QUALIFICATION TESTS OF COAXIAL-TYPE CABLES IN A SIMULATED STEAM LINE BREAK (SLB) AND LOSS-OF-COOLANT ACCIDENT (LOCA) ENVIRONMENT

Final Report
F-C5120-2

Prepared for

BRAND-REX COMPANY
A PART OF Akzona INC.
WILLIMANTIC, CONNECTICUT 06226
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REX

September 2, 1980

Franklin Research Center
A Division of The Franklin Institute
The Benjamin Franklin Parkway, Phila., Pa. 19103 (215) 448-1000

1. SUMMARY OF SALIENT FACTS

FRC Project No.	Report Title:
C5120	QUALIFICATION TESTS OF COAXIAL TYPE CABLES IN A SIMULATED STEAM LINE BREAK (SLB) AND LOSS-OF-COOLANT ACCIDENT (LOCA) ENVIRONMENT

Conducted and Reported By:	Conducted for:
Franklin Research Center The Parkway at Twentieth Street Philadelphia, PA 19103	Brand-Rex Company Industrial and Electronic Cable Division Willimantic, CT 06226

Report Date:	Period of Test Program:
September 2, 1980	August through December 1979

Objective:

To demonstrate performance of coaxial type cables for Class 1E service in nuclear power generating stations in accordance with appropriate guidelines presented in IEEE Stds 323-1974 and 383-1974.[1]

Equipment Tested:

Two RG-11A/u and four RG-59B/u coaxial cables with crosslinked polyethylene (XLPE) insulation and an overall Hypalon jacket. A complete description is provided as Table 1 herein.

Elements of Program:

Three of the specimens were unaged, and three specimens were thermally aged for 168 hours (7 days) at 136°C (227°F). All specimens were exposed to 200 Mrd of gamma irradiation (air equivalent dose) from a cobalt-60 source at a rate less than 1 Mrd/h and then to a steam/chemical-spray environment simulating a combined steam line break (SLB) and loss-of-coolant accident (LOCA) and the cooldown following the SLB/LOCA. The simulated SLB/LOCA exposure included two rapid rises in temperature/pressure to 385°F(196°C)/66 lbf/in^2 (455 kPa), two 10-minute dwells at those peak temperatures, followed by decreasing temperatures to a final 20-day dwell at 230°F (110°C)/10 lbf/in^2 (69 kPa). The total simulated SLB/LOCA duration was 30 days. A chemical solution (6200 ppm boron, 50 ppm hydrazine, sufficient sodium triphosphate to obtain a pH of 8.5, followed by sufficient sodium hydroxide to obtain a pH of 10.0 at room temperature) was sprayed on the specimens at the rate of 0.27 gpm per square foot (11 L/min per square meter),[2] starting at the completion of the 10-minute dwells at 385°F (196°C). The cables were electrically energized with ac potentials of 600 V during the 30-day SLB/LOCA exposure. Final tests consisted of a 40X diameter bend test and a 5-minute high-potential-withstand test at 80 V per mil (3150 V/mm) of insulation.

Summary of Test Results:

SLB/LOCA Exposure - All six specimens remained energized except for short periods to permit electrical measurements or for reasons not associated with the specimens of this report.

Final High-Potential-Withstand Tests - All specimens withstood high potentials with leakage/charging currents less than 3.0 mA.

[1]Full citations are provided in the text. [2]See Section 4.5 for description of spray area calculation.

2. IDENTIFICATION OF CABLES TESTED

The cable specimens were of the coaxial type as described in Table 1. The total length of each cable was approximately 30 ft; 15 ft of each specimen was within the test vessel during the steam/chemical-spray exposure.

Table 1. Identification of Specimens and Related Data

FRC SPECIMEN NUMBER	BRAND-REX DESIGNATION	INSULATION/ JACKET MATERIALS†	THERMAL AGING CONDITIONS	PUBLISHED INSULATION THICKNESS (in)/(mm)	SPECIMEN OUTSIDE DIAMETER (in)/(mm)
C5120-8-1	CS 75285(RG-11A/u)	XLPE/Hypalon	Unaged	0.121/3.1	0.39/9.9
C5120-8-2	CS 75285(RG-11A/u)	XLPE/Hypalon	168 h @ 277°F (136°C)	0.121/3.1	0.39/9.9
C5120-9-1	CS 75146(RG-59B/u)	XLPE/Hypalon	Unaged	0.06/1.5	0.24/6.1
C5120-9-2		XLPE/Hypalon	Unaged	0.06/1.5	0.24/6.1
C5120-9-3		XLPE/Hypalon	168 h @ 277°F (136°C)	0.06/1.5	0.24/6.1
C5120-9-4		XLPE/Hypalon	168 h @ 277°F (136°C)	0.06/1.5	0.24/6.1

†XLPE - Flame-retardant crosslinked polyethylene
Hypalon - Flame-retardant chlorosulphonated polyethylene

5. TEST RESULTS

5.1 INSULATION RESISTANCE

Results of IR measurements obtained during the test program are summarized in Table 2. IR measurements made during the S/C exposure include the IR effects of extension cables and terminal blocks used to connect the specimens to energizing circuits; the effects usually cause a small reduction in measured IR.

5.2 THERMAL AGING

The specimens that were thermally aged at 136°C (277°F) for 7 days appeared to be in generally good condition; there was no significant difference in flexibility from that observed before the thermal aging. Minor blocking, i.e., sticking, occurred between turns of some specimens and where the specimens touched the stainless steel mandrel and cable supports. There were no cracks or other irregularities observed.

5.3 GAMMA IRRADIATION

After being exposed to an air-equivalent dose of 200 Mrd, the specimens appeared to be in good condition with no apparent change in their flexibility. There were no cracks or other irregularities observed.

5.4 STEAM/CHEMICAL-SPRAY EXPOSURE

The steam/chemical-spray (S/C) exposure was provided in general accordance with the specified temperature/pressure profile illustrated in Figure 4 with the following comments:

- The pressure and temperature histories for the first 16 minutes of each transient are presented in Figures 5 and 6.
- A temperature of 300°F (149°C) was achieved in approximately 8 seconds during the first and second transient.
- A temperature of 385°F (196°C) was reached in 38 seconds during the first transient and 35 seconds during the second transient. These temperatures were indicated by a thermocouple located approximately 1 in (25 mm) inside the inner mandrel of cables.
- Within 15 minutes after the 12-minute superheated steam dwells, the minimum and maximum indicated temperatures were less than 10°F

Table 2. Summary of Insulation Resistance Measurements[a]
(All values are in ohms.)[b]

TEST PROGRAM PHASE	ELAPSED TIME	TEMPERATURE (°F)/(°C)	VESSEL PRESSURE (lbf/in^2)	CABLE NUMBER 8-1	8-2	9-1	9-2	9-3	9-4
Pre-Thermal Aging	As Received	Room Ambient	0 (In Water)	1.7 E+12	1.5 E+12	2.0 E+12	2.0 E+12	1.9 E+12	1.7 E+12
Post-Thermal Aging	After Heat Aging	↓	↓	Not aged	2.0 E+13	Not aged	Not aged	5.0 E+12	5.0 E+12
Post-Irradiation	Post-Irradiation	↓	↓	2.6 E+11	3.5 E+10	2.4 E+11	3.0 E+10	1.4 E+09	5.0 E+09
Pre-S/C Exposure[c]	Pretest	120/49	0 (Wet with spray)	4.5 E+09	3.5 E+09	5.0 E+09	4.5 E+09	9.0 E+09	9.4 E+09
S/C Exposure[c]	1.7 h (1st Transient)	346/174	113	1.0 E+07	2.8 E+07	8.4 E+06	8.6 E+06	1.1 E+07	1.1 E+07
↓	2.3 h (2nd Transient)	346/174	113	1.1 E+07	1.4 E+07	9.4 E+06	8.2 E+06	1.1 E+07	1.2 E+07
↓	4.7 h	335/168	95	1.7 E+07	2.2 E+07	1.5 E+07	1.4 E+07	1.6 E+07	2.0 E+07
↓	42.0 h	317/158	70	1.2 E+08	1.0 E+08	7.4 E+07	5.0 E+07	5.0 E+07	5.3 E+07
↓	7.6 d	280/138	34	7.4 E+08	3.0 E+08	6.8 E+08	5.2 E+08	1.1 E+06	3.5 E+08
↓	16.6 d	230/110	10	4.5 E+09	5.0 E+09	4.0 E+09	3.5 E+09	2.9 E+09	2.9 E+09
↓	22.8 d	230/110	10	5.4 E+09	6.2 E+09	5.0 E+09	4.0 E+09	2.4 E+09	3.0 E+09
S/C Exposure[c]	29.9 d	230/110	10	5.2 E+09	5.8 E+09	9.6 E+08	3.5 E+09	2.2 E+09	2.8 E+09
Post-Exposure[d]	Post-Test	Room Ambient	0 (In Water)	1.1 E+13	1.7 E+13	8.2 E+12	9.0 E+12	1.0 E+13	1.0 E+13

NOTES:

a. Insulation resistance (IR) measured at a dc potential of 500 volts for 1 minute unless otherwise indicated. Specimens immersed in water or being sprayed in the test vessel unless otherwise indicated.

b. The values of ohms are written as a number followed by the letter E (for exponent), a plus symbol, and two digits which indicate the power of 10 by which the number must be multiplied to obtain the correct value. For example, 1.2 E+09 is 1.2×10^9 or 1,200,000,000.

c. IR measurements of the specimens in the test vessel include the IR effects of extension cables.

d. The lengths of the post-test specimens were shorter by approximately 5 to 10 ft (1.5 to 3 m) than the pre-S/C exposure lengths previously measured. See Table 3.

Attachment 3 to AEP:NRC:0775AN

IMO-54 T-drains

Removal of IMO-54 From EQ List
T-Drains in Limitorque Actuators

Limitorque motor operator, Donald C. Cook Nuclear Plant tag number IMO-54, has been determined not to be within the scope of 10 CFR 50.49.

A design change to install a T-drain on selected valve operators (RFD-DC-12-2930) was written on June 9, 1986. A purchase requisition to Limitorque for the purchase of the T-drain had been written on April 15, 1986 (PO 02238-041-68). After the necessary management approval, the purchase order was telephoned to Limitorque on April 30, 1986. T-drains were installed in four inside containment and four outside containment valve operators in each unit (16 valves total) on June 13, 1986. IMO-54 was not one of the valves slated for installation.

The miscellaneous EQ issues involving Limitorque valve actuators were fully realized through our participation in the Nuclear Utility Group on Equipment Qualification (NUGEQ). These issues were being addressed prior to the EQ inspection. An April 1986 NUGEQ report, "Clarification of Information Related to the Environmental Qualification of Limitorque Valve Operations" addresses several of these issues.

IMO-54 was scoped to be removed from the EQ list prior to the NRC EQ inspection. This resulted from our investigation of various Limitorque EQ issues. Thus T-drains were not procurred for or installed on this valve.

IMO-54 is a motor-operated valve located in the Emergency Core Cooling System. It is normally open and remains open during normal plant operation and during a Design Basis Accident. Injection to the core via this path would be terminated by tripping the centrifugal charging pumps.

IMO-54 will not change position in the event of a DBA. This is due to the AEPSC "Double Break" control circuit philosophy which prevents the spurious operation of a valve due to contact failure or cable shorts. Therefore, the removal of this valve from the EQ list would not adversely impact the accident mitigation or lead to operator misinformation.

Attachment 4 to AEP:NRC:0775AN

Foxboro Transmitter Evaluation

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AMERICAN ELECTRIC AEP POWER SYSTEM

DATE: May 14, 1986

SUBJECT: D. C. Cook Units 1 & 2
Technical Review of Differences in Tested and Installed Configuration of Foxboro Pigtails

FROM: K. J. Munson - EGS

TO: R. G. Vasey - NS & L

During the recent NRC audit of the DCCNP Environmental Qualification Program, it was noted that the DCCNP installed configuration of the Foxboro instrument pigtail condulet per PDS-1341 under RFC-01-2827 & 02-2828 was physically different than the tested configuration by the vendor in Wyle Test Report 45592-4. The tested configuration utilized a small 1/4" weep hole at a low point on a flexible metal conduit protecting the Foxboro instrument seal assembly pigtails. The weep hole was used to drain condensation near the instrument which may have accumulated inside the flex conduit during the simulated DBA test (see attached sketches).

The DCCNP installed configuration incorporated the use of a sealtite flexible conduit plus the sealing of both the entrance and exit of the flexible conduit with an RTV silicone sealant. No provisions for a weep-hole were made for the DCCNP specific design. The applicable plant design standard for the installation of the instrument, pigtails, flex conduit, splice box, and pigtail splices is shown on drawing PDS-1341 (attached).

The sealtite flexible conduit used in the installation is tradenamed Liquatite and manufactured by the Alflex Co. The plastic covering over the flexible metal conduit is made of a Polyvinyl Chloride (PVC) material. According to the manufacturer, the Liquatite flex conduit has not been environmentally qualified.

The hypothesized failure mode of the D. C. Cook configuration is that the PVC jacket on the flex conduit may fail during an accident near any elevated point on the conduit and allow steam to enter and condense. The condensation would them "pool" at the conduit low points, thereby subjecting the pigtails to possible submergence. The following paragraphs of this memo address this concern.

Through conversations with Foxboro, it has been determined that the intent of the weep-hole was to avoid the "backing-up" of condensate from the chemical spray into the Integral Junction Box used in one of the two tested configurations. The integral junction box houses a terminal block which is known to be susceptible to leakage currents when exposed to chemical spray solution. The weep-hole design was carried-over to the second configuration which was used at D. C. Cook. The second configuration incorporates an internal instrument splice to a Conax seal assembly with no Integral Junction Box or terminal block installed. Therefore, the "backing-up" of condensate near the instrument seal assembly in the D. C. Cook configuration was of no significant concern.

Additionally, in both tested configurations the metal flex conduit looped back up after the weep hole and was routed down to a penetration at the bottom of the test chamber. The bottom end of the flex conduit was sealed which created a potential for the "pooling" of chemical spray condensate during the test. In this respect, the tested configuration is similar to what is hypothesized in the D. C. Cook Plant configuration.

The potential for pigtail submergence failure is much less of a concern for the D. C. Cook configuration due to the following reasons:

1) It is not likely that the D. C. Cook sealed flex conduit configuration would fail in such a way as to create a harsher chemical submergence environment for the pigtails than what was tested. The type of submergence in the speculated D. C. Cook case involves a steam condensate and is not associated with containment flooding conditions. The steam condensate should theoretically be at a pH value which is less severe than the chemical spray exposure during the test.

2) The Kapton-insulated pigtail wires of the Conax Seal assembly are individually protected by the application of a heat shrinkable polyolefin jacket. The heat shrink tubing jacket significantly improves the ability of the pigtail wires to withstand chemical submergence by adding a protective layer of material over the Kapton insulation. Where applied, the protective layer of heat shrink reduces the exposure of the Kapton insulation to the condensate. The typical failure of Kapton insulated wire is due to an abrasion of the insulating material during installation combined with the effects of the chemical solution. The potential for abrasion or other mechanical damage of the Kapton insulation during installation at D. C. Cook has been essentially eliminated by the application of the heat shrink jacket.

3) The test report configuration, which exposed the Kapton insulated pigtails to the test chamber environment via the 1/4inch weep hole, demonstrates the ability of the pigtail wires to withstand harsh chemical conditions even without a protective heat shrink jacket.

In conclusion, we believe that the omittance of the weep-hole in the flex conduit near the instrument in the D. C. Cook configuration does not have a detrimental impact on the environmental qualification of the instrument, seal assembly or seal assembly pigtails. In addition, we believe that there is no significant functional difference between the tested and the D. C. Cook installed configurations of the foxboro instrument pigtail conduits.

K. J. Munson

K. J. MUNSON

Approved R. C. Carruth / [initials]
R. C. Carruth

KJM:rd:50.95
cc. T. O. Argenta/S. H. Horowitz
L. F. Caso/J. V. Ruparel
D. N. Turnberg/J. R. Anderson
J. G. Feinstein - NS & L
R. Shoberg/W. G. Sotos - I & C
NCR No. REE-86-07-1/Reslog 860501

12.0 TRANSMITTER ELECTRICAL/MECHANICAL INTERFACES

12.1 Requirements

12.1.1 Electrical Interfacing

The Kapton pigtails protruding from the Conax stainless steel feed-through shall be protected using 1/2" flexible metal conduit. The conduit shall be attached to the transmitter interface by means of the conduit interface connector on each of the conductor seal assemblies. The unattached end of the conduit shall be permanently affixed to the side of the mounting bracket assembly to minimize any deleterious effects on the interface due to handling.

CAUTION: When connecting the flexible conduit to the midlock cap, DO NOT allow the cap to rotate. Rotation will damage integrity of the midlock cap seal.

The three (3) transmitters supplied with integral junction boxes shall be equipped with 18" of flexible metal conduit in the same manner as those fittings with the Foxboro-supplied Conax electrical conductor seal assemblies. However, the conduit will not be installed until the pre-LOCA transmitter test setup.

In addition, a 1/4" weep hole shall be drilled in the conduit at the lowest point of its arc to facilitate drainage of accumulated chemical spray, steam condensation, etc., during the accident simulation.

12.1.2 Mechanical Interfacing

Inlet supply pressure adaptors shall be permanently attached to the transmitters using the Swagelok fittings supplied by the manufacturer. The supply lines shall be made from 3/8" stainless steel tubing with one end flared and equipped with an AN flare fitting. The opposite end shall be deburred and left untouched to accept the Swagelok compression ring.

12.2 Procedures

12.2.1 Electrical Interfacing

A. Direct Transmitter Input

12.2.1.1 Cut a piece of 1/2" flexible metal conduit approximately 18" in length.

12.2.1.2 Install two (2) straight flexible conduit fittings, one (1) on each end of the conduit.

NOTE: The fitting at the end farthest from the midlock cap should also contain a strain relief adaptor.

TEST PROCEDURE NO. 45592-2

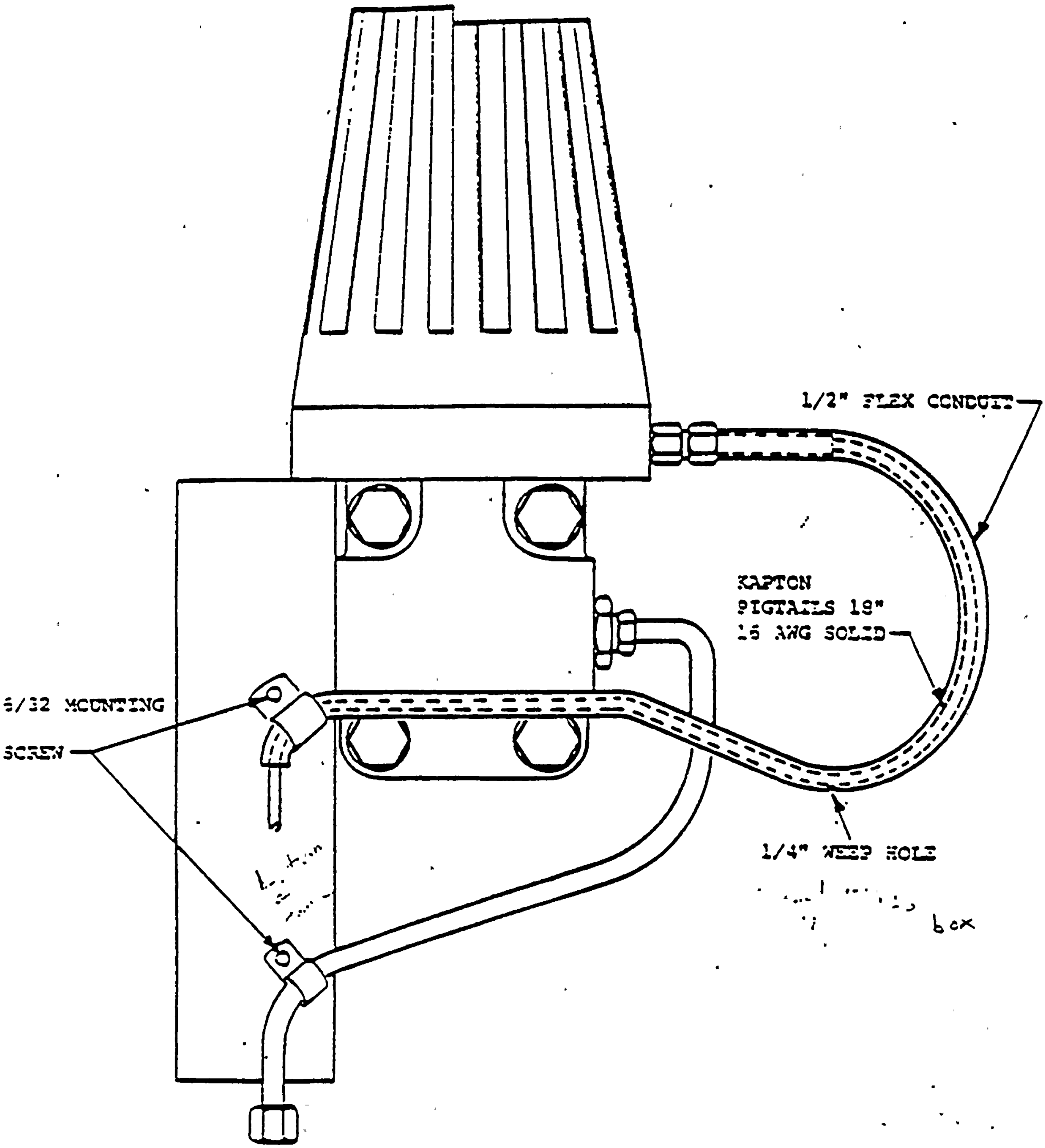

FIGURE 1. ELECTRICAL AND MECHANICAL INSTALLATIONS

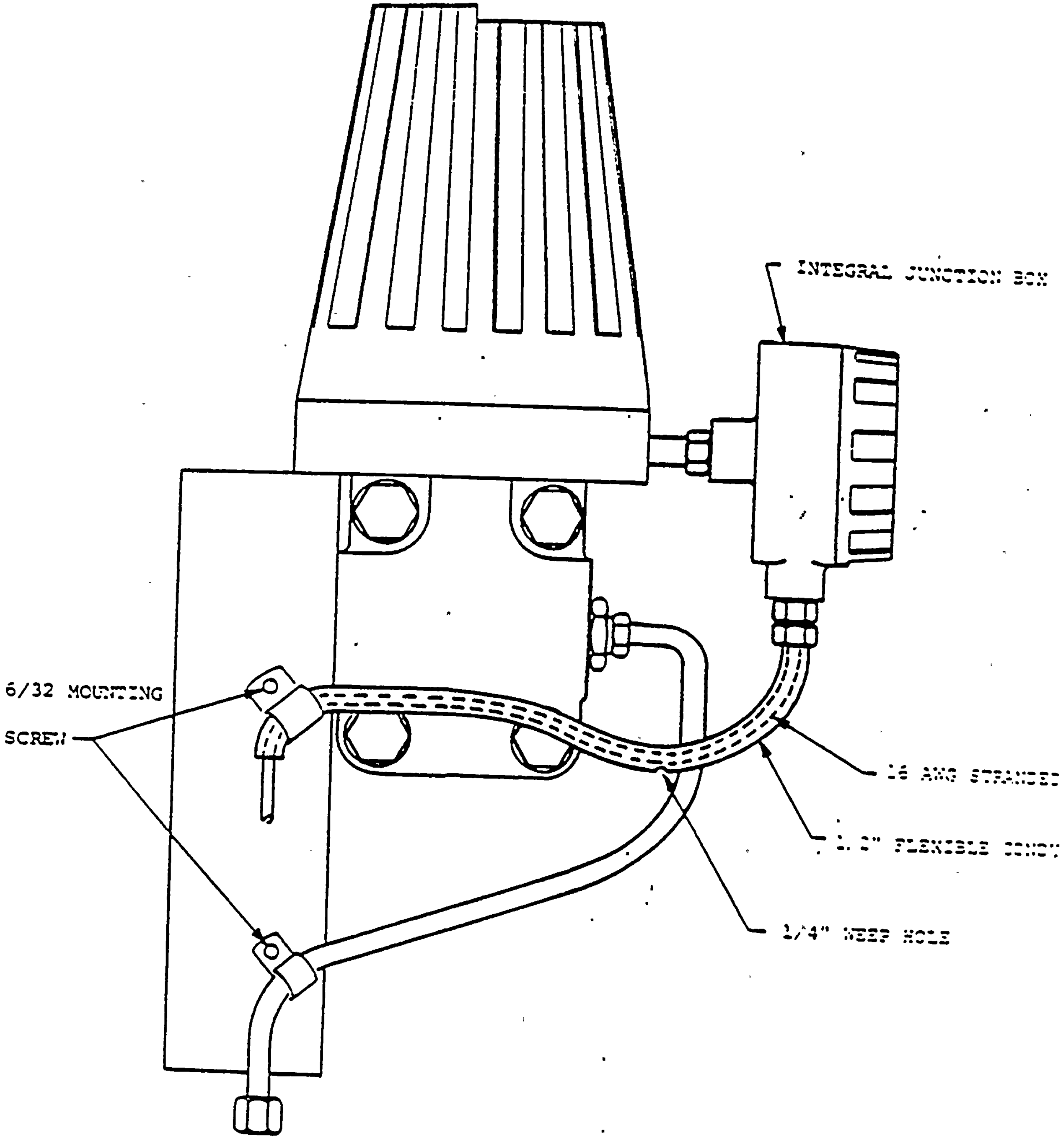

FIGURE 2A. ELECTRICAL AND MECHANICAL INSTALLATIONS

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12.0 TRANSMITTER ELECTRICAL/MECHANICAL INTERFACES (Continued)

12.2.1.3 Drill a 1/4" weep hole approximately 9" from the transmitter interface connector.

NOTE: Reference Figure 2 for the remaining steps.

12.2.1.4 Drill a 6/32 screw clearance hole in the mounting bracket assembly as shown.

12.2.1.5 Place a 4" piece of Raychem sleeving over the Kapton pigtails approximately 16"-20" from the transmitter to act as a strain relief point.

12.2.1.6 Carefully feed the pigtails and Conax stainless steel feedthrough into the flexible conduit.

12.2.1.7 Attach the conduit fitting to the Conax interface fitting. Before tightening the interface, rotate the conduit until the weep hole is positioned as shown.

12.2.1.8 Tighten the interface connections and arc the flexible conduit around to the mounting bracket while insuring that the ECSA is not disturbed.

12.2.1.9 Attach the conduit to the mounting bracket assembly using 6/32" hardware (screw, nut and lock washer) and a conduit mounting strap. Tighten the strain relief adaptor around the Raychem sleeve installed in step 12.2.1.5.

12.2.1.10 Photograph the transmitter to document the installation of the electrical interface protection.

12.2.1.11 Repeat steps 12.2.1.1 through 12.2.1.10 for each transmitter.

B. Integral Junction Box Input

12.2.1.1 Cut a piece of 1/2" flexible metal conduit approximately 18" in length.

12.2.1.2 Install two (2) straight flexible conduit fittings, one (1) on each end of the conduit.

NOTE: The fitting at the end farthest from the J-box input should also contain a strain relief adaptor.

12.2.1.3 Drill a 1/4" weep hole approximately 9" from the transmitter interface connector.

12.2.1.4 Drill a 6/32" screw clearance hole in the mounting bracket assembly.

12.2.1.5 Place a 4" piece of Raychem sleeving over the Kapton pigtails approximately 16"-20" from the transmitter to act as a strain relief point.

12.2 TRANSMITTER ELECTRICAL/MECHANICAL INTERFACES (Continued)

12.2.1.6 Attach the conduit fitting to the J-box input. Before tightening the interface, rotate the conduit until the weep hole is positioned at the lowest point of the arc.

12.2.1.7 Carefully feed the pigtails into the flexible conduit until they enter the J-box. Install a noninsulated crimp spade lug to each lead and connect them to the ± terminal within the J-box.

12.2.1.8 Tighten the interface connections and arc the flexible conduit around to the mounting bracket.

12.2.1.9 Attach the conduit to the mounting bracket assembly using 6/32" hardware (screw, nut and lock washer) and a conduit mounting strap. Tighten the strain relief adaptor around the Raychem sleeve installed in step 12.2.1.5.

12.2.1.10 Photograph the transmitter to document the installation of the electrical interface protection.

12.2.1.11 Repeat steps 12.2.1.1 through 12.2.1.10 for each transmitter with integral junction box inputs.

12.2.2 Mechanical Interfacing

12.2.2.1 Cut a piece of 3/8" stainless steel tubing and deburr each end.

12.2.2.2 Flare one end and slip on a 3/8" stainless steel "B" nut.

12.2.2.3 Bend the tubing as shown in Figure 2.

12.2.2.4 Place the Swagelok compression nut and fitting over the unflared end of the tubing. Connect the tubing to the remaining section of the Swagelok fitting mounted on the inlet port(s) of the transmitter as shown in Figure 2 using standard Swagelok procedures.

12.2.1.5 Position the tubing as shown in Figure 2 and tighten the fitting(s).

12.2.2.6 Attach the tubing to the mounting bracket assembly using 6/32 hardware (screws, nuts and lock washers) and a 3/8" tube mounting strap.

12.2.2.7 Photograph each transmitter to document the installation of the mechanical interface.

12.2.2.8 Repeat steps 12.2.2.1 through 12.2.2.7 for each transmitter.

13.0 PRESSURE/LEAK TEST

13.1 Requirements

13.1.1 Pressure Test

A Pressure Test shall be performed on each transmitter to verify the pressure integrity of the seals. A pressure medium of dry gaseous nitrogen shall be applied to the transmitter input pressure ports using a high-pressure regulator as shown in Figures 3 and 3A. The applied pressure shall be monitored using a 0.1% F.S. pressure gauge. During this test, voltage shall not be applied to the transmitter.

The applied pressures shall be supplied to the transmitters in the following manner for a duration of not less than 1 minute:

- The differential pressure transmitter shall have both pressure input ports pressurized simultaneously to the corresponding overpressure listed below:

Model No.	Overpressure (psig)
N-E13DM-IIM1	3000
N-E13DH-HIM1	4500
N-E13DH-IIH1	4500

- The gauge pressure transmitters shall have their single pressure input port pressurized to the corresponding overpressure listed below:

Model No.	Overpressure (psig)
N-E11GM-HIE2	4000
N-E11GH-IIM2	4500

All body seals shall be leak checked using chlorine-free bubble solution, and any seal leakage from a transmitter shall be evaluated by the Lead Customer.

13.1.2 Leak Test

A Leak Test shall be performed, where specified, during all Functional Tests with the exception of the Baseline and Post-LOCA Tests. To verify the pressure integrity of the seal, a pressure medium of dry gaseous nitrogen shall be applied to the transmitter input pressure port(s) using the Marotta System as shown in Figure 4. The applied pressure shall be monitored using a 0.1% F.S. pressure gauge. During this test, input voltage shall not be applied to the transmitter.

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OTHER THAN INSTRUMENT
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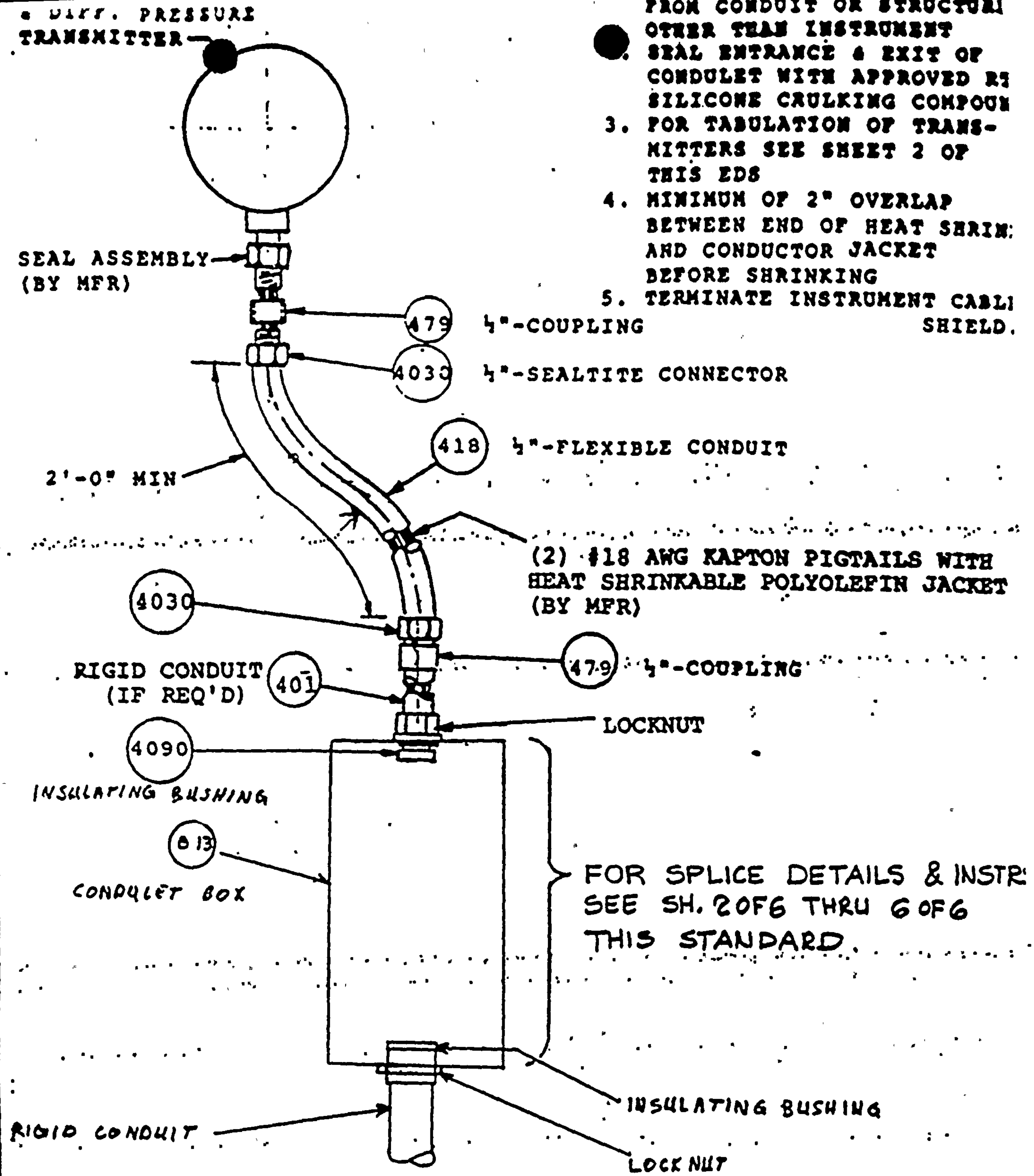
CONDULET WITH APPROVED R
SILICONE CAULKING COMPOUN

3. FOR TABULATION OF TRANS-MITTERS SEE SHEET 2 OF THIS EDS
4. MINIMUM OF 2" OVERLAP BETWEEN END OF HEAT SHRIN AND CONDUCTOR JACKET BEFORE SHRINKING
5. TERMINATE INSTRUMENT CABL SHIELD.



NUMBERS IN ◯ REFER TO B/M #1788

FOR USE IN NUCLEAR PLANT ONLY

RFC DC 01-2827
02-2828

INDIANA & MICHIGAN ELECT Co.	D.C. COOK NUCLEAR PLANT	PDS-1341-4
ELECTRICAL PLANT SECTION PLANT DESIGN STANDARD	REVISION- 4 FJM 11-10-85	FOXBORO NE SERIES TRANSMITTER CONNECTION DETAILS
APP'D FJM / DR. S.K.	CH. PG / DATE 4-19-85	
AMERICAN ELECTRIC POWER SERVICE CORP. COLUMBUS, OH.	1-2-EDS 343-4	SH. 1 OF 6

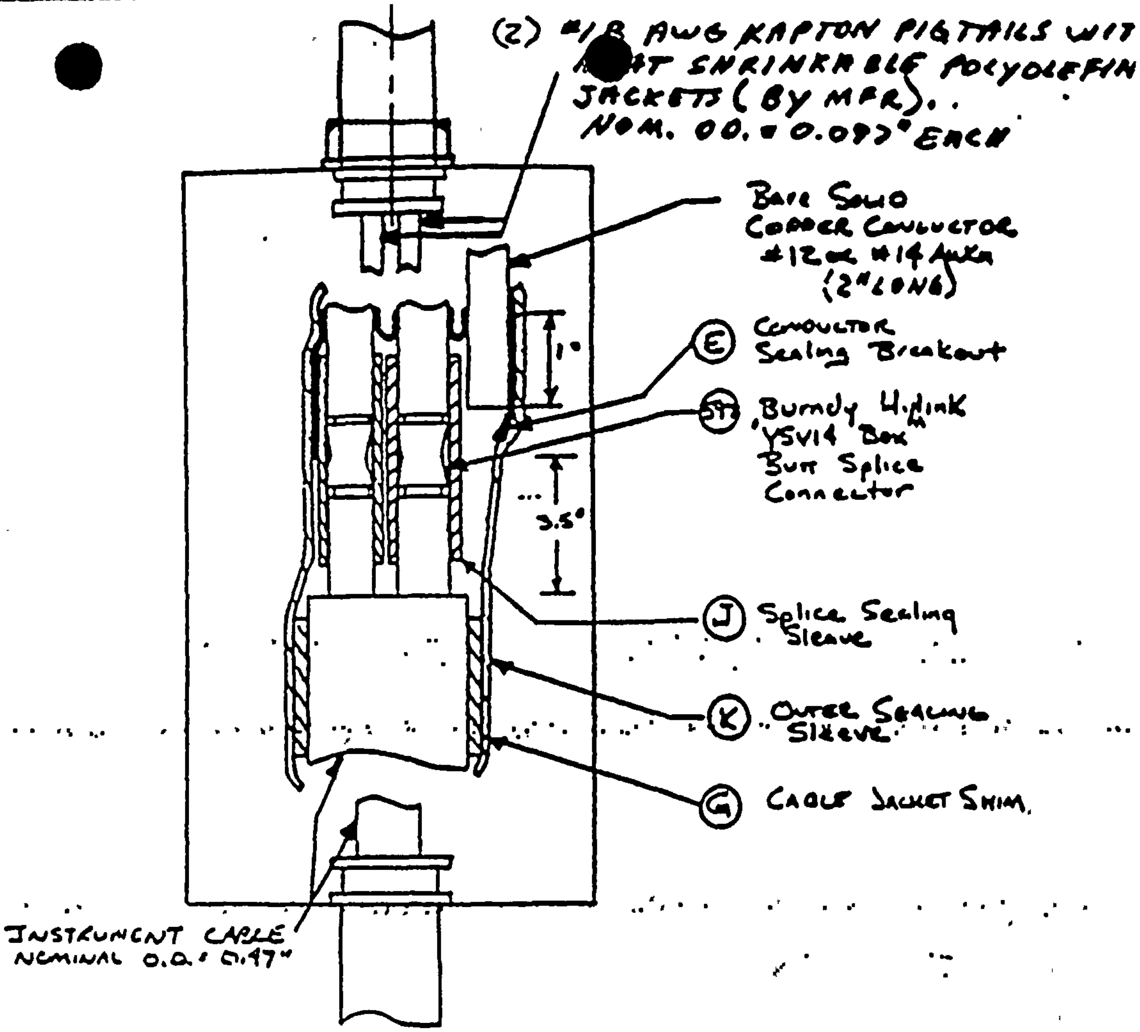


FIGURE A

LEGEND:

- (G) Cable Jacket Shim
- (J) Splice Sealing Sleeve
- (K) Outer Sealing Sleeve
- (R) Conductor Shim (not shown)
- (E) Conductor Sealing Breakout

NOTES:

1. Splice to be made using RAYCHEM SPLICE KIT. NPKS-2-21K
   For use range of KAPTON insulated wires & conductor, see Table A below.

TABLE A

Ranges of Conductor and Kapton Wire Dimensions for Use in Raychem Nuclear Plant Splice Kits

AEP Item No.	Kit No.	Cable Jacket Outer Diameter	Insulated Conductor Outer Diameter	Kapton Insulated Wire
6110	NPKS-2-21K	0.31" - 0.60"	0.11" - 0.23"	#16AWG - #12AWG

RFC DC.01-2827
02-2828

Number in ◯ refer to B/M 1788

INDIANA & MICHIGAN ELECT Co.	D.C. COOK NUCLEAR PLANT	PDS-1341
ELECTRICAL PLANT SECTION PLANT DESIGN STANDARD	REVISION - 1 F/M/P.L. 11-10-85	FOXBORO NE SERIES TRANSMITTER CONNECTION DETAILS
APP'D F/M/P.L. DR. PG	CH. SL DATE 11/8/85	
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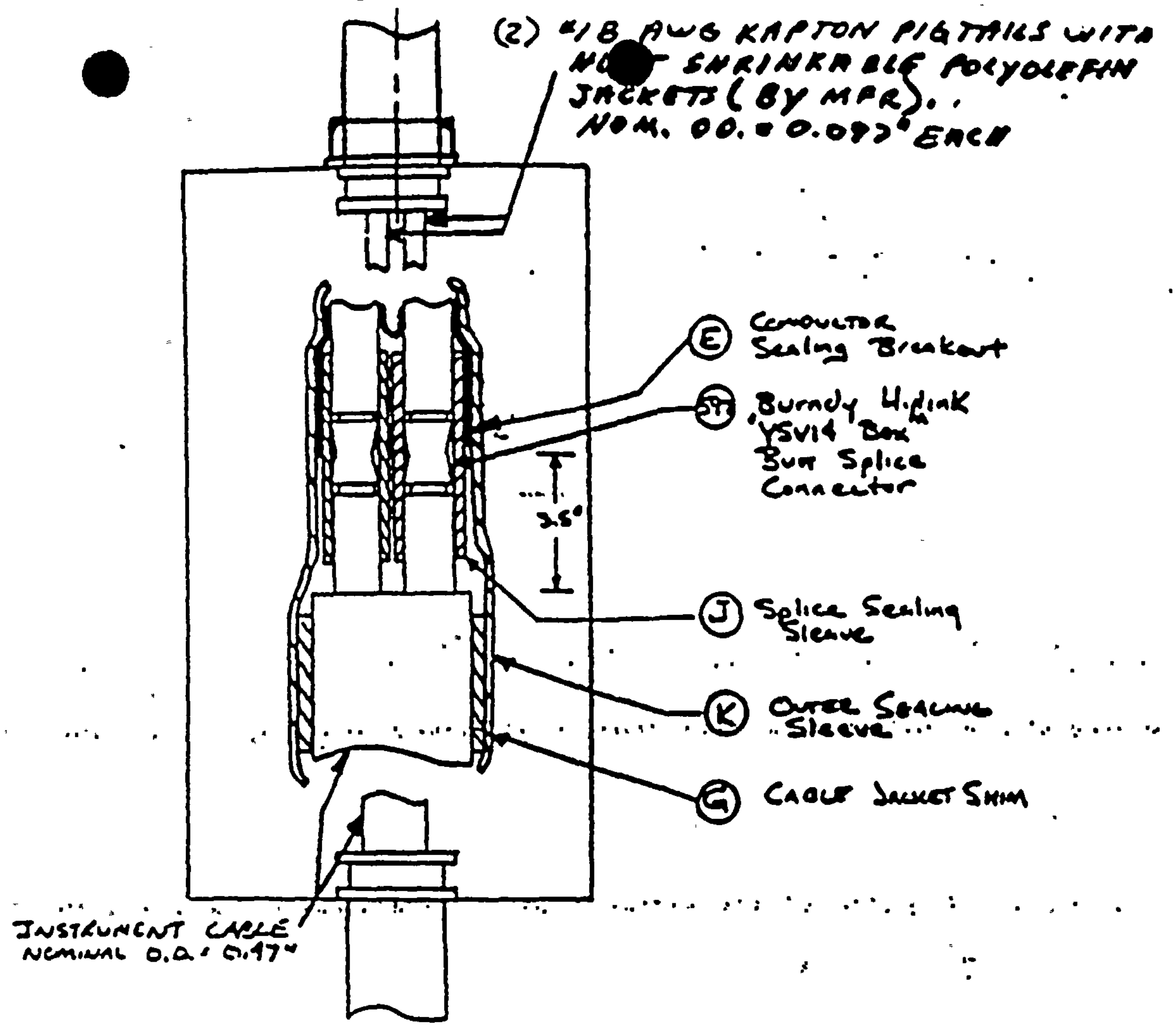

FIGURE A

LEGEND:

- (G) Cable Jacket Shim
- (J) Splice Sealing Sleeve
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- (R) Conductor Shim (not shown)
- (E) Conductor Sealing Breakout

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AEP Item No.	Kit No.	Cable Jacket Outer Diameter	Insulated Conductor Outer Diameter	Kapton Insulated Wire
6147	NPKX-2-21K	0.31" - 0.60"	0.11" - 0.23"	#16AWG - #12AWG

RFC DC.01-2827
02-2828

Number in ◯ refer to B/M 1788

INDIANA & MICHIGAN ELECT Co.	D.C. COOK NUCLEAR PLANT	PDS-1341-C
ELECTRICAL PLANT SECTION PLANT DESIGN STANDARD	REVISION - 0 FJM/T.K.	FOXBORO NE SERIES TRANSMITTER CONNECTION DETAILS
APP'D FJM/T.K. DR. PG	CH. SL DATE 11/10/85	
AMERICAN ELECTRIC POWER SERVICE CORP. COLUMBUS, OH.		1-2-EDS-242-0 SH 3 OF

INSTRUCTIONS

PREPARATION

1. Confirm that the kit selected is designated for the intended terminations (STP or STQ). Ensure that the cable and feedthrough conductor diameters are within the ranges specified in Table A of this PDS or the kit's label.

2. Remove all felted asbestos or braided jacketing material from the insulation in the splice area. Splice sealing sleeve (part J) will not seal to braided or woven surfaces.

3. Cut the end of the cable off square. Remove jacket material, tapes, fillers, shield foil and binders for a length of 3.5 inches from the end.

4. Cut the end of the feedthrough wire off square. Untwist the wires as required to install tubing.

5. Remove dirt, grease and other contaminants from the cable jacket and all insulated conductor areas which will make contact with components of the kit with a rag dampened, but not saturated, in an approved solvent such as alcohol or acetone.

INSTALLATION

1. Slide the conductor shims, Part R (not shown in Fig. A) over the Kapton insulated wires. Align with the insulation cutback. SHRINK IN PLACE.

2. When cable jacket shim, Part G, is supplied, install shim over the multi-conductor cable jacket. Align to within 1/4" of the cable jacket cutback. SHRINK IN PLACE.

3. Slide the outer sealing sleeve, Part K, over the multi-conductor cable jacket. DO NOT SHRINK.

4. Thread each Kapton insulated conductor through a leg of the Conductor Sealing Breakout, Part E. Ensure that the large open end faces the splice area. DO NOT SHRINK. FOR KIT, ITEM# 6110 INSER #12 OR #14 GAUGE BARE SOLID CONDUCTOR WIRE. (½ LENGTH OF WIRE IN BOOT)

5. Slide one splice sealing sleeve, Part J, over each Kapton insulated conductor except for the drain conductor. DO NOT SHRINK

   NOTE: Splice sealing sleeves are not used on the drain wire.

6. Strip 1/4" of insulation from the end of the cable conductors, shield wire and feedthrough wires.

FOR USE IN NUCLEAR PLANT ONLY

INDIANA & MICHIGAN ELECT Co.	D.C. COOK NUCLEAR PLANT		PDS-1341-
ELECTRICAL PLANT SECTION PLANT DESIGN STANDARD	REVISION 1 FJM/F.L. 11-10-85	FOXBORO NE SERIES TRANSMITTER CONNECTION DETAILS	
APP'D FJM/F.L.	DR. PG	CH. SL	DATE 11-8-85
AMERICAN ELECTRIC POWER SERVICE CORP. COLUMBUS, OH.		1-2-EDS-393-1	SH. 4 OF 6

7. Complete crimp connections between the cable conductors and the feedthrough wires using a Burndy YSV14 connector and the appropriate crimping tool. Ensure that wire is visible through holes in sleeve. Examine each connection area for sharp edges and protruding wire strands. Remove these with abrasive cloth or a file.

8. Center splice sealing sleeves, Parts J, over each connection area. SHRINK IN PLACE.

9. Slide the breakout body over the splice sealing sleeves. Ensure that Parts J do not protrude into the breakout legs. SHRINK IN PLACE.

10. Center the outer sealing sleeve, Part K, over the assembly such as that it covers the breakout and overlaps the cable jacket by 3" or overlaps the shim, when used. SHRINK IN PLACE.

CAUTION: DO NOT FLEX UNTIL COMFORTABLE TO TOUCH.

KIT REMOVAL INSTRUCTIONS

If the installed kit must be removed, the following procedure may be used to prevent conductor damage:

1. Warm the outer sealing sleeve with a torch or heat gun. Using a razor or sharp knive, score Part K longitudianally over its entire length at a depth of approximately 50 to 75% of its thickness. Do not scar cable jacket.

2. Gradually heat the entire surface of the sleeve. Using pliers, peel away sleeve along the cut area while continuing to apply heat.

3. This process can be repeated for each component of the Raychem splice kit; however, care must be taken not to damage the cable.

4. Remove as much of the old adhesive as possible prior to installating a new kit.

FOR USE IN NUCLEAR PLANT ONLY

INDIANA & MICHIGAN ELECT Co.		D.C. COOK NUCLEAR PLANT		PDS-1391-
ELECTRICAL PLANT SECTION PLANT DESIGN STANDARD		REVISION 1 FJM/PL 11-10-85		FOXBORO NE SERIES TRANSMITTER CONNECTION DETAILS
APP'D FJM/JK	DR. PG	CH. SL	DATE 11-8-85	
AMERICAN ELECTRIC POWER SERVICE CORP. COLUMBUS, OH.			1-2-EDS-343-1	SH. 5 OF (

RFC Nos. DC-01-2827 & DC-02-2828

Applicable Instruments

BLP-110	NLP-151	NPP-151
BLP-111	NLP-152	NPP-152
BLP-112	NLP-153	NPP-153
BLP-120		NPS-153
BLP-121	BLI-110	
BLP-122	BLI-120	NPS-121
BLP-130	BLI-130	NPS-122
BLP-131	BLI-140	
BLP-132		MPP-210
BLP-140	FFC-210	MPP-211
BLP-141	FFC-211	MPP-220
BLP-142	FFC-220	MPP-221
	FFC-221	MPP-230
MFC-110	FFC-230	MPP-231
MFC-111	FFC-231	MPP-240
MFC-120	FFC-240	MPP-241
MFC-121	FFC-241	MPP-212
MFC-130		MPP-222
MFC-131	IFI-051	MPP-232
MFC-140	IFI-052	MPP-242
MFC-141	IFI-053	
	IFI-054	
	IFI-310	
	IFI-320	

FOR USE IN NUCLEAR PLANT ONLY

INDIANA & MICHIGAN ELECT Co.	D.C. COOK NUCLEAR PLANT	PDS-1341-1
ELECTRICAL PLANT SECTION PLANT DESIGN STANDARD	REVISION -1 [signature] 11-10-85	FOXBURO NE SERIES TRANSMITTER CONNECTION DETAILS
APP'D [signature] DR. S. K.	CH [initials] DATE 4-19-85	
AMERICAN ELECTRIC POWER SERVICE CORP. COLUMBUS, OH.	1-2-EDS-343-1	SH. 6 OF 6

Attachment 5 to AEP:NRC:0775AN

Limitorque Actuator Part 21 Report

Indiana Michigan
Power Company
P O Box 16631
Columbus, OH 43216

INDIANA
MICHIGAN
POWER

AEP:NRC:0971E

Donald C. Cook Nuclear Plant Units Nos. 1 and 2
Docket Nos. 50-315 and 50-316
License Nos. DPR-58 and DPR-74
ENVIRONMENTAL QUALIFICATION OF TORQUE SWITCHES

THIS IS A
QA RECORD
DATE REC'D: 4/4/88
DATE FILED: 4/6/88
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NS&L SECTION

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555

Attn: T. E. Murley

April 4, 1988

Dear Dr. Murley:

This letter provides a written report confirming the telephone conversation of March 30, 1988, between Indiana Michigan Power and the NRC Operations Center, regarding notification made pursuant to Title 10 CFR Part 21.

On March 30, 1988, American Electric Power Service Corporation received notification from Limitorque Corporation that the torque switch design employed on some valve operators in use at Cook Nuclear Plant have not been qualification tested for nuclear safety related service. These valve operators are Limitorque Model SMB-00 that incorporate a design used during the first few years this model was produced.

Based on our evaluations, which considered the lack of torque switch qualification tests, we believe that safe plant operation will continue to be maintained.

Additional details are included in the attachment. For further details on clarification, Mr. Paul A. Barrett, Manager, Nuclear Safety and Licensing, can be reached at 614/223-2040.

This document has been prepared following Corporate procedures which incorporate a reasonable set of controls to ensure its accuracy and completeness prior to signature by the undersigned.

Sincerely,

M. P. Alexich
Vice President

eh

Attachment

cc: D. H. Williams, Jr.
W. G. Smith, Jr. - Bridgman
R. C. Callen
G. Bruchmann
G. Charnoff
NRC Resident Inspector - Bridgman
A. B. Davis - Region III

INDIANA MICHIGAN POWER
DONALD C. COOK NUCLEAR PLANT

Attachment to 10 CFR 21 Letter

Environmental Qualification of Torque Switches

Background and Discovery of Defect

Acceptable types of materials used in the switch body and dielectric of Limitorque valve operators were presented as a portion of environmental qualification training given to plant personnel. This training identified the acceptable types of torque switch materials to be limited to white melamine, brown fibrite, and red or black durez. Plant maintenance personnel recalled a fourth type of material (also brown in color) used in installed Model SMB-00 valve operators. The material appears to be a laminated phenolic. These switches can be mistaken for the qualified fibrite switches because of their brown color. Thus, the potential exists for torque switches which have not been qualification tested.

A review of Limitorque Model SMB-00 valve operators in use at Cook Nuclear Plant revealed a total of 70 such operators. Condition Report (Deficiency Report) 12-3-88-0450 was initiated on March 25, 1988 to investigate the qualification of these valve operators.

A suspect torque switch was sent to Limitorque Corporation and was analyzed. The Limitorque Corporation review revealed that this torque switch design (1) was used during the first few years Model SMB-00 was produced and (2) has not been qualification tested for nuclear safety related service. Notification of this finding was received by American Electric Power Service Corporation on March 30, 1988.

Corrective Action

The untested torque switches will either be replaced during the next respective Unit 1 and Unit 2 refueling outages or the existing torque switch design will be confirmed to be qualified by an acceptable test.

Locations of Torque Switches

Limitorque Model SMB-00 valve operators using the untested laminated phenolic material in the torque switch design are potentially installed on the following Cook Nuclear Plant valves:

Valve Number	Unit(s)	Description	Original Supplier
CMO-419	1 and 2	CCW from RHR Heat Exchanger	Centerline
CMO-429	1 and 2	CCW from RHR Heat Exchanger	Centerline
IMO-212	1 and 2	CTS Pump Eductor/Mini Flow	Wallworth
IMO-222	1 and 2	CTS Pump Eductor/Mini Flow	Wallworth
ICM-260	2	SI Pump Discharge	Wallworth
ICM-265	2	SI Pump Discharge	Wallworth
IMO-262	1 and 2	SI Pump Mini Flow/RWST Return	Westinghouse
IMO-263	1 and 2	SI Pump Mini Flow/RWST Return	Westinghouse
IMO-270	1 and 2	SI Pump Discharge Cross-Tie	Wallworth
IMO-275	1 and 2	SI Pump Discharge Cross-Tie	Wallworth
IMO-312	1 and 2	RHR Pump Mini Flow	Westinghouse
IMO-322	1 and 2	RHR Pump Mini Flow	Westinghouse
IMO-314	1 and 2	RHR Pump Discharge Cross-Tie	Anchor Darling
IMO-324	1	RHR Pump Discharge Cross-Tie	Westinghouse
IMO-324	2	RHR Pump Discharge Cross-Tie	Anchor Darling
IMO-320	1 and 2	RHR Pump Suction from RWST	Westinghouse
IMO-330	1 and 2	RHR Sprays	Wallworth
IMO-331	1 and 2	RHR Sprays	Wallworth
IMO-360	1 and 2	SI/CCP Suction Cross-Tie	Westinghouse
IMO-361	1 and 2	SI/CCP Suction Cross-Tie	Westinghouse
IMO-362	1 and 2	SI/CCP Suction Cross-Tie	Westinghouse
IMO-910	1 and 2	CCP Suction From RWST	Westinghouse
IMO-911	1 and 2	CCP Suction from RWST	Westinghouse
MCM-221	1 and 2	Main Steam to AFW Terry Turbine	Rockwell
MCM-231	1 and 2	Main Steam to AFW Terry Turbine	Rockwell
NMO-151	1 and 2	Pressurizer PORV Block Valve	Westinghouse
NMO-152	1 and 2	Pressurizer PORV Block Valve	Westinghouse
NMO-153	1 and 2	Pressurizer PORV Block Valve	Westinghouse
QCM-250	1 and 2	RCP Seal Return	Westinghouse
QMO-225	1 and 2	CCP Mini Flow	Westinghouse
QMO-226	1 and 2	CCP Mini Flow	Westinghouse
VMO-101	1 and 2	CEQ Fan Suction (H_2 Skimmer)	Fisher
VMO-102	1 and 2	CEQ Fan Suction (H_2 Skimmer)	Fisher
WMO-721	1	Diesel Generator After Coolers ESW	Centerline
WMO-722	2	Diesel Generator After Coolers ESW	Centerline
WMO-723	1	Diesel Generator After Coolers ESW	Centerline
WMO-724	2	Diesel Generator After Coolers ESW	Centerline
WMO-725	1	Diesel Generator After Coolers ESW	Centerline
WMO-726	2	Diesel Generator After Coolers ESW	Centerline
WMO-727	1	Diesel Generator After Coolers ESW	Centerline
WMO-728	2	Diesel Generator After Coolers ESW	Centerline