPU(RRK)-48 dated Jan. 9, 1981 (page 2d of the QDR) indicates that the actual maximum winding temperature rise from test is 70°C at 1.15 SF load for the Surry pump motors. This gives a maximum continuous operating temperature of 110°C (70+40) at the plant normal ambient temperature of 104°F (40°C).

2) Because the plant environmental conditions for the motors do not change during the LOCA/HELB the same operating temperature (110°C) is considered during normal as well as during LOCA conditions.

3) These low head safety injection pump motors are required to operate during LOCA period of 120 days and periodic testing of about 2 hours a month. The total operating time during 40 yrs life of the motor is calculated below.

i) Periodic testing during 40 years = (2 hrs/month)x12x40
= 960 hrs

ii) LOCA period = 120 days = 2880 hrs

Total continuous operation = (960+2880) = 3840 hrs

For conservatism it is assumed in the following analysis that the subject motor will run continuously for one year (8760 hrs) instead of 3840 hrs.

4) From Fig. 4-1 of WCAP-8754 (thermal aging curve for thermalastic epoxy system, per IEEE Std.-275-1966) the qualified life at 120°C = 200,000 hours and from Fig. 9-1 (in which Westinghouse has drawn a most conservative projected qualified insulation life of motor) the qualified life at 120°C = 96,000 hours.

5) <u>Activation Energy</u>:

The activation energy is calculated by Arrhenius extrapolation as follows:

From Fig. 9-1 of WCAP-8754 the qualified life at 120°C = 90,000 hours and at 130°C = 45,000 hours.

Arrhenius equation

$$T_x = T_L \, e^{-\frac{\varnothing}{K} \frac{(T_2-T_1)}{T_1 T_2}}$$

where

T_x = life at a higher temperature T_2 = 45,000 hours.

T_L = life at a lower temperature = 90,000 hours.

$\varnothing$ = activation energy = to be calculated

K = Boltzman Constant = 8.617×10^{-5}

T_2 = Higher temperature = 130+273 = 403°K

T_1 = Lower temperature = 120+273 = 393°K

Substituting in the above equation:

$$44{,}000 = 96{,}000\ e^{-\frac{\emptyset \times (403-393)}{8.617 \times 403 \times 393 \times 10^{-5}}}$$

Solving:

$$\emptyset = 1.08 \approx 1.0$$

6) CALCULATION OF QUALIFIED LIFE:

From Fig. 9-1 of WCAP the qualified life at 120°C is 96,000 hours. Out of this life the motor is required to operate for 8,600 hours only (see sec. 3 above) at 110°C. Assuming it operates at 120°C, (for further conservatism) the following analysis shows that the remaining continuous operating life of 87400 hours is more than the 39 years of how operating life at plant ambient of 40°C (104°F).

Applying Arrhenius equation.

$$T_x = T_L\ e^{-\frac{\emptyset}{K}\frac{(T_2-T_1)}{T_1 x T_2}}$$

where:

T_x = 87400 hours

T_L = to be calculated

T_1 = (40 + 273) = 313°K

T_2 = (120 + 273) = 292°K

K = 8.617×10^{-5}

Ø = 1.0 (see sec. 5 above)

Substituting:

$$87400 = T_L\ e^{-\frac{1.0 \times (393-313)}{8.617 \times 10^{-5} \times 393 \times 313}}$$

Solving:

T_L = 659642 hours = 75 years

Conclusion:

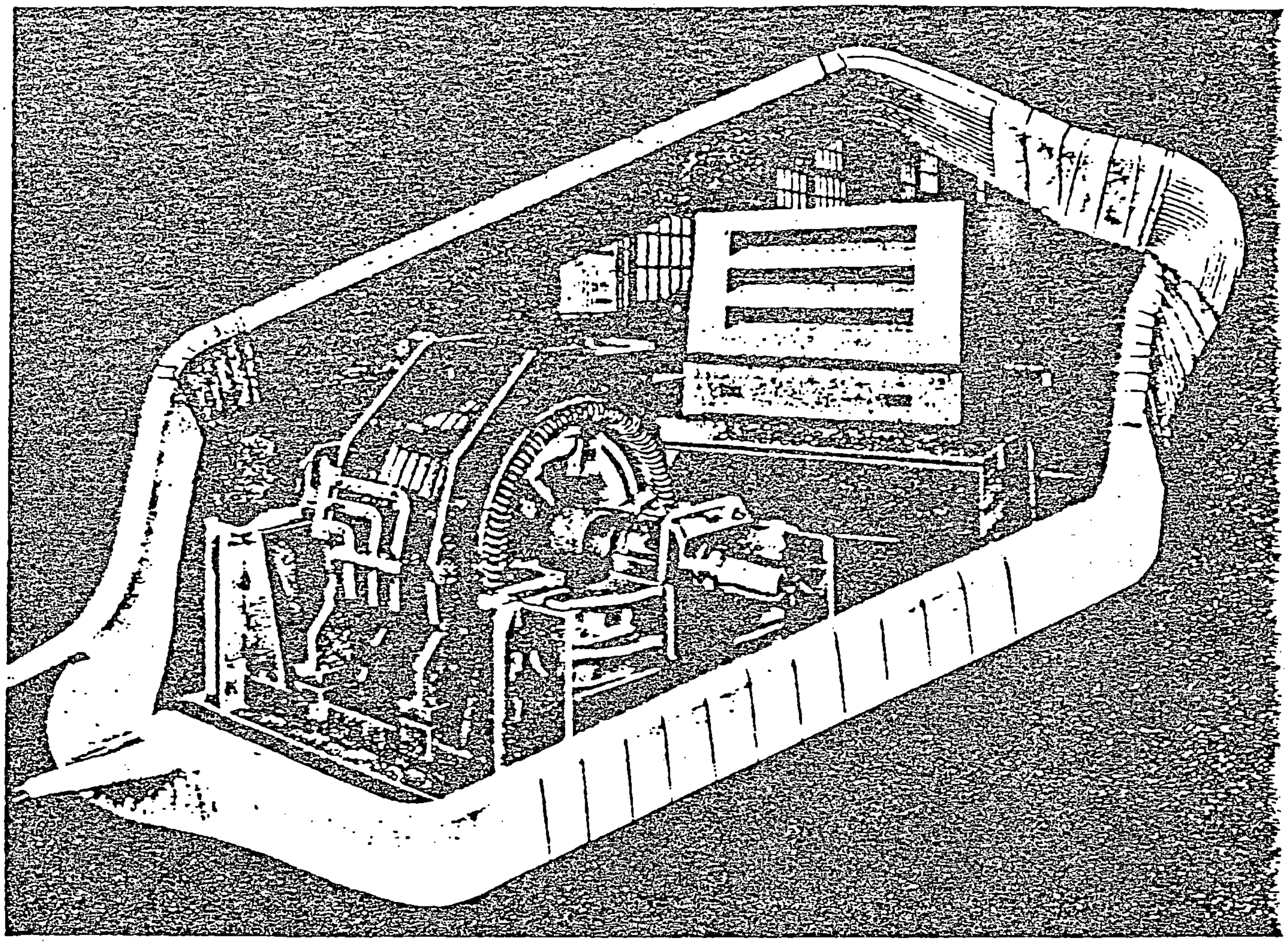
From the above analysis it is concluded that the subject motors are qualified for a life of at least 40 years under the specified service conditions of the plant.

Westinghouse

Thermalastic Epoxy Insulation

For Large Ac Motors

F/A and other Motors with Form-Wound Coils – Squirrel-Cage, PAM, Wound Rotor, Synchronous



Thermalastic Epoxy insulation is the standard on all large ac machines, 7,000 volts and below, built at East Pittsburgh using form-wound coils, up through the 85" diameter frame size. This will include practically all type F/A machines. It is also now available on some machines rated 13.8 kV.

Thermalastic Epoxy is also available on form-wound coils for ratings manufactured at the Buffalo Plant.

"Thermalastic" has made an enviable name for itself as an insulation. It was the first real advancement in insulation in over 20 years when it was first introduced in 1949 on large turbine generators.

Westinghouse began to use it on large motors in 1952. It is important to remember that Thermalastic insulation is a system, not a material. As such, it is not static and many improvements in its components and processing have been made since it was first used.

Continuous research and testing of all known insulating materials and systems have enabled Westinghouse to keep Thermalastic insulation better than any other insulation.

One basic feature of Thermalastic Epoxy insulation is the use of mica in the ground wall. No other material can equal mica from the standpoint of electric strength, voltage endurance and reliability.

Solventless epoxy resins are impregnated into the mica which has been preplaced on a form-wound coil. Then with both mica and resin in position, chemical reaction is initiated which transforms the resin into a solid which locks and binds the mica into a composite mass. The resulting end product then takes advantage of the excellent properties of both the mica and the resin. The outstanding characteristics of the epoxies is their extremely good resistance to moisture and to practically all types of chemical contaminants. They have been proven in laboratory tests described later and by field service.

Processing Thermalastic Epoxy insulation includes vacuum-pressure impregnation of the complete wound stator, stator coils as well as coil connections. This makes it possible to give all parts of the windings the full effect of the high resin fill that is achieved with the vacuum-pressure technique. The coils are not deformed or stressed after impregnation.

The processes described are those of the Large Rotating Apparatus Division in East Pittsburgh. Primarily due to differences in the size of motors manufactured at the Buffalo Large Ac and Dc Motor Division, specific processes vary in minor detail. The essential characteristics of the insulation system are the same.

September, 1971
Supersedes Technical Data 3170, dated June, 1968
E. C/1738, 1740/DB

Westinghouse

Stator Coils

The insulation immediately adjacent to the copper conductors is generally that which insulates the various turns in the coil from each other. This is a very important part of the insulation system, one which frequently is not given the attention it deserves. Since the majority of ac motors are started across-the-line, there is a possibility that steep fronted, impulse type waves can be imposed on the winding. These waves place high electric stress on the turn insulation, especially the turns of the stator coils near the line terminals.

In the light of these facts and the general industry trend to higher operating voltages, mica, which provides a positive electric barrier of very high strength, is used as turn insulation for all coils rated 4 kV and above for the larger size motors. On smaller size motors, this additional strength, where required, is obtained by the use of enamel plus double dacron-glass covering.

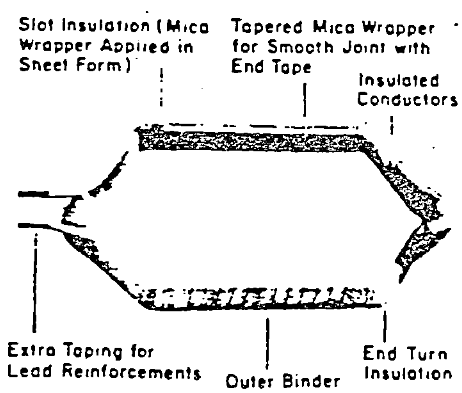


Fig. 1 Typical stator coil showing elements of insulation.

The micaceous ground insulating materials are applied as shown in detail in Fig. 1. All materials used are designed to be both compatible with, and selected components of, the complete insulation system.

Winding Stator

At the start of the winding operation the stator core consists of the assembled punchings and restraining end plates, thus providing a maximum of accessibility during coil assembly of larger size motors. The fact that the coils are unimpregnated at this stage provides ease of installation.

The end turns of the stator coils are firmly braced to withstand full-voltage starts with a series of insulated support rings as well as braces between coil end turns, which in effect form an archbound structure at these points. The material used as a brace between coil end turns is a non-woven polyester felt which has both resiliency and absorbency.

After installation of all coils and completion of wedging and bracing, the connections are made and insulated, and the stator is ready for impregnation.

Vacuum-Pressure Impregnation

The preheated stator is lowered into the vacuum pressure tank, and the air evacuated to a very low absolute pressure. The epoxy resin is then introduced, while maintaining the vacuum, to a level that completely submerges all parts of the winding. The vacuum is then released and replaced with positive pressure of several atmospheres over the liquid resin. Following these steps the stator is removed, as shown in Figure 2.

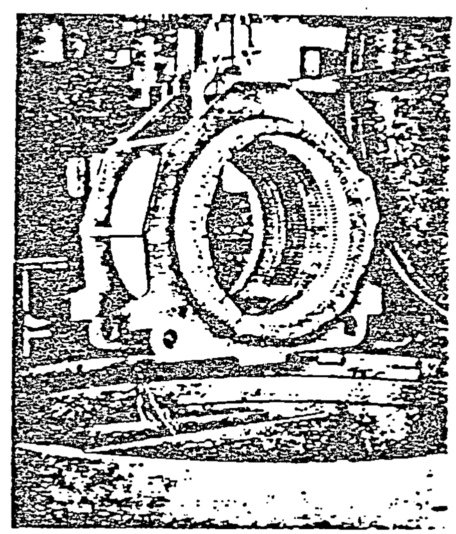


Fig. 2. After impregnation, the stator is removed from the tank and placed in an oven for curing.

The next step in the process takes place in an oven, where the resin is cured.

In addition to the impregnation of the winding, the bracing system has been built "in place" by the absorption of epoxy resin and subsequent cure in the polyester felt. This gives very high strength to the bracing scheme.

During the manufacture of the coils and winding, quality control procedures are used continuously to monitor the physical dimensions and electrical integrity of the insulation.

Thermalastic Epoxy Insulation
For Large Ac Motors

F/A and other Motors with Form-Wound Coils – Squirrel-Cage, PAM, Wound Rotor, Synchronous

Evaluation and Test Program
Thermalastic Epoxy insulation was adopted as standard for large ac motors only after completion of an extensive evaluation and test program. A description of some of the more important tests follows.

Electric Strength
Since the fundamental function of insulation is to withstand electric stress, the first series of tests on any insulation system is to determine its short-time electric strength. Complete insulated coils are used for this test.

It is desirable that for any particular voltage class the average breakdown voltage be as high as possible. However, it is essential that the values be examined and analyzed statistically. It is the Westinghouse concept that, using the principles of statistical analysis, the coils have a breakdown level well above the test level for individual coils.

Thermalastic Epoxy insulation has both a higher average short-time electric strength and is more reproducible from coil-to-coil than other insulation systems.

Voltage Endurance
Since insulation in large machines is expected to perform for a long period of time, a voltage endurance test has been devised. In this test, sample coils are prepared and connected as described for the short-time electric tests.

Electric strength is evaluated in depth by a series of breakdown tests for each insulation system. A group of sample coils for each system is tested at various voltage levels for fixed time intervals which may be one minute, one hour, one week or more. By plotting average "hold" values for the different time periods, a voltage endurance curve is created. Such a curve is shown in Figure 3.

Much of the data thus obtained tends to plot in a straight line. One way of looking at such data is to establish an "operating level" and examine where the extrapolated voltage endurance curve will intersect this "operating level". The Thermalastic insulation curve intersects the operating stress level at a time in excess of 100 years. These are results of laboratory tests on only one of the degrading mechanisms that affect insulation and, therefore, are not complete indications of actual operating life. However, systems that fail to give indications of satisfactory life in this very fundamental test are not considered favorably.

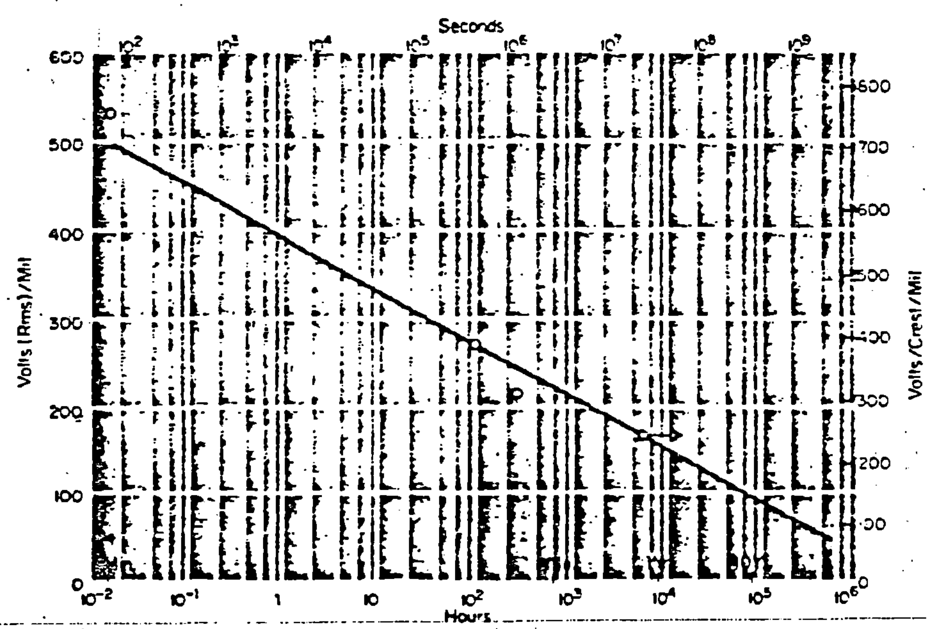
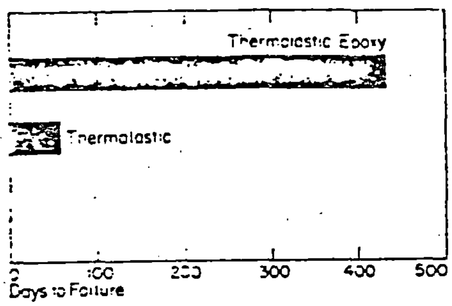


Fig. 3. Voltage Endurance.

Westinghouse

Moisture Resistance

The first screening test for moisture resistance is a test on individual coils suspended in salt water. These are standard coils submerged except for the leads and front loops and continuously subjected to normal voltage to ground. This is the value of the maximum line-to-ground operating voltage. Total hours to failure are then measured for each of the systems under investigation.



Average life of insulation systems, immersed ...age applied continuously.

Figure 4 shows the results obtained by this method. As can be seen, the epoxy resin impregnant imparts outstanding moisture resistance to the Thermalastic concept.

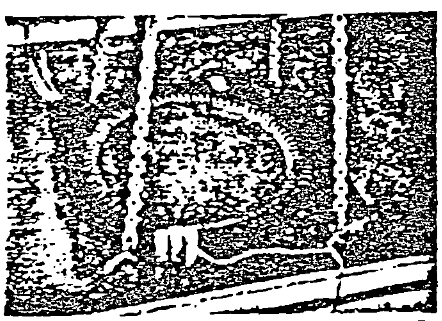


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Fig. 5 Complete motor winding immersed in water for test of moisture resistance.

Tests on individual coils without connections, however, are not the entire story. The moisture resistance of complete windings has also been investigated. In Figure 5 a winding including all connections is shown completely submerged in a tank of salt water. The winding leads are connected to a megohm bridge so that insulation resistance can be measured.

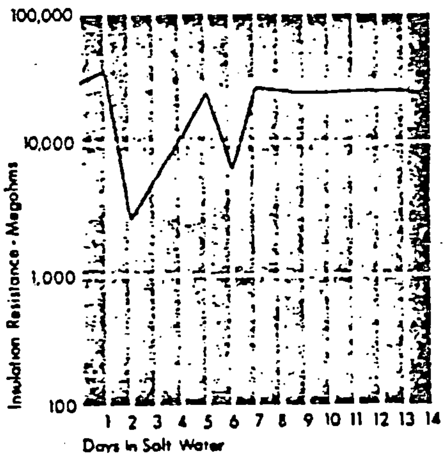

Fig. 6. Insulation resistance – throughout 14 day period.

A complete 4160 volt Thermalastic Epoxy stator was submerged in a tank of water containing 5% salt by weight (approximate sea water concentration) for a period of 14 days. The insulation resistance was checked throughout this period. Figure 6 is the plot of insulation resistance obtained throughout the 14 day period.

There are variations in the level, probably due to changes in the conductivity of the insulation surfaces at the winding terminals, but all readings are quite high. Figure 7 is a plot of the dielectric absorption tests taken before and after the 14 day period while in the water.

At the conclusion of this period the stator was removed from the tank and without rinsing or drying was subjected to a 4800 volt ac rms high potential test. The winding withheld this test with no difficulty. This indicates the winding could have been cleaned and dried and returned to service.

In still another test on a complete winding, the effect of continuous exposure to 100% relative humidity at 50°C was investigated. In some respects this is a more severe test than actual submersion since water vapor has a high degree of penetration through films. Figure 8 shows the results. After more than 3000 hours of this type of exposure, the Thermalastic Epoxy insulated winding still had insulation resistance measured in thousands of megohms.

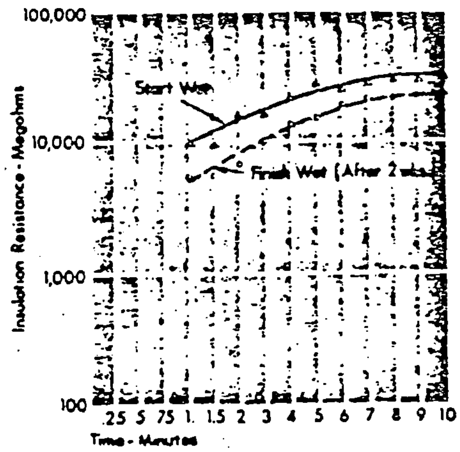

Fig. 7. Insulation resistance – before and after 14 day period.

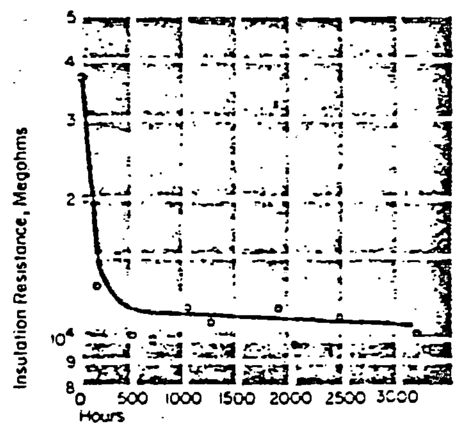

Fig. 8. Tests of wound 4160-volt stator under conditions of 100% humidity.

Thermalastic Epoxy Insulation
For Large Ac Motors

F/A and other Motors with Form-Wound Coils – Squirrel-Cage, PAM, Wound Rotor, Synchronous

Chemical Resistance
Resistance to chemical contaminants is another factor in many industries. In looking at resistance to acids, bases and solvents, nothing has been found that is the equal of the epoxy resins. Table A shows a tabulation of some of the many tests made wherein resin samples were subjected to liquid baths of various contaminating materials. The resin used in Thermalastic Epoxy insulation shows outstanding resistance to all of them.

Thermal Endurance
Temperature is widely accepted as being one of the limiting factors in insulation life. To determine the ability of insulation to stand up under thermal aging, testing is done by following the basic concept of functional testing outlined in IEEE 275.

This is the "motorette" type of testing wherein small, complete coils are made in accordance with actual processes employed in the insulation system being evaluated. These coils are then mounted in slots on a motorette and the leads brought out in an appropriate fashion as shown in Figure 9 so that electrical tests can be made. These motorettes are then subjected to a cycle of oven aging, mechanical vibration, humidification and electrical test. Following this, the cycle is repeated and the number of cycles to failure is recorded.

Table A
Solvent & Chemical Resistance of Thermalastic Epoxy Resin Castings

Solvent	Time of Immersion	Shore D Hardness	Percent② Weight Change	Percent② Thickness of Change	Rating
50% Acetic Acid	0	84	0	0	Excellent
	24 hours	85	0	0	
	48 hours	85	0	0	
	7 days	85	0	0	
	10 days	86	0	0	
10% Sodium Hydroxide	0	84	0	0	Excellent
	24 hours	86	0	0	
	48 hours	85	0	0	
	7 days	85	0	0	
	10 days	86	0	0	
Acetone	0	85	0	0	Good
	24 hours	61	+ 8.6	+ 9.5	
	48 hours	45	+15.3	+17.5	
	72 hours	..	Decomposed	....	
	10 days	..	....	....	
Benzene	0	87	0	0	Excellent
	24 hours	88	0	0	
	48 hours	88	0	0	
	7 days	88	0	0	
	10 days	88	0	0	
Trichloro-ethylene	0	86	0	0	Good
	24 hours	48	+ 7.6	+15.5	
	48 hours	..	Decomposed	....	
	7 days	..	....	....	
	10 days	..	....	....	
Distilled H_2O	0	83	0	0	Excellent
	24 hours	85	0	0	
	48 hours	85	0	0	
	7 days	85	0	0	
	10 days	85	0	0	

② Neglecting changes less than 1%.

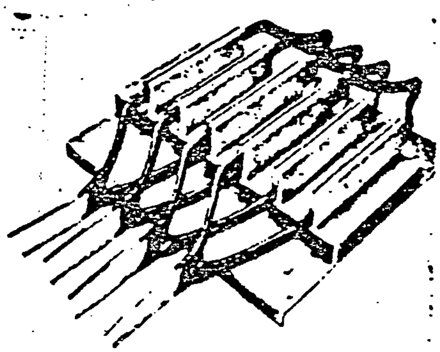

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Fig. 9. "Motorette" used for testing thermal endurance of insulation systems.

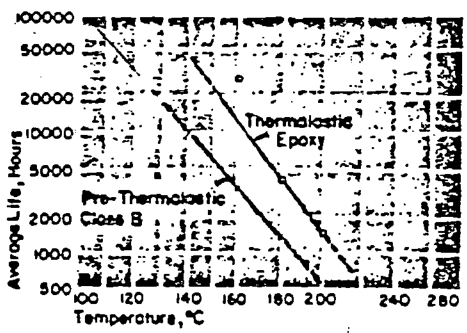

Fig. 10. Thermal endurance of insulation systems for rotating machines tested in motorettes in accordance with IEEE 275 (5000 volt proof test).

This is a comparative test only. There are no standard values for the test conditions or number of cycles or the hours of aging that a system should withstand. It is known, however, that for more than 30 years class B insulation has been in service and that it has performed satisfactorily. The procedure is, therefore, to compare new or proposed systems with the older service-proven systems. Figure 10 shows the data obtained by such tests. Hours of life is plotted logarithmically on the vertical axis against temperature on the horizontal axis. As can be seen, the life of all systems decreases with increased temperature. The "pre-Thermalastic" curve is the data obtained on the class B insulation system used prior to Thermalastic. In going to the Thermalastic Epoxy system, a curve is obtained which is shifted over on the thermal scale by about 25°C. This in itself indicates a high order of "thermal reserve" in Thermalastic Epoxy insulation. This system qualifies for class F thermal rating.

Westinghouse

Thermal Cycling

All motors in service are required to withstand varying degrees of thermal cycling. The ability of Thermalastic Epoxy insulation to withstand thermal cycling and maintain moisture resistance is dramatically demonstrated by the following test.

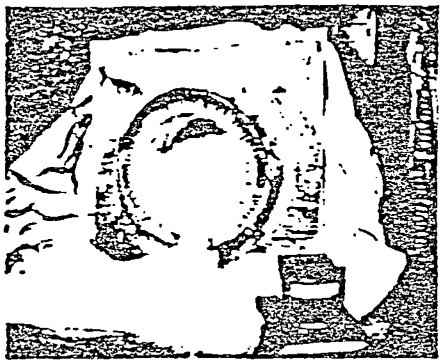

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Fig. 11. Cycling test of wound stator-packed with ice.

[illegible] 1 shows a wound stator packed [illegible] ice so that the embedded thermo-couples in the winding indicate minus 40°C. When the winding reached this temperature, the dry ice was removed and the stator was immediately placed in an oven, which had been preheated to 150°C. This was repeated four times, cycling between these temperature limits, and the stator then completely submerged in water. Figure 12 shows the results obtained, and indicates that the moisture resistance is unaffected by thermal shocks of 190°C.

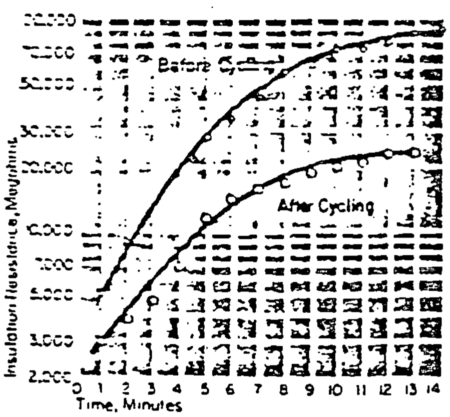


Fig. 12. Effect of thermal cycling on Thermalastic Ep[illegible]sulation between temperature of −40°C [illegible]°C.

Mechanical Strength

All motor insulation may be subjected to severe mechanical stresses during operation. To determine the ability of the complete Thermalastic Epoxy winding to withstand mechanical stresses, the following test has been devised.

When a motor winding is first connected across the line, there is a large current inrush to mechanical forces, which tend to severely distort them. Adequate bracing prevents the actual deformation, but the forces are nevertheless present.

A motor with Thermalastic Epoxy insulation was subjected to 1,000 full-voltage starts. After completion of the 1,000 full-voltage starts, the entire wound stator was submerged in a tank of water and a ten-minute dielectric absorption curve was made immediately after submersion.

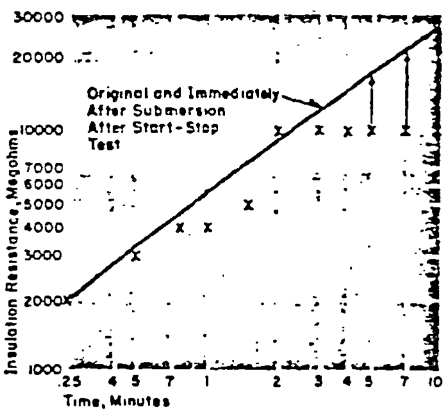


Fig. 13. Insulation resistance characteristics of submerged Thermalastic Epoxy stator winding (4160 volts) after motor was subjected to 1,000 full-voltage starts.

Even after these severe conditions, the winding had greater than 10,000 megohms of insulation resistance after ten minutes of voltage as shown in Figure 13.

Abrasion Resistance

Motors are not infrequently expected to operate in an environment which subjects the coil insulation to bombardment by highly abrasive particles. This occurs because the cooling air which is circulated through the motor comes from the surrounding atmosphere of the motor and often contains a great deal of abrasive particulate matter. This particulate matter is forced at high velocity over the end windings of the stator coils and is equivalent to a sandblast commonly used in many industrial applications for cleaning and stripping operations.

In order to allow the windings to operate under these adverse conditions, special treatments have been developed. It is well known that elastomers or rubbers are capable of absorbing energy upon impact with another harder material. Therefore, the special treatments consist of a layer of an elastomeric material which is capable of absorbing this energy and literally bouncing the abrasive particles off the surface.

The coatings are applied over the completed winding by dipping or spraying so as to provide an energy-absorbing surface. This had to be a very special coating which would have the ability to work not only as applied, but also at the operating temperature of the coil surface and to maintain this property over the long periods of time the machines are expected to run.

Radiation Resistance of Thermalastic Epoxy Insulation

Of the various components that go to make up the Thermalastic Epoxy insulation system, the epoxy impregnant is the most susceptible to radiation damage. The mica and fiber glass portions will be unaffected by dosage levels that would destroy the impregnating resin. However, the epoxy impregnant, because of its aromatic nature, is one of the better resinous materials with regard to radiation resistance, having a predicted life of 40 years at a dosage of up to 10^9 rads at low radiation rates of less than 100 rads per hour. Normal radiation levels within the containment vessel of a nuclear power station are below a rate of 50 rads per hour with a total dosage of 2×10^7 rads over a period of 40 years. Therefore, Thermalastic Epoxy windings in a typical radiation environment will operate many years with no measureable deterioration due to the radiation.

Winding Repairs
The standardization of Thermalastic Epoxy insulation for large motors allows a completely new approach to the subject of winding repairs and the desirability of carrying spare coils.

First of all, the possibility of winding repairs being required is reduced to a minimum far below that possible with any previous insulation system.

The basic approach is to provide for the contingencies that may arise with minimum total expense to the user including both repair and downtime cost.

Depending on the extent of damage, several alternatives are available for winding repairs:
1. Most failures resulting from accidental mechanical damage occur on the end windings where the coil is exposed. Repairs to the end winding external to the core can be made by the conventional patching method.

2. In the remote possibility of coil failure within the slot, it is not practical to replace coils by conventional means. The very processing of complete impregnation and bonding which insures a failure-free coil also makes it impractical to lift enough coils to replace both top and bottom coil sides of a damaged coil.

To replace a damaged coil in any machine, it has always been necessary to lift at least a full throw of coils to get the new coil in. Quite often, this operation results in damage to other coils. Therefore, when spare coils are considered desirable, it has been standard practice to carry at least ¼ or ⅓ of a set to replace one or two damaged coils.

Westinghouse has developed a technique of coil replacement, for use on motors manufactured at East Pittsburgh, which makes it unnecessary to disturb any coils except the damaged coil or, at most, the other coil in the same slot.

For Thermalastic Epoxy insulated machines, a standard repair kit can be supplied including six half coils suitable for replacing either top or bottom sides of the coil. Also included are the necessary materials, tools and instructions for replacing damaged coils. Complete spare Thermalastic Epoxy insulated coils are not furnished for these machines.

3. In the case of widespread damage involving a number of coils, a complete rewind is recommended. The elaborate facilities required for the Thermalastic Epoxy system make it necessary to return the stator to the factory to obtain the original processing. On a breakdown basis, this can be done usually in three weeks or less and requires no longer than would be required to order coils and rewind in the field.

If consideration is given to stocking a full set of coils to protect against such a failure on a Thermalastic Epoxy insulated machine, the recommendation is that a complete wound stator be stocked. This will cost no more than a full set of coils plus the expense of stripping the old winding and winding the new coils in any machine. Downtime is reduced to a minimum.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 1

COMPONENT

TER Item No.: 57

TER Category: IIa

Description: CHARGING PUMP MOTORS

Manufacturer, Model: Westinghouse 68659

Tag No(s).: 1-CH-P-1A, B, and C

Worksheet No(s).: 6-7, 6-8, 6-9

QDR No.: 5437-08-01

Location: AB-2C

DISCREPANCY

Licensee qualified the equipment, but did not furnish sufficient documentation to support 1) the similarity between test specimen and the equipment, 2) radiation resistance of the lube oil and bearing greases and 3) aging surveillance and replacement schedule.

RESPONSE

Westinghouse correspondence included in the reference QDR, were re-reviewed and the similarity between the test specimen and the equipment (including the motor leads) is established.

This equipment should be classified in Category IIc. "Equipment satisfies all Requirements Except Qualified Life or Replacement Schedule Justified".

The attached discussion and clarification of the charging pump motors should preclude FRC concern regarding the similarity between the test specimen and the equipment, radiation capabilities and aging qualification.

ATTACHMENT TO TER ITEM #57
(VEPCO SURRY UNIT #1)

CHARGING PUMP MOTORS:

Tag Nos: 1-CH-P-1A,1B & 1C for Unit #1
QDR Nos: 5437-08-01 for Unit #1
5437-69-01 for Unit #2

1. Similarity Between Test Specimen and the Equipment.

i) Similarity between the motor lead insulation of the test specimen and the equipment:

a) Westinghouse letter no. NAW-3615 dated Oct. 30, 1980 (included in the referenced QDR, page 3a) indicates on page 2 that the Surry pump motor insulation for the charging pumps is thermalastic epoxy and the qualification is covered by WCAP-8754.

ii) Similarity between the motor lead insulation of the test specimen and the equipment:

a) Westinghouse letter no. NAW-3620 (included in the referenced QDR, page 2c) indicates that for the motors which employ the thermalastic epoxy insulation system, the testing documented in WCAP-8754 includes all organic insulating materials in the motor. Therefore wedges and cabling need not be addressed separately for these motors.

b) The thermalastic epoxy system, developed by Westinghouse and first put into service in 1962, (see WCAP-8754, Para. 4-2) and only one insulation specification, LIT-711306, were in use for winding motor coils (see QDR-5437-08-01, Section 2, Page 2b), it has been determined that these motors had motor to leadsplice materials as discussed in specification LIT-711306.

Specification LIT-711306: lead insulation and tying (page 3 of 14), winding procedure (paragraph 29, page 5 of 14), and sketches D and E (page 13 of 14) indicate the use of sleeving (M#41524-AV), resin tape (M#9948-3), micatape (M#43865-AD), and glass tape (M#41514-CT) as the motor to leadsplice materials. These materials are in fact the materials used when winding the subject motor coils.

Westinghouse letter dated April 9, 1981, in reference to letters NCW-1317 and NAW-3615, states that motorettes using an insulation system similar to the one prescribed in the rewind specification (LIT-711306) were tested for thermal performance in accordance with IEEE 275. This is basically the same test as described in paragraph 4-3 of WCAP-8754 per IEEE 275-1966. Therefore the motor to leadsplice materials were tested, as part of the formettes, for thermal endurance to determine the resistance of the thermalastic epoxy system to thermal aging, following the guidelines for accelerated functional testing, as outlined in IEEE 275-1966.

c) In addition to the above the review of WCAP-7829, table #22, page 46 indicate that the motor lead cable is silicone rubberized glass taped insulation. This is the same as indicated in Westinghouse insulation spec. LIT-711306.

d) The same is confirmed from Westinghouse Application Data 3170 (copy attached).

Considering the above facts it is concluded that the motor lead insulation of the subject motor is the same as the test specimen of WCAP-8754 and 7829.

2. Lubrication Radiation Resistance and Aging

Review of the plant records shows that Exxon-Teresstic-46 has been used for charging pump motor lubrication. The radiation resistance capabilities of Exxon-Teresstic-46 is 1.4×10^7 Rads per Westinghouse letter no. NAW-3615 dated October 30, 1980 (copy attached).

The worksheets will be revised to reflect the overall radiation resistance qualification of the motors as 1.4×10^7 Rads.

Because this qualification value of 1.4×10^7 rads envelops the plant total required dose of 7.4×10^6 rads, the subject motors are considered qualified for the radiation.

3. Although an aging analysis is performed (see the attached analysis) a detailed maintenance procedures and aging surveillance and replacement schedule will be submitted.

QUALIFIED LIFE OF WESTINGHOUSE CHARGING PUMP MOTORS

1) Westinghouse letter no. VPU(RRK)-48 dated Jan. 9, 1981 (page 2c of the QDR) indicates that the actual maximum winding temperature rise from test is 70°C at 1.15 SF load for the Surry pump motors. This gives a maximum continuous operating temperature of 110°C (70+40) at the plant normal ambient temperature of 104°F(40°C).

2) Because the plant environmental conditions for the motors do not change during the LOCA the same operating temperature (110°C) is considered during normal as well as during LOCA conditions. During HELB conditions the ambient temperature goes to 140°F (from 104°F normal) for one hour.

3) Out of the three charging pumps one pump is required to operate continuously during the plant operation. It is conservative to assume that each pump motor will operate continuously for 14 years and remain idle for 26 years.

   In the following analysis it is shown that the qualified life of the motor is more than the required 14 years of continuous operating and 26 years of non operating lives.

4) From Fig. 4-1 of WCAP-8754 (thermal aging curve for thermalastic epoxy system, per IEEE Std.-275-1966) the qualified life at 120°C = 200,000 hours and from Fig. 9-1 (in which Westinghouse has drawn a most conservative projected qualified insulation life of motor) the qualified life at 120°C = 96,000 hours.

5) Activation Energy:

   The activation energy is calculated by Arrhenius extrapolation as follows:

   From Fig. 9-1 of WCAP-8754 the qualified life at 120°C = 90,000 hours and at 130°C = 45,000 hours.

Arrhenius equation

$$T_x = T_L \, e^{-\frac{\emptyset}{K} \frac{(T_2 - T_1)}{T_1 \, T_2}}$$

where

T_x = life at a higher temperature = 45,000 hours

T_L = life at a lower temperature = 90,000 hours

$\emptyset$ = activation energy = to be calculated

K = Boltzman Constant = $8.617\text{x}10^{-5}$

T_2 = higher temperature = 130 + 273 = 403°K

T_1 = lower temperature = 120 + 273 = 393°K

Substituting in the above equation:

$$44{,}000 = 96{,}000 \; e^{-\frac{\emptyset \text{x}(403-393)}{8.167\text{x}403\text{x}393\text{x}10^{-5}}}$$

Solving:

$\emptyset = 1.08 \approx 1.0$

6) Calculation of Qualified Life

i) From Fig. 9-1 of WCAP-8754 the qualified life at 120°C is 96,000 hours. This life is converted at 110°C (which is maximum operating temp of the motors per Westinghouse letter no. VPU(RRU)-48 dated Jan. 9, 1981) by using Arrhenius extrapolations:

Arrhenius equation

$$T_x = T_L \, e^{-\frac{\emptyset}{K} \frac{(T_2 - T_1)}{T_1 \text{x} T_2}}$$

where

T_x = 96,000 hours

T_L = to be calculated

T_2 = 120°C + 273 = 393°K

T_1 = 110°C + 273 = 383°K

0 = 1.0

Substituting the values

$$96{,}000 = T_L \, e^{-\frac{1.0 \text{ x } (393-383)}{8.617\text{x}10^{-5}\text{x}3-3\text{x}383}}$$

Solving:

$$T_L = 207{,}542 \text{ hours} = 23.69 \text{ years}$$

Conclusions

Hence the qualified life of the motor at 110°C is 23.69 years. Out of this the motor is required to run continuously for 14 years. For conservatism let us assume that it operated continuously for 20 years at 110°C.

ii) Now in the following calculations it is shown that the life of 3.69 years (23.69 - 20) at 110°C is much more severe than the required 20 years of non operating life at plant ambient temp. of 40°C.

T_x = 3.69 years = 32324 hours

T_L = to be calculated

T_2 = 110°C + 273 = 383°K

T_1 = 40°C + 273 = 313°K

Substituting in the Arrhenius equation

$$32324 = T_L \, e^{-\frac{1.0 \text{ x } (383-313)}{8.617\text{x}383\text{x}313\text{x}10^{-5}}}$$

Solving

$$T_L = 3235 \text{ years} > 20 \text{ years}$$

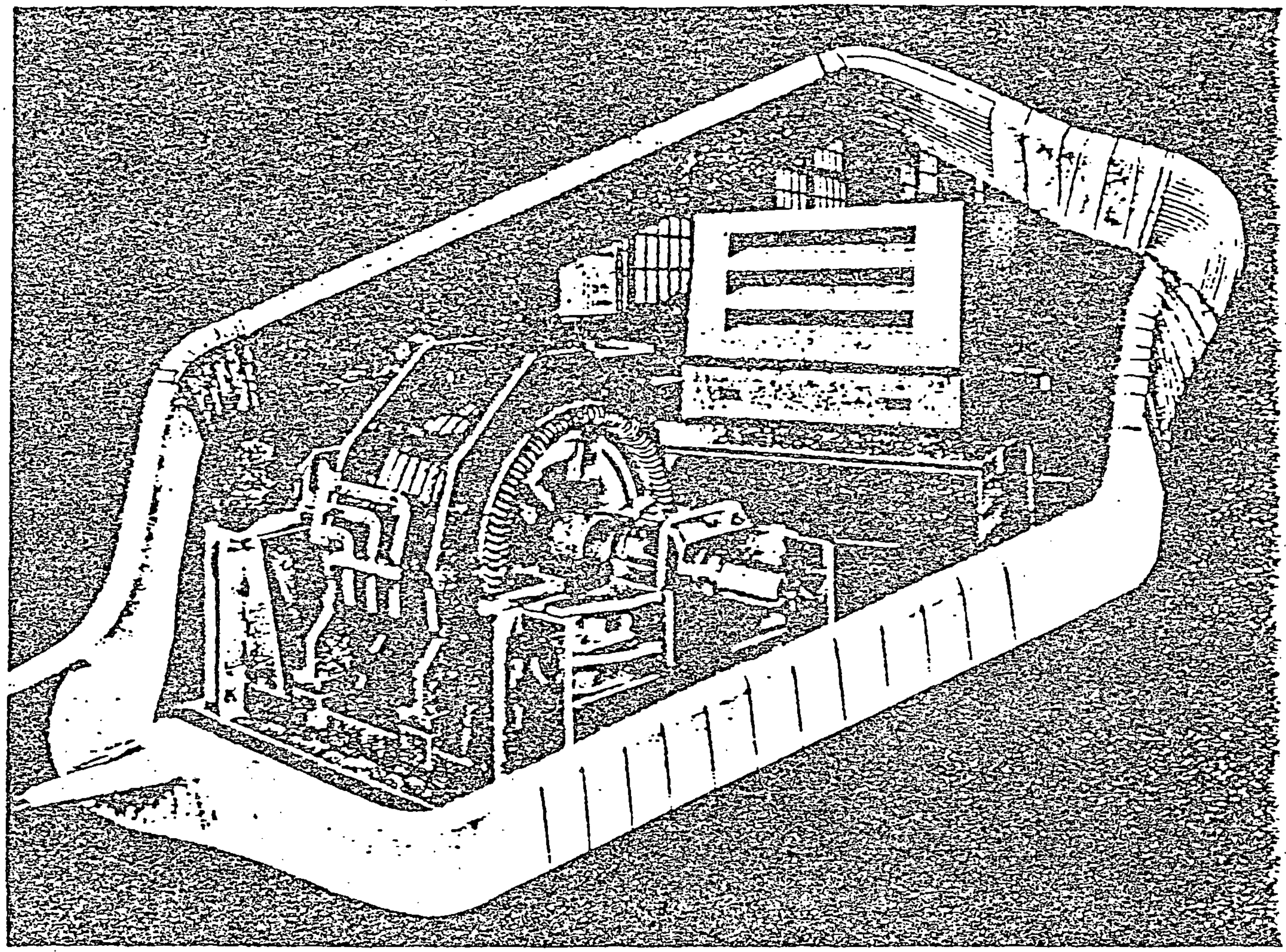
Hence from the above calculations it is concluded that the subject motor is qualified for 40 years of life for the required plant service conditions.

Westinghouse

Thermalastic Epoxy Insulation

For Large Ac Motors

F/A and other Motors with Form-Wound Coils – Squirrel-Cage, PAM, Wound Rotor, Synchronous



Thermalastic Epoxy insulation is the standard on all large ac machines, 7,000 volts and below, built at East Pittsburgh using form-wound coils, up through the 85" diameter frame size. This will include practically all type F/A machines. It is also now available on some machines rated 13.8 kV.

Thermalastic Epoxy is also available on form-wound coils for ratings manufactured at the Buffalo Plant.

"Thermalastic" has made an enviable name for itself as an insulation. It was the first real advancement in insulation in over 20 years when it was first introduced in 1949 on large turbine generators.

Westinghouse began to use it on large motors in 1952. It is important to remember that Thermalastic insulation is a system, not a material. As such, it is not static and many improvements in its components and processing have been made since it was first used.

Continuous research and testing of all known insulating materials and systems have enabled Westinghouse to keep Thermalastic insulation better than any other insulation.

One basic feature of Thermalastic Epoxy insulation is the use of mica in the ground wall. No other material can equal mica from the standpoint of electric strength, voltage endurance and reliability.

Solventless epoxy resins are impregnated into the mica which has been preplaced on a form-wound coil. Then with both mica and resin in position, chemical reaction is initiated which transforms the resin into a solid which locks and binds the mica into a composite mass. The resulting end product then takes advantage of the excellent properties of both the mica and the resin. The outstanding characteristics of the epoxies is their extremely good resistance to moisture and to practically all types of chemical contaminants. They have been proven in laboratory tests described later and by field service.

Processing Thermalastic Epoxy insulation includes vacuum-pressure impregnation of the complete wound stator, stator coils as well as coil connections. This makes it possible to give all parts of the windings the full effect of the high resin fill that is achieved with the vacuum-pressure technique. The coils are not deformed or stressed after impregnation.

The processes described are those of the Large Rotating Apparatus Division in East Pittsburgh. Primarily due to differences in the size of motors manufactured at the Buffalo Large Ac and Dc Motor Division, specific processes vary in minor detail: The essential characteristics of the insulation system are the same.

September, 1971
Supersedes Technical Data 3170, dated June, 1968
E C/1738, 1740/DB

Westinghouse

Stator Coils

The insulation immediately adjacent to the copper conductors is generally that which insulates the various turns in the coil from each other. This is a very important part of the insulation system, one which frequently is not given the attention it deserves. Since the majority of ac motors are started across-the-line, there is a possibility that steep fronted, impulse type waves can be imposed on the winding. These waves [illegible] electric stress on the turn insulation, especially the turns of the stator coils near the line terminals.

In the light of these facts and the general industry trend to higher operating voltages, mica, which provides a positive electric barrier of very high strength, is used as turn insulation for all coils rated 4 kV and above for the larger size motors. On smaller size motors, this additional strength, where required, is obtained by the use of enamel plus double dacron-glass covering.

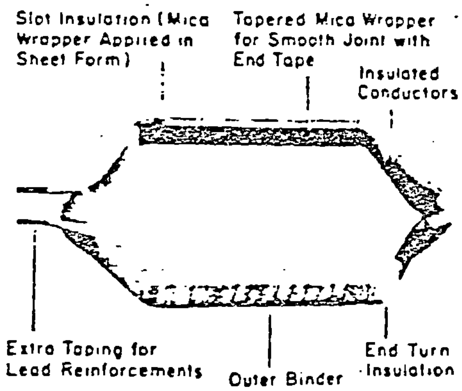


Fig. 1 Typical stator coil showing elements of insulation.

The micaceous ground insulating materials are applied as shown in detail in Fig. 1. All materials used are designed to be both compatible with, and selected components of, the complete insulation system.

Winding Stator

At the start of the winding operation the stator core consists of the assembled punchings and restraining end plates thus providing a maximum of accessibility during coil assembly of larger size motors. The fact that the coils are unimpregnated at this stage provides ease of installation.

The end turns of the stator coils are firmly braced to withstand full-voltage starts with a series of insulated support rings as well as braces between coil end turns, which in effect form an archbound structure at these points. The material used as a brace between coil end turns is a non-woven polyester felt which has both resiliency and absorbency.

After installation of all coils and completion of wedging and bracing, the connections are made and insulated, and the stator is ready for impregnation.

Vacuum-Pressure Impregnation

The preheated stator is lowered into the vacuum pressure tank, and the air evacuated to a very low absolute pressure. The epoxy resin is then introduced, while maintaining the vacuum, to a level that completely submerges all parts of the winding. The vacuum is then released and replaced with positive pressure of several atmospheres over the liquid resin. Following these steps the stator is removed, as shown in Figure 2.

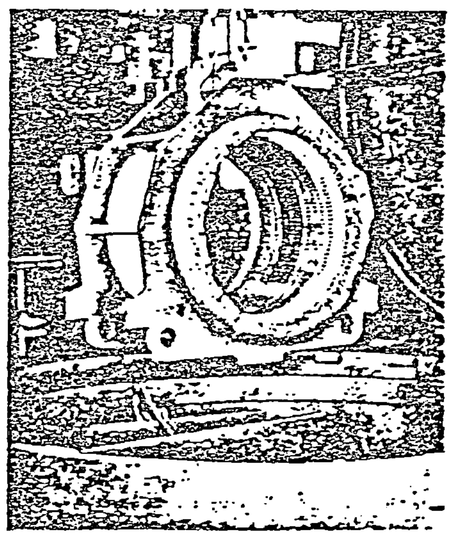


Fig. 2. After impregnation, the stator is removed from the tank and placed in an oven for curing.

The next step in the process takes place in an oven, where the resin is cured.

In addition to the impregnation of the winding, the bracing system has been built "in place" by the absorption of epoxy resin and subsequent cure in the polyester felt. This gives very high strength to the bracing scheme.

During the manufacture of the coils and winding, quality control procedures are used continuously to monitor the physical dimensions and electrical integrity of the insulation.

Evaluation and Test Program
Thermalastic Epoxy insulation was adopted as standard for large ac motors only after completion of an extensive evaluation and test program. A description of some of the more important tests follows.

Electric Strength
Since the fundamental function of insulation is to withstand electric stress, the first series of tests on any insulation system is to determine its short-time electric strength. Complete insulated coils are used for this test.

It is desirable that for any particular voltage class the average breakdown voltage be as high as possible. However, it is essential that the values be examined and analyzed statistically. It is the Westinghouse concept that, using the principles of statistical analysis, the coils have a breakdown level well above the test level for individual coils.

Thermalastic Epoxy insulation has both a higher average short-time electric strength and is more reproducible from coil-to-coil than other insulation systems.

Voltage Endurance
Since insulation in large machines is expected to perform for a long period of time, a voltage endurance test has been devised. In this test, sample coils are prepared and connected as described for the short-time electric tests.

Electric strength is evaluated in depth by a series of breakdown tests for each insulation system. A group of sample coils for each system is tested at various voltage levels for fixed time intervals which may be one minute, one hour, one week or more. By plotting average "hold" values for the different time periods, a voltage endurance curve is created. Such a curve is shown in Figure 3.

Much of the data thus obtained tends to plot in a straight line. One way of looking at such data is to establish an "operating level" and examine where the extrapolated voltage endurance curve will intersect this "operating level". The Thermalastic insulation curve intersects the operating stress level at a time in excess of 100 years. These are results of laboratory tests on only one of the degrading mechanisms that affect insulation and, therefore, are not complete indications of actual operating life. However, systems that fail to give indications of satisfactory life in this very fundamental test are not considered favorably.

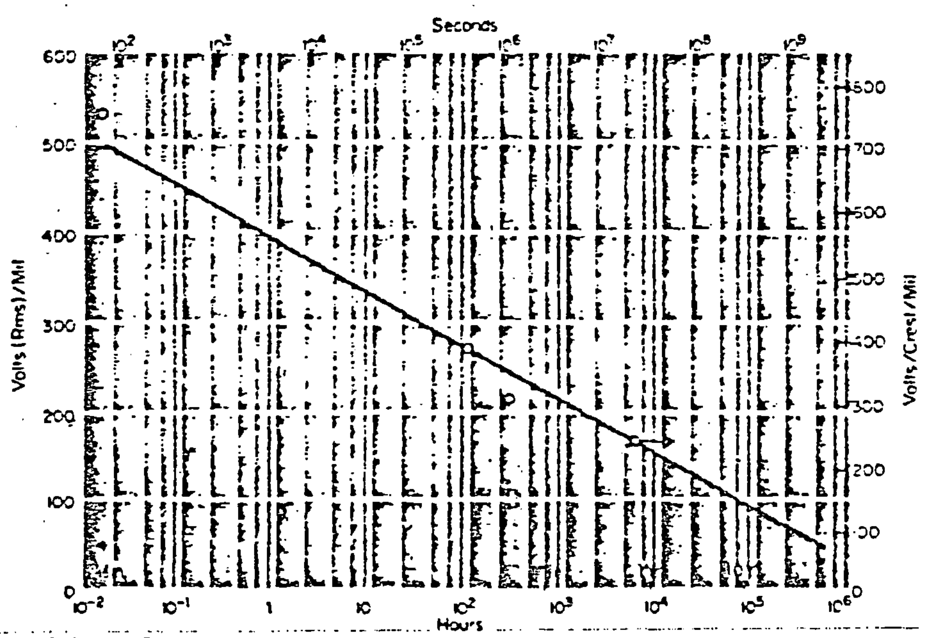
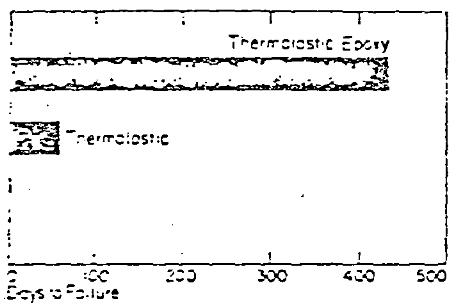


Fig. 3. Voltage Endurance.

Westinghouse

Moisture Resistance

The first screening test for moisture resistance is a test on individual coils suspended in salt water. These are standard coils submerged except for the leads and front loops and continuously subjected to normal voltage to ground. This is the value of the maximum line-to-ground operating voltage. Total hours to failure are then measured for each of the systems under investigation.



Average life of insulation systems, immersed ...ltage applied continuously.

Figure 4 shows the results obtained by this method. As can be seen, the epoxy resin impregnant imparts outstanding moisture resistance to the Thermalastic concept.

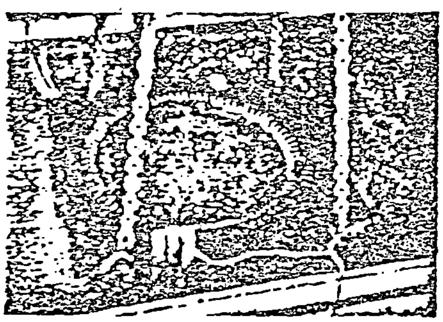


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Fig 5 Complete motor winding immersed in water for test of moisture resistance.

Tests on individual coils without connections, however, are not the entire story. The moisture resistance of complete windings has also been investigated. In Figure 5 a winding including all connections is shown completely submerged in a tank of salt water. The winding leads are connected to a megohm bridge so that insulation resistance can be measured.

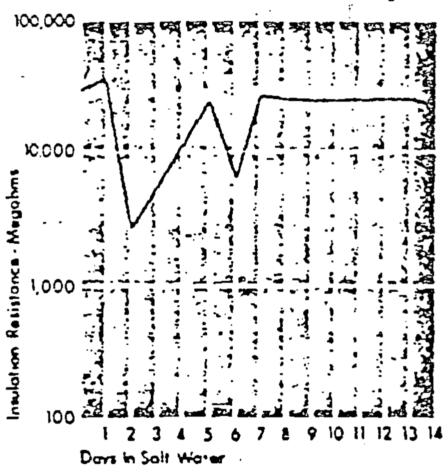

Fig. 6. Insulation resistance – throughout 14 day period.

A complete 4160 volt Thermalastic Epoxy stator was submerged in a tank of water containing 5% salt by weight (approximate sea water concentration) for a period of 14 days. The insulation resistance was checked throughout this period. Figure 6 is the plot of insulation resistance obtained throughout the 14 day period.

There are variations in the level, probably due to changes in the conductivity of the insulation surfaces at the winding terminals, but all readings are quite high. Figure 7 is a plot of the dielectric absorption tests taken before and after the 14 day period while in the water.

At the conclusion of this period the stator was removed from the tank and without rinsing or drying was subjected to a 4800 volt ac rms high potential test. The winding withheld this test with no difficulty. This indicates the winding could have been cleaned and dried and returned to service.

In still another test on a complete winding, the effect of continuous exposure to 100% relative humidity at 50°C was investigated. In some respects this is a more severe test than actual submersion since water vapor has a high degree of penetration through films. Figure 8 shows the results. After more than 3000 hours of this type of exposure, the Thermalastic Epoxy insulated winding still had insulation resistance measured in thousands of megohms.

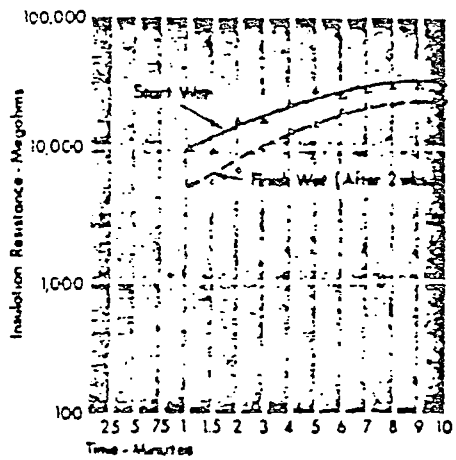

Fig. 7. Insulation resistance – before and after 14 day period.

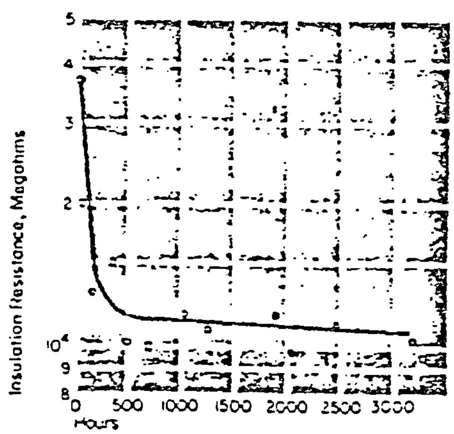

Fig. 8. Tests of wound 4160-volt stator under conditions of 100% humidity.

Chemical Resistance

Resistance to chemical contaminants is another factor in many industries. In looking at resistance to acids, bases and solvents, nothing has been found that is the equal of the epoxy resins. Table A shows a tabulation of some of the many tests made wherein resin samples were subjected to liquid baths of various contaminating materials. The resin used in Thermalastic Epoxy insulation shows outstanding resistance to all of them.

Thermal Endurance

Temperature is widely accepted as being one of the limiting factors in insulation life. To determine the ability of insulation to stand up under thermal aging, testing is done by following the basic concept of functional testing outlined in IEEE 275.

This is the "motorette" type of testing wherein small, complete coils are made in accordance with actual processes employed in the insulation system being evaluated. These coils are then mounted in slots on a motorette and the leads brought out in an appropriate fashion as shown in Figure 9 so that electrical tests can be made. These motorettes are then subjected to a cycle of oven aging, mechanical vibration, humidification and electrical test. Following this, the cycle is repeated and the number of cycles to failure is recorded.

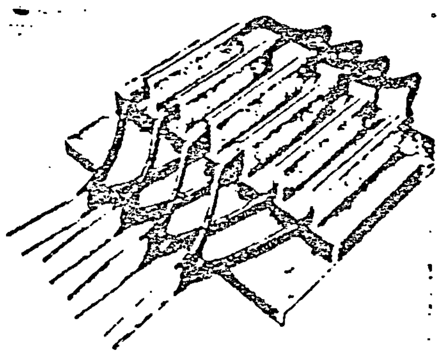

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Fig. 9. "Motorette" used for testing thermal endurance of insulation systems.

This is a comparative test only. There are no standard values for the test conditions or number of cycles or the hours of aging that a system should withstand. It is known, however, that for more than 30 years class B insulation has been in service and that it has performed satisfactorily. The procedure is, therefore, to compare new or proposed systems with the older service-proven systems. Figure 10 shows the data obtained by such tests. Hours of life is plotted logarithmically on the vertical axis against temperature on the horizontal axis. As can be seen, the life of all systems decreases with increased temperature. The "pre-Thermalastic" curve is the data obtained on the class B insulation system used prior to Thermalastic. In going to the Thermalastic Epoxy system, a curve is obtained which is shifted over on the thermal scale by about 25°C. This in itself indicates a high order of "thermal reserve" in Thermalastic Epoxy insulation. This system qualifies for class F thermal rating.

Table A
Solvent & Chemical Resistance of Thermalastic Epoxy Resin Castings

Solvent	Time of Immersion	Shore D Hardness	Percent① Weight Change	Percent① Thickness of Change	Rating
50% Acetic Acid	0	84	0	0	Excellent
	24 hours	85	0	0	
	48 hours	85	0	0	
	7 days	85	0	0	
	10 days	86	0	0	
10% Sodium Hydroxide	0	84	0	0	Excellent
	24 hours	86	0	0	
	48 hours	85	0	0	
	7 days	85	0	0	
	10 days	86	0	0	
Acetone	0	85	0	0	Good
	24 hours	61	+ 8.6	+ 9.5	
	48 hours	45	+15.3	+17.5	
	72 hours	..	Decomposed	....	
	10 days	..	....	....	
Benzene	0	87	0	0	Excellent
	24 hours	88	0	0	
	48 hours	88	0	0	
	7 days	88	0	0	
	10 days	88	0	0	
Trichloro-ethylene	0	86	0	0	Good
	24 hours	48	+ 7.5	+15.5	
	48 hours	..	Decomposed	....	
	7 days	..	....	....	
	10 days	..	....	....	
Distilled H_2O	0	83	0	0	Excellent
	24 hours	85	0	0	
	48 hours	85	0	0	
	7 days	85	0	0	
	10 days	85	0	0	

① Neglecting changes less than 1%.

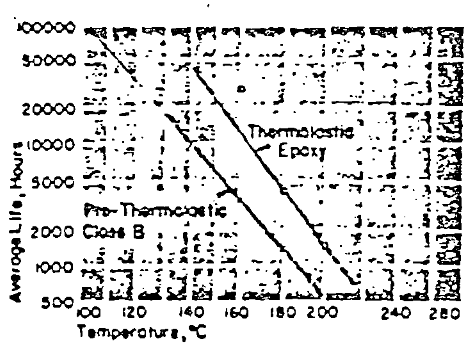

Fig. 10 Thermal endurance of insulation systems for rotating machines tested in motorettes in accordance with IEEE 275 (5000 volt proof test).

Westinghouse

Thermal Cycling

All motors in service are required to withstand varying degrees of thermal cycling. The ability of Thermalastic Epoxy insulation to withstand thermal cycling and maintain moisture resistance is dramatically demonstrated by the following test.

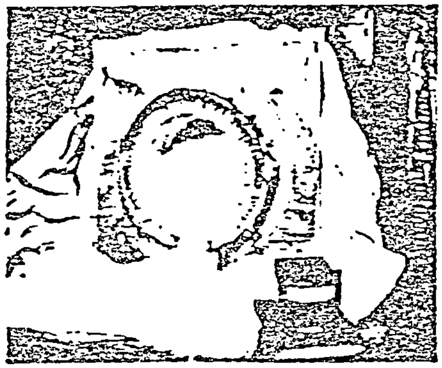

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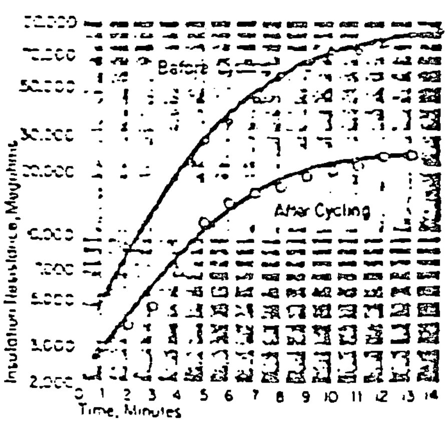
Fig. 11. Cycling test of wound stator-packed with ice.

[illegible] 11 shows a wound stator packed [illegible]ry ice so that the imbedded thermocouples in the winding indicate minus 40°C. When the winding reached this temperature the dry ice was removed and the stator was immediately placed in an oven, which had been preheated to 150°C. This was repeated four times, cycling between these temperature limits, and the stator then completely submerged in water. Figure 12 shows the results obtained, and indicates that the moisture resistance is unaffected by thermal shocks of 190°C.



[illegible]2. Effect of thermal cycling on Thermalastic [illegible]nsulation between temperature of −40°C [illegible]50°C.

Mechanical Strength

All motor insulation may be subjected to severe mechanical stresses during operation. To determine the ability of the complete Thermalastic Epoxy winding to withstand mechanical stresses, the following test has been devised.

When a motor winding is first connected across the line, there is a large current inrush to mechanical forces, which tend to severely distort them. Adequate bracing prevents the actual deformation, but the forces are nevertheless present.

A motor with Thermalastic Epoxy insulation was subjected to 1,000 full-voltage starts. After completion of the 1,000 full-voltage starts, the entire wound stator was submerged in a tank of water and a ten-minute dielectric absorption curve was made immediately after submersion.

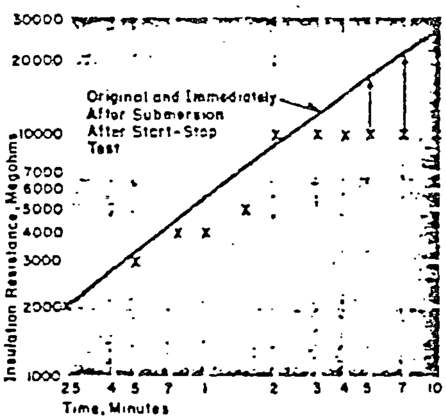


Fig. 13. Insulation resistance characteristics of submerged Thermalastic Epoxy stator winding (4160 volts) after motor was subjected to 1,000 full-voltage starts.

Even after these severe conditions, the winding had greater than 10,000 megohms of insulation resistance after ten minutes of voltage as shown in Figure 13.

Abrasion Resistance

Motors are not infrequently expected to operate in an environment which subjects the coil insulation to bombardment by highly abrasive particles. This occurs because the cooling air which is circulated through the motor comes from the surrounding atmosphere of the motor and often contains a great deal of abrasive particulate matter. This particulate matter is forced at high velocity over the end windings of the stator coils and is equivalent to a sandblast commonly used in many industrial applications for cleaning and stripping operations.

In order to allow the windings to operate under these adverse conditions, special treatments have been developed. It is well known that elastomers or rubbers are capable of absorbing energy upon impact with another harder material. Therefore, the special treatments consist of a layer of an elastomeric material which is capable of absorbing this energy and literally bouncing the abrasive particles off the surface.

The coatings are applied over the completed winding by dipping or spraying so as to provide an energy-absorbing surface. This had to be a very special coating which would have the ability to work not only as applied, but also at the operating temperature of the coil surface and to maintain this property over the long periods of time the machines are expected to run.

Radiation Resistance of Thermalastic Epoxy Insulation

Of the various components that go to make up the Thermalastic Epoxy insulation system, the epoxy impregnant is the most susceptible to radiation damage. The mica and fiber glass portions will be unaffected by dosage levels that would destroy the impregnating resin. However, the epoxy impregnant, because of its aromatic nature, is one of the better resinous materials with regard to radiation resistance, having a predicted life of 40 years at a dosage of up to 10^9 rads at low radiation rates of less than 100 rads per hour. Normal radiation levels within the containment vessel of a nuclear power station are below a rate of 50 rads per hour with a total dosage of 2×10^7 rads over a period of 40 years. Therefore, Thermalastic Epoxy windings in a typical radiation environment will operate many years with no measureable deterioration due to the radiation.

Winding Repairs

The standardization of Thermalastic Epoxy insulation for large motors allows a completely new approach to the subject of winding repairs and the desirability of carrying spare coils.

First of all, the possibility of winding repairs being required is reduced to a minimum far below that possible with any previous insulation system.

The basic approach is to provide for the contingencies that may arise with minimum total expense to the user including both repair and downtime cost.

Depending on the extent of damage, several alternatives are available for winding repairs:

1. Most failures resulting from accidental mechanical damage occur on the end windings where the coil is exposed. Repairs to the end winding external to the core can be made by the conventional patching method.

2. In the remote possibility of coil failure within the slot, it is not practical to replace coils by conventional means. The very processing of complete impregnation and bonding which insures a failure-free coil also makes it impractical to lift enough coils to replace both top and bottom coil sides of a damaged coil.

To replace a damaged coil in any machine, it has always been necessary to lift at least a full throw of coils to get the new coil in. Quite often, this operation results in damage to other coils. Therefore, when spare coils are considered desirable, it has been standard practice to carry at least ¼ or ⅓ of a set to replace one or two damaged coils.

Westinghouse has developed a technique of coil replacement, for use on motors manufactured at East Pittsburgh, which makes it unnecessary to disturb any coils except the damaged coil or, at most, the other coil in the same slot.

For Thermalastic Epoxy insulated machines, a standard repair kit can be supplied including six half coils suitable for replacing either top or bottom sides of the coil. Also included are the necessary materials, tools and instructions for replacing damaged coils. Complete spare Thermalastic Epoxy insulated coils are not furnished for these machines.

3. In the case of widespread damage involving a number of coils, a complete rewind is recommended. The elaborate facilities required for the Thermalastic Epoxy system make it necessary to return the stator to the factory to obtain the original processing. On a breakdown basis, this can be done usually in three weeks or less and requires no longer than would be required to order coils and rewind in the field.

If consideration is given to stocking a full set of coils to protect against such a failure on a Thermalastic Epoxy insulated machine, the recommendation is that a complete wound stator be stocked. This will cost no more than a full set of coils plus the expense of stripping the old winding and winding the new coils in any machine. Downtime is reduced to a minimum.

Westinghouse Electric Corporation
Water Reactor Divisions

Nuclear Commercial Operations Division

Box 355
Pittsburgh Pennsylvania 15230

October 30, 1980

Mr. S. C. Brown, Jr., Senior Vice President
Virginia Electric and Power Company
P.O. Box 26666
Richmond, VA 23261

Dear Mr. Brown:

VIRGINIA ELECTRIC AND POWER COMPANY
NORTH ANNA POWER STATION

NUREG-0588 Equipment Qualification

Reference: NCW-1315

This is to confirm information which has been provided to Mr. R. Newcomb in order to provide additional information in response to your request of the referenced letter as well as other telephone requests by Mr. R. Newcomb.

Lubricants for Westinghouse Pump Motors

Table 1 identifies a lubricant for which radiation exposure testing is available. This lubricant is recommended for use with the Westinghouse supplied Charging and SI pump motors for Surry and North Anna.

Grease for LHSI Pump Motors

Chevron SRI-2 grease is recommended for use with the Westinghouse supplied LHSI pump motors. Per our telephone conversation with Mr. R. Newcomb, Vepco has obtained radiation resistance testing information for this grease.

High Energy Break for Pump Motors

The Westinghouse supplied Charging Pump motors are capable of withstanding the temperature-time profile transmitted by the referenced letter. The reduction on qualified life due to operating through the transient is about one month. The bearings of the non-operating charging pumps can also withstand the referenced transient. The bearings of the operating charging pump will experience an operating temperature in excess of the allowable and thus cannot be assumed, based upon currently available information to withstand the transient. We are reviewing, with our motor manufacturing division, means for reducing the conservatism in the allowable operating temperature.

Seal Water Cooling Pumps

Information was requested relative to the capability of the Westinghouse supplied charging pumps to operate without seal water cooling due to failure at the seal water cooling pumps. With the pumped fluid temperature less than 115°F, operation without seal water cooling is acceptable. Since your pumped fluid temperature exceeds 170°F, we are investigating the resultant failure mechanism at R. Newcomb's request.

Surry Pump Motor Insulation

The motor insulation for the charging pumps at Surry, Motor Shop Order Number 68F13318 is thermoelastic epoxy wound and therefore is covered by WCAP-8754, Section 5-2. The safety injection pump motors appear to have been rewound and thus cannot be confirmed to be covered by WCAP-8754.

Auxiliary Oil Pump Motor

The Auxiliary Oil Pump Motor is not required for Class 1E operation of the Charging Pumps.

Should you have any questions on this matter, please call.

Very truly yours,

For Richard R. Kent

J. B. Cookinham, Manager
Vepco Projects

/rcc
attachment

S. C. Brown, 3L 3A19

cc: W. R. Cartwright, 1L
R. B. Bradbury, 1L /k

TABLE 1

Premium Grade, Corrosion and Oxidation Inhibited Mineral Base Turbine Oils.

Brand Name	Viscosity	Radiation Exposure Limit**
Exxon Teresstic-46	200 SUS@100°F	1.4×10^7 Rad.*

*Reference: EPRI report NP-1447 Vols. 1 & 2, Project 893-1, July 1980. Tests performed by Westinghouse R&D. Critical breakdown of oil would be expected by 2×10^8 Rad.

**Values presented for the Radiation Exposure Limit are the highest documented exposure levels obtained by the author to date, based on a non-conclusive data search.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 1

COMPONENT

TER Item No.: 104

TER Category: IIa

Description: PRESSURE TRANSMITTER FOR POST ACCIDENT MONITORING (TMI ITEM)

Manufacturer, Model: ROSEMOUNT, INC. Model No. 1152AP7A22PB

Tag No(s).: PT-LM-101A, PT-LM-101B

Worksheet No(s).: 10.3-1, 10.3-2

QDR No.: 5437-201-01

Location: AB-13A

DISCREPANCY

Qualification was not established for this item because the review package (QDR) was not provided.

RESPONSE

The QDR listed under COMPONENT was prepared subsequent to submittal of the SER and 90-day Rev. 4 responses. The QDR establishes qualification, and is being submitted at this time.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 1

COMPONENT

TER Item No.: 106

TER Category: IIa

Description: LEVEL TRANSMITTER FOR CONTAINMENT SUMP LEVEL (TMI ITEM)

Manufacturer, Model: GEMS Models XM54854 & XM54853

Tag No(s).: LT-RS-151A, B

Worksheet No(s).: TMI 10.3-30, 10.3-31

QDR No.: future

Location: RC-3A

DISCREPANCY

This is a new equipment item for TMI purposes.

RESPONSE

Qualification testing was recently completed for this item, but the qualification test report is not yet available. We continue to believe that the equipment is the best available for the purpose, and have no knowledge of type test failures that would compromise its capability for qualification.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 1

COMPONENT

TER Item No.: 107

TER Category: IIa

Description: LEVEL TRANSMITTER FOR RC SUMP WATER LEVEL (TMI ITEM)

Manufacturer, Model: GEMS, Model XM54854 & XM54853

Tag No(s).: LT-DA-110A, LT-DA-110B

Worksheet No(s).: TMI 10.3-5, 10.3-6

QDR No.: future

Location: RE-27B

DISCREPANCY

This is a new equipment item for TMI purposes.

RESPONSE

Qualification testing was recently completed for this item, but the qualification test report is not yet available. We continue to believe that the equipment is the best available for the purpose, and have no knowledge of type test failures that would compromise its capability for qualification.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 1

COMPONENT

TER Item No.: 115

TER Category: IIa

Description: LIMIT SWITCHES (TMI ITEM)

Manufacturer, Model: GORDOS, Model MR8901

Tag No(s).: ZS-SS-100A-1, 100A-2, ZS-SS100B-1, 100B-2

Worksheet No(s).: 10.3-54 thru 10.3-57 (TMI)

QDR No.: 5437-205-01

Location: RC-27A

DISCREPANCY

Qualification was not established for this item because the review package (QDR) was not provided.

RESPONSE

The QDR listed under COMPONENT was prepared subsequent to submittal of the SER and 90-day Rev. 4 responses. The QDR establishes qualification, and is being submitted at this time.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 1

COMPONENT

TER Item No.: 116

TER Category: IIa

Description: LIMIT SWITCHES (TMI ITEM)

Manufacturer, Model: GORDOS, Model MR8901

Tag No(s).: Numerous

Worksheet No(s).: (TMI): numerous

QDR No.: 5437-205-01

Location: RC-18B

DISCREPANCY

Qualification was not established for this item because the review package (QDR) was not provided.

RESPONSE

The QDR listed under COMPONENT was prepared subsequent to submittal of the SER and 90-day Rev. 4 responses. The QDR establishes qualification, and is being submitted at this time.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 1

COMPONENT

TER Item No.: 117

TER Category: IIa

Description: LIMIT SWITCHES (TMI ITEM)

Manufacturer, Model: GORDOS, Model MR8901

Tag No(s).: Numerous

Worksheet No(s).: (TMI) Numerous

QDR No.: 5437-205-01

Location: AB-2B

DISCREPANCY

Qualification was not established for this item because the review package (QDR) was not provided.

RESPONSE

The QDR listed under COMPONENT was prepared subsequent to submittal of the SER and 90-day Rev. 4 responses. The QDR establishes qualification, and is being submitted at this time.

TECHNICAL EVALUATION REPORTS
ENVIRONMENTAL QUALIFICATION OF SAFETY-RELATED ELECTRICAL EQUIPMENT
SURRY POWER STATION UNITS 1 AND 2

30-DAY RESPONSE TO
NRC LETTER OF JANUARY 26, 1983

MARCH 9, 1983

ATTACHMENT 3
UNIT 1: RESPONSE TO NRC CATEGORY II.B
EQUIPMENT NOT QUALIFIED

TER ITEMS

4
18

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 1

COMPONENT

TER Item No.: 4

TER Category: IIb

Description: RCS WIDE RANGE PRESSURE TRANSMITTERS (PAM)

Manufacturer, Model: Rosemount 1153D

Tag No(s).: PT-1402, PT-RC-1402-1

Worksheet No(s).: 6-267, 6-268

QDR No.: future

Location: RC-3B

DISCREPANCY

This is PAM equipment which was under review at the time of the 90-day Rev. 4 submittal. The TER classified the equipment in Category IIb, Equipment Not Qualified.

RESPONSE

Qualified replacement instrumentation is being installed during the current refueling outage, as stated in VEPCO letters to the NRC serial number 085 dated February 18, 1983, 085A dated March 2, 1983 and 085C dated March 9,1983.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 1

COMPONENT

TER Item No.: 18

TER Category: IIb

Description: SG WIDE RANGE LEVEL TRANSMITTERS (PAM)

Manufacturer, Model: Rosemount

Tag No(s).: LT-1477, 1487, and 1497

Worksheet No(s).: 6-269, 6-270, 6-271

QDR No.: 5437-

Location: RC-3B

DISCREPANCY

This is PAM equipment which was under review at the time of the 90-day Rev. 4 submittal. The TER classified the equipment in Category IIb, Equipment Not Qualified.

RESPONSE

Justification for Continued Operation is provided in VEPCO letter to the NRC serial number 085 dated February 18, 1983.

TECHNICAL EVALUATION REPORTS
ENVIRONMENTAL QUALIFICATION OF SAFETY-RELATED ELECTRICAL EQUIPMENT
SURRY POWER STATION UNITS 1 AND 2

30-DAY RESPONSE TO
NRC LETTER OF JANUARY 26, 1983

MARCH 9, 1983

ATTACHMENT 4
UNIT 2: RESPONSE TO NRC CATEGORY I.B EQUIPMENT
QUALIFICATION PENDING MODIFICATION

TER ITEMS

78
81
86
88
90
96
104
121
122
123

Except for those items addressed in this attachment, the replacement commitment and Justification for Continued Operation provided in Sections 7.1 and 7.2 of the 90-day Response Rev. 4 remain valid. This attachment addresses all changes that resulted from a complete review and updating of replacement plans.

With respect to the terminal blocks listed in Section 7.1.11 of the 90-day Response, all terminal blocks in safety related circuits inside containment have been replaced with qualified Raychem splices as stated in Section 7.1.11.1. We have completed review of terminal blocks outside containment and have scheduled replacement of all unqualified blocks in safety related circuits with qualified blocks.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 78

TER Category: Ib

Description: SOV FOR SG BLOWDOWN ISOLATION

Manufacturer, Model: ASCO 8320173E

Tag No(s).: SOV-BD-200A,C

Worksheet No(s).: 6-260

QDR No.: 5437-64-01

Location: RC-3B

DISCREPANCY

The 90-day response did not provide justification for continued operation for these valves.

RESPONSE

SOV-BD-200A: The worksheet states the valve will be replaced by a qualified NP series valve, although the conclusions section did not list it. Justification of continued operation for this type was provided in Section 7.2.2 of the 90-day Response, and replacement is still scheduled.

SOV-BD-200C was replaced in May, 1982 with a qualified NP-series replacement as discussed in the referenced QDR. Other valves of this series were assigned to Category IIc in the TER.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 81

TER Category: Ib

Description: SOV FOR SG BLOWDOWN ISOLATION

Manufacturer, Model: ASCO 8320A173V

Tag No(s).: SOV-BD-200E

Worksheet No(s).: 6-264

QDR No.: 5437-64-01

Location: RC-3B

DISCREPANCY

The 90-day response did not provide justification for continued operation.

RESPONSE

The worksheet states the valve will be replaced with a qualified NP-series valve, although the conclusions section did not list it. Justification for continued operation for this type was provided in Section 7.2.2 of the 90-day Response, and replacement is scheduled.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 86 (partial)

TER Category: Ib

Description: SOV FOR SAFETY INJECTION NITROGEN RELEASE

Manufacturer, Model: ASCO ___ ___

Tag No(s).: SOV-SI-201A

Worksheet No(s).: 6-122

QDR No.: 5437-64-01

Location:

DISCREPANCY

The 90-day response did not provide justification for continued operation for this tag number SOV.

RESPONSE

The conclusions section of the 90-day response incorrectly listed SOV-SI-202A instead of 201A. Justification for continued operation was provided in Section 7.2.2 of the 90-day Response, and replacement is scheduled.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 88 (partial)

TER Category: Ib

Description: SOVs FOR SI BORON INJECTION TANK RECIRCULATION

Manufacturer, Model: ASCO LB831654

Tag No(s).: SOV-2884A and B

Worksheet No(s).: 6-228 and 229

QDR No.: 5437-64-01

Location: AB-2B

DISCREPANCY

The 90-day response did not provide justification for continued operation for these two SOVs.

RESPONSE

The worksheets state the valve will be replaced with a qualified NP-series valve, although the conclusions section did not list it. Justification for continued operation for this type was provided in Section 7.2.2 of the 90-day Response, and replacement is scheduled.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 90

TER Category: Ib

Description: SOVs FOR PRESSURIZER RELIEF VALVE ACTUATION

Manufacturer, Model: Laurence 3300WA742DC

Tag No(s).: SOV-2455C-3, SOV-2456-3

Worksheet No(s).: 6-200e and h

QDR No.: None

Location: RC-47A

DISCREPANCY

The 90-day response did not provide justification for continued operation for Laurence SOVs.

RESPONSE

Both SOVs were replaced in November 1981 with qualified NP-series replacements as discussed in the referenced QDR. Other valves of this series were assigned to Category IIc in the TER.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 96

TER Category: Ib

Description: SOV FOR PRIMARY WATER TO PRESSURIZER RELIEF TANK

Manufacturer, Model: ASCO 8320A174E

Tag No(s).: SOV-2519A

Worksheet No(s).: 6-200

QDR No.: 5437-64-01

Location: AB-2B

DISCREPANCY

The 90-day response did not provide justification for continued operation.

RESPONSE

The worksheet states the valve will be replaced with a qualified NP-series valve, although the conclusions section did not list it. Justification for continued operation for this type was provided in Section 7.2.2 of the 90-day Response, and replacement is scheduled.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 104

TER Category: Ib

Description: SOV FOR CVCS ISOLATION

Manufacturer, Model: ASCO 831654

Tag No(s).: SOV-2204

Worksheet No(s).: 6-19

QDR No.: 5437-64-01

Location: AB-2B

DISCREPANCY

The 90-day response did not provide justification for continued operation.

RESPONSE

The worksheet states the valve will be replaced with a qualified NP-series valve, although the conclusions section did not list it. Justification for continued operation for this type was provided in Section 7.2.2 of the 90-day Response, and replacement is scheduled.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 121

TER Category: Ib

Description: ACCELEROMETER FOR ACCIDENT MITIGATION (TMI ITEM)

Manufacturer, Model: ENDEVCO, Model 2273AM20

Tag No(s).: NUMEROUS

Worksheet No(s).: TMI 10.3-9 thru 10.3-18

QDR No.: future

Location: RC-47A

DISCREPANCY

This is a new equipment item for TMI purposes. Qualification testing has not been completed.

RESPONSE

The qualification test report for this equipment is not yet available. We continue to believe that the equipment is the best available for the purpose, and have no knowledge of type test failures that would compromise its capability for qualification.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 122

TER Category: Ib

Description: HARDLINE COAXIAL CABLE FOR ACCIDENT MITIGATION (TMI ITEM)

Manufacturer, Model: ENDEVCO, Model 3075M6

Tag No(s).: Coaxial Cable

Worksheet No(s).: TMI 10.3-19

QDR No.: future

Location: RC-47A

DISCREPANCY

This is a new equipment item for TMI purposes. Qualification testing has not been completed.

RESPONSE

The qualification test report for this equipment is not yet available. We continue to believe that the equipment is the best available for the purpose, and have no knowledge of type test failures that would compromise its capability for qualification.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 123

TER Category: Ib

Description: CHARGE PREAMPLIFIER FOR ACCIDENT MITIGATION (TMI ITEM)

Manufacturer, Model: UNHOLTZ-DICKIE Model 22CA-2TR

Tag No(s).: NUMEROUS

Worksheet No(s).: TMI 10.3-20 thru 10.3-29

QDR No.: future

Location: RC-47A

DISCREPANCY

This is a new equipment item for TMI purposes. Qualification testing has not been completed.

RESPONSE

The qualification test report for this equipment is not yet available. We continue to believe that the equipment is the best available for the purpose, and have no knowledge of type test failures that would compromise its capability for qualification.

TECHNICAL EVALUATION REPORTS
ENVIRONMENTAL QUALIFICATION OF SAFETY-RELATED ELECTRICAL EQUIPMENT
SURRY POWER STATION UNITS 1 AND 2

30-DAY RESPONSE TO
NRC LETTER OF JANUARY 26, 1983

MARCH 9, 1983

ATTACHMENT 5
UNIT 2: RESPONSE TO NRC CATEGORY II.A EQUIPMENT
QUALIFICATION NOT ESTABLISHED

TER ITEMS

1	44
7	46
8	50
9	51
10	62
12	63
13	72
17	73
26	116
30	118
34	119
35	127
39	128
41	129

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 1

TER Category: IIa

Description: PRESSURE TRANSMITTER FOR R.S. PUMP DISCHARGE (PAM)

Manufacturer, Model: FISHER PORTER, Model 50EP1031BCXA

Tag No(s).: PT-RS-256A, PT-RS-256B

Worksheet No(s).: 6-278, 6-279

QDR No.: None

Location: SFGD-1

DISCREPANCY

This is PAM equipment which was under review at the time of the 90-day Rev. 4 submittal. Qualification was not established.

RESPONSE

This equipment will be replaced by qualified equipment within the schedule established in 10CFR50.49. In the interim, due to equipment type similarity, justification for continued operation is provided in the 90-day response section 7.2.4 for this equipment type. The TER classifies other equipment of this sort in Category Ib, Equipment Qualification Pending Modification.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 7

TER Category: IIa

Description: ELECTRICAL PENETRATION

Manufacturer, Model: Amphenol Type III, Spec. NUS-41

Tag No(s).:

Worksheet No(s).: 6-46

QDR No.: 5437-127-01

Location: RC-18B

DISCREPANCY

The TER identifies concerns in the following areas:

A. Similarity between equipment and test specimens
B. Aging and qualified life
C. Temperature/pressure test profile
D. Spray
E. Radiation

RESPONSE

The attached pages discuss these concerns in detail. It is concluded that all of these concerns are resolved except Aging and Qualified Life. As recommended in the QDR, the penetrations should be included in a surveillance program. The TER assigns other equipment of this sort to Category IIc.

ATTACHMENT TO SURRY 1 ITEM 7
AMPHENOL PENETRATIONS

A. CONCERN: (1) Similarity Between Equipment and Test Specimens (page 2 of TER)

(2) It is not clear why the manufacturer was not contacted to determine the applicability of the test reports. It is noted that Amphenol has provided test documentation to other plants, i.e., Calvert Cliffs, Trojan, San Onofre, Davis Besse and ANO (page 5f of TER)

RESOLUTION:

The Amphenol penetrations used at Surry are of the canister type, rather than the unitized header design supplied for later plants such as Davis Besse and ANO-2. Copies of ten references are attached documenting contacts with Amphenol to obtain copies of suitable test reports for the canister design (which they could not provide) or for the unitized header design (which were ultimately obtained directly from Toledo Edison and Arkansas Power & Light).

Additionally, the referenced QDR contains substantial documentation relating the canister and unitized header designs. In particular, the "Design Evolution" report included with the original Amphenol proposal in Section 2b of the QDR provides a detailed description of Amphenol's penetration design evolution from canister to unitized header. The photographs and drawings in this report, together with the drawings in the Proposal, clearly establish that at the time Surry penetrations were fabricated the two designs employed the the same connector modules, insulation materials, potting compounds, and sealants; only the structural metallic components in which these items are mounted and related welds differ.

Amphenol's Design Verification Test Report, included in Section 3d of the QDR, summarizes the reasons for evolving from the canister to the unitized header design (page 1): "The unitized header assembly (UHA) offers the advantages of a lighter, more compact unit than the canisters which have been used heretofore and also provides for versatility and interchangeability of components. In addition, the UHA promises to considerably reduce the required field installation effort."

Sheet 10 of the QDR, reproduced on page 5f of the TER, documents additional comparisons performed by NUS to verify the similarity between Surry equipment and the test specimens used for the test reports employed by the QDR.

Summarizing, the manufacturer was contacted repeatedly to obtain applicable test reports. In the absence of complete test reports for the canister design used at Surry, design similarity to the tested unitized header penetrations was established using information provided by the manufacturer. Test reports for the unitized header penetrations were obtained and used to establish the qualification of the Surry penetrations. This effort adequately determines similarity between the plant equipment and test specimens in conformance to the DOR Guidelines.

B. CONCERN: (1) Aging Degradation Evaluation (page 2 of TER)
(2) Qualified Life or Replacement Schedule Established (page 2 of TER)
(3) No aging evaluation has been conducted (page 5h of TER)

RESOLUTION:

Sheet 11 of the QDR, reproduced on page 5i of the TER, summarizes the thermal cycle test in Amphenol report 123-1275 but does not provide an Arrhenius calculation to predict a qualified life. Clearly such a calculation would predict a very long life: for example, using the conservative activation energy of 0.7 ev developed on sheet 13 of the QDR, the one hour of thermal testing at 400°F corresponds to over 1,000 years at the compartment ambient of 105°F.

The QDR concluded that the evidence is not sufficient to justify a 40 year qualified life, and an Ongoing Aging Surveillance Program should be performed. This deficiency by itself would not cause the penetrations to be classified in TER Category IIa. Category IIc, "Qualified Life Deficiency," would be appropriate.

C. CONCERN: (1) Temperature/Pressure Test Duration (TER page 2)
(2) Temperature/Pressure Required Profile Enveloped by Test Profile (TER page 2)
(3) Note 5 states that two referenced tests envelop neither the peak temperature nor entire duration, while a third referenced test which exceeds the peak temperature does not have adequate duration. (TER page 5j; test and plant profiles reproduced on pages 5k through 5n).

RESOLUTION:

This concern primarily reflects the fact that in 1972 the industry did not conduct 120-day LOCA tests; secondarily, the peak temperature in the Davis Besse LOCA test (the most closely related test to Surry LOCA conditions) is slightly lower than for Surry. This concern is not considered significant for the reasons that follow.

The Surry peak LOCA temperature for the penetrations is 280°F for 30 minutes. It decays to 150°F in the next 30 minutes, then to 120°F by the end of two days and remains at 120°F for the balance of the 120 day post-LOCA required operating period.

Attachment No. 2 of the QDR presents a series of Arrhenius calculations to show that the Davis Besse LOCA test is more severe than the Surry LOCA. This is shown by converting both profiles to equivalent time at 120°F, using a conservative actiation energy of 0.7 ev. The calculations show that the Davis Besse test corresponds to an additional two months of post-LOCA operation at Surry after the required 120 day operating time. The two LOCA profiles, shown in Figure 13 of the QDR, do not differ significantly, and this approach is not considered to represent an abusive use of the Arrhenius technique.

Since the Davis Besse test did not bound the Surry peak temperature, the QDR also referred to Amphenol's "Maximum Credible Accident" test. In this test the penetrations experienced 300°F for 15 minutes dropping to 250°F for the balance of 24 hours. The thermal aging test discussed under the aging concern exposed the penetrations to seven hours at or above 300°F; this test was performed in dry air rather than steam. These two tests provide substantial evidence that threshold effects or other adverse behavior will not occur in the small portion of the Surry LOCA peak not enveloped by the Davis Besse test.

With respect to the concern that Arrhenius calculations should not be used to extrapolate high-temperature, saturated steam exposure to low temperature, oxygen-rich operation, two points are noted: First, in Attachment No. 2 of the QDR it is evident that most of the "credit" for post-LOCA operating time derives from testing at or below 180°F, which does not reflect a steam environment. Second, the aging justifies many years operation at ambient temperature, based on the oxygen-rich thermal aging test.

It is noted that the QDR contains an error in presenting LOCA test results. For the Davis Besse test both temperature and duration values used are incorrect because the test procedure rather than the test report was used. The TER presents correct conditions. In spite of the error the results of the calculation in Attachment No. 2 of the QDR remain valid (lower temperature and longer time tend to offset), but the QDR will be corrected.

Summarizing, the justification for LOCA qualification of the penetrations is considered valid.

D. CONCERN: (1) Spray (page 2 of TER)
(2) "Boric acid was mixed and boiled to make steam. No spray was used." (page 5j of TER)

RESOLUTION:

The direct impingement forces of droplets from containment spray nozzles become insignificant relative to LOCA pressures beyond one or two feet from the nozzle. The Surry penetrations are located no closer than several feet from spray nozzles. Thus the spray test is considered to have adequately simulated the Surry LOCA environment even though the solution was not directly sprayed through a nozzle into the test chamber.

E. CONCERN: (1) Radiation (TER page 2)
(2) Note 4 challenges the qualified radiation dose of 1.03×10^8 rads claimed in the QDR (TER page 5i)

RESPONSE:

The TER presents (on page 5h) documentation from the Hanford laboratory showing that, although portions of the test container received 1.03×10^8 R, other portions received as little as 1.22×10^7 R. The TER further presents on page 5h a caution that radiation exposure was quoted in Roentgens and would have to be converted to rads to reflect absorbed dose.

The required radiation dose for the Surry penetrations is 7.44×10^6 rads (40 years plus LOCA). The conversion from Roentgens to rads for the organic materials of concern is unlikely to vary from 1.0 by more than ten to twenty percent, so the qualified dose is at least 1×10^7 rads. This exceeds the plant environment.

ATTN. MR. W. C. SPENCER

AMPHENOL
SPACE AND MISSILE
SYSTEMS DIVISION

9201 INDEPENDENCE AVENUE • CHATSWORTH, CALIFORNIA 91311 • TEL: 213-341-0710 • TWX 910-494-1211

4.10-1

HF:4:1:603

April 12, 1971

TELECOPIED
TIME 245 P
DATE 4/14/71

Stone & Webster
225 Franklin Street
Boston, Massachusetts 02107

Attention: A. W. Goldman, Consultant
Electrical Division

Subject: Qualificaiton Test of Connector in Type IA, IIA & III Penetration Assemblies

Reference: Your TWX of 4-8-71

Gentlemen:

In answer to Stone & Webster's question, the connectors provided have not been qualification tested. However, the design of these connectors is based upon the requirements of military specification No. MIL-C-5015 which includes environmental testing. Connector design is such that at least one and in some cases, two silastic components are provided in the connector to feedthru interface. This type of interface has been proven adequate to meet the environmental requirements of MIL-C-5015. Also, additional capability to withstand elevated temperatures, is provided in the silicone material used for the sealing members.

A copy of MIL-C-5015 is attached for your review. Obviously, the tests outlined in the spec are not based on the "accident" condition in question, but I think a useful comparison can be made.

Should you require verification testing, it can be performed at additional cost.

Sincerely,

Harry J. Fleck
Sales Correspondent

HJF:fp

cc: E. Stadler
W. Sullivan
D. Sorenson
R. Purinton
K. Rabe

SK

TELECON NOTE

Date: 4/15/81 Time: 11:45 A.M File: 5627-4.10

Between: H HILBEIG of: DG O'BRIEN

And: J Solano (NUS)

DISCUSSION:

I CALLED DG O'BRIEN CO. AND TALKED TO MR. H. HILBEIG ABOUT SENDING US SOME PENETRATION REPORTS ON EQUIP TESTED FOR SURRY 1+2. MR. HILBEIG SAID THAT THEY MAY HAVE SUCH REPORTS ON FILE AND HE WOULD BE VERY GLAD TO SEND THEM TO US.

ACTION ITEMS:

MR. HILBEIG NEEDS A REQUEST LETTER FROM US IN ORDER TO RELEASE SUCH REPORTS.

ENGINEERING DIVISION
~~Equipment Qualification~~

APR 23 1981

TELECON NOTE

No.

Date: 4/23/81 Time: 9-40 AM File: 5437-4.10

Between: H. Hilbeig (603-470-5576) & D.G. O'brien

And: Nick Garg (NUS)

DISCUSSION:

Hilbeig told me that he did not receive our letter yet. He will dig into his files for the following types of penetration and will try to send available reports on them by 4/24/81.

Pent. — Amphenol type IA, IB, IC, III & IV

In case he doesn't find any thing on these penetrations he will call me back.

I asked them to send report # 123-1268, 123-1269, 123-2045 Rev A and the report prepared on Aging. These reports were prepared for Davis Besse.

ACTION ITEMS:

cc. J. Salano
S. Kasturi.

~~Memo~~ Mano - Aron
EX-377

ENGINEERING DIVISIO
Equipment Qualificatio

APR 23 1981

TELECON NOTE

No.

Date: 4/23/81 Time: 1-10 PM File: 5437-4.108

Between: [illegible] of: Amphenol

And: Nick Garg (NUS)

DISCUSSION:

Called and talked to the [illegible] dept. They told me Mr Mano - Aron is looking after [illegible]. He was not in the office. A message is left in his office to call me as soon as possible.

His Telephone No is 213-341-0710 Ext 377

cc: Salama
Kalhir

N. Garg

ACTION ITEMS:

NUS CORPORATION
4 RESEARCH PLACE
ROCKVILLE MARYLAND 20850
301 948-7010

SK

ENGINEERING DIVISION
Equipment Qualification
APR 27 1981
No.

April 24, 1981
5437-4.10

Amphenol Sams-Bunker Ramos Corporation
9201 Independent Avenue
Chatsworth, California 91311

ATTN: Mano Aaron

Subject: Penetration Qualification Documentation

Gentlemen:

Confirming our telecon of April 24, 1981, please send me a complete set of qualification documentation for Nuclear Applications on Power, Thermocouples, Instruments and Triaxial Penetrations.

Thank you for your kind assistance.

Very truly yours,

J. R. Solano
Staff Engineer

TELECON NOTE 5437-TL-046

Date: 5/5/81 Time: ______ File: 5437 ~~4.10~~

Between: R. J. Crowell of: D. G. O'brien

And: J. Solano JL (NUS)

DISCUSSION:

I told Mr. Crowell that the report #C19QA061 on Amphenol penetration does not include the test on Rad. and chemical spray exposures. He told me that this report was prepared a long time ago and at that time they did not have the facility to do rad. and spray test.

He will find out if some tests were conducted on radiation and spray tests and will call me back.

cc: Nick Garg
S. Kasturi

5437-TL-049

TELECON NOTE

Date: 5/6/81 Time: 12. P M. File: 5437- Hilton

Between: JO Armstrong. (213-341-0710) of: Amphenol.

And: N. K. GARG / J Solano. (NUS)

DISCUSSION:

Mrs. Armstrong told me that the requested reports can be sent to us only after getting a authorization letter from either Stones & Webster or VEPCO. After getting a authorization letter she will work on the cost of these reports for which VEPCO has to issue a Purchase order.

At this time she doesnot have any idea of what kind of information they can supply to us.

N. Garg

ACTION ITEMS:

CC: S. Kasturi.

J. Solano.

N. GARG.

TELECON NOTE 5437-TC-050

Date: 5/6/81 Time: 12-50 PM File: 5437 - 1.0 /4.10 ✓

Between: Rip Newcomb of: VEPCO.

And: Nick GARG (NUS)

DISCUSSION:

1. Asked about DCP No - Rip told me that DCP # shall be given by VEPCO. He will find out the person who will assign these numbers and let me know. He also told me that NUS' other departments are preparing DCP for Vepco. Same procedure can be followed.

2. I told him about the conversation with Amphenol comp. Amphenol company can issue the reports to NUS only after getting a authorization either from VEPCO or Stones & Webster. After getting the authorization

ACTION ITEMS:

Amphenol shall submit the cost for these reports etc and after getting a P.O from Vepco they will issue the reports.

Rip is going to check on it and will call me back.

N. Garg

CC: S - KASTURI
B - Golenbiki
J - Solano.
N - GARG.

TELECON NOTE: 5437-TL-053

Date: 5/7/81 Time: 10:30 AM File: 5437 ~~-410~~

Between: D Howard of: Arkansas Power & Light

And: I Solano (NUS)

DISCUSSION:

Asked Mr. Howard for copies of Amphenol Penetration Reports Nos. 123-2045, 123-1268 & 123-1269. Mr Howard referred me to Mr. Tony Eyman in Florida. He said that in case Mr. Inman does not have them, he'll send them to us.

CC: N Gock
S Kasturi

ACTION ITEMS:

AMPHENOL NORTH AMERICA

Bunker Ramo Corporation
9201 Independence Ave • Chatsworth, California 91311 • 213/341-0710

S KASTURI
N · GARG. — NG
file.

May 29, 1981 BJA:5:1:049

4.10

NUS Corporation
4 Research Place
Rockville, MD 20850

Attention: J. R. Solano, Staff Engineer

Reference: Your request for Qualification Documentation for Nuclear Applications on Power, Thermocouples, Instruments and Triaxial Penetrations.
Technical Reports 123-2045, 123-1268 and 123-1269

BUNKER RAMO

Dear Mr. Solano:

Because the referenced reports were prepared for Toledo Edison and Arkansas Power and Light Company, it is necessary for you to obtain their permission prior to our releasing the reports. The documents are available and will be sent to you after approval has been received.

As previously quoted to you, our minimum order value is $250.00.

Upon receipt of the releases from the Utilities and your P.O. for $250.00, the reports will sent immediately.

Thank you for your interest in Bunker Ramo. We look forward to hearing from you.

Sincerely,

BUNKER RAMO CORPORATION
Amphenol North America Division
SAMS Operation

Jo Armstrong

(Mrs.) Jo Armstrong
Nuclear Product Manager

BJA:bln

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 8

TER Category: IIa

Description: ELECTRICAL PENETRATION

Manufacturer, Model: Amphenol Type IC, Spec. NUS-41

Tag No(s).:

Worksheet No(s).: 6-45

QDR No.: 5437-127-01

Location: RC-18B

DISCREPANCY

(Refer to Surry 2 Item 7)

RESPONSE

(Refer to Surry 2 Item 7)

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 9

TER Category: IIa

Description: ELECTRICAL PENETRATION

Manufacturer, Model: Amphenol Type IB, Spec. NUS-41

Tag No(s).:

Worksheet No(s).: 6-44

QDR No.: 5437-127-01

Location: RC-18B

DISCREPANCY

(Refer to Surry 2 Item 7)

RESPONSE

(Refer to Surry 2 Item 7)

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 10

TER Category: IIa

Description: ELECTRICAL PENETRATION

Manufacturer, Model: Amphenol Type IA, Spec. NUS-41

Tag No(s).:

Worksheet No(s).: 6-43

QDR No.: 5437-127-01

Location: RC-18B

DISCREPANCY

(Refer to Surry 2 Item 7)

RESPONSE

(Refer to Surry 2 Item 7)

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 12

TER Category: IIa

Description: FLOW TRANSMITTER FOR COLD LEG SI (PAM)

Manufacturer, Model: BARTON, Model 386

Tag No(s).: FT-2961, FT-2962, FT-2963

Worksheet No(s).: 6-280, 6-281, 6-282

QDR No.: None

Location: RC-27B

DISCREPANCY

This is PAM equipment which was under review at the time of the 90-day Rev. 4 submittal. Qualification was not established.

RESPONSE

This equipment will be replaced by qualified equipment within the schedule established in 10CFR50.49. In the interim, due to equipment type similarity, justification for continued operation is provided in the 90-day response section 7.2.5 for this equipment type. The TER classifies other equipment of this type in Category Ib, Equipment Qualification Pending Modification.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 13

TER Category: IIa

Description: FLOW TRANSMITTER FOR LOW HEAD INJECTION HEAD (PAM)

Manufacturer, Model: ROSEMOUNT, Model 1152DP5

Tag No(s).: FT-2945, 2946

Worksheet No(s).: 6-283, 6-284

QDR No.: 5437-241-01

Location: SFGD-1

DISCREPANCY

Qualification was not established for this item because the review package (QDR) was not provided.

RESPONSE

The QDR listed under COMPONENT was prepared subsequent to submittal of the SER and 90-day Rev. 4 responses. The QDR establishes qualification, and is being submitted at this time.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 17

TER Category: IIa

Description: LEVEL TRANSMITTER FOR CONTAINMENT SUMP (TMI ITEM)

Manufacturer, Model: GEMS Model XM54853/XM54854

Tag No(s).: LT-RS-251A, B

Worksheet No(s).: 6-271, 6-272

QDR No.: future

Location: RC-27B

DISCREPANCY

This is a new equipment item for TMI purposes. Qualification testing has not been completed.

RESPONSE

This equipment item duplicates item 118; 90-day worksheets 6-271 and 6-272 cover the same equipment as TMI worksheets 10.3-30 and 10.3-31, respectively.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 26

TER Category: IIa

Description: DAMPERS FOR HVAC/AUXILIARY BUILDING VENTILATION

Manufacturer, Model: RCS, Inc. Type BL

Tag No(s).: 3A(2), 3B(2)

Worksheet No(s).: 6-112, 113

QDR No.: 5437-80-01

Location: AB-45

DISCREPANCY

Licensee deleted equipment from Master List, but provided no reason and no qualification documentation.

RESPONSE

Surry 1 worksheet 6-110(attached) provided the reason for deleting the corresponding Unit 1 dampers; namely, that the HELB for which damper operation is required does not affect the damper environment.

The Surry 2 worksheets are labeled "Deleted - see conclusion section," which does not provide a reason. However, the Surry 2 dampers are not exposed to a harsh environment and should be deleted from the Master List.

This equipment should be classified in Category IIIb, "Equipment Not in the Scope of the Qualification Review."

Facility: VEPCO, SURRY
Unit: 2
Docket: 51-281

SYSTEM COMPONENT EVALUATION WORKSHEET - 90 DAY REVIEW

SYSTEM:
HVAC/AUXILIARY BUILDING VENTILATION

EQUIPMENT DESCRIPTION

PLANT ID NO.
1-VS-F-58A

COMPONENT:
Central Exhaust Fan Motor

MANUFACTURER:
Siemens-Allis Inc.

MODEL NUMBER:
Frame No. 444TS
Class F - Insulation

FUNCTION:

ACCURACY:
Spec:
Demo: NR

LOCATION: AB-45
Auxiliary Building Ventilation

SERVICE:
Auxiliary Building Control Area Exhaust Fan

FLOOD LEVEL ELEV: NR
ABOVE FLOOD LEVEL: Yes
No

	Environment		Documentation Reference			
Units	Specification	Qualification	Specification	Qualif.	Method	Outstanding Items
OPER. TIME	120 days	365 days	Westinghouse Ref. Ltr. No. NS-SS-79287	91	Vendor Analysis & Prototype Test	None
TEMP F	205, 0-30 sec 205-120, 30 sec-1 hr (See Note 2)	122	S&W Calc. 12846.44-PE-050-0	91	Vendor Analysis & Prototype Test	None
PRESS. psia	15.2, 0-1 min 14.9, 1-60 min	14.7 psia	S&W Calc. 12846.44-PE-046-0	91	Vendor Analysis & Prototype Test	None
REL. HUM. %	100	100%	S&W Calc. 12846.44-PE-046-0	91	Vendor Analysis & Prototype Test	None
CHEM. SPRAY	NR	NR	NR	NR	NR	None
RAD.	LOCA = 2.7 x 10E5 40 yr = 1.1 x 10E5	2 x 10E8	S&W Calc. 12846.44-UR(B)-043-0	91	Vendor Analysis & Prototype Test	None
AGING	40 Yrs	40 Yrs (Note 1)	VEPCO Spec. NUS-9060	91	Vendor Analysis & Prototype Test	None
SUB.	NR	NR	NR	NR	NR	None

VOID

NR = Not required. All numbers written in Documentation Reference Qualification column are identified in Section 8.

NOTES: 1) In Vendor's Analysis report the theoretically qualified life is 113 yrs. which is much higher than 40 yrs. Vendor is contacted to provide their backup calculations and assumptions for 113 yrs. life.
2) Based on a review of the postulated HELBs, it was determined that safety-related equipment required to mitigate the HELB and bring the plant to a safe shutdown is not affected by the break. However, this equipment is being reviewed against the effects of an HELB to determine our ability to maintain minimum boration capability, to assure additional plant operations capability.

DELETED - See conclusion section.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 30

TER Category: IIa

Description: ELECTRICAL PENETRATION (THERMOCOUPLES)

Manufacturer, Model: Amphenol Type IV

Tag No(s).:

Worksheet No(s).: 6-47

QDR No.: 5437-127-01

Location: RC-18B

DISCREPANCY

The worksheet identified this item as "Thermocouples", and in the Surry 2 TER it was addressed as "Thermocouple Cable." In fact the equipment is containment penetrations for thermocouples (see Surry 1 item 10). Qualification was not established.

RESPONSE

(Refer to Surry 2 Item 7)

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 34

TER Category: IIa

Description: 5KV COLLYER CROSS LINKED POLYETHYLENE INSULATED CABLE

Manufacturer, Model: Collyer Insulated Wire Co.

Tag No(s).: Spec. No. NUS-364, SN-1250

Worksheet No(s).: 6-60a

QDR No.: 5437-132-01

Location: AB-27

DISCREPANCY

Licensee qualified the subject cables but did not furnish the manufacturer's certification regarding: 1) cable construction methods (chemically cross linked or irradiationally cross linked) used and 2) applicability of the test reports to the subject cables.

RESPONSE

The review of the plant records reveals that the Collyer cables are not used for any safety-related equipment which is located in harsh environment.

This equipment should be classified in Category IIIa "Equipment Exempt from Qualification".

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 35

TER Category: IIa

Description: HIGH TEMPERATURE CABLE

Manufacturer, Model: CONTINENTAL WIRE & CABLE, CROSS-LINKED POLYETHYLENE

Tag No(s).: NUS-326

Worksheet No(s).: 6-60

QDR No.: 5437-131-01

Location: RC-3A

DISCREPANCY

Qualification was not established for this item because the review package (QDR) was not provided.

RESPONSE

The QDR listed under COMPONENT was prepared subsequent to submittal of the SER and 90-day Rev. 4 responses. The QDR establishes qualification, and is being submitted at this time.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 39

TER Category: IIa

Description: 600 VOLT, COLLYER CROSS LINKED POLYETHYLENE INSULATED CABLE

Manufacturer, Model: Collyer Insulated Wire Co.

Tag No(s).: Spec. No. NUS-365E, SN-457

Worksheet No(s).: 6-54

QDR No.: 5437-135-01

Location: RC-3A

DISCREPANCY

Licensee qualified the subject cables but did not furnish the manufacturer's certification regarding: 1) cable construction methods (chemically cross linked or irradiationally cross linked) used and 2) applicability of the test reports to the subject cables.

RESPONSE

Per Collyer correspondence letter dated Sept. 10, 1971 (included in the referenced QDR page 2a, in the end) the Purchase Order No. SN-457 (Spec. NUS-365E) was cancelled in its entirety.

Also the review of the plant records reveals that the Collyer, XLPE cables are not used for any safety-related equipment which is located in the harsh environment and listed on the Master List.

This equipment should be classified in Category IIIa "Equipment Exempt from Qualification."

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 41

TER Category: IIa

Description: 1000 VOLT CONTINENTAL CROSS LINKED POLYETHYLENE INSULATED CABLE

Manufacturer, Model: Continental Wire & Cable

Tag No(s).: Spec. No. NUS-420, SN-1463

Worksheet No(s).: 6-42

QDR No.: 5437-130-01

Location: RC-3A

DISCREPANCY

Licensee qualified the subject cables but did not furnish the manufacturer's certification regarding: 1) cable construction methods (chemically cross linked or irradiationally cross-linked) used and 2) applicability of the test reports to the subject cables.

RESPONSE

Continental Wire & Cable (Anaconda) letters included in the referenced QDR (also included as an attachment to this TER item) were re-reviewed and the applicability of the test reports to the subject cables has been established.

Per IEEE Paper dated May, 1969 "Insulation and Jackets for Control and Power Cables in Thermal Reactor Nuclear Generating Stations" the XLPE insulated are designated in radiation class 3 (8.8×10^8 Rads) and recommended for nuclear use for safety related equipment.

This equipment should be classified in Category Ia, "Equipment Qualified".

This clarification of the cable qualification should preclude FRC concerns regarding the construction methods used for the test cables and the applicability of the test reports as referenced.

ATTACHMENT TO TER ITEM NO. 41
VEPCO SURRY UNIT #2

QUALIFICATION OF 1000V, XLPE Continental Cables

The qualification of 1000V, Continental (Anaconda) cross linked polyethylene insulated cable is established in QDR-5437-60-01.

1) These cables were bought under specification no. NUS-420 (SN-1463) in November 1971.

2) Attached Anaconda (Continental) letters dated July 14, 1978 and July 11, 1978 (also included in referenced QDR on page 3a) indicate that they used CC-2210 FR-XLP compound for all their cross linked polyethylene cables which they supplied to VEPCO for Surry Power Plants.

3) Anaconda supplied the physical properties of CC-2210 cross linked polyethylene (used for Surry order) after various environmental conditioning, simulating a LOCA incident. They also provided the radiation resistance curve vs the tensile strength and elongation which are good for 600V cables thicknesses listed in Table I of Attach. 3 in page 3a of referenced QDR.

4) In attachment no. 3 of page 3a of the referenced QDR 5437-60-01 for Unit #1 (5437-130-01 for Unit #2), per Table I they supply 600V XLPE cables from 25 mil's thickness to 78 mils of the same compound, qualified under the same curves which they provided with their July 11, 1978 letter.

5) As stated on page 11 of Section No. 1 of the referenced QDR-5437-60-01 (QDR-5437-130-01 for Unit #2) the insulation thickness of the compound, used for the subject cables is 45 mils which is in between the values listed above in item 4. This indicates that the radiation curves and other physical property curves are applicable to this cable also.

Conclusion:

After considering the above facts we conclude that, because the same compound is used and the thicknesses meet Anaconda's specification, the same qualification reports are applicable to these cables which qualified 600 volt XLPE Continental as shown in QDR-5437-60-01 (5437-130-01 for Unit #2).

ANACONDA

July 11, 1978

Stone & Webster Engineering Co.
P.O. Box 2325
Boston, MA 02107

Attn: Howard Redgate

Re: VEPCO/Surry Generating Station;
Continental Wire and Cable PO's SN-285 and SN-1458.

Dear Mr. Redgate:

In response to your request for additional information on CC-2210 FR-XLP please find attached our data sheet of August, 1971 entitled "Physical Properties of CC-2210 Cross-linked PE After Various Environmental Conditioning, Simulating a L.O.C.A. Incident in a Nuclear Generating Station". We further state that a FR-XLP insulation material designated CC-2210 was used on the above referenced orders.

Very truly yours,

CONTINENTAL WIRE & CABLE

Paul S Cardello

Paul S. Cardello
Chief Engineer

PSC:ts
cc: File
Attachments-2

This drawing or document and information set forth herein are the property of Continental Wire & Cable Corp. and shall not be used or disclosed, except in accordance with its written permission.

PHYSICAL PROPERTIES OF CC-2210 CROSS-LINKED PE AFTER VARIOUS ENVIRONMENTAL CONDITIONING, SIMULATING A L.O.C.A. INCIDENT IN A NUCLEAR GENERATING STATION.

CONDITIONING	TENSILE (PSI)	ELONGATION (%)
NONE	2440	550
STEAM/BORIC ACID[1]	2390	450
RADIATION ONLY		
$1X10^7$ RADS (GAMMA)[2]	2640	425
$5X10^7$ RADS "	2230	238
$1X10^8$ RADS "	1710	100
RADIATION AFTER STEAM/BORIC ACID[1]		
$1X10^7$ RADS (GAMMA)[2]	2580	393
$5X10^7$ RADS (GAMMA)[2]	2200	200
$1X10^8$ RADS (GAMMA)[2]	1600	69

WIRE SAMPLE #16 (7) AWG, .030" WALL CC-2210

(1) 120 HOURS, 50 PSIG STEAM at 298°F, FOLLOWED BY 120 HOUR IMMERSION IN 0.5% BORIC ACID SOLUTION @ 160°F.

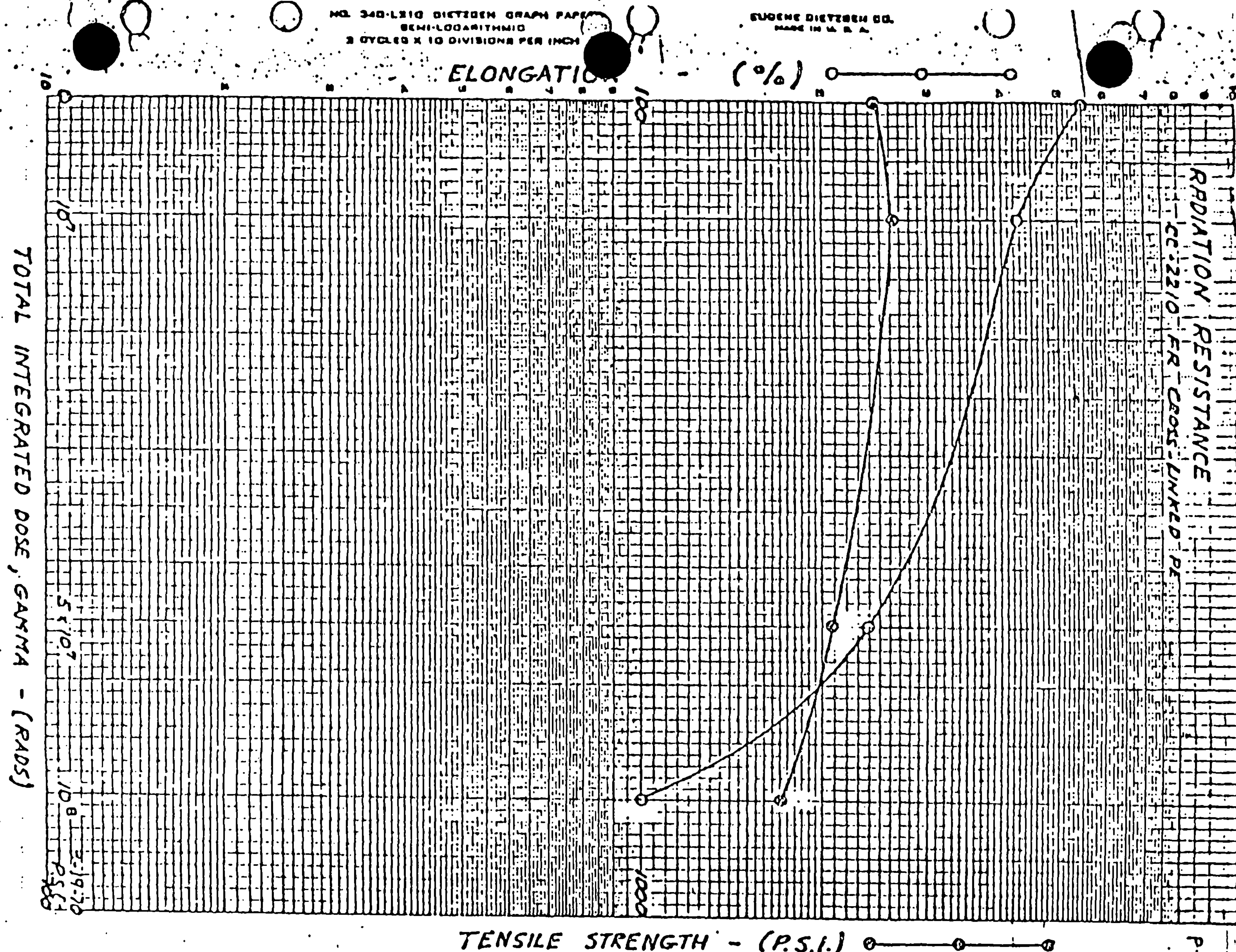
(2) COBALT 60 SOURCE (NEUTRON PRODUCTS, MD.).

NO.	CHANGE	DATE	BY

REVISIONS

CONTINENTAL WIRE & CABLE CORP.

DRN. M.O.A. DATE
CKD. DATE
APP. [initials] DATE 8/71


NO. 340-L210 DIETZGEN GRAPH PAPER
SEMI-LOGARITHMIC
3 CYCLES X 10 DIVISIONS PER INCH
EUGENE DIETZGEN CO.
MADE IN U. S. A.
ELONGATION - (%)
10
100
1000
10^7
5×10^7
10^8
TOTAL INTEGRATED DOSE, GAMMA - (RADS)
RADIATION RESISTANCE
CC-2210 FR CROSS-LINKED PE
TENSILE STRENGTH - (P.S.I.)
2-19-70

ANACONDA

July 14, 1978

Stone & Webster Engineering Co.
P.O. Box 2325
Boston, MA 02107

Attn: Howard Redgate

Re: VEPCO/Surry Generating Station

Dear Mr. Redgate:

In response to your request, we have checked our files and find that all instrumentation cable manufactured for the referenced project, of the FR-XLP and Hypalon variety, which was ordered in the time period of 1969 through 1971, was manufactured with a cross-linked polyethylene insulation material designated as CC-2210.

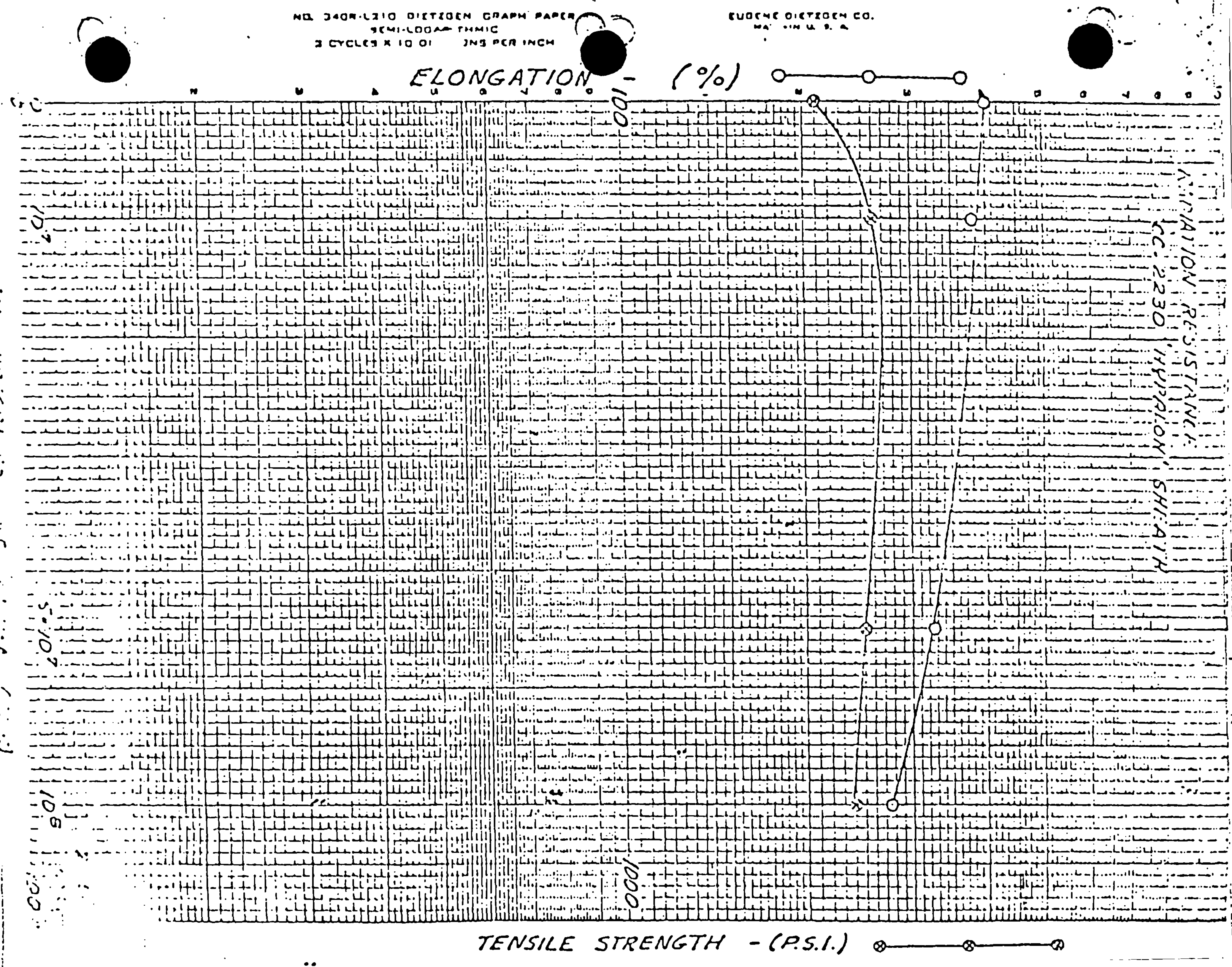
Very truly yours,

CONTINENTAL WIRE & CABLE

Paul S. Cardello

Paul S. Cardello
Chief Engineer

PSC:ts
cc: File



NO. 340R-L210 DIETZGEN GRAPH PAPER
SEMI-LOGARITHMIC
3 CYCLES X 10 DIVISIONS PER INCH
EUGENE DIETZGEN CO.
MADE IN U.S.A.
ELONGATION - (%)
100
1000
TENSILE STRENGTH - (P.S.I.)
RADIATION RESISTANCE, CC-2230 HYPALON, SHEATH
10⁷
5×10⁷
10⁸

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 44

TER Category: IIa

Description: 300 VOLT, CERRO CROSS LINKED POLYETHYLENE INSULATED CABLES

Manufacturer, Model: Cerro Wire & Cable Company

Tag No(s).: Spec. No. NAS-430, NA-392/1392

Worksheet No(s).: 6-35

QDR No.: 5437-121-01

Location: RC-3A

DISCREPANCY

Licensee qualified the subject cables but did not furnish the manufacturer's certification regarding: 1) cable construction methods (chemically cross linked or irradiationally cross-linked) used and 2) applicability of the test reports to the subject cables.

RESPONSE

Cerro Wire and Cable Company correspondence included in the referenced QDR, were re-reviewed and the applicability of the test reports to various cables is established in the attachment of this TER ITE No. 36.

Per IEEE Paper dated May, 1969 "Insulation and Jackets for Control and Power Cables in Thermal Reactor Nuclear Generating Stations" the XLPE insulated are designated in radiation class 3 ($8.8x10^8$ Rads) and recommended for nuclear use for safety related equipment.

This equipment should be classified in Category Ia, "Equipment Qualified".

ATTACHMENT TO TER ITEM NO. 44
OF VEPCO SURRY UNIT #2

Qualification of Cerro XLPE Cables

Following is the summary on Cerro XLPE cable qualification in regard to FRC evaluation:

1. 1000V, XLPE Cables: (TER ITEM #36 for Unit #1 & 73 for Unit #2)

   1000V, XLPE cables were bought under the following 4-different specifications:

   i) Specification No. NUS-325, (P.O. #SN-246), dated July 30,69.
   ii) Specification No. NUS-362, (P.O. #SN-1246), dated Feb. 17,70.
   iii) Specification No. NUS-381C, (P.O. #SN-446), dated Jan. 22 / March 22]-71.
   iv) Specification No. NUS-381E, (P.O. #SN-1447/1246), dated April 13 / June 10]- 1971

All the above cables were covered in QDR-5437-55-01 for Unit No. 1 and 5437-134-01 for Unit No. 2.

Qualification is established as follows:

i) Per Stone and Webster letter, dated Dec. 12, 1980, to Rockbestos (attached) and the purchase order, the cables under

   Spec. NUS-325, P.O. SN-246 were bought from Dec. 15, 69 thru July, 23, 70
   Spec. NUS-381C, P.O. SN-446 were bought from July 19, 1971 thru Aug. 23, 1971
   Spec. NUS-381E, P.O. SN-1447 were bought from Aug. 18, 1971 thru Sept. 7, 1971
   Spec. NUS-362, P.O. SN-1246 were bought from June 19, 1970 thru March 8, 1971

   Therefore, all the above cables were shipped from Dec. 15, 1969 thru Sept. 1971.

ii) Cerro letter dated Aug. 1, 1969 (included on page 3b of the referenced QDR) indicates that all the 1000V XLPE cables will be "Pyro Trol-III" control cables in accordance with the VEPCO specifications. These were manufactured by Cerro Company per their Specification No. RSS-3-701 of 11/1/68 (page 3b of the of the QDR) with the exception of thickness. Thickness was in accordance with IPCEA Standard.

   The Specification No. RSS-3-701 indicates that the insulating compound used was flame-retardant, chemically cross-linked polyethylene.

iii) Cerro Wire & Cable Comp. letter dated Aug. 20, 1969 (Page 20 of the referenced QDR) indicates that the cables manufactured were "Pyro-Trol III" cables which were tested by FRC Report No. F-C2404-01, dated June 1969.

iv) Franklin Report No. F-C2404-01 was prepared in June 1969. It included only radiation testing upto 2.5x10^7 rads, humidity testing of 6 hrs, and steam pressure test @ 62 psig for 15 min., and cooled down to 150°F in 30 min. Four samples were tested from product code 644N30 and 655N30 - series (four diff. batches).

v) We procured one more Franklin Report #F-C2857 dated Sept. 1970 in which they tested 8 different types of Cerro cable. They included one sample of "Pyro-Trol III" cable also with the same product code 655N30 series (30 mils of flame retardant cross-linked polyethylene insulation thickness). This report addressed radiation (from 55 Mrad thru 179 Mrad), humidity, steam press. & chemical spray test for 7 days.

The spray test of seven days is quite severe to justify the LOCA requirement of the plant (see the attached analysis).

Our QDR will be revised to reflect the review of the subject cables per these reports and the Franklin Report #F-C3798 which is used to qualify these cables will be deleted.

2. 300V & 600V, XLPE Cables: (QDRs-5437-50-01,51-01,53-01 for Unit #1&
QDRs-5437-118-01,119-01,121-01--Unit #2

Originally these 300V & 600V, XLPE cables were bought for N. Anna power plant but later were transferred to Surry power plant for the required use.

These were bought under the following 2 different specifications:

i) Specification No. NAS-120, (P.O. #NA-312/1312), dated Oct. 1969 thru March, 1972.
ii) Specification No. NAS-3187, (P.O. #NA-3187/4183), dated Oct. 11, 1973.
iii) Specification No. NAS-430, (P.O. #NA-392/1392), dated June, 1974.

Qualification of cables in Spec. NAS-120, NAS-3187, & NAS-430 is addressed in QDR #s. 5437-50-01, 5437-51-01 & 5437-53-01 respectively for Unit #1 (QDR #5437-118-01, 5437-119-01, 5437-121-01 for Unit #2).

Qualification is established as follows:

i) Per Stone & Webster letter, dated Dec. 12, 1980, to Rockbestos and the purchase orders the cables were supplied during the following period:

Cables under Spec. NAS-120, P.O. NA-312/1312 - June 23, 1972 thru March, 1978.
Cables under Spec. NAS-3187, P.O. NA-3187/4187 - May 21, 1976 thru Nov. 1976.
Cables under Spec. NAS-430, P.O. NA-392/1392 - June 24, 1974 thru Aug. 1978.

ii) Rockbestos Comp. wrote a letter to S&W on Feb. 21, 1979 which indicates that the cross-linked polyethylene cables supplied under P.O. NA-392 were certified Class IE which are qualified to LOCA. They also enclose the qualification report for Firewall III cables, dated July 7, 1977 which covers these cables.

Although the letter indicated P.O. #392 (spec. no. NAS-430) because all the cables were bought in the same time frame it has been concluded that all the cables in all the three specifications were covered by this report.

Cerro Cable Company revised the same qualification report in Nov. 26, 1979, Dec. 8, 1980 and Dec. 23, 1980. (Ref. 27A) and called the same samples with the same name Firewall III cables with the insulation description as chemically cross-linked polyolefin instead of cross-linked polyethylene. They also provided their specification of Firewall III cables #RSS-3-021. In Pkg. # 5437-51-01 we used one report for XLPE cables which was also prepared by Rockbestos in May, 1976 for the same Firewall III cable.

From a detailed review of all the above mentioned reports it has been concluded that Cerro Cable Co. prepared all cables prior to 1978 by using chemically cross-linked polyethylene.

NRC Concerns

1) In reviewing the qualification cables FRC reviewed the various QDRs for the cables. The following table reveals the discrepancy:

S. No.	Cable Spec. No.	FRC REVIEW SHEETS				Right Applicable QDR #s	
		ITEM #		QDR #s			
		Unit #1	Unit #2	Unit #1	Unit #2	Unit #1	Unit #2
1	NUS-325, 362, 381C, 381E	36	73	5437-53-01	5437-118-01	5437-55-01	5437-134-01
2	NAS-120	32	46	5437-53-01	5437-119-01	5437-50-01	5437-118-01
3	NAS-3187	32	46	5437-53-01	5437-119-01*	5437-51-01	5437-119-01
4	NAS-430	34	44	5437-55-01	5437-55-01	5437-53-01	5437-121-01

* - This is the only right QDR FRC reviewed for the right cable.

2) FRC's general comment is to get the applicability of the specific test report from the vendor.

In this regard as discussed in Sec. 1 & 2 above we found the letters from the vendor which describe the material used for the subject cables and applicability of the test report.

Conclusion:

By reviewing various test reports on Rockbestos XLPE cables from 1969 thru 1981 we found that all the cables manufactured by them, have successfully passed the radiation and LOCA test, irrespective whether it was chemically or irradiationally cross-linked. Based on this finding we have no discrepancies in the qualifications of the cables used in Surry Power Station.

This clarification of cable qualification should preclude FRC concerns regarding the construction method used for the test cables, and the applicability of the test reports as referenced.

Folder 30
48-2

COPY

Copy to:
SCBrown, Jr.
Attn: EGLifrage-2
(VEPCO INTERNAL DIST. TO BE MADE BY VEPCO IN ACCORDANCE WITH NOPPS MANUAL)

SCRossier
HWDurkin
DAPiccione
CECole
ESherwood
JMcCann
GJBurroughs
JHBarnhart
JFinnimore
WBDodson

CWilbur
ABanerjee
PReilly
WPC/12
LWBrown-Surry-3
EBroderick/C Files
EBroderick/Job Bk
General Files
PBienick
ISMacFarlane

Mr. J. R. Kushner
Vice President/Technical Director
The Rockbestos Company
195 Church Street
New Haven, CT 06510

December 12, 1980
J.O. No. 12846.44

Dear Sir:

IE BULLETIN 79-01B
ENVIRONMENTAL QUALIFICATION OF EQUIPMENT
SURRY POWER STATION - UNITS 1 & 2
VIRGINIA ELECTRIC AND POWER COMPANY

NRC IE Bulletin 79-01B, "Environmental Qualification of Class IE Equipment," issued to operating plants on January 14, 1980, outlines the qualification parameters for the environmental qualification of Class IE instrumentation and electrical equipment operating within these plants. With reference to your telephone conversation with our Mr. I. S. MacFarlane on December 5, 1980, we request any and all qualification test reports you can furnish on the following cables you supplied for VEPCO's Surry Power Station Units 1 and 2.

1. 600 volt control cable supplied to North Anna but utilized at Surry.

   a. Cable purchased under Stone & Webster P.O. No. NA-3187/4187 with a Specification No. NAS-3187 (Reference Mr. P. Reilly's letter to Mr. W. J. Patterson dated October 6, 1980). The following additional information is provided:

      (1) Cable supplied under NA-3187 originally had a Cerro order number of 80805 which was subsequently changed to 52313. The order addressed 16 items, which were shipped between May 21, 1976, and November 4, 1976.

      (2) Cable supplied under NA-4187 originally had a Cerro order number of 80806 which was subsequently changed to 52314. The order addressed 16 items, which were shipped between May 21, 1976, and November 4, 1976.

   b. Cable purchased under Stone & Webster P.O. No. NA-312/1312 with Specification No. NAS-120.

      (1) The items purchased under NA-312 were shipped between June 23, 1972, and September 14, 1977, and consisted of the following Cerro order numbers:

COPY

Cerro Order No.	Change to P.O. No. NA-312	Items Involved
21522	Original	1-19
22950	CH 3	20-23
24640	CH 5	21A
25231	CH 6	1
72655	CH 7	1
73555	CH 8	1,2,4,9, 12,18,19
80330	CH 9	1-15
50411	CH 14	5A
51816	CH 18	9
60741	CH 24	1-4
63603	CH 27	11
63904	CH 28	2,4,5,7,9
70511	CH 33	5,9
72107	CH 36	1,2,11,18

(2) The items purchased under NA-1312 were shipped between June 23, 1972, and March 9, 1978, and consisted of the following Cerro Order Numbers:

Cerro Order No.	Change to P.O. No. NA-1319	Items Involved
21522	Original	1-19
22949	CH 3	20-22
25320	CH 4	1
72654	CH 5	21B
73554	CH 6	1,2,4,9, 12,18,19

COPY

Cerro Order No.	Change to P.O. No. NA-1319	Items Involved
80331	CH 7	1-15
50412	CH 13	5A
51815	CH 17	9
60742	CH 23	1-4
63604	CH 26	11
63904	CH 27	2,4,5,7,9
70511	CH 32	5,9,12
71205	CH 36	1,2,11,18
71205	CH 39	2,3,4,6,7,9

2. 1000 volt control cable supplied to Surry.

a. Cable purchased under Stone & Webster P.O. No. SN-246 with Specification No. NUS-325 (Reference Mr. P. Reilly's letter to Mr. W. J. Patterson dated October 6, 1980). The cables were shipped between December 15, 1969, and July 23, 1970, and consisted of the following Cerro order numbers:

Cerro Order No.	Change to P.O. No. SN-246	Items Involved
EG 93609	Original	1-17
70820	CH 1	18,19

b. Cable purchased under Stone & Webster P.O. No. SN-446 with Specification No. NUS-381C (Reference Mr. P. Reilly's letter to Mr. W. J. Patterson dated October 6, 1980). The order, shipped under Cerro Order No. 11529 between July 19, 1971, and August 23, 1971, consisted of two items.

c. Cable purchased under Stone & Webster P.O. No. SN-1447 with Specification No. NUS-381E (Reference Mr. P. Reilly's letter to Mr. W. J. Patterson dated October 6, 1980). The order, shipped under Cerro Order No. 12328 between August 18, 1971, and September 7, 1971, consisted of one item.

d. Cables purchased under Stone & Webster P.O. No. SN-1246, which were shipped between June 19, 1970, and March 8, 1971, consisted of the following Cerro order numbers:

COPY

Cerro Order No.	Change to P.O. No. SN-1245	Spec. No.	Items Involved
71611	Original	NUS-362	1-17
71917	CH 1	NUS-362	3,4,10-12, 15,16,17
71917	CH 1	NUS-325	18
72406	CH 2	NUS-362	19,20,21
74329	CH 3	NUS-362	3
74521	CH 4	NUS-381	3,4,6,20
12428	CH 7	NUS-325	18
20946	Field Ordered	NUS-362	2 new items

All of the cables discussed above must be proven to be operable before, during, and after exposure to the following environments:

40 Year Life Conditions:

Conductor Temperature: $90^{\circ}C$

Integrated Radiation (Gamma): 1.3×10^{7} Rads

Accident Conditions:

Duration: 120 days

Temperature: $275^{\circ}F$, 0-30 Minutes

$275-150^{\circ}F$, 30-60 Minutes

$150-120^{\circ}F$, 1-48 Hours

$120^{\circ}F$, 2-120 Days

Pressure (PSIA): 58.7, 0-30 Minutes

58.7-12.7, 30 Minutes - 48 Hours

12.7, 2-120 Days

Relative Humidity: 100 percent

Chemical Spray: H_3BO_3 (2,000-2,200 ppm B)

Buffered to pH of

8.5-11 NaOH, 4 Hours

Integrated Radiation (Gamma): 2.4×10^{7} Rads

COPY

We appreciate your cooperation in this matter, and request receipt of this material by January 5, 1981. If you have any question regarding this information, please contact Mr I. S. MacFarlane at (617) 973-0013.

Very truly yours,

J. H. Barnhart
Principal Electrical Engineer

ISM:PBF

ANALYSIS OF LOCA TEST

Verification of 7 days LOCA Test (Described in FRC - Report No. F-C2857 dated September 1970) Equivalent to the required operating time of 120 day LOCA

As shown on Fig. No. 10 the test profile ABCDEF envelops the plant LOCA profile AGCHIJ for 7 days. The following analysis shows that the effect of test profile is more severe than the required plant profile.

As evident from the Fig. 10 the plant ambient temperature falls to 150°F after one hour and to 120°F after 48 hours. For conservatism we assumed 150°F LOCA temperature for all the 120 days of LOCA.

The object of this analysis is to show that the effect of the test profile CDEF is equivalent or more to the required 120 days at 150°F (assumed for conservatism).

The first hour of the test profile which envelops the required profile of the plant is neglected and only 11 hours of the test (profile CD) is converted to 150°F by using Arrhenius extrapolation.

a) Profile CD (Referring to Fig. 10)

Arrhenius equations:

$$T_x = T_L \, e^{-\frac{\emptyset}{K} \frac{(T_2 - T_1)}{T_1 T_2}}$$

where

T_x = time at an accelerated temperature = 11 hours

T_{La} = equivalent time at lower temperature = to be calculated

$\emptyset$ = Activation energy, EV (1.13 for XLPE per EPRI NP-1558 Final Report, Sept. 1980, Appendix B)

K = Boltzmann's Constant = 8.617×10^{5} EV/°K

T_2 = Elevated temperature = 276°F = 135°C + 273 = 408°K

T_1 = Required temperature = 150°F = 65°C + 273 = 338°K

Substituting all the values

$$11 = T_L \, e^{-\frac{1.13\,(408-338)}{8.617 \times 10^{-5} \times 408 \times 338}}$$

Solving:

T_{La} = 343 days

b) <u>Profile EF</u> (Referring to Fig. 10)

T_x = 7 days at 160°F

T_{Lb} = 7 days (assumed same for conservatism)

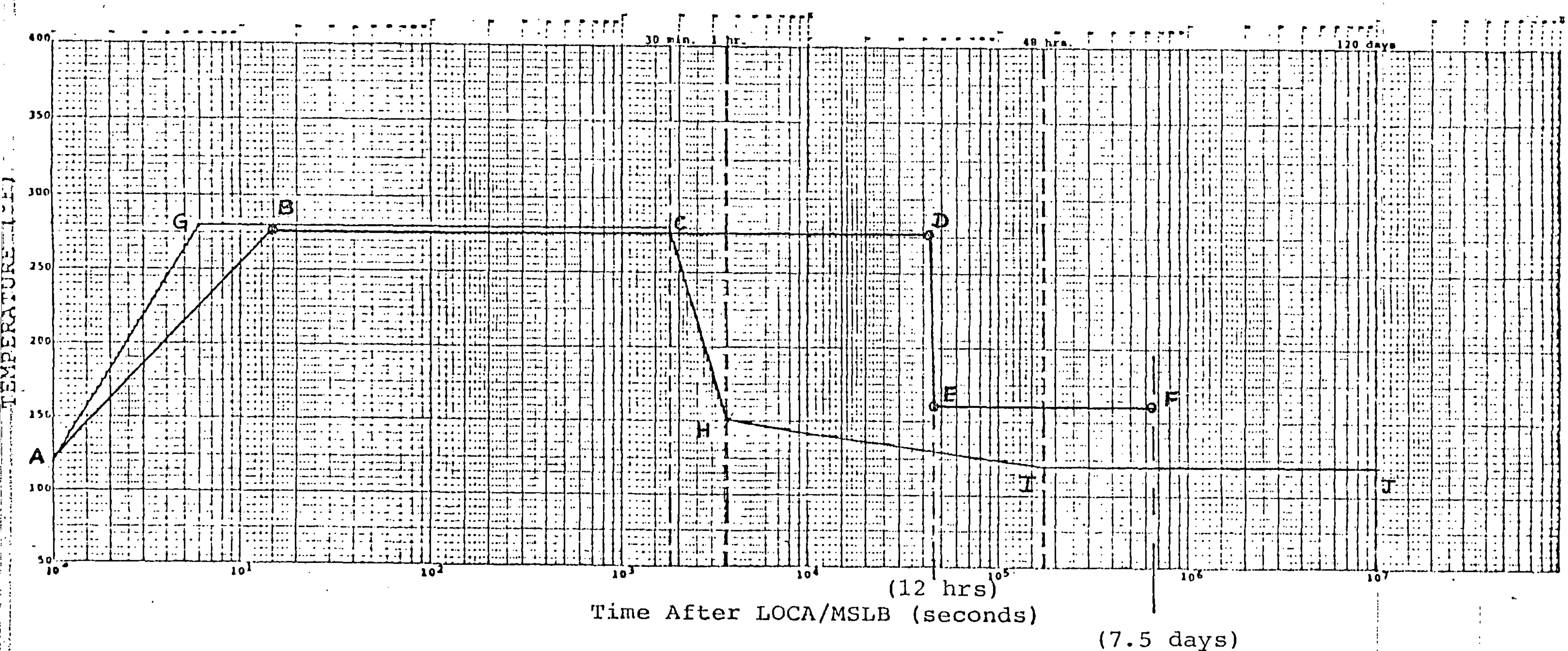
Total Profile CDEF = T_L = 343 + 7 = 350 days > 120 days

<u>Conclusion</u>:

i) As analyzed in above calculations it is obvious that the conducted test is equivalent to 350 days of LOCA at 150°F which is about 3 times the required operating time of 120 days after LOCA at 120°F.

ii) A solution of Borated water (1720 ppm of boron as boric acid) was sprayed throughout the test.

Considering the above it is concluded that the conducted test is more severe than the required conditions of the plant.



——— LOCA PROFILE [Ref.: S&W Calculation No. 12846.44-US(B)-052-1 for Zone RC-3A]

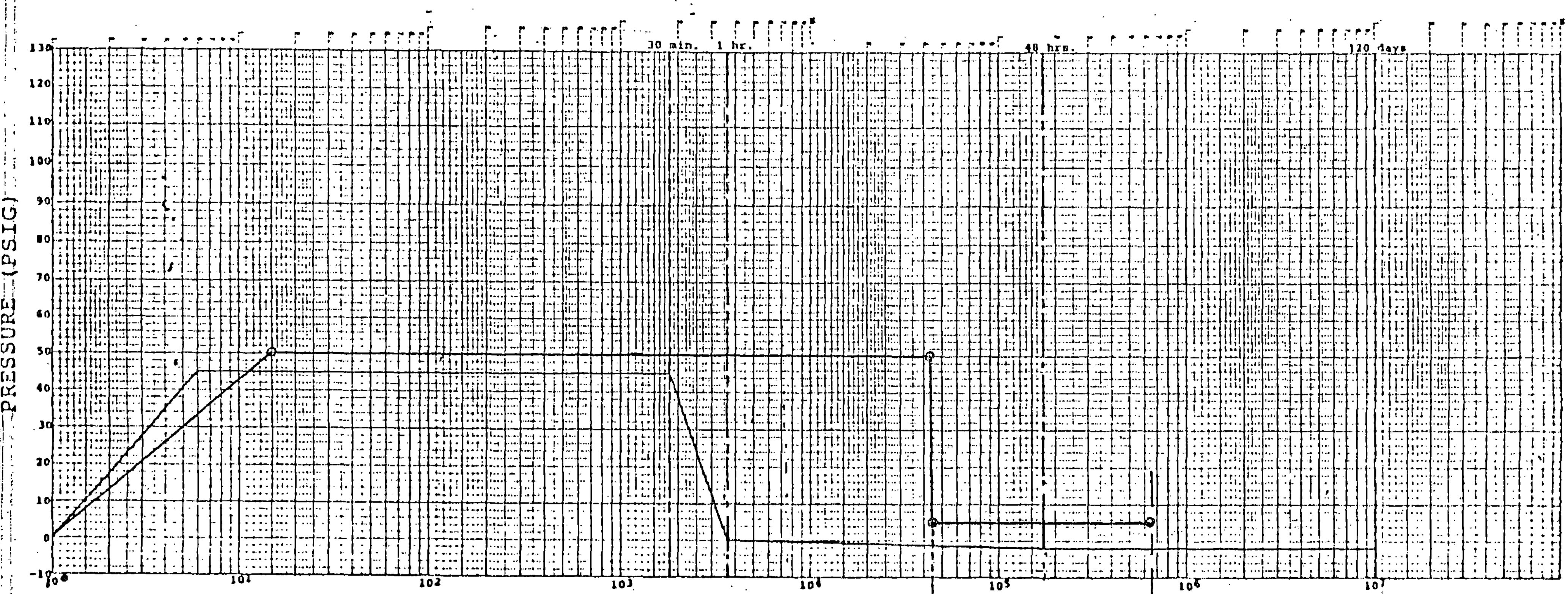
o———o ACTUAL TEST PROFILE (Report No. F-C2857, dated Sept. 1970, Page 5 thru 9)

NOTE: The seven day conducted LOCA test is equivalent to 360 days at 150°F (see analysis). Hence it is more severe than the required LOCA period.

LOCA/MSLB TEMPERATURE TRANSIENT

FIGURE 10

(CERRO 1000V XLPE INSULATED CABLES)



Time After LOCA/MSLB (seconds)

——— LOCA PROFILE [Ref.: S&W Calculation No. 12846.44-US(B)-052-1 for Zone RC-3A]

o———o ACTUAL TEST PROFILE (Report No. F-C2857, dated Sept. 1970, Page 5 thru 9)

Rev. 2

LOCA/MSLB PRESSURE TRANSIENT

FIGURE 10A

(CERRO 1000V XLPE INSULATED CABLES)

Sheet 17
QDR-5437-55-01
Surry Unit 1

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 46

TER Category: IIa

Description: 600 VOLT, CERRO CROSS LINKED POLYETHYLENE INSULATED CABLES

Manufacturer, Model: Cerro Wire and Cable Company

Tag No(s).: Spec. NUS: NAS-120,NA-312/1312, and NAS-3187, NA-3187/4183

Worksheet No(s).: 6-32 and 6-33

QDR No.: 5437-119-01 and 5437-121-01

Location: RC-3A

DISCREPANCY

(See TER Item No. 44)

RESPONSE

(See TER Item No. 44)

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 50

TER Category: IIa

Description: LOW HEAD SAFETY INJECTION PUMP MOTORS

Manufacturer, Model: Westinghouse ABDP

Tag No(s).: 2-SI-P-IA and IB

Worksheet No(s).: 6-201, 6-202

QDR No.: 5437-105-01

Location: SFGD-1

DISCREPANCY

Licensee qualified the equipment, but did not furnish sufficient documentation to support (1) the similarity between test specimen and the equipment, (2) radiation resistance of the lube oil and bearing grease and (3) aging surveillance and replacement schedule.

RESPONSE

Westinghouse correspondence included in the referenced QDR, were re-reviewed and we conclude that the similarity between the test specimen and the equipment is established.

This equipment should be classified in Category IIc. "Equipment Satisfies all Requirements Except Qualified Life or Replacement Schedule Justified".

The attached discussion and clarification of the low head safety injection motors should preclude FRC concerns regarding the similarity between the test specimen and the equipment, radiation capabilities and aging qualification.

ATTACHMENT TO TER ITEM #50
(VEPCO SURRY UNIT # 2)

LOW HEAD SAFETY INJECTION PUMP MOTORS (Tag Nos. 1-SI-P-1A,1B)

Tag Nos: 1-SI-P-1A,1B & 2-SI-P-1A,1B
QDR Nos: 5437-43-01 for Unit #1 and 5437-105-01 for Unit #2

1. Similarity Between Test Motors and Plant Equipment:

   i) Westinghouse letter dated 4/9/81 in reference to letter NCW-1317/NAW-3615 (page 2d of QDR) indicate that:

      a) The subject low head safety injection pump motors were rewound in accordance with their insulation specification, LIT-Spec-711306 (Page 26 of QDR-5437-105-01*). Since this specification was in use for several years before and after these motors were rewound, the probability for the use of other materials or procedures is minimal.

      b) The thermal endurance test of this thermalastic epoxy system was in accordance with IEEE Standard 275-1966 which describes the complete procedure (like cycle of oven aging, temperatures, aging time, mechanical, vibration, humidification, etc.).

      c) Test results show that this insulation system performed as well as the latest Class B thermalastic epoxy system.

   ii) Westinghouse letter no. NAW-3601 dated Aug. 19, 1980 (page 2c of QDR) indicates successful qualification testing of motors with thermalastic epoxy insulation systems, documented in WCAP-8754, including all organic insulating materials. Therefore wedges and cabling need not be addressed separately. The results of actual tests are available in Westinghouse files.

   iii) Review of the insulation specification LIT-711306 (page 2c of QDR-5437-105-01) indicates that the insulation system consists of sheets of Mica embedded in a solvent-less epoxy resin which is the same as that described in Westinghouse WCAP-8754, Para. 4.2.

   iv) Westinghouse discussed thermalastic epoxy insulation in their application data 3170 (copy attached). Review of the insulation specification LIT-711306 used for the subject motors indicates that the insulation materials, listed in the questioned specification are the same as discussed in their application date 3170.

*Page 2c of Unit #1 QDR-5437-43-01 does not contain specification LIT-711306.

Considering the above it is concluded that the insulation system of the subject motor is the same thermalastic epoxy insulation as that of the test specimen of Westinghouse WCAP-8754. This conclusion is further supported with the fact that all Westinghouse motors with thermalastic epoxy insulation system were wound in accordance with the only one insulation specification no. LIT-711306.

2. Lubrication Radiation Resistance and Aging

Review of the plant maintenance records confirms that for low head safety injection motor lubrication chevron SRI #2 has been used. The radiation resistance capabilities of Chevron SRI #2 is 1.8×10^8 Rads per Westinghouse letter NAW-3620 dated Nov. 18, 1980 (included in the Ref. QDR).

Because this qualification value of 1.8×10^8 Rads envelops the plant required dose of 8.0×10^6 Rads, the subject motor lubrication are considered qualified for the radiation.

3. Although an aging analysis was performed (see the attached analysis) a detailed maintenance, aging surveillance and replacement schedule will be submitted.

QUALIFIED LIFE OF WESTINGHOUSE LOW HEAD SAFETY INJECTION MOTORS

1) Westinghouse letter #VPU(RRK)-48 dated Jan. 9, 1981 (page 2d of the QDR) indicates that the actual maximum winding temperature rise from test is 70°C at 1.15 SF load for the Surry pump motors. This gives a maximum continuous operating temperature of 110°C (70+40) at the plant normal ambient temperature of 104°F (40°C).

2) Because the plant environmental conditions for the motors do not change during the LOCA/HELB the same operating temperature (110°C) is considered during normal as well as during LOCA conditions.

3) These low head safety injection pump motors are required to operate during LOCA period of 120 days and periodic testing of about 2 hours a month. The total operating time during 40 yrs life of the motor is calculated below.

i) Periodic testing during 40 years = (2 hrs/month)x12x40
= 960 hrs

ii) LOCA period = 120 days = 2880 hrs

Total continuous operation =(960+2880)= 3840 hrs

For conservatism it is assumed in the following analysis that the subject motor will run continuously for one year (8760 hrs) instead of 3840 hrs.

4) From Fig. 4-1 of WCAP-8754 (thermal aging curve for thermalastic epoxy system, per IEEE Std.-275-1966) the qualified life at 120°C = 200,000 hours and from Fig. 9-1 (in which Westinghouse has drawn a most conservative projected qualified insulation life of motor) the qualified life at 120°C = 96,000 hours.

5) Activation Energy:

The activation energy is calculated by Arrhenius extrapolation as follows:

From Fig. 9-1 of WCAP-8754 the qualified life at 120°C = 90,000 hours and at 130°C = 45,000 hours.

Arrhenius equation

$$T_x = T_L \, e^{-\frac{\phi}{K}\frac{(T_2-T_1)}{T_1 T_2}}$$

where

T_x = life at a higher temperature T_2 = 45,000 hours.

T_L = life at a lower temperature = 90,000 hours.

ϕ = activation energy = to be calculated

K = Boltzman Constant = 8.617×10^{-5}

T_2 = Higher temperature = 130+273 = 403°K

T_1 = Lower temperature = 120+273 = 393°K

Substituting in the above equation:

$$44{,}000 = 96{,}000\ e^{-\frac{\phi \times (403-393)}{8.617 \times 403 \times 393 \times 10^{-5}}}$$

Solving:

$\phi = 1.08 \approx 1.0$

6) CALCULATION OF QUALIFIED LIFE:

From Fig. 9-1 of WCAP the qualified life at 120°C is 96,000 hours. Out of this life the motor is required to operate for 8,600 hours only (see sec. 3 above) at 110°C. Assuming it operates at 120°C, (for further conservatism) the following analysis shows that the remaining continuous operating life of 87400 hours is more than the 39 years of how operating life at plant ambient of 40°C (104°F).

Applying Arrhenius equation.

$$T_x = T_L\ e^{-\frac{\phi}{K}\frac{(T_2-T_1)}{T_1 x T_2}}$$

where:

T_x = 87400 hours

T_L = to be calculated

T_1 = (40 + 273) = 313°K

T_2 = (120 + 273) = 292°K

$K = 8.617 \times 10^{-5}$

ϕ = 1.0 (see sec. 5 above)

Substituting:

$$87400 = T_L\ e^{-\frac{1.0 \times (393-313)}{8.617 \times 10^{-5} \times 393 \times 313}}$$

Solving:

T_L = 659642 hours = 75 years

Conclusion:

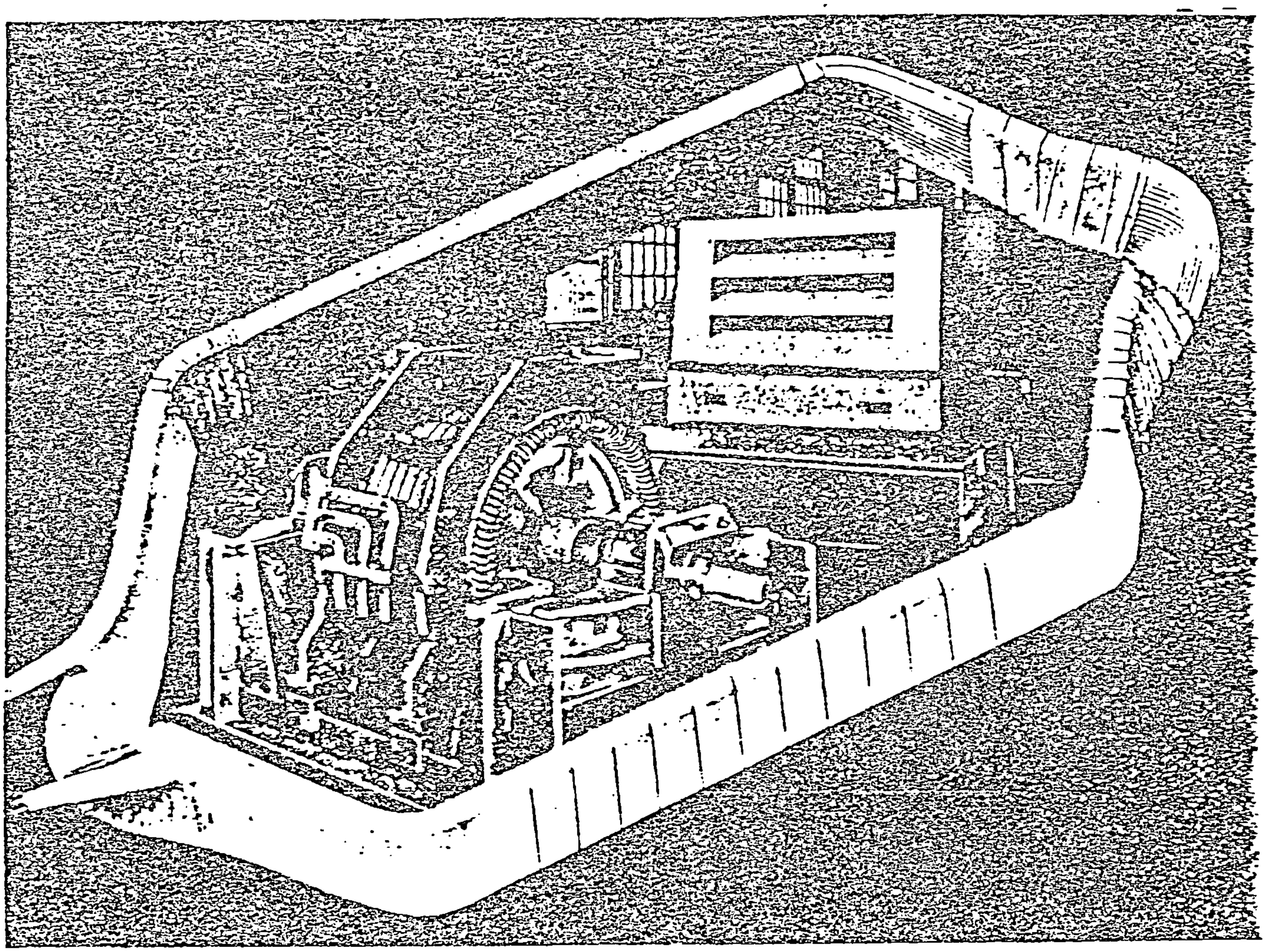
From the above analysis it is concluded that the subject motors are qualified for a life of at least 40 years under the specified service conditions of the plant.

Westinghouse

Thermalastic Epoxy Insulation

For Large Ac Motors

F/A and other Motors with Form-Wound Coils – Squirrel-Cage, PAM, Wound Rotor, Synchronous



Thermalastic Epoxy insulation is the standard on all large ac machines, 7,000 volts and below, built at East Pittsburgh using form-wound coils, up through the 85" diameter frame size. This will include practically all type F/A machines. It is also now available on some machines rated 13.8 kV.

Thermalastic Epoxy is also available on form-wound coils for ratings manufactured at the Buffalo Plant.

"Thermalastic" has made an enviable name for itself as an insulation. It was the first real advancement in insulation in over 20 years when it was first introduced in 1949 on large turbine generators.

Westinghouse began to use it on large motors in 1962. It is important to remember that Thermalastic insulation is a system, not a material. As such, it is not static and many improvements in its components and processing have been made since it was first used.

Continuous research and testing of all known insulating materials and systems have enabled Westinghouse to keep Thermalastic insulation better than any other insulation.

One basic feature of Thermalastic Epoxy insulation is the use of mica in the ground wall. No other material can equal mica from the standpoint of electric strength, voltage endurance and reliability.

Solventless epoxy resins are impregnated into the mica which has been preplaced on a form-wound coil. Then with both mica and resin in position, chemical reaction is initiated which transforms the resin into a solid which locks and binds the mica into a composite mass. The resulting end product then takes advantage of the excellent properties of both the mica and the resin. The outstanding characteristics of the epoxies is their extremely good resistance to moisture and to practically all types of chemical contaminants. They have been proven in laboratory tests described later and by field service.

Processing Thermalastic Epoxy insulation includes vacuum-pressure impregnation of the complete wound stator, stator coils as well as coil connections. This makes it possible to give all parts of the windings the full effect of the high resin fill that is achieved with the vacuum-pressure technique. The coils are not deformed or stressed after impregnation.

The processes described are those of the Large Rotating Apparatus Division in East Pittsburgh. Primarily due to differences in the size of motors manufactured at the Buffalo Large Ac and Dc Motor Division, specific processes vary in minor detail. The essential characteristics of the insulation system are the same.

September, 1971
Supersedes Technical Data 3170, dated June, 1968
E, C/1738, 1740/DE

Westinghouse

Stator Coils

The insulation immediately adjacent to the copper conductors is generally that which insulates the various turns in the coil from each other. This is a very important part of the insulation system, one which frequently is not given the attention it deserves. Since the majority of ac motors are started across-the-line, there is a possibility that steep fronted, impulse type waves can be imposed on the winding. These waves ... electric stress on the turn insulation, especially the turns of the stator coils near the line terminals.

In the light of these facts and the general industry trend to higher operating voltages, mica, which provides a positive electric barrier of very high strength, is used as turn insulation for all coils rated 4 kV and above for the larger size motors. On smaller size motors, this additional strength, where required, is obtained by the use of enamel plus double dacron-glass covering.

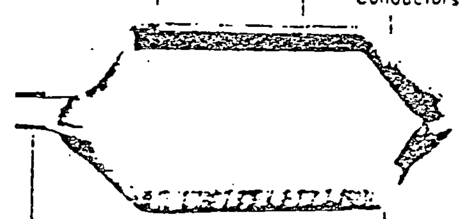


Fig 1 Typical stator coil showing elements of insulation.

The micaceous ground insulating materials are applied as shown in detail in Fig 1. All materials used are designed to be both compatible with, and selected components of, the complete insulation system.

Winding Stator

At the start of the winding operation the stator core consists of the assembled punchings and restraining end plates, thus providing a maximum of accessibility during coil assembly of larger size motors. The fact that the coils are unimpregnated at this stage provides ease of installation.

The end turns of the stator coils are firmly braced to withstand full-voltage starts with a series of insulated support rings as well as braces between coil end turns, which in effect form an archbound structure at these points. The material used as a brace between coil end turns is a non-woven polyester felt which has both resiliency and absorbency.

After installation of all coils and completion of wedging and bracing, the connections are made and insulated, and the stator is ready for impregnation.

Vacuum-Pressure Impregnation

The preheated stator is lowered into the vacuum pressure tank, and the air evacuated to a very low absolute pressure. The epoxy resin is then introduced, while maintaining the vacuum, to a level that completely submerges all parts of the winding. The vacuum is then released and replaced with positive pressure of several atmospheres over the liquid resin. Following these steps the stator is removed, as shown in Figure 2.

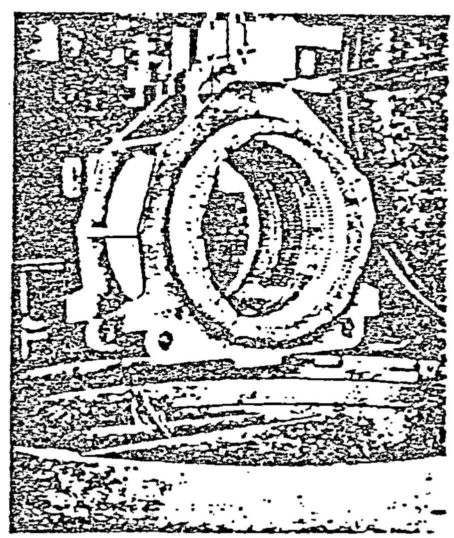


Fig 2. After impregnation, the stator is removed from the tank and placed in an oven for curing.

The next step in the process takes place in an oven, where the resin is cured.

In addition to the impregnation of the winding, the bracing system has been built "in place" by the absorption of epoxy resin and subsequent cure in the polyester felt. This gives very high strength to the bracing scheme.

During the manufacture of the coils and winding, quality control procedures are used continuously to monitor the physical dimensions and electrical integrity of the insulation.

Evaluation and Test Program

Thermalastic Epoxy insulation was adopted as standard for large ac motors only after completion of an extensive evaluation and test program. A description of some of the more important tests follows.

Electric Strength

Since the fundamental function of insulation is to withstand electric stress, the first series of tests on any insulation system is to determine its short-time electric strength. Complete insulated coils are used for this test.

It is desirable that for any particular voltage class the average breakdown voltage be as high as possible. However, it is essential that the values be examined and analyzed statistically. It is the Westinghouse concept that, using the principles of statistical analysis, the coils have a breakdown level well above the test level for individual coils.

Thermalastic Epoxy insulation has both a higher average short-time electric strength and is more reproducible from coil-to-coil than other insulation systems.

Voltage Endurance

Since insulation in large machines is expected to perform for a long period of time, a voltage endurance test has been devised. In this test, sample coils are prepared and connected as described for the short-time electric tests.

Electric strength is evaluated in depth by a series of breakdown tests for each insulation system. A group of sample coils for each system is tested at various voltage levels for fixed time intervals which may be one minute, one hour, one week or more. By plotting average "hold" values for the different time periods, a voltage endurance curve is created. Such a curve is shown in Figure 3.

Much of the data thus obtained tends to plot in a straight line. One way of looking at such data is to establish an "operating level" and examine where the extrapolated voltage endurance curve will intersect this "operating level". The Thermalastic insulation curve intersects the operating stress level at a time in excess of 100 years. These are results of laboratory tests on only one of the degrading mechanisms that affect insulation and, therefore, are not complete indications of actual operating life. However, systems that fail to give indications of satisfactory life in this very fundamental test are not considered favorably.

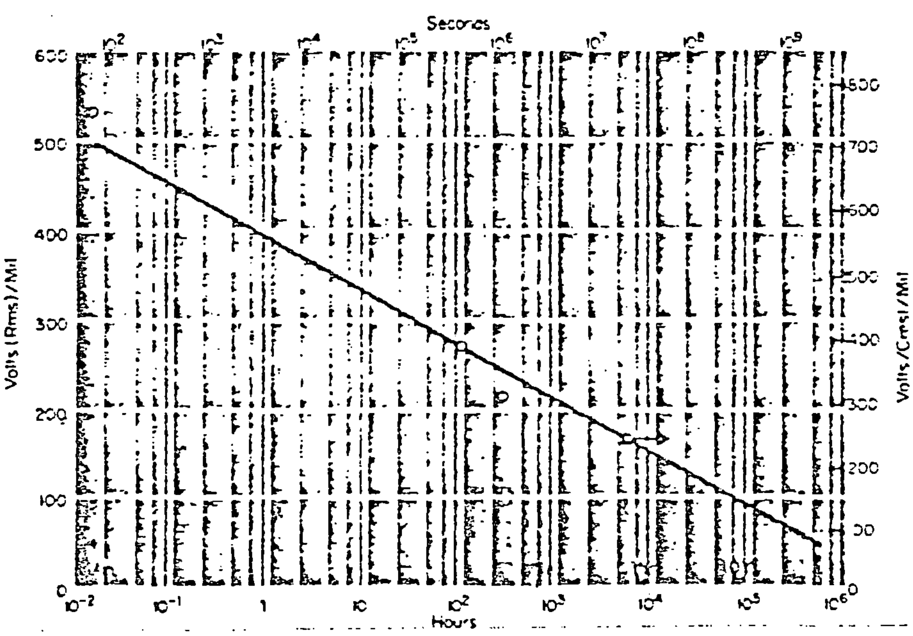


Fig. 3. Voltage Endurance.

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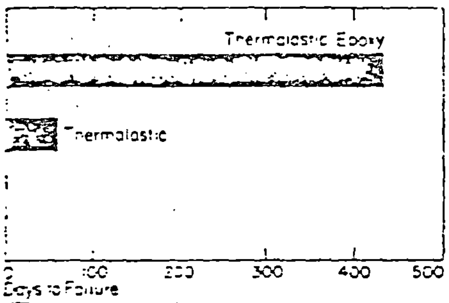
Moisture Resistance

The first screening test for moisture resistance is a test on individual coils suspended in salt water. These are standard coils submerged except for the leads and front loops and continuously subjected to normal voltage to ground. This is the value of the maximum line-to-ground operating voltage. Total hours to failure are then measured for each of the systems under investigation.



[illegible] Average life of insulation systems, immersed [illegible]oltage applied continuously.

Figure 4 shows the results obtained by this method. As can be seen, the epoxy resin impregnant imparts outstanding moisture resistance to the Thermalastic concept.

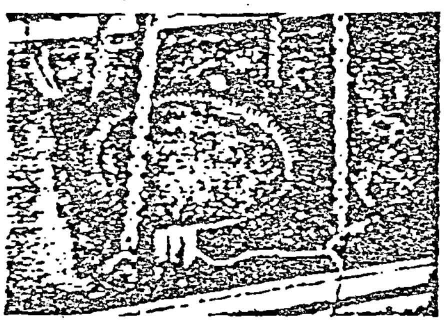


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Fig 5. Complete motor winding immersed in water for test of moisture resistance.

Tests on individual coils without connections, however, are not the entire story. The moisture resistance of complete windings has also been investigated. In Figure 5 a winding including all connections is shown completely submerged in a tank of salt water. The winding leads are connected to a megohm bridge so that insulation resistance can be measured.

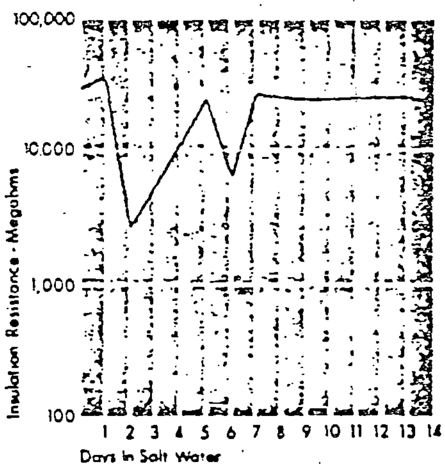

Fig. 6. Insulation resistance – throughout 14 day period.

A complete 4160 volt Thermalastic Epoxy stator was submerged in a tank of water containing 5% salt by weight (approximate sea water concentration) for a period of 14 days. The insulation resistance was checked throughout this period. Figure 6 is the plot of insulation resistance obtained throughout the 14 day period.

There are variations in the level, probably due to changes in the conductivity of the insulation surfaces at the winding terminals, but all readings are quite high. Figure 7 is a plot of the dielectric absorption tests taken before and after the 14 day period while in the water.

At the conclusion of this period the stator was removed from the tank and without rinsing or drying was subjected to a 4800 volt ac rms high potential test. The winding withheld this test with no difficulty. This indicates the winding could have been cleaned and dried and returned to service.

In still another test on a complete winding, the effect of continuous exposure to 100% relative humidity at 50°C was investigated. In some respects this is a more severe test than actual submersion since water vapor has a high degree of penetration through films. Figure 8 shows the results. After more than 3000 hours of this type of exposure, the Thermalastic Epoxy insulated winding still had insulation resistance measured in thousands of megohms.

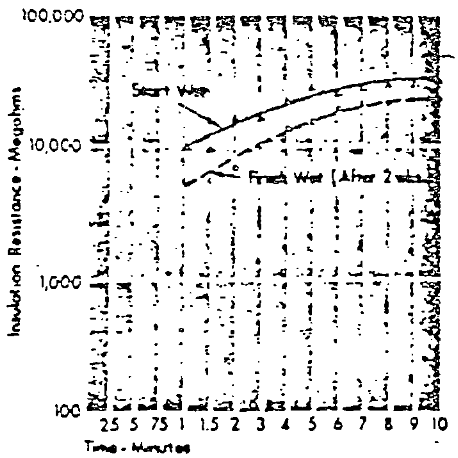

Fig. 7. Insulation resistance – before and after 14 day period.

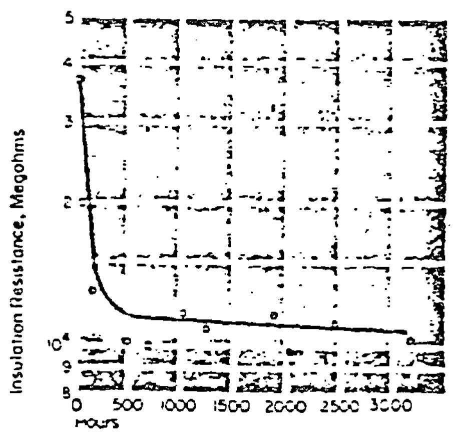

Fig 8. Tests of wound 4160-volt stator under conditions of 100% humidity.

Chemical Resistance

Resistance to chemical contaminants is another factor in many industries. In looking at resistance to acids, bases and solvents, nothing has been found that is the equal of the epoxy resins. Table A shows a tabulation of some of the many tests made wherein resin samples were subjected to liquid baths of various contaminating materials. The resin used in Thermalastic Epoxy insulation shows outstanding resistance to all of them.

Thermal Endurance

Temperature is widely accepted as being one of the limiting factors in insulation life. To determine the ability of insulation to stand up under thermal aging, testing is done by following the basic concept of functional testing outlined in IEEE 275.

This is the "motorette" type of testing wherein small, complete coils are made in accordance with actual processes employed in the insulation system being evaluated. These coils are then mounted in slots on a motorette and the leads brought out in an appropriate fashion as shown in Figure 9 so that electrical tests can be made. These motorettes are then subjected to a cycle of oven aging, mechanical vibration, humidification and electrical test. Following this, the cycle is repeated and the number of cycles to failure is recorded.

Table A
Solvent & Chemical Resistance of Thermalastic Epoxy Resin Castings

Solvent	Time of Immersion	Shore D Hardness	Percent① Weight Change	Percent① Thickness of Change	Rating
50% Acetic Acid	0	84	0	0	Excellent
	24 hours	85	0	0	
	48 hours	85	0	0	
	7 days	85	0	0	
	10 days	86	0	0	
10% Sodium Hydroxide	0	84	0	0	Excellent
	24 hours	85	0	0	
	48 hours	85	0	0	
	7 days	85	0	0	
	10 days	86	0	0	
Acetone	0	85	0	0	Good
	24 hours	61	+ 8.6	+ 9.5	
	48 hours	45	+15.3	+17.5	
	72 hours	..	Decomposed	....	
	10 days	..	....	....	
Benzene	0	87	0	0	Excellent
	24 hours	88	0	0	
	48 hours	88	0	0	
	7 days	88	0	0	
	10 days	88	0	0	
Trichloroethylene	0	86	0	0	Good
	24 hours	46	+ 7.5	+15.5	
	48 hours	..	Decomposed	....	
	7 days	..	....	....	
	10 days	..	....	....	
Distilled H_2O	0	83	0	0	Excellent
	24 hours	85	0	0	
	48 hours	85	0	0	
	7 days	85	0	0	
	10 days	85	0	0	

① Neglecting changes less than 1%.

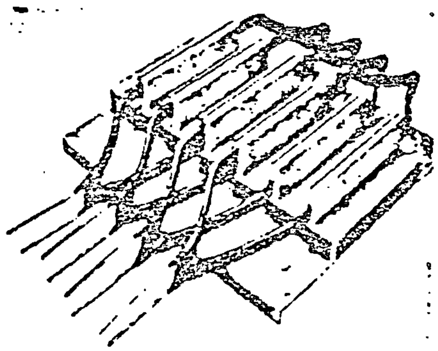

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Fig. 9. "Motorette" used for testing thermal endurance of insulation systems.

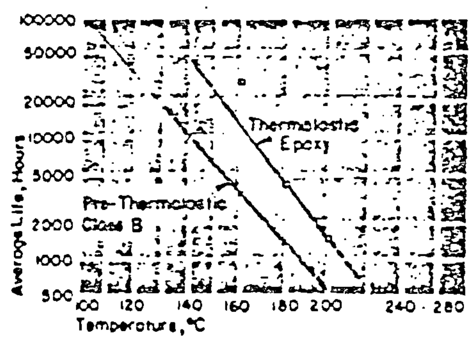

Fig. 10 Thermal endurance of insulation systems for rotating machines tested in motorettes in accordance with IEEE 275 (5000 volt proof test).

This is a comparative test only. There are no standard values for the test conditions or number of cycles or the hours of aging that a system should withstand. It is known, however, that for more than 30 years class B insulation has been in service and that it has performed satisfactorily. The procedure is, therefore, to compare new or proposed systems with the older service-proven systems. Figure 10 shows the data obtained by such tests. Hours of life is plotted logarithmically on the vertical axis against temperature on the horizontal axis. As can be seen, the life of all systems decreases with increased temperature. The "pre-Thermalastic" curve is the data obtained on the class B insulation system used prior to Thermalastic. In going to the Thermalastic Epoxy system, a curve is obtained which is shifted over on the thermal scale by about 25°C. This in itself indicates a high order of "thermal reserve" in Thermalastic Epoxy insulation. This system qualifies for class F thermal rating.

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Thermal Cycling

All motors in service are required to withstand varying degrees of thermal cycling. The ability of Thermalastic Epoxy insulation to withstand thermal cycling and maintain moisture resistance is dramatically demonstrated by the following test.

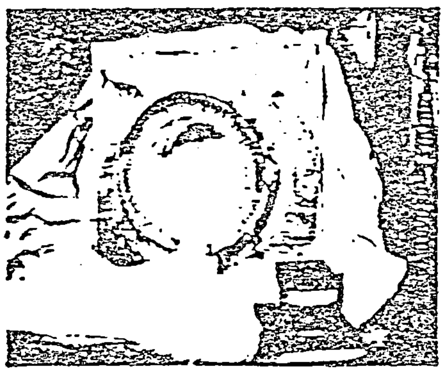

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Fig. 11 Cycling test of wound stator-packed with ice.

[illegible] 11 shows a wound stator packed [illegible]y ice so that the imbedded thermo-[illegible]es in the winding indicate minus 40°C. When the winding reached this temperature, the dry ice was removed and the stator was immediately placed in an oven, which had been preheated to 150°C. This was repeated four times, cycling between these temperature limits, and the stator then completely submerged in water. Figure 12 shows the results obtained, and indicates that the moisture resistance is unaffected by thermal shocks of 190°C.

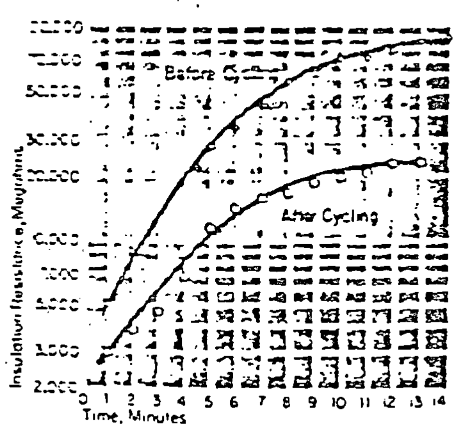


Fig. 12. Effect of thermal cycling on Thermalastic [illegible] insulation between temperature of −40°C [illegible]50°C.

Mechanical Strength

All motor insulation may be subjected to severe mechanical stresses during operation. To determine the ability of the complete Thermalastic Epoxy winding to withstand mechanical stresses, the following test has been devised.

When a motor winding is first connected across the line, there is a large current inrush to mechanical forces, which tend to severely distort them. Adequate bracing prevents the actual deformation, but the forces are nevertheless present.

A motor with Thermalastic Epoxy insulation was subjected to 1,000 full-voltage starts. After completion of the 1,000 full-voltage starts, the entire wound stator was submerged in a tank of water and a ten-minute dielectric absorption curve was made immediately after submersion.

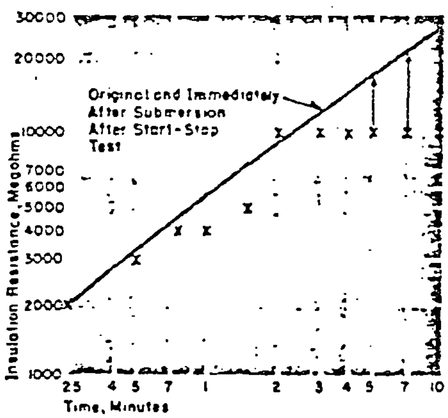


Fig. 13. Insulation resistance characteristics of submerged Thermalastic Epoxy stator winding (4160 volts) after motor was subjected to 1,000 full-voltage starts.

Even after these severe conditions, the winding had greater than 10,000 megohms of insulation resistance after ten minutes of voltage as shown in Figure 13.

Abrasion Resistance

Motors are not infrequently expected to operate in an environment which subjects the coil insulation to bombardment by highly abrasive particles. This occurs because the cooling air which is circulated through the motor comes from the surrounding atmosphere of the motor and often contains a great deal of abrasive particulate matter. This particulate matter is forced at high velocity over the end windings of the stator coils and is equivalent to a sandblast commonly used in many industrial applications for cleaning and stripping operations.

In order to allow the windings to operate under these adverse conditions, special treatments have been developed. It is well-known that elastomers or rubbers are capable of absorbing energy upon impact with another harder material. Therefore, the special treatments consist of a layer of an elastomeric material which is capable of absorbing this energy and literally bouncing the abrasive particles off the surface.

The coatings are applied over the completed winding by dipping or spraying so as to provide an energy-absorbing surface. This had to be a very special coating which would have the ability to work not only as applied, but also at the operating temperature of the coil surface and to maintain this property over the long periods of time the machines are expected to run.

Radiation Resistance of Thermalastic Epoxy Insulation

Of the various components that go to make up the Thermalastic Epoxy insulation system, the epoxy impregnant is the most susceptible to radiation damage. The mica and fiber glass portions will be unaffected by dosage levels that would destroy the impregnating resin. However, the epoxy impregnant, because of its aromatic nature, is one of the better resinous materials with regard to radiation resistance, having a predicted life of 40 years at a dosage of up to 10^9 rads at low radiation rates of less than 100 rads per hour. Normal radiation levels within the containment vessel of a nuclear power station are below a rate of 50 rads per hour with a total dosage of 2×10^7 rads over a period of 40 years. Therefore, Thermalastic Epoxy windings in a typical radiation environment will operate many years with no measureable deterioration due to the radiation.

Winding Repairs

The standardization of Thermalastic Epoxy insulation for large motors allows a completely new approach to the subject of winding repairs and the desirability of carrying spare coils.

First of all, the possibility of winding repairs being required is reduced to a minimum far below that possible with any previous insulation system.

The basic approach is to provide for the contingencies that may arise with minimum total expense to the user including both repair and downtime cost.

Depending on the extent of damage, several alternatives are available for winding repairs:

1. Most failures resulting from accidental mechanical damage occur on the end windings where the coil is exposed. Repairs to the end winding external to the core can be made by the conventional patching method.

2. In the remote possibility of coil failure within the slot, it is not practical to replace coils by conventional means. The very processing of complete impregnation and bonding which insures a failure-free coil also makes it impractical to lift enough coils to replace both top and bottom coil sides of a damaged coil.

To replace a damaged coil in any machine, it has always been necessary to lift at least a full throw of coils to get the new coil in. Quite often, this operation results in damage to other coils. Therefore, when spare coils are considered desirable, it has been standard practice to carry at least ¼ or ⅓ of a set to replace one or two damaged coils.

Westinghouse has developed a technique of coil replacement, for use on motors manufactured at East Pittsburgh, which makes it unnecessary to disturb any coils except the damaged coil or, at most, the other coil in the same slot.

For Thermalastic Epoxy insulated machines, a standard repair kit can be supplied including six half coils suitable for replacing either top or bottom sides of the coil. Also included are the necessary materials, tools and instructions for replacing damaged coils. Complete spare Thermalastic Epoxy insulated coils are not furnished for these machines.

3. In the case of widespread damage involving a number of coils, a complete rewind is recommended. The elaborate facilities required for the Thermalastic Epoxy system make it necessary to return the stator to the factory to obtain the original processing. On a breakdown basis, this can be done usually in three weeks or less and requires no longer than would be required to order coils and rewind in the field.

If consideration is given to stocking a full set of coils to protect against such a failure on a Thermalastic Epoxy insulated machine, the recommendation is that a complete wound stator be stocked. This will cost no more than a full set of coils plus the expense of stripping the old winding and winding the new coils in any machine. Downtime is reduced to a minimum.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 51

TER Category: IIa

Description: OUTSIDE RECIRCULATION SPRAY PUMP MOTOR

Manufacturer, Model: GE 5K6287XH41A

Tag No(s).: 2-RS-P-2A and -2B

Worksheet No(s).: 6-167, 6-168

QDR No.: 5437-104-01

Location: SFGD-1

DISCREPANCY

The conclusions section of the 90-day response states that the lube oil and bearing grease were replaced. Documentation of the lubricant radiation resistance was not provided.

RESPONSE

These motors have oil lubricated bearings (see GE report 492HA248, included in QDR). Appendix III of the QDR documents radiation resistance of the recommended lubricating oil, Mobil DTE 797, to 10^9 rads, which far exceeds the service condition of $8x10^6$ rads. GE manual GEH-3292C, included in the QDR, recommends "regular" oil changes. Under the plant maintenance program the oil is periodically replaced with the oil recommended by the motor manufacturer. The statement provided in the 90-day response conclusions section is a generic statement that was applied to several motors, intended to show that lubricants of more than adequate radiation resistance are being used.

This item is considered fully qualified and should be assigned to TER Category Ia.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 62

TER Category: IIa

Description: CHARGING PUMP MOTORS

Manufacturer, Model: Westinghouse

Tag No(s).: 2-CH-P-1A, 1B, and 1C

Worksheet No(s).: 6-7, 6-8, 6-9

QDR No.: 5437-69-01

Location: AB-2C

DISCREPANCY

Licensee qualified the equipment, but did not furnish sufficient documentation to support 1) the similarity between test specimen and the equipment, 2) radiation resistance of the lube oil and bearing greases and 3) aging surveillance and replacement schedule.

RESPONSE

Westinghouse correspondence included in the reference QDR, were re-reviewed and the similarity between the test specimen and the equipment (including the motor leads) is established.

This equipment should be classified in Category IIc. "Equipment satisfies all Requirements Except Qualified Life or Replacement Schedule Justified".

The attached discussion and clarification of the charging pump motors should preclude FRC concern regarding the similarity between the test specimen and the equipment, radiation capabilities and aging qualification.

ATTACHMENT TO TER ITEM #62
(VEPCO SURRY UNIT #2)

CHARGING PUMP MOTORS:

Tag Nos: 1-CH-P-1A,1B & 1C for Unit #1
QDR Nos: 5437-08-01 for Unit #1
5437-69-01 for Unit #2

1. Similarity Between Test Specimen and the Equipment.

i) Similarity between the motor lead insulation of the test specimen and the equipment:

a) Westinghouse letter no. NAW-3615 dated Oct. 30, 1980 (included in the referenced QDR, page 3a) indicates on page 2 that the Surry pump motor insulation for the charging pumps is thermalastic epoxy and the qualification is covered by WCAP-8754.

ii) Similarity between the motor lead insulation of the test specimen and the equipment:

a) Westinghouse letter no. NAW-3620 (included in the referenced QDR, page 2c) indicates that for the motors which employ the thermalastic epoxy insulation system, the testing documented in WCAP-8754 includes all organic insulating materials in the motor. Therefore wedges and cabling need not be addressed separately for these motors.

b) The thermalastic epoxy system, developed by Westinghouse and first put into service in 1962, (see WCAP-8754, Para. 4-2) and only one insulation specification, LIT-711306, were in use for winding motor coils (see QDR-5437-08-01, Section 2, Page 2b), it has been determined that these motors had motor to leadsplice materials as discussed in specification LIT-711306.

Specification LIT-711306: lead insulation and tying (page 3 of 14), winding procedure (paragraph 29, page 5 of 14), and sketches D and E (page 13 of 14) indicate the use of sleeving (M#41524-AV), resin tape (M#9948-3), micatape (M#43865-AD), and glass tape (M#41514-CT) as the motor to leadsplice materials. These materials are in fact the materials used when winding the subject motor coils.

Westinghouse letter dated April 9, 1981, in reference to letters NCW-1317 and NAW-3615, states that motorettes using an insulation system similar to the one prescribed in the rewind specification (LIT-711306) were tested for thermal performance in accordance with IEEE 275. This is basically the same as described in paragraph 4-3 of WCAP-8754 per IEEE 275-1966. Therefore the motor to leadsplice materials were tested, as part of the formettes, for thermal endurance to determine the resistance of the thermalastic epoxy system to thermal aging, following the guidelines for accelerated functional testing, as outlined in IEEE 275-1966.

c) In addition to the above the review of WCAP-7829, table #22, page 46 indicate that the motor lead cable is silicone rubberized glass taped insulation. This is the same as indicated in Westinghouse insulation spec. LIT-711306.

d) The same is confirmed from Westinghouse Application Data 3170 (copy attached).

Considering the above facts it is concluded that the motor lead insulation of the subject motor is the same as the test specimen of WCAP-8754 and 7829.

2. Lubrication Radiation Resistance and Aging

Review of the plant records shows that Exxon-Teresstic-46 has been used for charging pump motor lubrication. The radiation resistance capabilities of Exxon-Teresstic-46 is 1.4×10^7 Rads per Westinghouse letter no. NAW-3615 dated October 30, 1980 (copy attached).

The worksheets will be revised to reflect the overall radiation resistance qualification of the motors as 1.4×10^7 Rads.

Because this qualification value of 1.4×10^7 rads envelops the plant total required dose of 7.4×10^6 rads, the subject motors are considered qualified for the radiation.

3. Although an aging analysis is performed (see the attached analysis) a detailed maintenance procedures and aging surveillance and replacement schedule will be submitted.

QUALIFIED LIFE OF WESTINGHOUSE CHARGING PUMP MOTORS

1) Westinghouse letter no. VPU(RRK)-48 dated Jan. 9, 1981 (page 2c of the QDR) indicates that the actual maximum winding temperature rise from test is 70°C at 1.15 SF load for the Surry pump motors. This gives a maximum continuous operating temperature of 110°C (70+40) at the plant normal ambient temperature of 104°F(40°C).

2) Because the plant environmental conditions for the motors do not change during the LOCA the same operating temperature (110°C) is considered during normal as well as during LOCA conditions. During HELB conditions the ambient temperature goes to 140°F (from 104°F normal) for one hour only.

3) Out of the three charging pumps one pump is required to operate continuously during the plant operation. It is conservative to assume that each pump motor will operate continuously for 14 years and remain idle for 26 years.

   In the following analysis it is shown that the qualified life of the motor is more than the required 14 years of continuous operating and 26 years of non operating lives.

4) From Fig. 4-1 of WCAP-8754 (thermal aging curve for thermalastic epoxy system, per IEEE Std.-275-1966) the qualified life at 120°C = 200,000 hours and from Fig. 9-1 (in which Westinghouse has drawn a most conservative projected qualified insulation life of motor) the qualified life at 120°C = 96,000 hours.

5) Activation Energy:

   The activation energy is calculated by Arrhenius extrapolation as follows:

   From Fig. 9-1 of WCAP-8754 the qualified life at 120°C = 90,000 hours and at 130°C = 45,000 hours.

Arrhenius equation

$$T_x = T_L\, e^{-\frac{\phi}{K}\,\frac{(T_2 - T_1)}{T_1\, T_2}}$$

where

T_x = life at a higher temperature = 45,000 hours

T_L = life at a lower temperature = 90,000 hours

ϕ = activation energy = to be calculated

K = Boltzman Constant = 8.617×10^{-5}

T_2 = higher temperature = 130 + 273 = 403°K

T_1 = lower temperature = 120 + 273 = 393°K

Substituting in the above equation:

$$44{,}000 = 96{,}000\; e^{-\frac{\phi x (403-393)}{8.167x403x393x10^{-5}}}$$

Solving:

$\phi = 1.08 \approx 1.0$

6) <u>Calculation of Qualified Life</u>

i) From Fig. 9-1 of WCAP-8754 the qualified life at 120°C is 96,000 hours. This life is converted at 110°C (which is maximum operating temp of the motors per Westinghouse letter no. VPU(RRU)-48 dated Jan. 9, 1981) by using Arrhenius extrapolations:

Arrhenius equation

$$T_x = T_L\, e^{-\frac{\phi}{K}\,\frac{(T_2 - T_1)}{T_1 x T_2}}$$

where

T_x = 96,000 hours

T_L = to be calculated

T_2 = 120°C + 273 = 393°K

T_1 = 110°C + 273 = 383°K

0 = 1.0

Substituting the values

$$96,000 = T_L\, e^{-\frac{1.0 \times (393-383)}{8.617 \times 10^{-5} \times 3 - 3 \times 383}}$$

Solving:

$$T_L = 207,542 \text{ hours} = 23.69 \text{ years}$$

Conclusions

Hence the qualified life of the motor at 110°C is 23.69 years. Out of this the motor is required to run continuously for 14 years. For conservatism let us assume that it operated continuously for 20 years at 110°C.

ii) Now in the following calculations it is shown that the life of 3.69 years (23.69 - 20) at 110°C is much more severe than the required 20 years of non operating life at plant ambient temp. of 40°C.

T_x = 3.69 years = 32324 hours

T_L = to be calculated

T_2 = 110°C + 273 = 383°K

T_1 = 40°C + 273 = 313°K

Substituting in the Arrhenius equation

$$32324 = T_L\, e^{-\frac{1.0 \times (383-313)}{8.617 \times 383 \times 313 \times 10^{-5}}}$$

Solving

$$T_L = 3235 \text{ years} > 20 \text{ years}$$

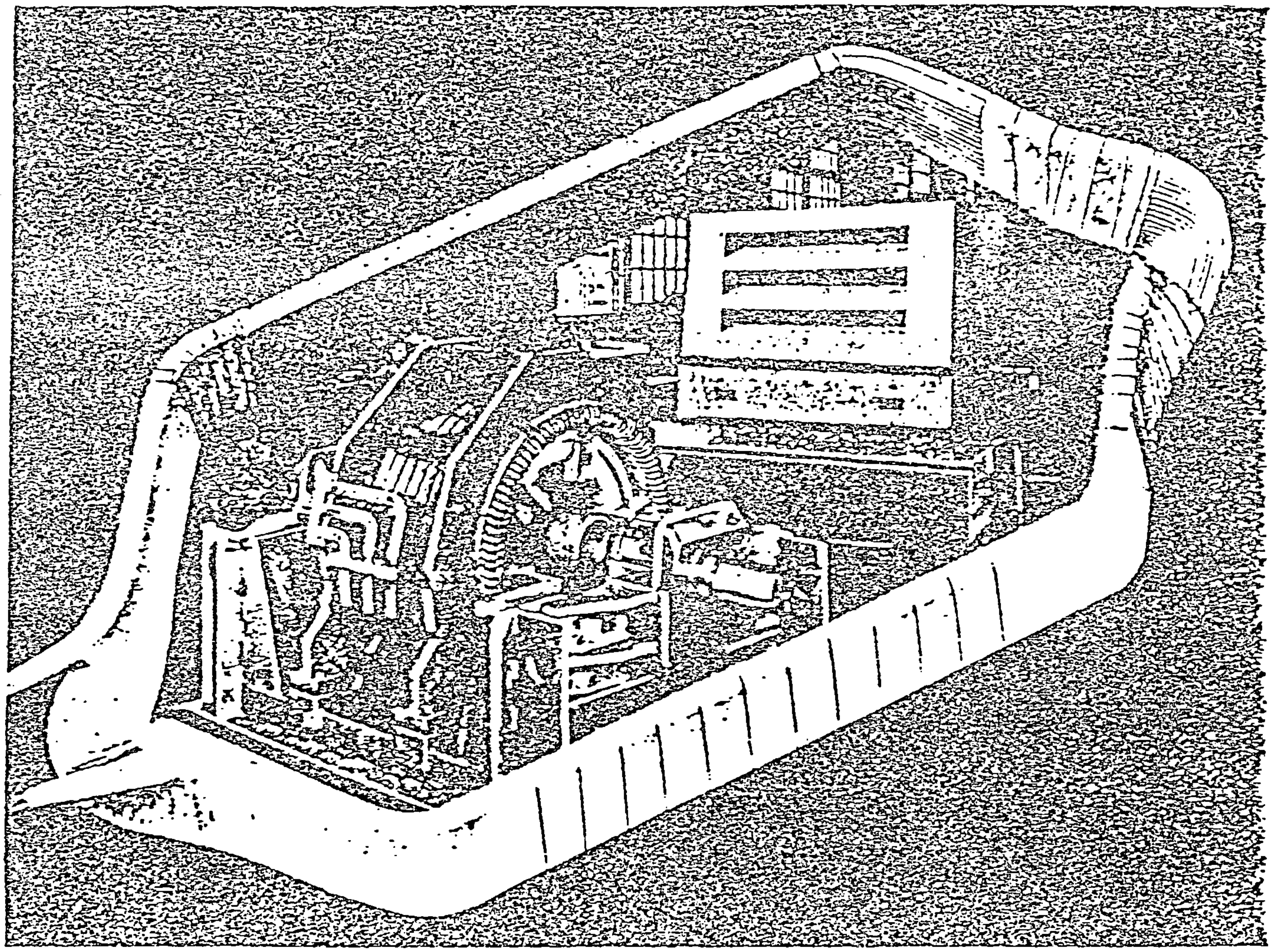
Hence from the above calculations it is concluded that the subject motor is qualified for 40 years of life for the required plant service conditions.

Westinghouse

Thermalastic Epoxy Insulation

For Large Ac Motors

F/A and other Motors with Form-Wound Coils – Squirrel-Cage PAM, Wound Rotor, Synchronous



Thermalastic Epoxy insulation is the standard on all large ac machines, 7,000 volts and below, built at East Pittsburgh using form-wound coils, up through the 85" diameter frame size. This will include practically all type F/A machines. It is also now available on some machines rated 13.8 kV.

Thermalastic Epoxy is also available on form-wound coils for ratings manufactured at the Buffalo Plant.

"Thermalastic" has made an enviable name for itself as an insulation. It was the first real advancement in insulation in over 20 years when it was first introduced in 1949 on large turbine generators.

Westinghouse began to use it on large motors in 1952. It is important to remember that Thermalastic insulation is a system, not a material. As such, it is not static and many improvements in its components and processing have been made since it was first used.

Continuous research and testing of all known insulating materials and systems have enabled Westinghouse to keep Thermalastic insulation better than any other insulation.

One basic feature of Thermalastic Epoxy insulation is the use of mica in the ground wall. No other material can equal mica from the standpoint of electric strength, voltage endurance and reliability.

Solventless epoxy resins are impregnated into the mica which has been preplaced on a form-wound coil. Then with both mica and resin in position, chemical reaction is initiated which transforms the resin into a solid which locks and binds the mica into a composite mass. The resulting end product then takes advantage of the excellent properties of both the mica and the resin. The outstanding characteristics of the epoxies is their extremely good resistance to moisture and to practically all types of chemical contaminants. They have been proven in laboratory tests described later and by field service.

Processing Thermalastic Epoxy insulation includes vacuum-pressure impregnation of the complete wound stator, stator coils as well as coil connections. This makes it possible to give all parts of the windings the full effect of the high resin fill that is achieved with the vacuum-pressure technique. The coils are not deformed or stressed after impregnation.

The processes described are those of the Large Rotating Apparatus Division in East Pittsburgh. Primarily due to differences in the size of motors manufactured at the Buffalo Large Ac and Dc Motor Division, specific processes vary in minor detail. The essential characteristics of the insulation system are the same.

September, 1971
Supersedes Technical Data 3170, dated June, 1968
E, D/1736, 1740/DE

Westinghouse

Stator Coils

The insulation immediately adjacent to the copper conductors is generally that which insulates the various turns in the coil from each other. This is a very important part of the insulation system, one which frequently is not given the attention it deserves. Since the majority of ac motors are started across-the-line, there is a possibility that steep fronted, impulse type waves can be imposed on the winding. These waves put high electric stress on the turn insulation, especially the turns of the stator coils near the line terminals.

In the light of these facts and the general industry trend to higher operating voltages, mica, which provides a positive electric barrier of very high strength, is used as turn insulation for all coils rated 4 kV and above for the larger size motors. On smaller size motors, this additional strength, where required, is obtained by the use of enamel plus double dacron-glass covering.

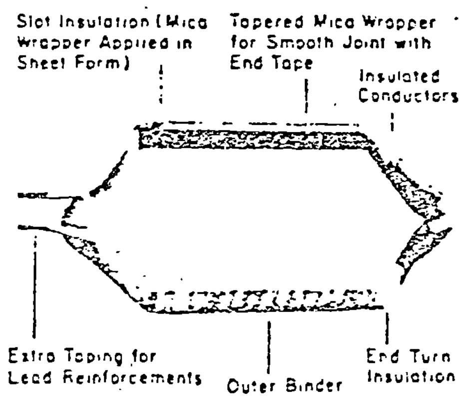


Fig. 1 Typical stator coil showing elements of insulation.

The micaceous ground insulating materials are applied as shown in detail in Fig. 1. All materials used are designed to be both compatible with, and selected components of, the complete insulation system.

Winding Stator

At the start of the winding operation the stator core consists of the assembled punchings and restraining end plates, thus providing a maximum of accessibility during coil assembly of larger size motors. The fact that the coils are unimpregnated at this stage provides ease of installation.

The end turns of the stator coils are firmly braced to withstand full-voltage starts with a series of insulated support rings as well as braces between coil end turns, which in effect form an archbound structure at these points. The material used as a brace between coil end turns is a non-woven polyester felt which has both resiliency and absorbency.

After installation of all coils and completion of wedging and bracing, the connections are made and insulated, and the stator is ready for impregnation.

Vacuum-Pressure Impregnation

The preheated stator is lowered into the vacuum pressure tank, and the air evacuated to a very low absolute pressure. The epoxy resin is then introduced, while maintaining the vacuum, to a level that completely submerges all parts of the winding. The vacuum is then released and replaced with positive pressure of several atmospheres over the liquid resin. Following these steps the stator is removed, as shown in Figure 2.

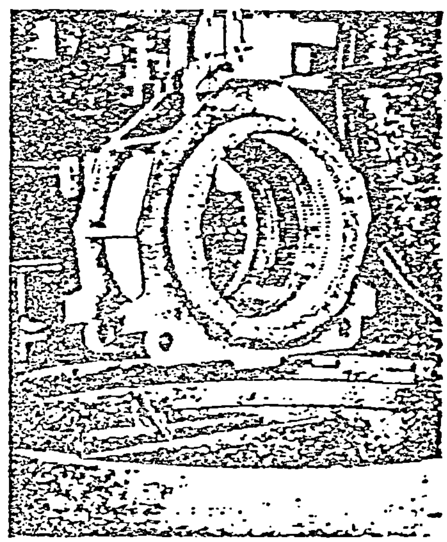


Fig. 2 After impregnation, the stator is removed from the tank and placed in an oven for curing.

The next step in the process takes place in an oven, where the resin is cured.

In addition to the impregnation of the winding, the bracing system has been built "in place" by the absorption of epoxy resin and subsequent cure in the polyester felt. This gives very high strength to the bracing scheme.

During the manufacture of the coils and winding, quality control procedures are used continuously to monitor the physical dimensions and electrical integrity of the insulation.

Evaluation and Test Program
Thermalastic Epoxy insulation was adopted as standard for large ac motors only after completion of an extensive evaluation and test program. A description of some of the more important tests follows.

Electric Strength
Since the fundamental function of insulation is to withstand electric stress the first series of tests on any insulation system is to determine its short-time electric strength. Complete insulated coils are used for this test.

It is desirable that for any particular voltage class the average breakdown voltage be as high as possible. However, it is essential that the values be examined and analyzed statistically. It is the Westinghouse concept that, using the principles of statistical analysis, the coils have a breakdown level well above the test level for individual coils.

Thermalastic Epoxy insulation has both a higher average short-time electric strength and is more reproducible from coil-to-coil than other insulation systems.

Voltage Endurance
Since insulation in large machines is expected to perform for a long period of time, a voltage endurance test has been devised. In this test, sample coils are prepared and connected as described for the short-time electric tests.

Electric strength is evaluated in depth by a series of breakdown tests for each insulation system. A group of sample coils for each system is tested at various voltage levels for fixed time intervals which may be one minute, one hour, one week or more. By plotting average "hold" values for the different time periods, a voltage endurance curve is created. Such a curve is shown in Figure 3.

Much of the data thus obtained tends to plot in a straight line. One way of looking at such data is to establish an "operating level" and examine where the extrapolated voltage endurance curve will intersect this "operating level". The Thermalastic insulation curve intersects the operating stress level at a time in excess of 100 years. These are results of laboratory tests on only one of the degrading mechanisms that affect insulation and, therefore, are not complete indications of actual operating life. However, systems that fail to give indications of satisfactory life in this very fundamental test are not considered favorably.

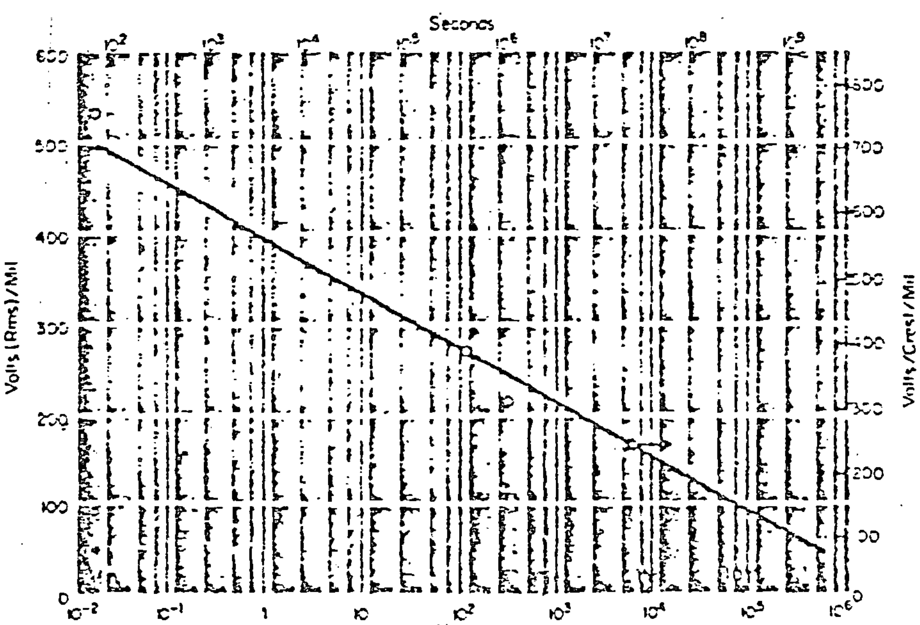


Fig. 3. Voltage Endurance.

Westinghouse

Moisture Resistance

The first screening test for moisture resistance is a test on individual coils suspended in salt water. These are standard coils submerged except for the leads and front loops and continuously subjected to normal voltage to ground. This is the value of the maximum line-to-ground operating voltage. Total hours to failure are then measured for each of the systems under investigation.

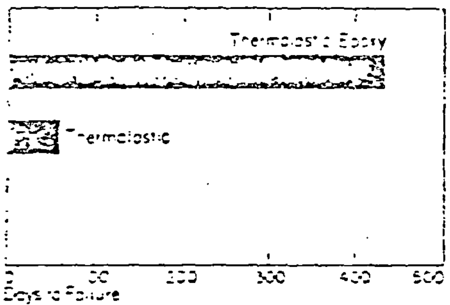


Fig. 4 Average life of insulation systems, immersed with voltage applied continuously.

Figure 4 shows the results obtained by this method. As can be seen, the epoxy resin impregnant imparts outstanding moisture resistance to the Thermalastic concept.

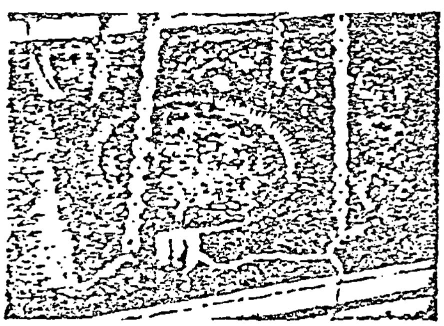


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Fig. 5 Complete motor winding immersed in water for test of moisture resistance.

Tests on individual coils without connections, however, are not the entire story. The moisture resistance of complete windings has also been investigated. In Figure 5 a winding including all connections is shown completely submerged in a tank of salt water. The winding leads are connected to a megohm bridge so that insulation resistance can be measured.

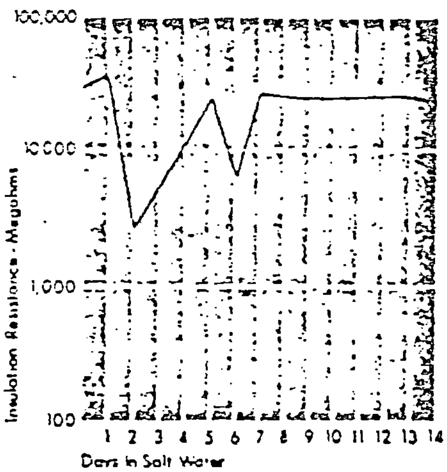

Fig. 6. Insulation resistance – throughout 14 day period.

A complete 4160 volt Thermalastic Epoxy stator was submerged in a tank of water containing 5% salt by weight (approximate sea water concentration) for a period of 14 days. The insulation resistance was checked throughout this period. Figure 6 is the plot of insulation resistance obtained throughout the 14 day period.

There are variations in the level, probably due to changes in the conductivity of the insulation surfaces at the winding terminals, but all readings are quite high. Figure 7 is a plot of the dielectric absorption tests taken before and after the 14 day period while in the water.

At the conclusion of this period the stator was removed from the tank and without rinsing or drying was subjected to a 4300 volt ac rms high potential test. The winding withheld this test with no difficulty. This indicates the winding could have been cleaned and dried and returned to service.

In still another test on a complete winding, the effect of continuous exposure to 100% relative humidity at 50°C was investigated. In some respects this is a more severe test than actual submersion since water vapor has a high degree of penetration through films. Figure 8 shows the results. After more than 3000 hours of this type of exposure, the Thermalastic Epoxy insulated winding still had insulation resistance measured in thousands of megohms.

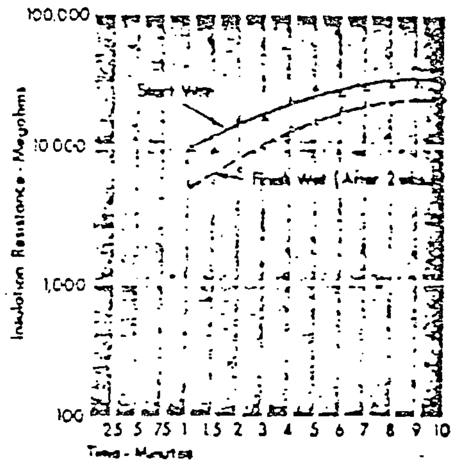

Fig. 7. Insulation resistance – before and after 14 day period.

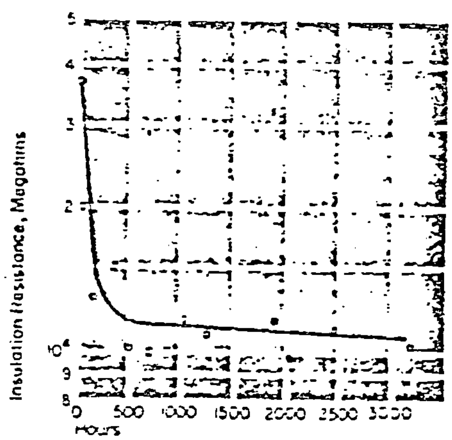

Fig. 8. Tests of wound 4160-volt stator under conditions of 100% humidity.

Chemical Resistance

Resistance to chemical contaminants is another factor in many industries. In looking at resistance to acids, bases and solvents, nothing has been found that is the equal of the epoxy resins. Table A shows a tabulation of some of the many tests made wherein resin samples were subjected to liquid baths of various contaminating materials. The resin used in Thermalastic Epoxy insulation shows outstanding resistance to all of them.

Thermal Endurance

Temperature is widely accepted as being one of the limiting factors in insulation life. To determine the ability of insulation to stand up under thermal aging, testing is done by following the basic concept of functional testing outlined in IEEE 275.

This is the "motorette" type of testing wherein small, complete coils are made in accordance with actual processes employed in the insulation system being evaluated. These coils are then mounted in slots on a motorette and the leads brought out in an appropriate fashion as shown in Figure 9 so that electrical tests can be made. These motorettes are then subjected to a cycle of oven aging, mechanical vibration, humidification and electrical test. Following this, the cycle is repeated and the number of cycles to failure is recorded.

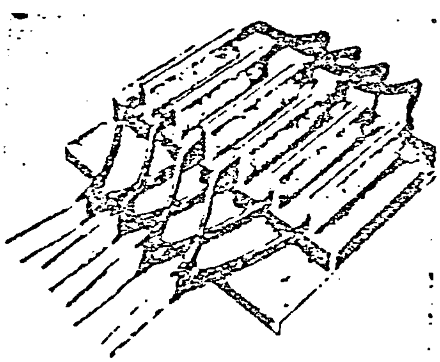

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Fig. 9. "Motorette" used for testing thermal endurance of insulation systems.

This is a comparative test only. There are no standard values for the test conditions or number of cycles or the hours of aging that a system should withstand. It is known, however, that for more than 30 years class B insulation has been in service and that it has performed satisfactorily. The procedure is, therefore, to compare new or proposed systems with the older service-proven systems. Figure 10 shows the data obtained by such tests. Hours of life is plotted logarithmically on the vertical axis

Table A
Solvent & Chemical Resistance of Thermalastic Epoxy Resin Castings

Solvent	Time of immersion	Shore D hardness	Percent ① Weight Change	Percent ① Thickness of Change	Rating
50% Acetic Acid	0	84	0	0	Excellent
	24 hours	85	0	0	
	48 hours	85	0	0	
	7 days	85	0	0	
	10 days	86	0	0	
10% Sodium Hydroxide	0	84	0	0	Excellent
	24 hours	85	0	0	
	48 hours	85	0	0	
	7 days	85	0	0	
	10 days	86	0	0	
Acetone	0	85	0	0	Good
	24 hours	81	+ 8.6	+ 9.5	
	48 hours	45	+15.3	+17.5	
	72 hours	..	Decomposed	....	
	10 days	..	....	....	
Benzene	0	87	0	0	Excellent
	24 hours	83	0	0	
	48 hours	83	0	0	
	7 days	83	0	0	
	10 days	83	0	0	
Trichloroethylene	0	86	0	0	Good
	24 hours	45	+ 7.5	+15.5	
	48 hours	..	Decomposed	....	
	7 days	..	....	....	
	10 days	..	....	....	
Distilled H_2O	0	83	0	0	Excellent
	24 hours	85	0	0	
	48 hours	85	0	0	
	7 days	85	0	0	
	10 days	85	0	0	

① Neglecting changes less than 1%.

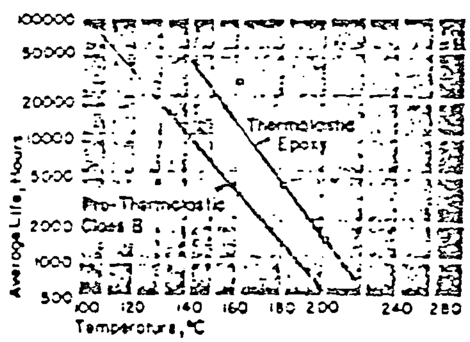

Fig. 10. Thermal endurance of insulation systems for rotating machines tested in motorettes in accordance with IEEE 275 (5000 volt proof test).

against temperature on the horizontal axis. As can be seen, the life of all systems decreases with increased temperature. The "pre-Thermalastic" curve is the data obtained on the class B insulation system used prior to Thermalastic. In going to the Thermalastic Epoxy system, a curve is obtained which is shifted over on the thermal scale by about 25°C. This in itself indicates a high order of "thermal reserve" in Thermalastic Epoxy insulation. This system qualifies for class F thermal rating.

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Thermal Cycling

All motors in service are required to withstand varying degrees of thermal cycling. The ability of Thermalastic Epoxy insulation to withstand thermal cycling and maintain moisture resistance is dramatically demonstrated by the following test.

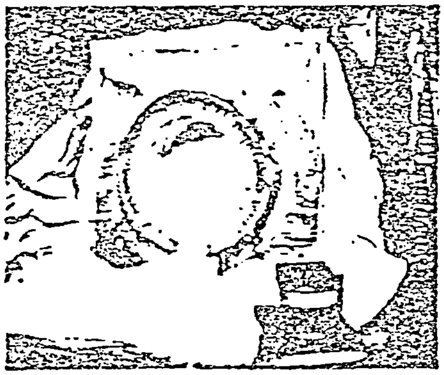

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Fig. 11 Cycling test of wound stator-packed with ice.

Figure 11 shows a wound stator packed in dry ice so that the imbedded thermocouples in the winding indicate minus 40°C. When the winding reached this temperature the dry ice was removed and the stator was immediately placed in an oven, which had been preheated to 150°C. This was repeated four times, cycling between these temperature limits, and the stator then completely submerged in water. Figure 12 shows the results obtained, and indicates that the moisture resistance is unaffected by thermal shocks of 190°C.

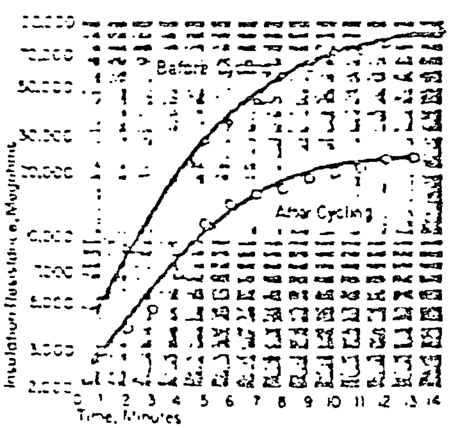

Fig. 12. Effect of thermal cycling on Thermalastic Epoxy insulation between temperature of −40°C and +150°C.

Mechanical Strength

All motor insulation may be subjected to severe mechanical stresses during operation. To determine the ability of the complete Thermalastic Epoxy winding to withstand mechanical stresses, the following test has been devised.

When a motor winding is first connected across the line there is a large current inrush to mechanical forces, which tend to severely distort them. Adequate bracing prevents the actual deformation but the forces are nevertheless present.

A motor with Thermalastic Epoxy insulation was subjected to 1,000 full-voltage starts. After completion of the 1,000 full-voltage starts, the entire wound stator was submerged in a tank of water and a ten-minute dielectric absorption curve was made immediately after submersion.

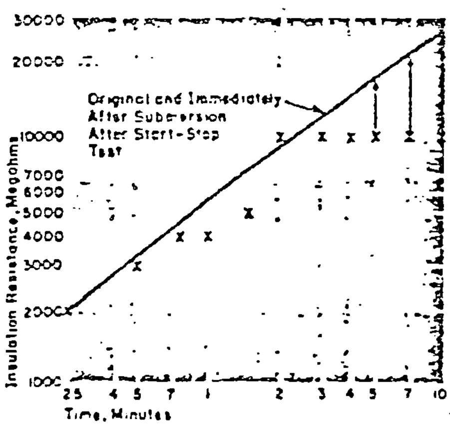

Fig. 13 Insulation resistance characteristics of submerged Thermalastic Epoxy stator winding (4160 volts) after motor was subjected to 1,000 full-voltage starts.

Even after these severe conditions, the winding had greater than 10,000 megohms of insulation resistance after ten minutes of voltage as shown in Figure 13.

Abrasion Resistance

Motors are not infrequently expected to operate in an environment which subjects the coil insulation to bombardment by highly abrasive particles. This occurs because the cooling air which is circulated through the motor comes from the surrounding atmosphere of the motor and often contains a great deal of abrasive particulate matter. This particulate matter is forced at high velocity over the end windings of the stator coils and is equivalent to a sandblast commonly used in many industrial applications for cleaning and stripping operations.

In order to allow the windings to operate under these adverse conditions, special treatments have been developed. It is well known that elastomers or rubbers are capable of absorbing energy upon impact with another harder material. Therefore the special treatments consist of a layer of an elastomeric material which is capable of absorbing this energy and literally bouncing the abrasive particles off the surface.

The coatings are applied over the completed winding by dipping or spraying so as to provide an energy-absorbing surface. This had to be a very special coating which would have the ability to work not only as applied, but also at the operating temperature of the coil surface and to maintain this property over the long periods of time the machines are expected to run.

Radiation Resistance of Thermalastic Epoxy Insulation

Of the various components that go to make up the Thermalastic Epoxy insulation system, the epoxy impregnant is the most susceptible to radiation damage. The mica and fiber glass portions will be unaffected by dosage levels that would destroy the impregnating resin. However, the epoxy impregnant, because of its aromatic nature, is one of the better resinous materials with regard to radiation resistance, having a predicted life of 40 years at a dosage of up to 10^9 rads at low radiation rates of less than 100 rads per hour. Normal radiation levels within the containment vessel of a nuclear power station are below a rate of 50 rads per hour with a total dosage of 2×10^7 rads over a period of 40 years. Therefore, Thermalastic Epoxy windings in a typical radiation environment will operate many years with no measureable deterioration due to the radiation.

Winding Repairs

The standardization of Thermalastic Epoxy insulation for large motors allows a completely new approach to the subject of winding repairs and the desirability of carrying spare coils.

First of all, the possibility of winding repairs being required is reduced to a minimum far below that possible with any previous insulation system.

The basic approach is to provide for the contingencies that may arise with minimum total expense to the user including both repair and downtime cost.

Depending on the extent of damage, several alternatives are available for winding repairs:

1. Most failures resulting from accidental mechanical damage occur on the end windings where the coil is exposed. Repairs to the end winding external to the core can be made by the conventional patching method.

2. In the remote possibility of coil failure within the slot, it is not practical to replace coils by conventional means. The very processing of complete impregnation and bonding which insures a failure-free coil also makes it impractical to lift enough coils to replace both top and bottom coil sides of a damaged coil.

To replace a damaged coil in any machine, it has always been necessary to lift at least a full throw of coils to get the new coil in. Quite often, this operation results in damage to other coils. Therefore, when spare coils are considered desirable, it has been standard practice to carry at least ¼ or ½ of a set to replace one or two damaged coils.

Westinghouse has developed a technique of coil replacement, for use on motors manufactured at East Pittsburgh, which makes it unnecessary to disturb any coils except the damaged coil or, at most, the other coil in the same slot.

For Thermalastic Epoxy insulated machines, a standard repair kit can be supplied including six half coils suitable for replacing either top or bottom sides of the coil. Also included are the necessary materials, tools and instructions for replacing damaged coils. Complete spare Thermalastic Epoxy insulated coils are not furnished for these machines.

3. In the case of widespread damage involving a number of coils, a complete rewind is recommended. The elaborate facilities required for the Thermalastic Epoxy system make it necessary to return the stator to the factory to obtain the original processing. On a breakdown basis, this can be done usually in three weeks or less and requires no longer than would be required to order coils and rewind in the field.

If consideration is given to stocking a full set of coils to protect against such a failure on a Thermalastic Epoxy insulated machine, the recommendation is that a complete wound stator be stocked. This will cost no more than a full set of coils plus the expense of stripping the old winding and winding the new coils in any machine. Downtime is reduced to a minimum.

NAW-3615

Westinghouse Electric Corporation

Water Reactor Divisions

Nuclear Commercial Operations Division

Box 355
Pittsburgh Pennsylvania 15230

Mr. S. C. Brown, Jr., Senior Vice President
Virginia Electric and Power Company
P.O. Box 26666
Richmond, VA 23261

October 30, 1980

Dear Mr. Brown:

VIRGINIA ELECTRIC AND POWER COMPANY
NORTH ANNA POWER STATION

NUREG-0588 Equipment Qualification

Reference: NCW-1315

This is to confirm information which has been provided to Mr. R. Newcomb in order to provide additional information in response to your request of the referenced letter as well as other telephone requests by Mr. R. Newcomb.

Lubricants for Westinghouse Pump Motors

Table 1 identifies a lubricant for which radiation exposure testing is available. This lubricant is recommended for use with the Westinghouse supplied Charging and SI pump motors for Surry and North Anna.

Grease for LHSI Pump Motors

Chevron SRI-2 grease is recommended for use with the Westinghouse supplied LHSI pump motors. Per our telephone conversation with Mr. R. Newcomb, Vepco has obtained radiation resistance testing information for this grease.

High Energy Break for Pump Motors

The Westinghouse supplied Charging Pump motors are capable of withstanding the temperature-time profile transmitted by the referenced letter. The reduction on qualified life due to operating through the transient is about one month. The bearings of the non-operating charging pumps can also withstand the referenced transient. The bearings of the operating charging pump will experience an operating temperature in excess of the allowable and thus cannot be assumed, based upon currently available information to withstand the transient. We are reviewing, with our motor manufacturing division, means for reducing the conservatism in the allowable operating temperature.

Seal Water Cooling Pumps

Information was requested relative to the capability of the Westinghouse supplied charging pumps to operate without seal water cooling due to failure at the seal water cooling pumps. With the pumped fluid temperature less than 115°F, operation without seal water cooling is acceptable. Since your pumped fluid temperature exceeds 170°F, we are investigating the resultant failure mechanism at R. Newcomb's request.

Surry Pump Motor Insulation

The motor insulation for the charging pumps at Surry, Motor Shop Order Number 68F13318 is thermoelastic epoxy wound and therefore is covered by WCAP-8754, Section 5-2. The safety injection pump motors appear to have been rewound and thus cannot be confirmed to be covered by WCAP-8754.

Auxiliary Oil Pump Motor

The Auxiliary Oil Pump Motor is not required for Class 1E operation of the Charging Pumps.

Should you have any questions on this matter, please call.

Very truly yours,

For [signature]

J. B. Cookinham, Manager
Vepco Projects

/rcc
attachment

S. C. Brown, 3L 3A19

cc: W. R. Cartwright, 1L
R. B. Bradbury, 1L 1k

TABLE 1

Premium Grade, Corrosion and Oxidation Inhibited Mineral Base Turbine Oils.

Brand Name	Viscosity	Radiation Exposure Limit**
Exxon Teresstic-46	200 SUS@100°F	1.4×10^7 Rad.*

*Reference: EPRI report NP-1447 Vols. 1 & 2, Project 893-1, July 1980. Tests performed by Westinghouse R&D. Critical breakdown of oil would be expected by 2×10^8 Rad.

**Values presented for the Radiation Exposure Limit are the highest documented exposure levels obtained by the author to date, based on a non-conclusive data search.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 63

TER Category: IIa

Description: 450V MOTOR CONTROL CENTERS - SUPPLY POWER TO SAFETY SYSTEM

Manufacturer, Model: CUTLER-HAMMER, Model UNITROL

Tag No(s).: 2-H1-2S,N, 2-J1-2E,W

Worksheet No(s).: 6-23 to 6-26

QDR No.: 5437-78-01

Location: AB-13B

DISCREPANCY

Qualification was not established for this item because the review package (QDR) was not provided.

RESPONSE

The QDR listed under COMPONENT was prepared subsequent to submittal of the SER and 90-day Rev. 4 responses. The QDR establishes qualification, and is being submitted at this time.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 72

TER Category: IIa

Description: VALVE OPERATORS FOR CONTROL AND RELAY ROOM CHILLED WATER

Manufacturer, Model: Limitorque SMB-000

Tag No(s).: MOV-PG-107A,B, and C

Worksheet No(s).: 6-84, 85, and 86

QDR No.: 5437-66-01

Location: SB-9B

DISCREPANCY

The peak accident temperature exceeds the qualified peak temperature, as defined on the worksheets.

RESPONSE

The equipment in this item should be assigned to TER Category IIIa, Equipment Exempt from Qualification, because alternate backup equipment not affected by a Surry 2 Turbine Building HELB can cool the control room. The following statement, from section 7.4.2 of the Rev. 4 90-day response, is applicable:

> The control room habitability equipment located in Unit No. 1 Service Building Machinery room can provide the function. This can be accomplished by opening manual cross-connect valves in the chilled water supply and return headers. These valves are located in the cable spreading area and are accessible from the control room without being exposed to the turbine building environment.

Further discussion of this item is attached.

ATTACHMENT FOR SURRY 2 ITEM 72
VALVE OPERATORS FOR CONTROL AND RELAY ROOM CHILLED WATER

The Rev. 3 worksheets (dated February 1, 1981) for these operators state that "we are presently determining what the pressure and temperature will be resulting from a postulated Unit 2 Turbine Building HELB." The worksheets also provided essentially the same description of backup equipment availability that is included in the Rev. 4 (August, 1982) conclusions section. Even though the backup equipment is available, the intent was to qualify the operators if possible.

After submittal of the 90-day Rev. 3 response, the pipe break calculation for the room containing these valve operators was completed, yielding the 310°F temperature for the first 30 minutes shown in the Rev. 4 worksheets. This temperature is clearly above the qualification limits for Limitorque SMB-000 operators. The Errata sheet for Section 7 of the REv. 4 90-day response deleted these operators from the list of control room habitability equipment for which satisfactory backup equipment is available.

We have re-reviewed this concern and conclude that in fact the discussion of backup equipment availability does apply to these valve operators. Accordingly they are exempt from qualification and will be deleted from the Master List.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 73

TER Category: IIa

Description: 1000 VOLT, CROSS LINKED POLYETHYLENE INSULATED CABLES

Manufacturer, Model: Cerro Wire & Cable Company

Tag No(s).: Spec. Nos: NUS-325, SN-246, NUS-362, SN-1246, NUS-381C, SN-446, and NUS-381E, SN-1447

Worksheet No(s).: 6-37, 6-42a, 6-38, 6-39

QDR No.: 5437-134-01

Location: RC-3A

DISCREPANCY

(See TER Item No. 44)

RESPONSE

(See TER Item No. 44)

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 116

TER Category: IIa

Description: PRESSURE TRANSMITTER FOR POST ACCIDENT MONITORING (TMI ITEM)

Manufacturer, Model: ROSEMOUNT, INC., Model #1152AP7A22PB

Tag No(s).: PT-LM-201A, B

Worksheet No(s).: TMI 1, 2

QDR No.: 5437-241-01

Location: Inside Containment, RC-3A

DISCREPANCY

Qualification was not established for this item because the review package (QDR) was not provided.

RESPONSE

The QDR listed under COMPONENT was prepared subsequent to submittal of the SER and 90-day Rev. 4 responses. The QDR establishes qualification, and is being submitted at this time.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 118

TER Category: IIa

Description: LEVEL TRANSMITTER FOR CONTAINMENT SUMP LEVEL (TMI ITEM)

Manufacturer, Model: GEMS, Model XM54854, XM54853

Tag No(s).: LT-RS-251A, B

Worksheet No(s).: TMI, 30, 31

QDR No.: future

Location: RC-3A

DISCREPANCY

This is a new equipment item for TMI purposes.

RESPONSE

Qualification testing was recently completed for this item, but the qualification test report is not yet available. We continue to believe that the equipment is the best available for the purpose, and have no knowledge of type test failures that would compromise its capability for qualification.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 119

TER Category: IIa

Description: LEVEL TRANSMITTER FOR RC SUMP WATER LEVEL (TMI ITEM)

Manufacturer, Model: GEMS, Model XM54854

Tag No(s).: LT-DA-210A, B

Worksheet No(s).: (TMI) 5, 6

QDR No.: future

Location: RE-27B

DISCREPANCY

This is a new equipment item for TMI purposes.

RESPONSE

Qualification testing was recently completed for this item, but the qualification test report is not yet available. We continue to believe that the equipment is the best available for the purpose, and have no knowledge of type test failures that would compromise its capability.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 127

TER Category: IIa

Description: LIMIT SWITCHES (TMI ITEM)

Manufacturer, Model: GORDOS, Model MR8901

Tag No(s).: ZS-SS-200A1, 200A2, B1, B2

Worksheet No(s).: TMI Numerous

QDR No.: 5437-245-01

Location: RC-3A

DISCREPANCY

Qualification was not established for this item because the review package (QDR) was not provided.

RESPONSE

The QDR listed under COMPONENT was prepared subsequent to submittal of the SER and 90-day Rev. 4 response. The QDR establishes qualification, and is being submitted at this time.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 128

TER Category: IIa

Description: LIMIT SWITCHES (TMI ITEM)

Manufacturer, Model: GORDOS, Model MR8901

Tag No(s).: Numerous

Worksheet No(s).: (TMI) Numerous

QDR No.: 5437-245-01

Location: RC-3A

DISCREPANCY

Qualification was not established for this item because the review package (QDR) was not provided.

RESPONSE

The QDR listed under COMPONENT was prepared subsequent to submittal of the SER and 90-day Rev. 4 responses. The QDR establishes qualification, and is being submitted at this time.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 129

TER Category: IIa

Description: LIMIT SWITCH (TMI ITEM)

Manufacturer, Model: GORDOS Model MR8901

Tag No(s).: Numerous

Worksheet No(s).: (TMI) Numerous

QDR No.: 5437-245-01

Location: RC-3A

DISCREPANCY

Qualification was not established for this item because the review package (QDR) was not provided.

RESPONSE

The QDR listed under COMPONENT was prepared subsequent to submittal of the SER and 90-day Rev. 4 responses. The QDR establishes qualification, and is being submitted at this time.

TECHNICAL EVALUATION REPORTS
ENVIRONMENTAL QUALIFICATION OF SAFETY-RELATED ELECTRICAL EQUIPMENT
SURRY POWER STATION UNITS 1 AND 2

30-DAY RESPONSE TO
NRC LETTER OF JANUARY 26, 1983

MARCH 9, 1983

ATTACHMENT 6
UNIT 2: RESPONSE TO NRC CATEGORY II.B
EQUIPMENT NOT QUALIFIED

TER ITEMS

2
16

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 2

TER Category: IIb

Description: RCS WIDE RANGE PRESSURE TRANSMITTERS (PAM)

Manufacturer, Model: Rosemount 1153D

Tag No(s).: PT-2402, PT-RC-2402-1

Worksheet No(s).: 6-273, 6-274

QDR No.: future

Location: RC-3B

DISCREPANCY

This is PAM equipment which was under review at the time of the 90-day Rev. 4 submittal. The TER classified the equipment in Category IIb, Equipment Not Qualified.

RESPONSE

Qualified replacement instrumentation will be installed during the outage planned to begin on May 1, 1983, as committed in VEPCO letter to the NRC serial number 085A dated March 2, 1983. In the interim, Justification for Continued Operation is provided in VEPCO letter to the NRC serial number 085 dated February 18, 1983. Additional information was submitted by letter number 085B dated March 9,1983.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 16

TER Category: IIb

Description: SG WIDE RANGE LEVEL TRANSMITTERS (PAM)

Manufacturer, Model: Rosemount 1153A

Tag No(s).: LT-2477, 2487, and 2497

Worksheet No(s).: 6-275, 6-276, 6-277

QDR No.: None

Location: RC-3B

DISCREPANCY

This is PAM equipment which was under review at the time of the 90-day Rev. 4 submittal. The TER classified the equipment in Category IIb, Equipment Not Qualified.

RESPONSE

Justification for Continued Operation is provided in VEPCO letter to the NRC serial number 085 dated February 18, 1983.

TECHNICAL EVALUATION REPORTS
ENVIRONMENTAL QUALIFICATION OF SAFETY-RELATED ELECTRICAL EQUIPMENT
SURRY POWER STATION UNITS 1 AND 2

30-DAY RESPONSE TO
NRC LETTER OF JANUARY 26, 1983

MARCH 9, 1983

ATTACHMENT 7
UNITS 1 AND 2: RE-REVIEW OF CATEGORY III.A
EQUIPMENT EXEMPT FROM QUALIFICATION

TER ITEMS

UNIT 1: 40
UNIT 2: 107

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 1

COMPONENT

TER Item No.: 40

TER Category: IIIa

Description: 600 VOLT POWER CABLE

Manufacturer, Model: Kaiser Aluminum and Chemical Sales, XLPE/Neoprene

Tag No(s).: Spec. Nos: NUS-225, SN-251; NUS-365A, SN-1251

Worksheet No(s).: 6-48 & 6-49

QDR No.: 5437-40-01

Location: AB-2B, AB-2C, AB-45 and SFGD-1

DISCREPANCY

Equipment was deleted from the Master List based on Licensee's field test verification (special test 104) that these cables have not been used in safety related application.

RESPONSE

During Surry Site records search on March 5, 1983 it was discovered that six 600 volt, XLPE Kaiser cables were used in Unit No. 1.

The qualification of this cable is established, using similarity as the basis, and a summary is attached with this TER item no. 40. We are preparing a complete review package to reflect the qualification of this cable.

This equipment should be classified in Category Ia, "Equipment Qualified" based on the attached qualification summary.

ATTACHMENT TO TER ITEM NO. 40
VEPCO SURRY UNIT NO. 1
QUALIFICATION OF KAISER, 600 VOLTS, XLPE INSULATED CABLES

During the Surry site records search for cable identification on March 5, 1983, it was discovered that 11 Kaiser 600 Volt, XLPE cables were used (6 in Unit No. 1 and 5 in Unit No. 2). A breakdown, by unit, of the safety related equipment (listed on the master list) for which these cables are used is as follows:

Surry Unit No. 1

Equipment Tag No.	Cable No.	Location
1-VS-F-8B	1J10PL214	AB-45
SOV-VG-109B	1VB350	AB-2B
1-SI-P-1A	1H3PL1	SFGD-1
1-SI-P-1B	1J3PL1	SFGD-1
1-RS-P-2A	1H7PL1	SFGD-1
1-RS-P-2B	1J8PL1	SFGD-1

Surry Unit No. 2

Equipment Tag No.	Cable No.	Location
2-CH-P-1B	2J5PH1	AB-2C
2-RS-P-2A	2H7PL1	SFGD-1
2-RS-P-2B	2J8PL1	SFGD-1
2-SI-P-1A	2H3PL1	SFGD-1
2-SI-P-1B	2J3PL1	SFGD-1

The above review indicates that Kaiser cables are used for redundant equipment in four zones whose environmental parameters are as follows:

Zone	Total Radiation Dose	HELB Conditions
1. AB-2B	5.0×10^6 Rads	120-205°F - 20 min, 205-120°F - 40 min
2. AB-2C	1.08×10^7 Rads	120-140°F - 20 min, 140-120°F - 40 min
3. AB-45	3.8×10^5 Rads	120-125°F - 20 min, 125-120°F
4. SFGD-1	8.0×10^6 Rads	120°F (normal ambient)

The highest radiation level to which the cables could be subjected during a LOCA is 1.08×10^7 Rads, and for temperature profile would be 205°F for 20 minutes during

HELB conditions. There is no steam or LOCA (chemical spray) environment applicable to any of the above listed zones.

JUSTIFICATION

There is no qualification report available for the above cables; however we are preparing a qualification review package, using similarity as the basis. The QDR Nos. for Kaiser cables are QDR-5437-40-01 for Unit No. 1 and QDR-5437-139-01 for Unit No. 2.

ANALYSIS

We are qualifying these cables based on several leading vendor test reports, EPRI final report no. EPRI-NP-1558 project 890-1, dated Sept. 1980, Table C-1 in DOR Guidelines, and IEEE transaction paper, Vol. PAS-88, No. 5, May, 1969 for "Insulations and Jackets for Control and Power Cables in Thermal Reactor Nuclear Generating Stations."

i. Per Table C-1 of DOR Guidelines, the threshold value of cross-linked polyethylene is 1×10^7 rads.

ii. Per IEEE Paper the cross-linked (filled and non-filled) polyethylene cables are categorized in Class 3 radiation level which is 8.8×10^8 rads. These XLPE cables are recommended for nuclear power plant applications.

iii. The leading vendors like Okonite, Continental, Cerro, and Raychem have qualified XLPE insulated cables for 2.0×10^8 rads irrespective it is chemically or irradiationally cross-linked.

Considering the above facts, these cables are concluded to be qualified for at least 1.08×10^7 rads which is about one twentieth the dose to which XLPE cable has been qualified by all other available sources.

These cables will not be subjected to either steam or LOCA (chemical spray) environment. The relatively low temperature profile during HELB conditions, 205°F for less than one hour, will have little or no effect on the life of the cable. Hence, these cables are concluded to be qualified for the subject environment conditions.

30 DAY RESPONSE TO SER & TER
ELECTRICAL EQUIPMENT ENVIRONMENTAL QUALIFICATION
SURRY 2

COMPONENT

TER Item No.: 107

TER Category: IIIa

Description: 600 VOLT POWER CABLE

Manufacturer, Model: Kaiser Aluminum and Chemical Sales, XLPE/Neoprene

Tag No(s).: Spec. Nos: NUS-225, SN-251; NUS-365A, SN-1251

Worksheet No(s).: 6-48 & 6-49

QDR No.: 5437-139-01

Location: AB-2B, AB-2C, AB-45 and SFGD-1

DISCREPANCY

Equipment was deleted from the Master List based on Licensee's field test verification (special test 104) that these cables have not been used in safety related application.

RESPONSE

During Surry Site records search on March 5, 1983 it was discovered that five 600 volt, XLPE Kaiser cables were used in Unit No. 2.

The qualification of this cable is established, using similarity as the basis, and a summary is attached.

We are preparing a complete review package to reflect the qualification of this cable.

This equipment should be classified in Category Ia, "Equipment Qualified" based on the attached qualification summary.

ATTACHMENT TO TER ITEM NO. 107
VEPCO SURRY UNIT NO. 1
QUALIFICATION OF KAISER, 600 VOLTS, XLPE INSULATED CABLES

During the Surry site records search for cable identification on March 5, 1983, it was discovered that 11 Kaiser 600 Volt, XLPE cables were used (6 in Unit No. 1 and 5 in Unit No. 2). A breakdown, by unit, of the safety related equipment (listed on the master list) for which these cables are used is as follows:

Surry Unit No. 1

Equipment Tag No.	Cable No.	Location
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1-SI-P-1B	1J3PL1	SFGD-1
1-RS-P-2A	1H7PL1	SFGD-1
1-RS-P-2B	1J8PL1	SFGD-1

Surry Unit No. 2

Equipment Tag No.	Cable No.	Location
2-CH-P-1B	2J5PH1	AB-2C
2-RS-P-2A	2H7PL1	SFGD-1
2-RS-P-2B	2J8PL1	SFGD-1
2-SI-P-1A	2H3PL1	SFGD-1
2-SI-P-1B	2J3PL1	SFGD-1

The above review indicates that Kaiser cables are used for redundant equipment in four zones whose environmental parameters are as follows:

Zone	Total Radiation Dose	HELB Conditions
1. AB-2B	5.0×10^6 Rads	120-205°F - 20 min, 205-120°F - 40 min
2. AB-2C	1.08×10^7 Rads	120-140°F - 20 min, 140-120°F - 40 min
3. AB-45	3.8×10^5 Rads	120-125°F - 20 min, 125-120°F
4. SFGD-1	8.0×10^6 Rads	120°F (normal ambient)

The highest radiation level to which the cables could be subjected during a LOCA is 1.08×10^7 Rads, and for temperature profile would be 205°F for 20 minutes during

HELB conditions. There is no steam or LOCA (chemical spray) environment applicable to any of the above listed zones.

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We are qualifying these cables based on several leading vendor test reports, EPRI final report no. EPRI-NP-1558 project 890-1, dated Sept. 1980, Table C-1 in DOR Guidelines, and IEEE transaction paper, Vol. PAS-88, No. 5, May, 1969 for "Insulations and Jackets for Control and Power Cables in Thermal Reactor Nuclear Generating Stations."

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Considering the above facts, these cables are concluded to be qualified for at least 1.08×10^7 rads which is about one twentieth the dose to which XLPE cable has been qualified by all other available sources.

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NUS CORPORATION
910 CLOPPER ROAD
GAITHERSBURG, MARYLAND 20878
(301) 258-6000

N08.1-V01-412
September 23, 1982
File 4.8

Mr. A. L. Parrish, III
Manager, Multiple Power Projects
Virginia Electric and Power Co.
P.O. Box 564
Richmond, Virginia 23204

Attention: J. E. Wroniewicz

Subject: Surry Unit 1 Transmittal of Final Rev. 1 of Qualification Review Package

Dear Mr. Parrish:

Transmitted herewith is one (1) copy of the final signed-off Revision No. 1 of the qualification document review package QDR-5437-47-01 Continental Wire & Cable Company 600V and 1000V Cables with Silicone Rubber Insulation & Hypalon Jacket dated 9/21/82 for your permanent files. All VEPCO's comments have been resolved and incorporated along with additional NUS comments in this revision. Revised sheet numbers are listed in Record of Revisions Table.

Our review for the above equipment is complete and the package is closed. The original master file with one additional copy shall be turned over to you at any time you advise.

If you have any questions, please call.

Very truly yours,

N. K. Garg

for R. C. Wilson
Project Manager

cc: N. Garg, NUS w/enc.
A. Ballav, NUS w/enc.
B. J. Reckman, NUS w/o enc.
J. L. Renehan, NUS w/o enc.
S. B. Gerges, NUS w/o enc.