Qualification Test Program

for Terminal Blocks

TEST REPORT 45603-1

NUCLEAR

ENVIRONMENTAL

QUALIFICATION

Prepared for

MARATHON™
SPECIAL PRODUCTS

P.O. Box 468
Bowling Green, Ohio 43402
(419) 352-8441

FEB., 1982

Prepared by

WYLE LABORATORIES

REVISION A

1.0 SCOPE

This document has been prepared by Wyle Laboratories for Marathon Special Products, hereinafter referred to as the equipment supplier, for equipment used in various nuclear power generating stations.

1.1 Objectives

The purpose of this Qualification Plan is to present the approach, methods, philosophies, and procedures for qualifying Fixed Barrier Terminal Blocks (Series 1500 NUC and 1600 NUC) and Power Stud Blocks (Series 142 NUC), assembled and/or manufactured by Marathon Special Products, for use in various nuclear power generating stations. The devices shall be qualified for use with metallic terminal lugs (uninsulated) and housed in a metal enclosure with a gasketed door.

Nuclear environmental qualification of any safety-related device to meet the intent of IEEE 323-1974 is usually a three-step process, i.e., 1) radiation exposure; 2) aging; and 3) design basis event qualification (seismic, and, for equipment inside containment, LOCA). The purpose of the first two steps is to put the sample equipment to be used for qualification into a condition that represents the worst state of deterioration that a plant operator will permit prior to taking corrective action, i.e., its end-of-qualified-life condition. The next step demonstrates that it still has adequate integrity remaining to withstand the added environmental stresses of specified design basis events and still perform its safety-related functions.

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

1.2 Applicable Qualification Standards, Specifications, and Documents

- IEEE 323-1974, "IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations"
- IEEE 344-1975, "IEEE Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations"
- NUREG 0588
- Reg. Guides 1.89 and 1.100
- "Beaver Valley Power Station - Unit No. 2, J.O. No. 12241 - O.F.E. No. 10080 - C.O. No. 6289, Duquesne Light Company, Environmental Qualification Testing of Marathon 1500 Series Terminal Blocks," Letter, S. L. Chapin, Jr. (Stone & Webster) to H. Black (Marathon), dated August 22, 1980

1.0 SCOPE (CONTINUED)

1.2 Applicable Qualification Standards, Specifications, and Documents (Continued)

- Document No. 251/140, "Allens Creek NGS Unit No. 1, Class 1E Terminal Blocks Test Condition," Letter, J. Tana (EBASCO) to H. Black (Marathon), dated October 1, 1980
- "Beaver Valley Power Station - Unit No. 2, J.O. No. 12241 - O.F.E. No. 10080 - C.O. No. 6289, Purchase Order No. 2BV-821, Terminal Block Qualification Testing," Letter, S. L. Chapin, Jr. (Stone & Webster) to J. Keglewitsch (Marathon), not dated
- Document No. AC-ES-MA-01, "Allens Creek NGS Unit No. 1, Class 1E Terminal Blocks, Revision Seismic Spectra," Letter, J. Tana (EBASCO) to H. Black (Marathon), dated October 14, 1980
- Commonwealth Edison Environmental Accident Profiles and Seismic Curves, Letter, D. C. Lamken (Commonwealth Edison) to C. G. Poplin (Wyle), dated October 14, 1980
- Commonwealth Edison Test Parameters for Joint Qualification Program, Marathon Terminal Blocks, dated September 11, 1980
- Letter, D. C. Lamken, Commonwealth Edison, to G. Endicott, Wyle, dated February 9, 1981

1.3 Equipment Description

The test specimens to be supplied by the equipment supplier shall consist of three (3) Terminal Block Assemblies, each consisting of the following items:

- Two (2) Marathon Fixed Barrier Terminal Blocks, Series 1600 NUC, Type 1612929, 600 Volts, 75 Amperes, 12 Point

  Dimensions: 9"L x 2"W x 1-3/16"H
  Weight: Approximately 1 pound

- Two (2) Marathon Fixed Barrier Terminal Blocks, Series 1500 NUC, Type 1512929, 600 Volts, 75 Amperes, 12 Point

  Dimensions: 8-1/4"L x 2"W x 1-3/16"H
  Weight: Approximately 1 pound

1.0 SCOPE (CONTINUED)

1.3 Equipment Description (Continued)

- Two (2) Marathon Power Stud Blocks, Series 142 NUC, Type 1423589, 600 Volts, 3 Circuits, 1/4-20 Studs

  Dimensions: 2-3/4"L x 2-7/8"W x 1-3/4"H
  Weight: Approximately 1 pound

- One (1) Type 4 NEMA Enclosure, Hoffman, Single-Door, Part No. A20H20ALP

  Dimensions: 20" x 20" x 6"
  Weight: 38 pounds

- One (1) NEMA Mounting Panel, Hoffman, Part No. A-20P20

  Dimensions: 17" x 17"
  Weight: 9 pounds

- Cable conduit (2), metallic, 1-1/2" I.D., 90° bend, mounted to the top panel of the NEMA enclosure

- Cable, Delco, #8 AWG, Teflon insulation, 4-inch sections (not to be qualified, for test purposes only)

- Terminal Lugs, ring-tongue, copper/tin plated, uninsulated, #8 AWG barrel:

  1) For 1512929 and 1612929 Blocks: .190-inch hole
  2) For 1423589 Blocks: .270-inch hole

The Terminal Block Assemblies shall be preassembled by the equipment supplier per the following:

1) Jumper wires shall be prepared, using commercially available crimping machinery, to assure uniform terminal lug/cable connection. Each end of each 4-inch cable section shall be stripped to bare wire per standard commercial practice. Uninsulated metallic terminal lugs shall be attached to each bare end of each wire.

2) The terminal blocks and power stud blocks shall be attached to the appropriate mounting panel, using commercially available bolts, nuts, and washers, as shown in Figure 2.

1.0 SCOPE (CONTINUED)

1.3 Equipment Description (Continued)

3) Each Type 1512929 or 1612929 terminal block shall require ten (10) jumper wires. Each Type 1423589 power stud block shall require one (1) jumper wire. The wires shall be installed on each block per the wiring diagram(s) depicted in Figure 1. When connected as shown, two (2) separate series circuits occur through each block. These circuits parallel each other for the entire length of each block (i.e., one circuit utilizes odd-numbered terminals, the other circuit utilizes even-numbered terminals). During installation, terminal screws/nuts shall be tightened in accordance with the equipment supplier's recommendations, as follow, to simulate actual installation procedures.

- o Even number series circuit (reference Figure 1) shall be torqued to 25 (+0, -5) inch-pounds.
- o Odd number series circuit (Reference Figure 1) shall be hand tightened until snug, then tightened an additional 1/8 to 1/4 turn.

4) The cable conduits shall be affixed to the top panel of the NEMA enclosure, using standard conduit mounting hardware.

5) Two (2) 1/4-inch drain holes shall be drilled in the bottom panel of the NEMA enclosure in diagonally opposite corners.

In addition to the items specified above, the equipment supplier shall furnish the following:

- o Three (3) "dummy" NEMA enclosures shall be required to allow for accident (LOCA) chamber calibration.
- o Terminal lugs, ring-tongue, copper/tin plated, uninsulated, #8 AWG, uncrimped, quantity (TBD)*

* TBD = To Be Determined

1.0 SCOPE (CONTINUED)

1.4 Qualification Sequence

Qualification shall be performed in the following sequence. It is considered that the radiation exposure and the aging effects on the equipment are cumulative and result in the same effects as simultaneous exposure experienced while operational in a nuclear power plant.

- o Baseline Functional Tests
- o Radiation Exposure
- o Functional Test
- o Thermal Aging
- o Functional Test
- o Vibration Aging
- o Functional Test
- o Seismic Qualification
- o Functional Test
- o Accident Qualification
- o Functional Test
- o Post-Test Inspection

Radiation prior to thermal aging is normally a more severe test sequence. Tests sponsored by the NRC and reported by Sandia Laboratories in Report No. SAND-79-092CK have shown that radiation may sensitize some polymers, which causes them to degrade to a greater extent when followed by thermal aging. The report states that the mechanistic postulate is that radiation-cleaved bonds, in the form of radicals, react with oxygen to give degradation products, including peroxides. The peroxides are chemically weak links which are susceptible to thermal cleavage. This thermal peroxide cleavage gives more radicals which, in the presence of oxygen, lead to more degradation and more peroxides.

1.5 Test Specimen Configurations

The test specimens shall be received by Wyle Laboratories in the configuration presented in Paragraph 1.3. At various stages of the test program, minor modifications to the initial configuration shall be required. The following presents these modifications as they apply to the test sequence.

1.5.1 Configuration A (Functional Tests, Vibration Aging, Seismic Qualification, and Accident Qualification)

This designation refers to the original test specimen configuration, as described in Paragraph 1.3.

1.0 SCOPE (CONTINUED)

1.5.2 Configuration B (Radiation Exposure)

The jumper wires installed on each Terminal Block Assembly shall be removed and replaced by uninsulated metallic terminal lugs (uncrimped) which are identical to those used on the jumper wires. Appropriate terminal screws/nuts shall be tightened to the torque values specified in Paragraph 1.3.

1.5.3 Configuration C (Thermal Aging)

Same as Configuration B, except all mounting panels (with terminal blocks attached) shall be removed from their respective enclosures. Each vacant enclosure and each terminal block/mounting panel combination shall constitute a subassembly.

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.4 Aging

The desired qualified life of the subject equipment is 40 years. The desired qualified life for components is also 40 years. Where 40-year qualified life for components is not demonstrated during the test program, a shorter qualified life shall be established and the component assigned a maximum maintenace-replacement interval no greater than its qualified life.

Each component in the subject equipment has been reviewed for function and age-related failure mechanisms which could affect its function. A matrix, Table I, has been prepared which defines the components, manufacturer ratings, materials, service conditions, and aging mechanisms. A literature search of Wyle's Aging Library has been utilized to obtain auditable aging data. This data was used to define artificial aging procedures. The aging mechanisms to be addressed for this equipment are time-temperature effects and humidity effects.

3.4.1 Time-Temperature Effects

For many materials normal temperature conditions coupled with time create an aging mechanism known as time-temperature effects. The significance of these effects is strongly dependent on the type of material under consideration.

In general, materials may be classified in one of three broad categories: B

1) Organic materials (i.e., polymers, lubricants, etc.)
2) Inorganic materials (i.e., ceramics, minerals, etc.)
3) Metallic materials

It can be shown that the deterioration due to time-temperature effects is insignificant for inorganic materials since these materials exhibit no permanent changes in geometry or properties for the time period under consideration (Reference 1). Similarly, time-temperature effects are judged to be insignificant for metallic materials during the same time frame.

In contrast, it is known that time-temperature aging effects can result in significant deterioration of many organic materials. As noted in Reference 2, "The exposure of polymers to the influence of environmental factors over a period of time generally leads to deterioration in physical properties."

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.4.1 Time-Temperature Effects (Continued)

The present state-of-the-art will allow for artificial acceleration of the time-temperature effects associated with organic materials by increasing the temperature. Therefore, the aging of these components shall be based on their organic materials.

For many organic materials, it is known that the degradation process can be defined by a single temperature-dependent reaction that follows the Arrhenius equation (References 3 and 4):

$$k = A \exp(-(Ea/k_B T)) \qquad (1)$$

where,

k	=	reaction rate
A	=	frequency factor
exp	=	exponent to base e
Ea	=	activation energy
k_B	=	Boltzmann's Constant
T	=	absolute temperature

It is further noted that, for many reactions, the activation energy can be considered to be constant over the applicable temperature range. Equation (1) can be transformed into a form which yields an acceleration factor.

The acceleration factor is defined as t_2/t_1.

The equation is:

$$t_2/t_1 = \exp(-(Ea/k_B)(1/T_1 - 1/T_2)) \qquad (2)$$

where,

t_1	=	accelerated aging time at temperature T_1
t_2	=	normal service time at temperature T_2
exp	=	exponent to base e
Ea	=	activation energy (eV)
k_B	=	Boltzmann's Constant (8.617×10^{-5} eV/^{o}K)
T_1	=	accelerated aging temperature (^{o}K)
T_2	=	normal service temperature (^{o}K)

The transformation of the reaction rate form of the Arrhenius equation to an acceleration form is accomplished as follows:

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.4.1 Time-Temperature Effects (Continued)

Life is assumed to be inversely proportional to the chemical reaction rate (References 3 and 4). In terms of life, and after converting to Napierian base logarithms, Equation (1) becomes:

$$\ln(\text{life}) = (Ea/k_B)(1/T) + \text{Constant} \quad (3)$$

Equation (3) has the algebraic form:

$$y = mx + b \quad (4)$$

where,

y = ln (life)
x = 1/T
m = Ea/k_B, constant for single dominant reactions
b = constant

The constants, m and b, can be estimated by fitting the experimental data in the form of ln (life) versus 1/T into the above simple linear relationship.

The derivation of an acceleration factor is accomplished by taking the difference between any two points of the linear relationship.

Thus, if we substitute t for life into Equation (3), we obtain:

$$\ln t = (Ea/k_B)(1/T) + \text{Constant} \quad (5)$$

For the set of points (t_1, T_1), Equation (5) becomes:

$$\ln t_1 = (Ea/k_B)(1/T_1) + \text{Constant} \quad (6)$$

For the set of points (t_2, T_2), Equation (5) becomes:

$$\ln t_2 = (Ea/k_B)(1/T_2) + \text{Constant} \quad (7)$$

Subtracting Equation (6) from Equation (7) yields:

$$\ln t_2 - \ln t_1 = (Ea/k_B)(1/T_2) + \text{Constant} - (Ea/k_B)(1/T_1) - \text{Constant} \quad (8)$$

Simplifying and rearranging of Equation (8) yields:

$$\ln(t_2/t_1) = -(Ea/k_B)(1/T_1 - 1/T_2) \quad (9)$$

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.4.1 Time-Temperature Effects (Continued)

Taking antilogarithms yields:

$$t_2/t_1 = \exp(-(Ea/k_B)(1/T_1 - 1/T_2)) \quad (10)$$

Equation (10) is the same as Equation (2).

The acceleration factor (t_2/t_1) is the reciprocal of the time compression factor, (t_1/t_2). Taking the reciprocal of Equation (10) yields:

$$t_1/t_2 = \exp((Ea/k_B)(1/T_1 - 1/T_2)) \quad (11)$$

Solving Equation (11) for t_1 yields:

$$t_1 = t_2 \exp((Ea/k_B)(1/T_1 - 1/T_2)) \quad (12)$$

Equation (12) can be used to derive the accelerated aging times for materials with known activation energies. In many cases, it is not practical to independently accelerate the time-temperature effects of each organic material. In this case, a determination is made as to which material has the lowest activation energy. The time-temperature effects are accelerated based upon the lowest activation energy for conservatism. This assures that the degradation of each age-sensitive material is accelerated to at least the equivalent degradation as that to be encountered during the qualified life.

The conservatism of basing accelerated aging on the lowest activation energy is demonstrated as follows:

The acceleration factor (t_2/t_1) of Equation (10) is greater than 1, for a constant activation energy, when the accelerated aging temperature T_1 is greater than the normal service temperature T_2.

With T_1 greater than T_2, the term ($1/T_1 - 1/T_2$) is negative. This negative multiplied by the negative in the exponent results in a positive exponent. A positive exponent, in turn, results in an acceleration factor greater than 1.

The acceleration factor versus ($1/T$) for various activation energies is plotted in Figure 45. Since the slope of each plot is proportional to the activation energy, per Equation (4), it is shown that a lower activation energy causes a lower slope. Thus, for a given accelerated aging temperature, different activation energies cause different acceleration factors, assuming that the normal service temperature is the same. This is demonstrated in the following example.

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.4.1 Time-Temperature Effects (Continued)

EXAMPLE: Assume that a system consists of four (4) materials which have activation energies of 0.4, 0.8, 1.0, and 2.0 eV. It is assumed that each material is normally at a service temperature of 30°C for a qualified life of 40 years. It is further assumed that accelerated thermal aging shall be performed at 50°C.

If the accelerated aging program is based upon the material with an activation energy of 1.0 eV, the following results:

The relationship for the curves of Figure 1 is generated from Equation (10) and is defined as:

$$t_2/t_1 = \exp\left(-(E_a/k_B)(1/T_1 - 1/T_2)\right) \quad (13)$$

Substituting $E_a = 1.0$ eV, $T_1 = 323$°K, $T_2 = 303$°K, into Equation (13) yields an acceleration factor of approximately:

$$t_2/t_1 = 11 \quad (14)$$

Thus, for a normal service time of 40 years ($t_2 = 40$), the accelerated aging time from Equation (14) is:

$$t_1 = 40/11 = 3.64 \text{ years} \quad (15)$$

Therefore, using the accelerated thermal aging program of 50°C for 3.64 years, the equivalent demonstrated normal service times at 30°C for the other materials with activation energies of 0.4, 0.8, and 2.0 eV can be calculated using Equation (13).

Thus, for $E_a = 2.0$ eV,

$$t_2 = 3.64 \exp\left(-(2.0/8.617^{-5})(1/323 - 1/303)\right) \quad (16)$$

$$t_2 - 418 \text{ years} \quad (17)$$

For $E_a = 0.8$ eV,

$$t_2 = 3.64 \exp\left(-(0.8/8.617 \times 10^{-5})(1/323 - 1/303)\right) \quad (18)$$

$$t_2 = 24.3 \text{ years} \quad (19)$$

For $E_a = 0.4$ eV,

$$t_2 = 3.64 \exp\left(-(0.4/8.617 \times 10^{-5})(1/323 - 1/303)\right. \quad (20)$$

$$t_2 = 9.4 \text{ years} \quad (21)$$

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.4.1 Time-Temperature Effects (Continued)

Thus, it is seen that materials with activation energies less than 1.0, upon which the aging program was based, are underaged by the accelerated aging of 50°C for 3.64 years.

In order to assure the demonstration of a 40-year service time for all materials, the lowest activation energy should be chosen.

Basing the accelerated aging program on the lowest activation energy of 0.4 eV results in the following:

Substituting Ea = 0.4 eV, T_1 = 323°K, T_2 = 303°K, into Equation (13) yields an acceleration factor of approximately

$$t_2/t_1 = 2.6 \tag{22}$$

Thus, the aging time is:

$$t_1 = 40/2.6 = 15.4 \text{ years} \tag{23}$$

Rechecking the other materials for adequate aging results in the following for an accelerated aging program of t_1 = 15.4 years, T_1 = 323°K, T_2 = 303°K.

For Ea = 0.8 eV,

$$t_2 = 103 \text{ years} \tag{24}$$

For Ea = 1.0 eV,

$$t_2 = 165 \text{ years} \tag{25}$$

For Ea = 2.0 eV,

$$t_2 = 1{,}768 \text{ years} \tag{26}$$

Thus, it has been demonstrated that basing an accelerated thermal aging program on the lowest activation energy, when the baseline temperatures are common, provides the conservatism desired.

END OF EXAMPLE

For components with time-temperature-related aging mechanisms, the aging was based upon available auditable aging data.

Where adequate information was available, a determination of age sensitivity was performed to determine the qualified life goal. Those items found to be age insensitive are noted in the column entitled "Aging

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.4.1 Time-Temperature Effects (Continued)

Mechanisms, Time-Temperature Effects," Table I. A reference was made for the conclusion of age insensitivity. These references are to paragraphs in this document which justify the conclusion, reference documents, or other basis, such as inorganic materials.

For organic materials, a determination was made as to whether the material can be qualified for a 40-year life. This was done by using the normal service temperatures for the baseline temperature. For each organic material, the applicable Arrhenius equation was evaluated, using the baseline temperature, as demonstrated by the following example:

The Arrhenius equation, Equation (3), is repeated:

$$\ln(\text{life}) = (E_a/k_B)(1/T) + \text{Constant} \quad (27)$$

A substitution shall be made for the applicable slope and constant and the equation evaluated, e.g., for laminate, XXX, Item 1.1.6, Table I, for mechanical properties, the Arrhenius curve is:

$$\ln(\text{life}) = 14101.11669\,(1/T) - 24.3612882 \quad (28)$$

For a baseline temperature of 135°F (57.2°C):

$$T = 57.2^{\circ}C + 273^{\circ}C = 330.2^{\circ}K \quad (29)$$

$$\text{life} = \text{greater than } 10{,}000 \text{ years} \quad (30)$$

It is concluded that this laminate, XXX, can be qualified for 40 years at a baseline temperature of 57.2°C.

Based on a baseline temperature of 135°F, which shall be experienced for over 99% of the desired qualified life, projected lives of the remaining organic materials considered in this qualification program are:

Material	Projected Life (Years)
Phenolic (Genal 4000)	1.47 million
Phenolic (G.E. 12968)	2.75 million
Neoprene	42.2

The applicable Arrhenius equation refers to the equation which is most appropriate to the material application when more than one equation is known.

For components with time-temperature-related aging mechanisms, the aging was based upon available auditable aging data, as noted in Table I.

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.4.2 Humidity Effects

Humidity effects are not considered to be an aging mechanism for terminal block assemblies. The ability of the equipment to perform within its relative humidity environment shall be demonstrated when safety-related functions are tested during the design basis accident.

3.5 Aging Analysis

3.5.1 Time-Temperature Effects

The time-temperature effects can be accelerated by increasing the temperature, as explained in Paragraph 3.4.1. A review of the materials indicates that the neoprene gasket utilized in the Type 4 NEMA enclosure will require the greatest amount of thermal aging. In order to avoid excessive thermal degradation of the terminal block specimens, the mounting panels (with terminal blocks attached) shall be removed from their respective enclosures and thermally aged independent of the vacant enclosures. This corresponds to Configuration C, described in Paragraph 1.5.3.

It is desirable to thermally age the equipment in one (1) environmental chamber. Therefore, the maximum aging temperature has been based on the lowest rated temperature, 120°C, for neoprene (Item 1.4.2, Table I).

3.5.1.1 NEMA Enclosure Subassemblies

For the vacant NEMA enclosures, a review of the materials indicates that the material with the lowest activation energy is the neoprene, Item 1.4.2, Table I, with a value of 1.05 eV, based on mechanical properties (Reference 8). Calculations based on this value, the baseline temperatures presented in Paragraph 2.1.1, and a projected qualified life of 40 years, yield a thermal aging time of 44 days (1,056 hours) at 120°C.

3.5.1.2 Terminal Block/Mounting Panel Subassemblies

For the terminal block/mounting panel subassemblies, the material with the lowest activation energy is the NEMA Grade XXX laminate, Item 1.1.6, Table I, which has a value of 1.21 eV, based on mechanical properties (Reference 7). Calculations based on this value, the baseline temperatures presented in Paragraph 2.1.1, and a projected qualified life of 40 years yield a thermal aging time of 18.5 days (443 hours) at 120°C.

3.5.2 Functional Test

The equipment shall be converted to Configuration A, Paragraph 1.5.1, and functionally tested per Paragraph 3.2.

Item No.	TABLE I. AGING MATRIX ITEM AND MANUFACTURER	MANUFACTURER'S RATING ENVIRONMENTAL AND OPERATIONAL	MATERIALS	ACTIVATION ENERGY (eV)	APPLICATION	AGING MECHANISMS TIME-TEMPERATURE EFFECTS	RADIATION DAMAGE THRESHOLD	
1.0	Assembly, Marathon Terminal Blocks, NEMA Type 4 Enclosure, Terminal Lugs, Cable Conduits (2)							
1.1	Terminal Blocks (2), Marathon Fixed Barrier, Series 1500 NUC (Nuclear Grade), Type 1512929, 12-Point, 600 Volts, 75 Amperes	150°C						
1.1.1	Molded Block, P/N 9783612	150°C	Cellulose Phenolic, G.E. Type P-4000	1.59(Ref 5)		X	2.7 x 10^6 (Ref 6)	
1.1.2	#10-32 Insert, P/N 9743805		Brass, CDA Alloy 360	NAS(Para 3.3.1)				
1.1.3	Connector, P/N 9064121		Brass, CDA Alloy 260	"				
1.1.4	#10-32 Washer-Head Machine Screw, P/N 9743307		Brass, CDA Alloy 360	"				
1.1.5	#4-40 Pan-Head Screw		Stainless Steel	"				
1.1.6	Marking Strip, .060 Thick, P/N 9795012	140°C	NEMA Grade XXX Laminate	1.21(Ref 7)		X	"	
1.2	Terminal Blocks (2), Marathon Fixed Barrier, Series 1600 NUC (Nuclear Grade), Type 1612929, 12-Point, 600 Volts, 75 Amperes	150°C	SAME AS ITEM 1.1					
1.2.1	Molded Block, P/N 9740612	150°C	"					

LEGEND: NAS = Not Age Sensitive; X = Material is sensitive to the aging mechanism.

Item No.	TABLE I. AGING MATRIX (CONTINUED) ITEM AND MANUFACTURER	MANUFACTURER'S RATING ENVIRONMENTAL AND OPERATIONAL	MATERIALS	ACTIVATION ENERGY (eV)	APPLICATION	AGING MECHANISMS TIME-TEMPERATURE EFFECTS	RADIATION DAMAGE THRESHOLD	
1.2.2	#10-32 Insert, P/N 9743805		Same as Item 1.1					
1.2.3	Connector, P/N 9064121		"					
1.2.4	#10-32 Washer-Head Machine Screw, P/N 9743307		"					
1.2.5	#4-40 Pan-Head Screw, P/N 9784035		"					
1.2.6	Marking Strip, .060 Thick, P/N 9795112	140°C	"					
1.3	Terminal Blocks (2), Marathon Power Stud Block, Series 142 NUC (Nuclear Grade), Type 1423589, 3 Circuits	150°C						
1.3.1	Molded Block, P/N 9703613	150°C	G.E. #12968 General Purpose Phenolic Molding Compound	1.67(Ref 5)		X	2.7×10^6 (Ref 6)	
1.3.2	Screw, Self-Tapping, P/N 9782508		Steel	NAS(Para 3.3.1)				
1.3.3	Connector Assembly, P/N 9513130							
1.3.3.1	Stud, 1/4-20 NC Thread, P/N 9711606		Brass	"				
1.3.3.2	Connector, P/N 9513113		Copper, CDA Alloy 260	"				

LEGEND: NAS = Not Age Sensitive; X = Material is sensitive to the aging mechanism.

Item No.	TABLE I. AGING MATRIX (CONTINUED) ITEM AND MANUFACTURER	MANUFACTURER'S RATING ENVIRONMENTAL AND OPERATIONAL	MATERIALS	ACTIVATION ENERGY (eV)	APPLICATION	AGING MECHANISMS TIME-TEMPERATURE EFFECTS	RADIATION DAMAGE THRESHOLD	
1.4	Assembly Enclosure, Hoffman, NEMA Type 4, Single-Door, 20" x 20" x 6", P/N A20H20ALP							
1.4.1	Body, Door, Hinges, Hinge Pins, Clamps, Clamp Screws, Hasp, Staple, Gasket Retaining Strip, Feet		Steel	NAS(Para 3.3.1)				
1.4.2	Gasket		Neoprene	1.05(Ref 8)		X	2×10^6 (Ref 6)	
1.4.3	Gasket Adhesive			Not Safety Related				
1.4.4	Paint		Acrylic	"				
1.5	Enclosure Mounting Panel, Hoffman, 17" x 17", P/N A-20P20		Steel	NAS(Para 3.3.1)				
1.6	Terminal Lugs, #8 AWG, Uninsulated		Metallic	"				
1.7	Cable Conduits (2), 90°Bend, 1-1/2" I.D.		"	"				

LEGEND: NAS = Not Age Sensitive; X = Material is sensitive to the aging mechanism.

TABLE I. AGING MATRIX (CONTINUED)

Item No.	ITEM AND MANUFACTURER	MANUFACTURER'S RATING ENVIRONMENTAL AND OPERATIONAL	MATERIALS	ACTIVATION ENERGY (eV)	APPLICATION	AGING MECHANISMS		
						TIME-TEMPERATURE EFFECTS	RADIATION DAMAGE THRESHOLD	
2.0	Assembly, Marathon Terminal Blocks, NEMA Type 4 Enclosure, Cable, Terminal Lugs, Cable Conduits (2)	SAME AS ITEM 1.0						
3.0	Assembly, Marathon Terminal Blocks, NEMA Type 4 Enclosure, Cable, Terminal Lugs, Cable Conduits (2)	SAME AS ITEM 1.0						

LEGEND: NAS = Not Age Sensitive; X = Material is sensitive to the aging mechanism.

Attachment 4 to AEP:NRC:0775AE

SCEW Sheet TC-13 Revisions

AMERICAN ELECTRIC POWER SERVICE CORPORATION

DATE: May 21, 1986

SUBJECT: D. C. Cook Units 1 & 2
SCEW Sheet TC-13 Revisions

FROM: R. G. Heurich

TO: CEEQF #0000A

The following changes were made to SCEW sheet TC-13, for both units, as a result of the NRC audit.

1) Added Penn Union and Marathon as the manufacturer. These are the two types of terminal blocks used at D. C. Cook

2) Added model numbers a) 6000 series (Penn Union) b) 1600 series (Marathon)

3) Changed system from "various" to "see attached list". The attached list contains all the device systems where the marathon and Penn Union terminal blocks are found.

4) Deleted qualification document reference CEEQF#63K. Test report lasts longer than what the TB's will see in an accident outside containment

5) Added qualification document reference CEEQF#45C. CEEQF#45C contains the qualification test report for Marathon terminal blocks.

6) Added qualification document reference CEEQF#46. CEEQF#46 replaces CEEQF#45 for Penn Union terminal blocks. Conax report IPS-349 (#46) includes radiation while Conax report IPS-339(#45) does not.

7) For aging, changed qualification document reference CEEQF#177 to #177A (Penn Union) and to #45C (Marathon).

8) For qualified environmental temperature, "384^{0}F" was added for Marathon Terminal Block.

9) For qualified environmental pressure, "94.7" PSIA qas added for Marathon terminal block.

10) For qualified environmental chemical spray, "2000ppmB pH 8.5-10.5" was added for Marathon terminal block.

11) For qualified environmental radiation dosage, "200 Mrad was added for Marathon terminal block.

12) Changed qualification method from "combination" and "simultaneous" to "sequential" (for perating time to radiation)

13) Deleted the following outstanding items.

    a) "see Ref. 63K" for operating time
    b) "see Ref. 72" for chemical spray

14) Add CEEQF#45 as a supplementary information packet (along with CEEQF#45A).

The procedure 3 for the Marathon Terminal Block Qualification Test Report explains each environmental qualification category. All other changes are administrative.

R. G. Heurich

Approved ______________
R. C. Carruth

RGH:rd:52.27
Attachments
cc. W/O Attachments
T. O. Argenta/S. H. Horowitz
L. F. Caso/J. V. Ruparel
D. N. Turnberg/J. R. Anderson
K. J. Munson

SCEW Sheet Pg.	Unit	Revision No.	Date
TC-13	1	5	May 21, 1986
TC-13	2	4	May 21, 1986

DONALD C. COOK NUCLEAR PLANT UNIT NO. 1 DOCKET NO. 50-315 LICENSE NO. DPR-58

EQUIPMENT DESCRIPTION	ENVIRONMENT			DOCUMENTATION REF.*		QUALIFICATION METHOD	OUTSTANDING ITEMS
	PARAMETER	SPEC.	QUAL.	SPEC.	QUAL.		
SYSTEM: SEE ATTACHED LIST	Operating Time	4 mos.	7.4 mos.	110	a) 46 b) 45C	Sequential	NONE
PLANT ID NO: NA	Temperature (°F)	230	a) 345 b) 384	107	a) 46 b) 45C	Sequential	NONE
COMPONENT: CABLE TERMINATION	Pressure (PSIA)	26.2	a) 124.7 b) 94.7	107	a) 46 b) 45C	"	"
MANUFACTURER: a) Penn Union b) Marathon MODEL NUMBER: a) 6000 Series b) 1600 Series	Relative Humidity (%)	100	100	107	a) 46 b) 45C	"	"
FUNCTION: CABLE CONNECTION AT TERMINAL BLOCK ACCURACY: SPEC: NA DEMON: NA	Chemical Spray	NA	a) 2500 ppm B Ph 7.0-12.0 b) 2000 ppm B pH 8.5-10.5	NA	a) 46 b) 45C	"	NONE
SERVICE: SEE ATTACHED LIST	Radiation (10^6 rads)	11.4	a) 20 b) 200	106	a) 46 b) 45C	"	NONE
LOCATION: OUTSIDE CONTAINMENT	Aging (years)	NA	40	NA	a) 17a b) 45C	Combination	None
FLOOD LEVEL ELEV: NA ABOVE FLOOD LEVEL: NA	Submergence	NA	NA	NA	NA	NA	NA

*Documentation References:

1. Supplementary Information Packet #45, 45A
2. FRC TER Item #69, See CEQF 514
2. Supplementary Information Packet #45D

Notes: 1) The Two acceptable Terminal Blocks qualified for outside containment use only are manufactured by Penn Union denoted by (a), or Marathon, denoted by (b).

The environmental qualification parameters provided on this SCEW have been obtained from reference documents, such as test reports and the FSAR. The Westinghouse Owners Group (WOG) has undertaken a program to address potential superheated steam releases outside containment as a result of a main steam line break with steam generator U-tube uncovery. Upon completion of the WOG study these parameters may require revision. Continued operation of the D. C. Cook Plant pending completion of this effort has been justified by letter No. AEP:NRC:0775H, dated August 3, 1984 [M. P. Alexich (IMECo) to H. R. Denton (NRC)].

Rev 5 5/21/86

Unit #1

SCEW Sheet: TC-13

Function: Control Cable Termination at Terminal Box

Device Served	MEL Pg.	Device Served	MEL Pg.
FMO-211	17	IMO-275	67
FMO-212	18	IMO-360	68
FMO-221	19	IMO-361	69
FMO-222	20	IMO-362	70
FMO-231	21	IMO-310	79
FMO-232	22	IMO-312	80
FMO-241	23	IMO-314	81
FMO-242	24	IMO-320	84
FRV-210	25	IMO-322	85
FRV-220	26	IMO-324	86
FRV-230	27	IMO-330	89
FRV-240	28	IMO-331	90
WMO-711	30	IMO-340	91
WMO-713	31	IMO-350	92
WMO-723	32	IMO-210	101
WMO-725	33	IMO-211	102
WMO-715	35	IMO-220	103
WMO-717	36	IMO-221	104
WMO-721	37	IMO-212	105
WMO-727	38	IMO-222	106
IMO-910	41	IMO-215	107
IMO-911	42	IMO-225	108
QMO-225	43	ICM-250	204
QMO-226	44	ICM-251	205
CMO-419	49	ICM-260	206
CMO-429	50	ICM-265	207
IMO-255	61	ICM-305	208
IMO-256	62	ICM-306	209
IMO-262	64	ICM-311	210
IMO-263	65	ICM-321	211
IMO-270	66		

DONALD C. COOK NUCLEAR PLANT UNIT NO. 2 DOCKET NO. 50-316 LICENSE NO. DPR-74

EQUIPMENT DESCRIPTION	ENVIRONMENT			DOCUMENTATION REF.*		QUALIFICATION METHOD	OUTSTANDING ITEMS
	PARAMETER	SPEC.	QUAL.	SPEC.	QUAL.		
SYSTEM: SEE ATTACHED LIST	Operating Time	4 mos	74 mos	110	a) 46 b) 45C	Sequential	NONE
PLANT ID NO: NA	Temperature (°F)	230	a) 345 b) 384	107	a) 46 b) 45C	"	NONE
COMPONENT: CONTROL CABLE TERMINATION MANUFACTURER: a) Penn Union b) Marathon	Pressure (PSIA)	26.2	a) 124.7 b) 94.7	107	a) 46 b) 45C	"	"
MODEL NUMBER: a) 6000 Series b) 1600 Series	Relative Humidity (%)	100	100	107	a) 46 b) 45C	"	"
FUNCTION: CONNECT CABLES AT TERMINAL BLOCK ACCURACY: SPEC: NA DEMON: NA	Chemical Spray	NA	a) 2500 PPMB pH 9-10 b) 2000 ppm pH 8.5-10.5	NA	a) 46 b) 45C	"	NA
SERVICE: SEE ATTACHED LIST	Radiation (10^6 rads)	1.4	a) 20 b) 200	106	a) 46 b) 45C	SEQUENTIAL	NONE
LOCATION: OUTSIDE CONTAINMENT	Aging (years)	NA	40	NA	a) 177a b) 45C	COMBINATION	NONE
FLOOD LEVEL ELEV: NA ABOVE FLOOD LEVEL: NA	Submergence	NA	NA	NA	NA	NA	NA

*Documentation References:

1. Supplementary Information Packet #45, 45A, 45D
2. ~~FRC TER Item #69~~, See CEEQF #514

Notes:

1) The Two acceptable Terminal Blocks qualified for outside containment use only are manufactured by Penn Union, denoted by (a) or Marathon, denoted by (b).

"The environmental qualification parameters provided on this SCEW have been obtained from reference documents, such as test reports and the FSAR. The Westinghouse Owners Group (WOG) has undertaken a program to address potential superheated steam releases outside containment as a result of a main steam line break with steam generator U-tube uncovery. Upon completion of the WOG study these parameters may require revision. Continued operation of the D. C. Cook Plant pending completion of this effort has been justified by letter No. AEP:NRC:0775M, dated August 3, 1984 [M. P. Alexich (IMECo) to H. R. Denton (NRC)]."

Rev. 4 5/27/86

Page IC13-1

Form EQ #97-2

SCEW Sheet: TC-13

Function: Control Cable Termination at Terminal Box

Device Served	MEL Pg.	Device Served	MEL Pg.
FRV-210	17	IMO-360	71
FRV-220	18	IMO-361	72
FRV-230	19	IMO-362	73
FRV-240	20	IMO-310	82
FMO-211	25	IMO-312	83
FMO-212	26	IMO-314	84
FMO-221	27	IMO-320	91
FMO-222	28	IMO-322	92
FMO-231	29	IMO-324	93
FMO-232	30	IMO-330	96
FMO-241	31	IMO-331	97
FMO-242	32	IMO-340	98
WMO-712	34	IMO-350	99
WMO-714	35	IMO-212	108
WMO-724	36	IMO-222	109
WMO-726	37	IMO-221	110
WMO-716	39	IMO-220	111
WMO-718	40	IMO-210	112
WMO-722	41	IMO-211	113
WMO-728	42	IMO-215	114
IMO-910	44	IMO-225	115
IMO-911	45	ICM-250	107
QMO-225	46	ICM-251	208
QMO-226	47	ICM-260	209
CMO-419	52	ICM-265	210
CMO-429	53	ICM-305	211
IMO-255	64	ICM-306	212
IMO-256	65	ICM-311	213
IMO-262	67	ICM-321	214
IMO-263	68	MCM-221	215
IMO-270	69	MCM-231	216
IMO-275	70		

52.27

Attachment 5 to AEP:NRC:0775AE

Conax Electrical Penetration

7222(9-83)
FORM GE-8 (C)

ENGINEERING DEPT.
AMERICAN ELECTRIC POWER SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OHIO

DATE 5/15/86 BY LPD CK. KM
COMPANY ______ G.O. ______
PLANT DCCNP

SUBJECT EP-14 Penetration Qualification Analysis

Objective:
This FDR provides an engineering review which addresses the environmental qualification of equipment shroud penetration assemblies which are designated as EP-14.
There is currently no documentation from the manufacturer, Conax, which certifies EP-14 to any Conax environmental qualification test report.

General Background:
~~Type EP-14~~ These penetrations are used to provide power and control to valves ICM-305 + 306. These valves are the containment sump to RHR pump valves and are physically located in separate enclosures which are outside containment. These penetrations are installed thru the enclosures which can be subject to the containment environment under accident conditions.

Engineering Review:
The Conax drawing for the EP-14 assembly 2SK-665, was compared to Conax drawing 2325-8386 which shows a typical containment penetration assembly. The drawings indicate that similar parts are used in the same manner in both assemblies. Both assemblies also have pressurizing capabilities. The same

7222(9/83)
FORM GE-8 (C)

ENGINEERING DEPT.
AMERICAN ELECTRIC POWER SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OHIO

SHEET 7 OF 7
DATE 5/15/86 BY LPD CK KM
COMPANY ______ G.O. ______
PLANT DCCNP

SUBJECT EP-14 Penetration Qualification Analysis

feedthru assemblies differing in length and conductor size/arrangement only are used in both penetrations.

Containment penetration assemblies designated EP-2 thru EP-13 are environmentally qualified by Conax test report IPS-234.
Based on the similarity of parts used on EP-14 and EP-2 thru 13 assemblies, it is concluded that EP-14 would also be qualified by IPS-234.

To confirm this conclusion we have requested that Conax provide documentation which certifies EP-14 to IPS-234. (memo from L.P. DeMarco to S.J. Medwid - Conax, dated 5/13/86.)

Additional References:
Conax PL-2325-8386 - Penetration Assembly Parts List.

AMERICAN ELECTRIC POWER *Service Corporation*

AEP

1 Riverside Plaza (614) 223-1000
P.O. Box 16631
Columbus, Ohio 43216-6631

May 13, 1986

Mr. S. J. Medwid
Conax Corporation
2300 Walden Avenue
Buffalo, NY 14225

RE: D. C. Cook Nuclear Plant Penetration Equipment Qualifications

Dear Mr. Medwid:

Please provide a quotation to provide documentation which certifies the penetrations purchased on our purchase order 06878-821-1 (copy attached) to Conax test report IPS-234.

The purchase order was for equipment shroud penetration assemblies per Conax sketch 2SK-665-03. These assemblies are similar to the containment penetrations provided by Conax in that similar parts and pressurizing capability were provided with the shroud assemblies.

Test report IPS-234 is used to establish the environmental qualification of our containment penetrations.

If there are any questions, please let me know.

Very truly yours,

Louis P. DeMarco

L. P. DeMarco
Generation and Telecommunication Division

Approved R. C. Carruth
R. C. Carruth

LPD:rd:50.90
cc. T. O. Argenta/S. H. Horowitz
L. F. Caso/J. V. Ruparel
D. N. Turnberg/J. R. Anderson
K. J. Munson

Attachment 6 to AEP:NRC:0775AE

Penetration Wire Similarity

AMERICAN ELECTRIC POWER SERVICE CORPORATION

DATE: April 26, 1986

SUBJECT: Environmental Qualification of Kapton Insulated Wire Penetration Feedthrough Extension Wire

FROM: J. A. Pria

TO: CEEQF #13

Penetration feedthrough extension wire at DCC Nuclear Power Plant includes power, control and instrument cable. The feedhtrough extension wire is all manufactured by Haveg and supplied to us by Conax Corporation (the manufacturer of DCCNP electrical penetrations).

The feedthrough extension wire is a stranded Kapton insulated wire. A stranded #10AWG Haveg, Kapton insulated penetration extension wire was tested under Westinghouse test report CWAPD-332 (CEEQF #13).

Kapton feedthrough wires in Conax penetrations were also tested under Conax test reports IPS-234 (CEEQF #1) a penetration with 37 #10 AWG conductors, and IPS-62 (CEEQF #2) ten penetrations with conductor sizes ranging from #10 AWG to 1000MCM.

Haveg Kapton insulated wires are part of the Conax Seal Assemblies (pigtails) and have been tested (24 #12 AWG, 20 #16 AWG, 8 #18 AWG) under Conax test reports IPS-409 and IPS-409.1 (CEEQF1 #75).

Foxboro instruments with Conax seal assemblies equipped with #16 AWG Kapton insulated wire instrument cable pigtails have been tested under Wyle test report 45592-4 (CEEQF #149).

Based on the results of test reports referenced above and the variety of the samples tested we, therefore, conclude that the power, control and instrument Kapton insulated penetration extension wire installed at DC Cook plant are environmentally qualified.

J. A. Pria

Approved R.C. Carruth/ LFC
R. C. Carruth

JAP:rd:50.21
cc. T. O. Argenta/S. H. Horowitz
L. F. Caso/J. V. Ruparel
D. N. Turnberg/J. R. Anderson

Attachment 7 to AEP:NRC:0775AE

Foxboro Transmitter Test Configuration

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 / Kfc
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.

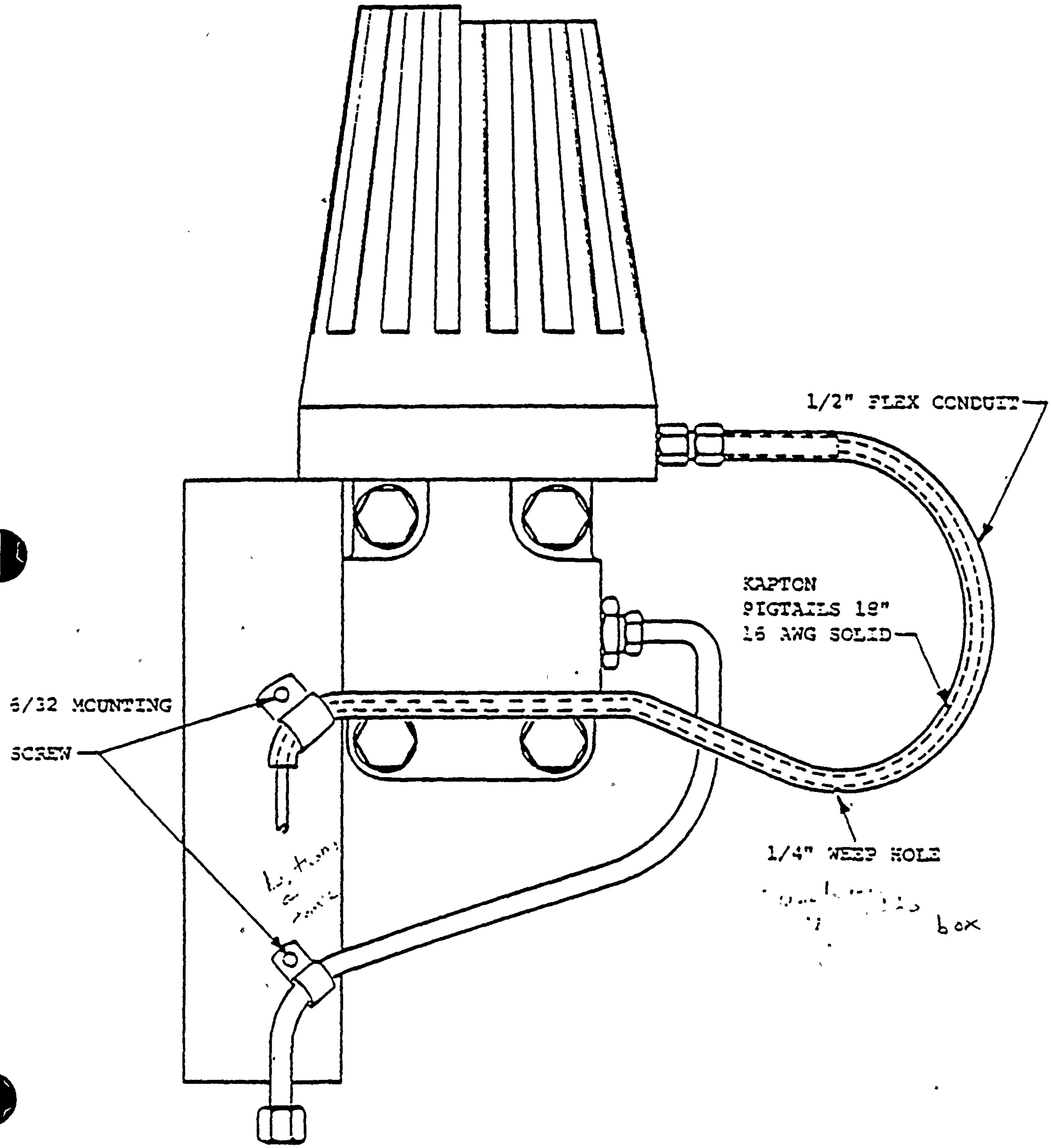


FIGURE 1. ELECTRICAL AND MECHANICAL INSTALLATIONS

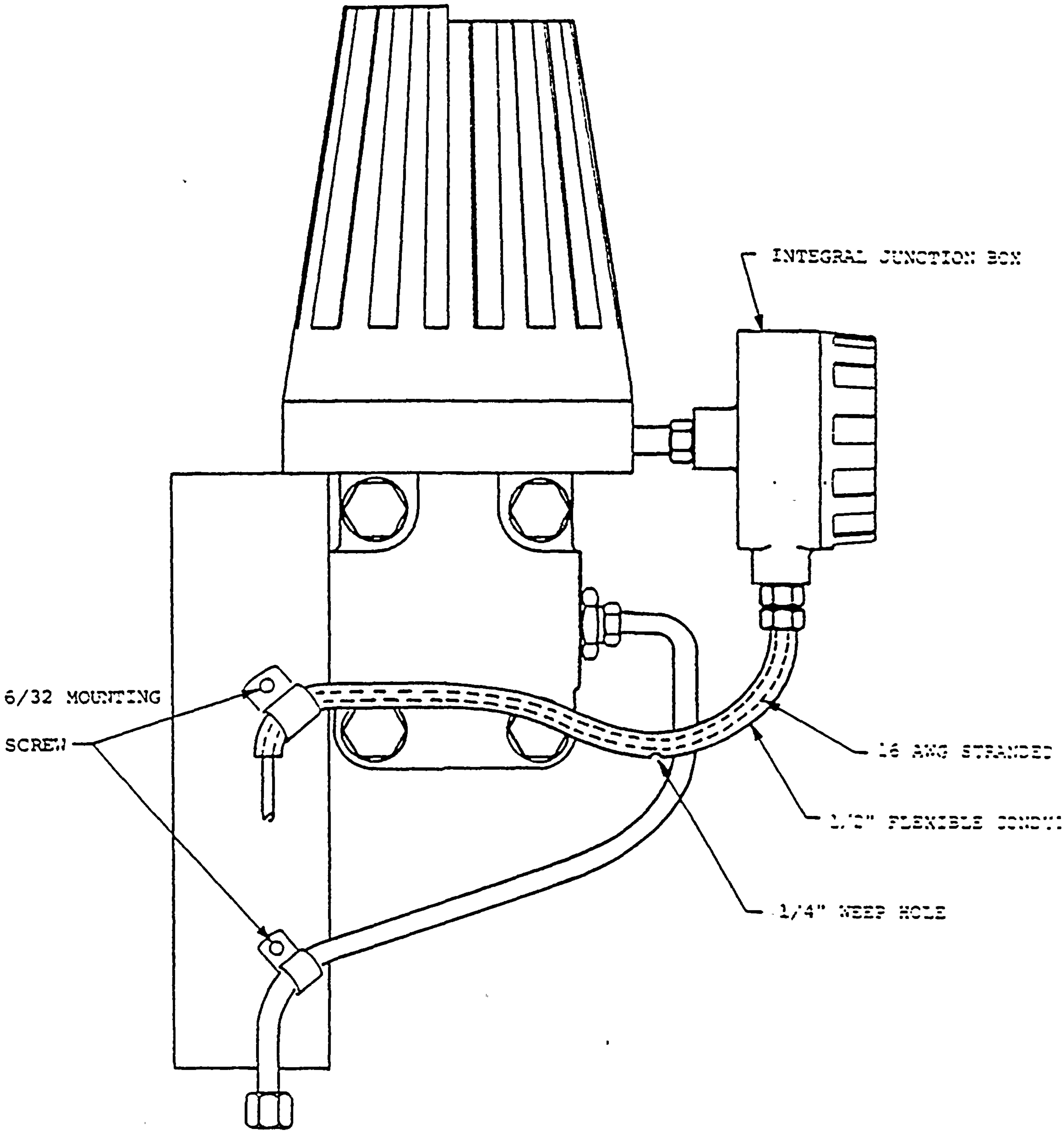


FIGURE 2A. ELECTRICAL AND MECHANICAL INSTALLATIONS

This page intentionally left blank.

This page intentionally left blank.

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

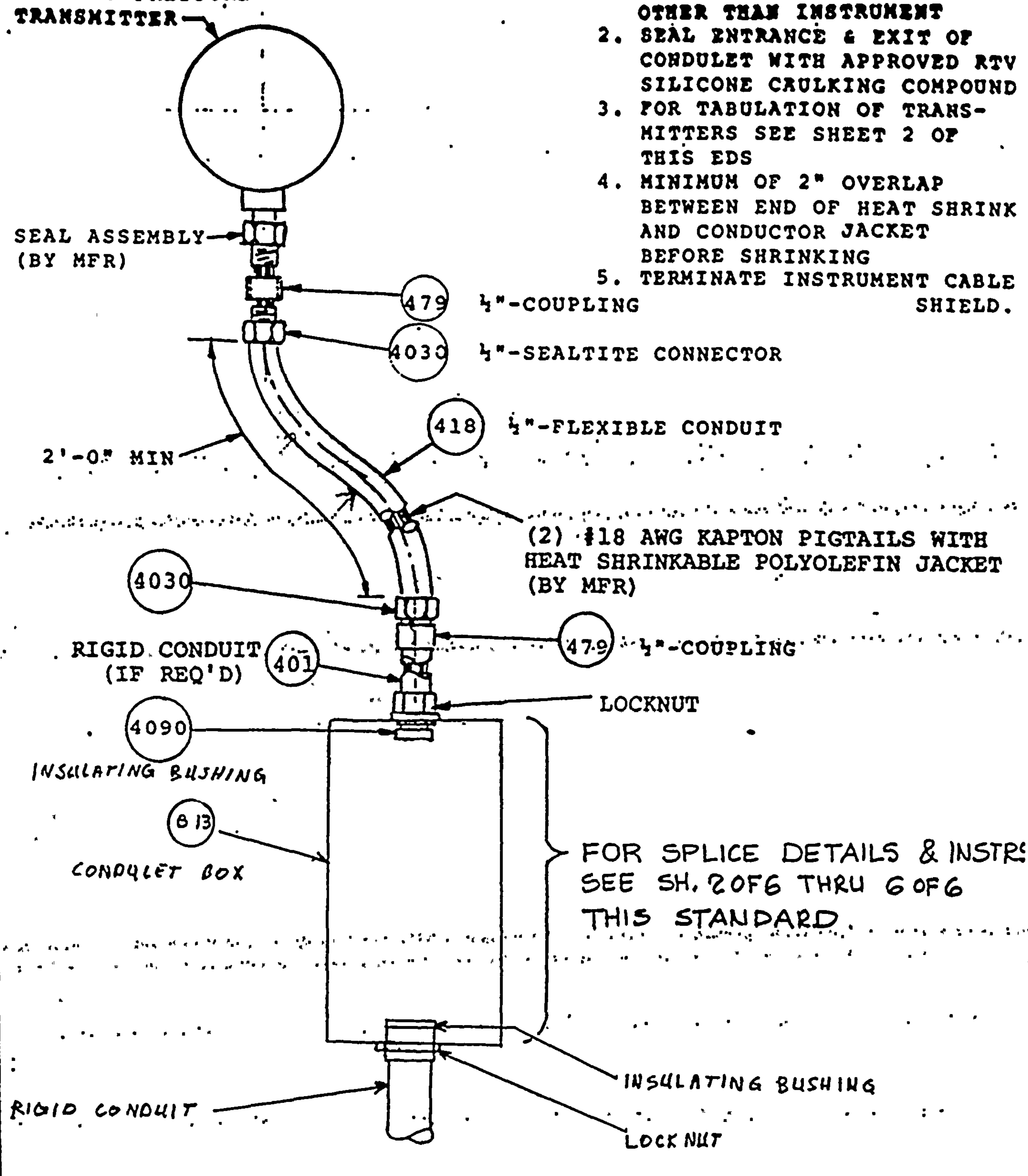
All body seals shall be leak checked using chlorine-free bubble solution, and any seal leakage from a transmitter shall be evaluated by the Lead Customer.

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.

NOTES:

1. CONDULET TO BE SUPPORTED FROM CONDUIT OR STRUCTURE OTHER THAN INSTRUMENT
2. SEAL ENTRANCE & EXIT OF CONDULET WITH APPROVED RTV SILICONE CAULKING COMPOUND
3. FOR TABULATION OF TRANSMITTERS SEE SHEET 2 OF THIS EDS
4. MINIMUM OF 2" OVERLAP BETWEEN END OF HEAT SHRINK AND CONDUCTOR JACKET BEFORE SHRINKING
5. TERMINATE INSTRUMENT CABLE SHIELD.



NUMBERS IN ◯ REFER TO B/M # 1788

FOR USE IN NUCLEAR PLANT ONLY

RFC DC01-2827
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.	I-2-EDS 343-4	SH. 1 OF 6

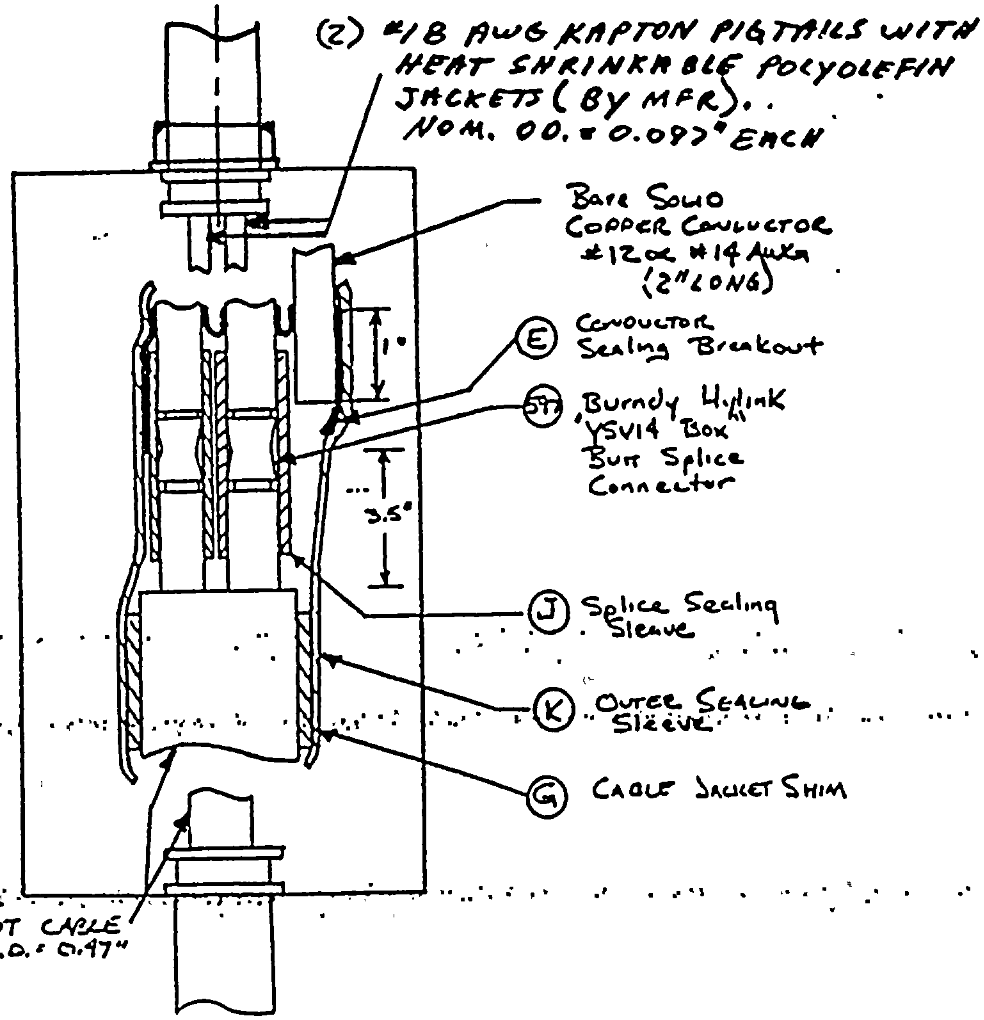


FIGURE A

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 FJM/T.L. 11-10-85	FOXBORO NE SERIES TRANSMITTER CONNECTION DETAILS
APP'D FJM/T.F.L. DR. PG	CH. SL DATE 11/8/85	
AMERICAN ELECTRIC POWER SERVICE CORP. COLUMBUS, OH.	1-2-EDS-393-1	SH. 2 OF (

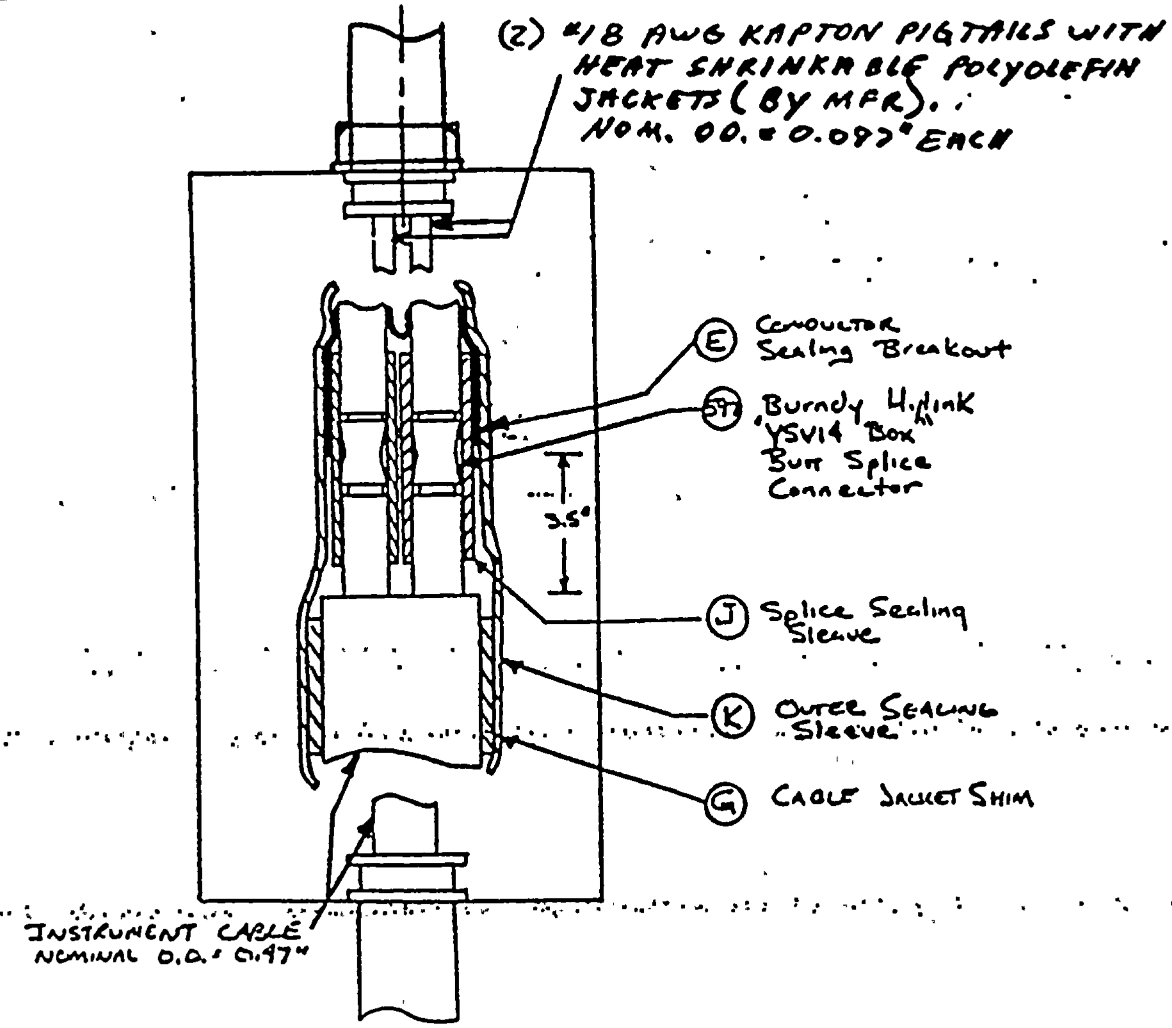


FIGURE A

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
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.T.L.	FOXBORO NE SERIES TRANSMITTER CONNECTION DETAILS
APP'D FJM/T.T.L. DR. PG	CH. SL DATE 11/10/85	
AMERICAN ELECTRIC POWER SERVICE CORP. COLUMBUS, OH.	1-2-EDS-393-d	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 INSERT #12 OR #14 GAUGE BARE SOLID CONDUCTOR WIRE. (1/2 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-343-1	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.

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

Applicable Instruments

BLP-110
BLP-111
BLP-112
BLP-120
BLP-121
BLP-122
BLP-130
BLP-131
BLP-132
BLP-140
BLP-141
BLP-142

MFC-110
MFC-111
MFC-120
MFC-121
MFC-130
MFC-131
MFC-140
MFC-141

NLP-151
NLP-152
NLP-153

BLI-110
BLI-120
BLI-130
BLI-140

FFC-210
FFC-211
FFC-220
FFC-221
FFC-230
FFC-231
FFC-240
FFC-241

IFI-051
IFI-052
IFI-053
IFI-054
IFI-310
IFI-320

NPP-151
NPP-152
NPP-153
NPS-153

NPS-121
NPS-122

MPP-210
MPP-211
MPP-220
MPP-221
MPP-230
MPP-231
MPP-240
MPP-241
MPP-212
MPP-222
MPP-232
MPP-242

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 8 to AEP:NRC:0775AE

Limitorque Issues

AMERICAN ELECTRIC POWER SERVICE CORPORATION

DATE: April 18, 1986

SUBJECT: Donald C. Cook Nuclear Plant Unit No. 2
Condition Reports 2-3-86-295, 310, and 323
Limitorque Internal Wiring Jumpers

FROM: D. E. van Deusen

TO: B. A. Svensson

The subject Condition Reports (C/Rs) point out the use of jumper wires which were not qualified for harsh environment, and were located inside Limitorque switches.

A review was performed by the Electrical Generation Section (memo from K. J. Munson to J. G. Feinstein dated 4/09/86) with the following key findings:

1. The unqualified jumper wires removed from 2-WMO-714, -724, and -726 have been identified as outdoor control wire taken from cable having item numbers 314, 315, or 316, purchased under specification DCCEE-159-QCN.

2. All three valves (green (A) train) listed in (1) have redundant back-up valves (2-WMO-718, -722, and -728, respectively) in the red (B) train. All of the jumper wires in the back-up valves were inspected and found to be fully qualified.

3. Valve 2-WMO-714 and its back-up (2-WMO-718) are located in an area which will not be affected by a HELB. These valves are to be removed from the Environmental Qualification List.

It should be noted that the plant has replaced these Class IE jumper wires (specified in the subject C/Rs) with Class IE wires qualified for harsh environment.

Based on the study performed on a HELB outside containment (FSAR section 14.4), there are no breaks postulated in the section of the Steam Supply to Auxiliary Feedwater Pump Turbine piping which is located in the same compartment as valves 2-WMO-724 and -726. As such, these valves will not be subjected to the harsh environment of a pipe break during a postulated HELB outside containment.

Based on this information, we believe that the Class IE jumper wires in question did not pose a threat to the health and safety of the public, nor did it create an unreviewed safety question as defined in 10 CFR 50.59. It is concluded, therefore, that this situation is not reportable under 10 CFR 50.73.

D. E. van Deusen

Approved by:
J. G. Feinstein, Manager
Nuclear Safety & Licensing

pm

cc: M. P. Alexich/J. G. Feinstein/R. G. Vasey
R. C. Carruth/L. F. Caso/K. J. Munson
J. C. Jeffrey/R. L. Shoberg/W. G. Sotos
A. A. Blind - Bridgman
J. D. Allard - Bridgman
DC-N-6947
AEP:NRC:9470
MEMOSB:LIWJ.mem

AMERICAN ELECTRIC POWER SERVICE CORPORATION

AMERICAN ELECTRIC AEP POWER SYSTEM

DCC FILE
AEP: NRC: 9445
DATE 3/25/86
XR ~~[illegible]~~ 9419
XR RESLOG 860208
DCC FILE EGS-NUC

DATE: March 21, 1986

SUBJECT: D. C. Cook Units 1&2
IE Notice 86-03, C/R 2-03-86-295, AIT No. 9445
MOV Operability with Control Wire EQ Uncertainties

FROM: K. J. Munson - EGS

TO: D. E. VanDeusen - NS&L

IE Notice 86-03 identifies potential problems with the environmental qualification of the internal control wiring in the limitorque motor operators. C/R 2-03-86-295 reports that a jumper wire was found during the MOV walkdown which was not listed as an acceptable environmentally qualified wire in my memo to the plant dated 1/9/86. The purpose of this memo is to determine typical valve operability in light of the control wire qualification uncertainties.

The control wiring in question is located completely within the Limitorque operator's limit switch compartment and is used to interconnect torque and limit switches. For D. C. Cook, terminal blocks are not installed or used inside the compartment. Instead, field cable is directly terminated onto the switches with internal jumper wiring providing any additional interconnections. The MOV control circuit voltage is ungrounded 220VAC or 250VDC.

The postulated control wire failure modes are open-circuits, single-wire grounds and wire-to-wire shorts which, depending on the circumstances explained below, may cause inadvertent or incorrect operation of the associated MOV.

Open circuits or high resistance connections are normally attributed to incorrect termination of the control circuit wiring and will generally not occur as a result of extreme environmental conditions. The internal wiring of an MOV is protected by the limit switch compartment cover from direct spray impingement during an accident which could theoretically loosen a control wire and create an open circuit.

Circuit shorts and grounds (including both high impedance/leakage current or low impedance/direct short conditions) may hypotehtically occur as a result of gross electrical insulation breakdown or as a result of insulation leakage currents sufficient to cause misoperation of the valve control circuit. For the DCCNP control voltage levels, gross electrical breakdown could only occur on direct conductor-to-conductor or conductor-to-ground contact. Electric arc-over is highly unlikely at low voltage levels during normal operation of the MOV. Direct shorts are possible only where conductor breakthrough occurs as a result of severe cable insulation

damage. Such damage could only occur when substantial insulation embrittlement due to high radiation doses combines with mechanical wear or when extremely high temperatures softens the insulation to the point of conductor exposure. Based on the generic properties of possible jumper wiring at DCCNP, we believe that this type of extreme degradation should not occur under specified accident conditions.

The configuration of the individual control wires within the limit switch compartment greatly minimizes the probability of the individual conductors achieving contact with grounded components or other exposed conductors. Most jumpers are less than a few inches long, especially between limit switch termination points. Excess wire is normally kept to a minimum with the majority of wires taking a direct path between terminal points thus reducing the likelihood of electrical contact. The general construction of the limit switch and torque switch insulating blocks also reduces the exposure of possible electrical contacts with receded terminal points.

Although conductor breakthrough should not occur, sufficient insulation degradation may cause changes in the individual wire insulation resistances for severe environments. While such changes could result in the wire's inability to adequately pass a high voltage withstand test performed as part of the qualification (e.g. IEEE-383), these changes are unlikely to cause significantly low conductor-to-conductor or conductor-to-ground Insulation Resistance (IR) values necessary to cause MOV failure or misoperation. The physical wire separation mentioned above creates long leakage current paths which effectively insure that low IR valves will not occur.

Further reducing the probability of MOV misoperation during an accident is that a large percentage of installed jumper wiring is environmentally qualified wire as explained in my memo to A. A. Blind - DCCNP dated 1/9/86. (Attached)

Additional justification for safe continued operation is the fact that the DCCNP MOV control circuit voltages are ungrounded. Ungrounded or "floating" voltage systems typically allow a single conductor to ground fault without having an impact on the control circuit. Only when two simsultaneous conductor-to-ground (i.e. conductor-to-conductor) faults occur would there be a chance for misoperation of the MOV.

The possibility of spurious operation of MOV's due to short circuits is also minimized by AEP's design philosophy of double breaking of the control circuit. The double break concept requires control contacts to be located at both polarities of the actuating circuit. With this configuration and ungrounded control voltages, a short circuit to ground of a single internal jumper wire of the MOV cannot cause a spurious operation of the valve.

Finally, it should be noted that in the unlikely event that wire degradation effects MOV operability, remote valve repositioning can be accomplished from the valve control center. Manual actuation of the motor contactor can adequately reposition the affected valve assuming the VCC is accessible during the post-DBE.

K. J. Munson

KJM/ris/47.3

Approved ______________
/R. C. Carruth

w/Attachments
cc. T. O. Argenta/S. H. Horowitz
L. F. Caso/J. V. Ruparel
D. N. Turnberg/J. R. Anderson
J. G. Feinstein/D. VanDeusen - NS&L
R. F. Kroeger/D. Cooper - QA
IE Notice 86-03/AEP:NRC:9419 File

AMERICAN ELECTRIC POWER SERVICE CORPORATION

DATE: January 9, 1986

SUBJECT: D. C. Cook Units 1 & 2
Limitorque Valve M. O. Jumper Wiring
Environmental Qualification

FROM: K. J. Munson - EGS

TO: A. A. Blind - D. C. Cook

We have been notified of a potential unresolved problem at other utilities with the environmental qualification of jumper wiring inside the limit/torque switch compartment of limitorque motor operated valves. The normal procedure during installation at DCCNP was to use a qualified wire, however this practice was not sufficiently documented. Therefore, some uncertainty exists as to the type and manufacturer of the internal jumper wiring. Since all qualified components are required to be fully documented, an inspection of the jumper wiring of all limitorque valves that are on the EQ list is necessary.

The inspection involves noting the gauge of the wire and the type of insulating material. It is suspected that most jumper wires will be a solid #12 Awg wire with an asbestos braided material surface taken from the older control cables having item nos. 3092, 3093, 3119 through 3123. Exceptions to this wire type and descriptions need to noted. Pending the outcome of the inspection, it may be necessary to replace the existing jumper wiring with a single known qualified wire which can be better documented for qualification purposes.

We have identified 78 MOV's (14 inside containment) in Unit 1 and 72 MOV's (13 inside containment) in Unit 2 which are EQ listed and need to be addressed. Attached is a listing of these MOV's including plant locations.

Requested is the inspection of these valves and an estimate of the manhours it will take to replace the existing jumper wiring with a single known qualified wire if necessary.

If you have any questions, please call me at extension 2158 or J. Anderson at 2137.

K. J. Munson

KJM/ris/43.95
Approved ______________
R. C. Carruth

cc: T. O. Argenta/S. H. Horowitz
J. R. Anderson/D. N. Turnberg
L. F. Caso/J. V. Ruparel
R. Kroeger/D. Cooper
J. Feinstein
W. G. Smith, Jr. - Bridgman
J. Allard - D. C. Cook - MT

INTRA-SYSTEM

AMERICAN ELECTRIC POWER SERVICE CORPORATION

DATE: April 9, 1986

SUBJECT: D. C. Cook Units 1 & 2
Limitorque MOV Walkdown
C/R Nos. 2-03-86-295/310/323

FROM: K. J. Munson - EGS

TO: J. G. Feinstein - NS&L

The jumper wires removed from 2-WMO-714, -724, -726 have been identified as outdoor control wire taken from cable having item nos. 314, 315 or 316 purchased under specification DCCEE-159-QCN. These are a 4, 7 or 12 conductor cables having 7 strands of #18 Awg. wire with a nominal 20 mils of clear polyethylene insulation and 10 mils of color-coded PVC conductor jacket material applied directly over the polyethylene insulation. The wires and cable are rated for continual use at 75°C. The cables were purchased N-grade from either Triangle/Plastic Wire & Cable, Essex, Collyer Wire & Cable or Paige Electric.

Three individual jumper wires were taken from each valve and were used in an identical wiring application as follows:

Point-to-Point Wiring	Approx. Length
a) 46 to 56	4 to 5 1/2 inches
b) 53 to 58	11 inches
c) 43 to 57	6 1/2 to 8 inches

The three jumper wires are shown marked-up on the attached wiring drawing which is typical for all three valves. Jumper wire denoted a) above connects two limit switch contacts at the low-side polarity of the control voltage bus. Jumper wire denoted b) above connects a torque switch contact with a limit switch contact near the high-side of the control voltage bus. Jumper wire denoted c) above connects a torque switch contact with a limit switch contact at the high-side of the control voltage bus. See the attached copy of valve circuit elementary dwg. which is typical for all three valves.

2-WMO-724 and 2-WMO-726 are green (A) train valves which feed essential service water to the 2-AB and 2-CD emergency diesel generators, respectively. These valves open automatically when the EDG is running or can be opened by control switch. The redundant back-up to these two valves are red (B) train valves 2-WMO-722 and 2-WMO-728 which provide essential service water to the 2-AB and 2-CD EDG's, respectively. All four valves are located in an HELB area pipe tunnel north of the 2-CD EDG. 2-WMO-714 is a green (A) train exit valve from the 2E containment spray heat exchanger. The redundant back-up is a red (B) train valve from the 2W Containment Spray Heat Exchanger. Both of these valves are located just east of the passenger elevator at elev. 621 ft. in the aux. building at approximately 30ft. north of an HELB area pipeway which is on the opposite side of a poured concrete wall. 2-WMO-714 and 2-WMO-718 are not in an HELB area and are to be removed from the list of equipment required to be environmentally qualified.

During the walkdown of valves 2-WMO-718, 2-WMO-722 and 2-WMO-728, no unqualified jumper wires were found. Therefore, the opposite train valves of 2-WMO-714, 2-WMO-724 and 2-WMO-726 were fully qualified with no jumper wire qualification uncertainties.

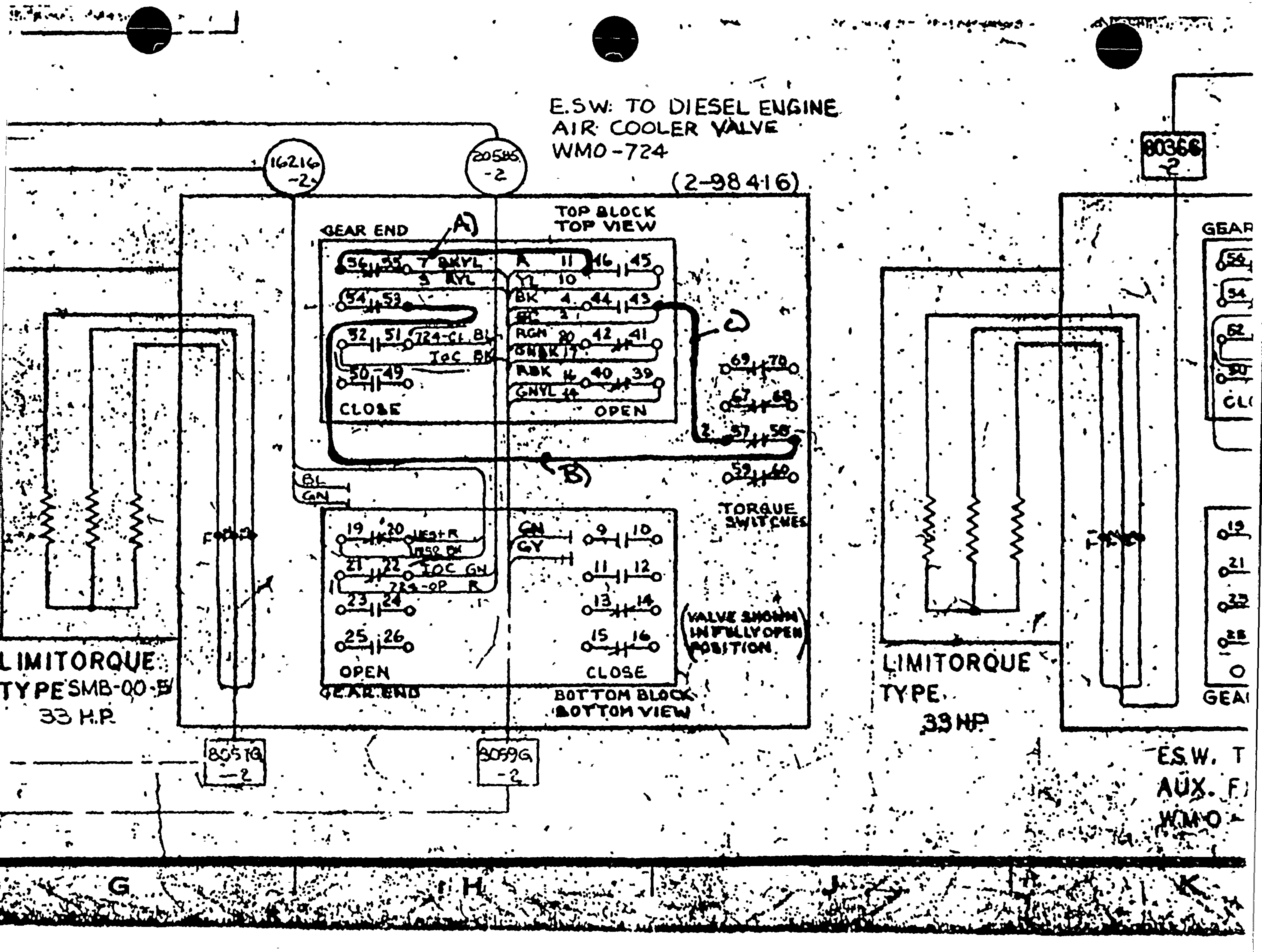
Additionally, all of the above valves are located outside containment and could be subjected to a HELB which peaks at 230°F and would have a duration of only seconds. Radiation doses are low and are not a concern. According to one wire manufacturer, polyethylene is extruded at temperatures above 300°F which can be considered the approximate melting point of this material. This is in agreement with the typical temperature specifications for polyethylene of 75°C (167°F) normal continuous operation, 90°C (194°F) emergency operation for 36 hours per year over several years and 150°C (302°F) short-circuit operation for very short durations in seconds or less. Therefore, it is highly unlikely that the polyethylene insulation on the found jumper wires would melt and expose their conductors when subjected to an outside-containment HELB temperature environment.

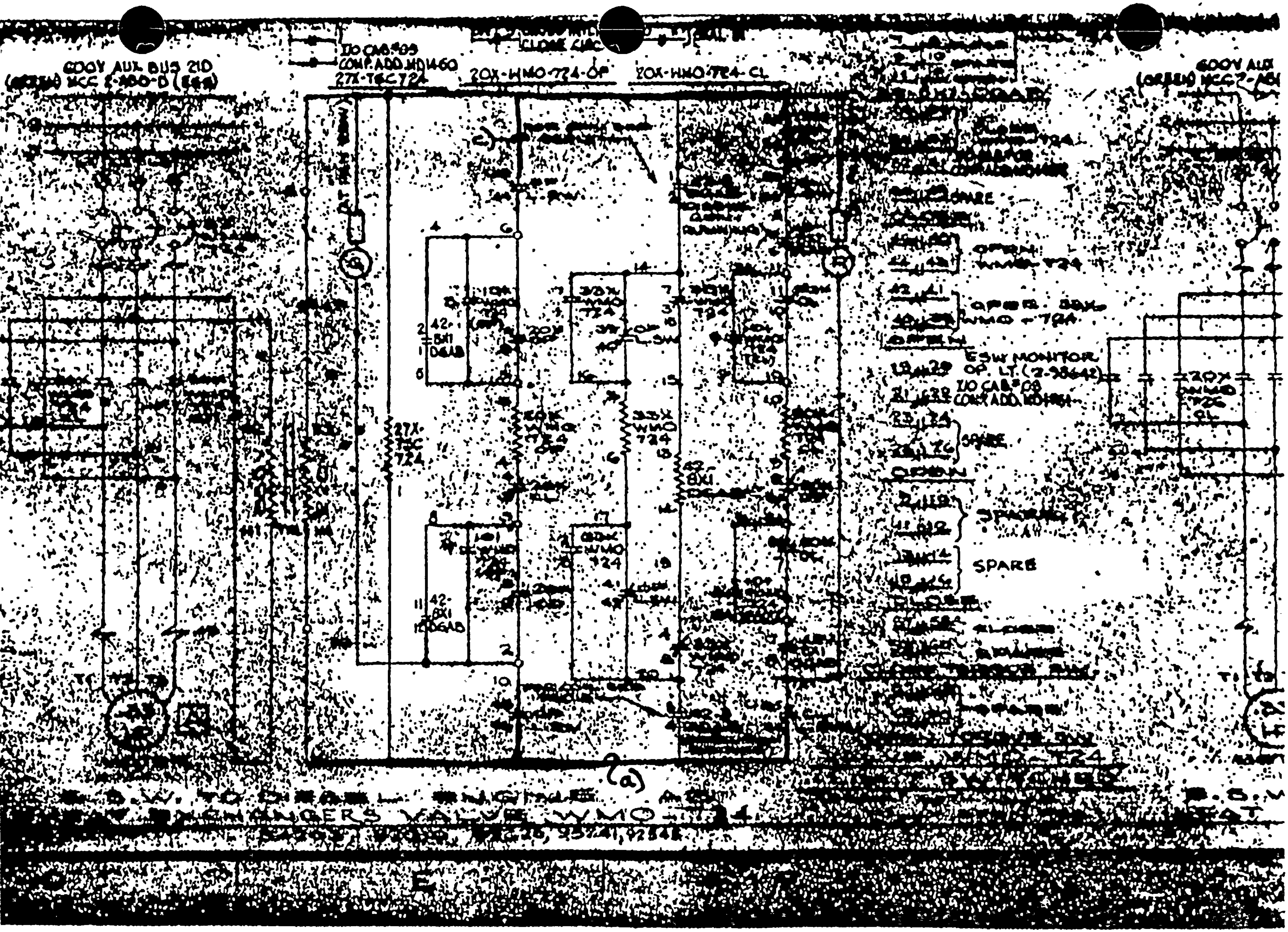
K. J. Munson

KJM/ris/49.23

Approved ______ R. C. Carruth

w/o Attachments
cc. T. O. Argenta/S. H. Horowitz
L. F. Caso/J. V. Ruparel
D. N. Turnberg/J. R. Anderson
IE Notice 86-03/AEP:NRC:9419 File (w/attach.)


E.SW: TO DIESEL ENGINE
AIR COOLER VALVE
WMO-724
(2-98416)
16216 -2
20585 -2
80366 -2
TOP BLOCK
TOP VIEW
GEAR END
CLOSE
OPEN
TORQUE SWITCHES
VALVE SHOWN IN FULLY OPEN POSITION
BOTTOM BLOCK
BOTTOM VIEW
LIMITORQUE
TYPE SMB-00-5
33 H.P.
80570 -2
80599G -2
LIMITORQUE
TYPE
33 HP
E.S.W. T
AUX. F
WMO
G
H
J
K



600V AUX BUS 21D
TO CAB. 485
COMP. ADD. MO1460
27X-TSC724
20X-HMO-724-OP
20X-HMO-724-CL
CLOSE CIRC.
27X-TSC-724
ESW MONITOR
OP. LT. (2-38642)
TO CAB. 28
COMP. ADD. MO1461
SPARE
OPEN
CLOSE
600V AUX

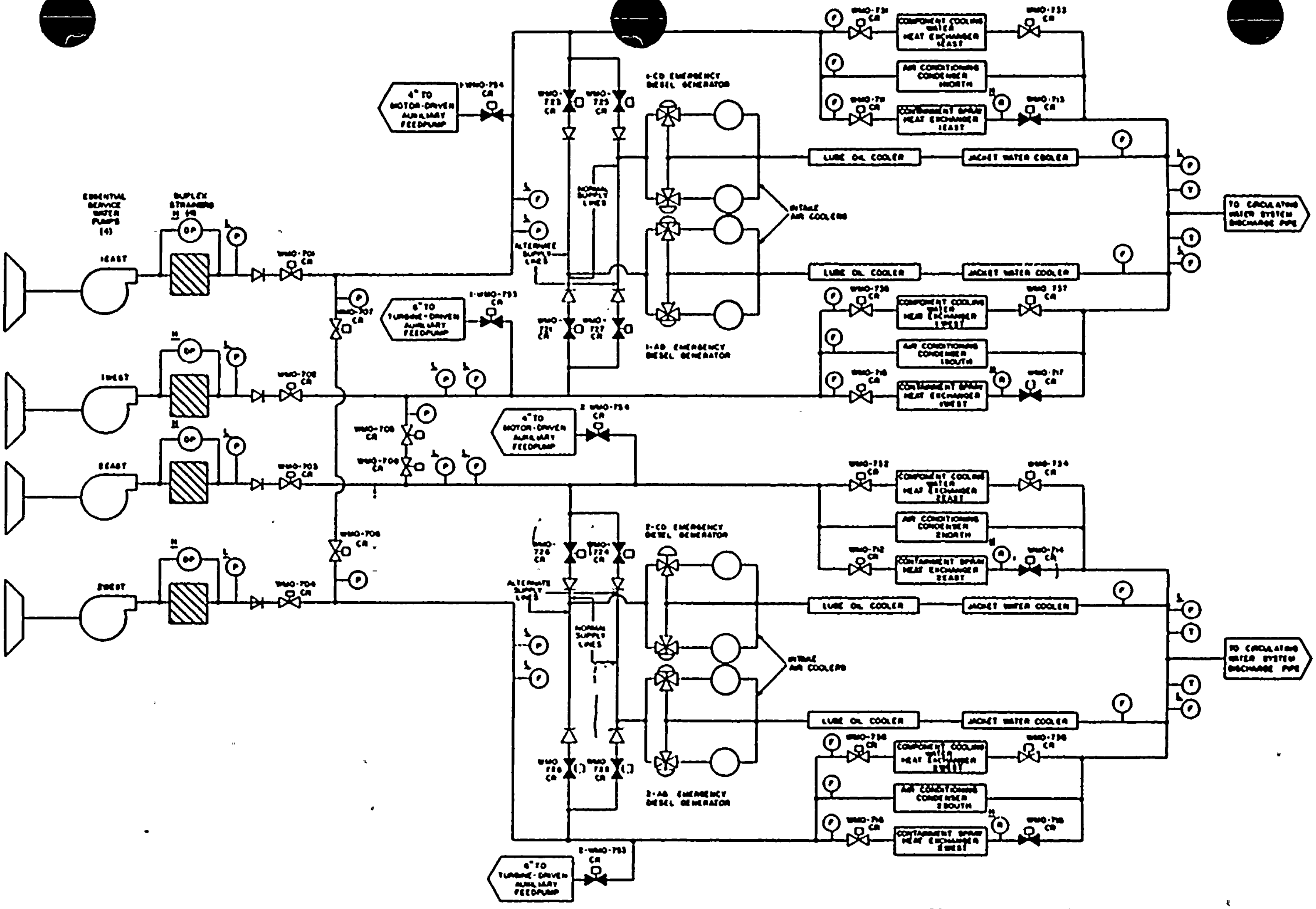
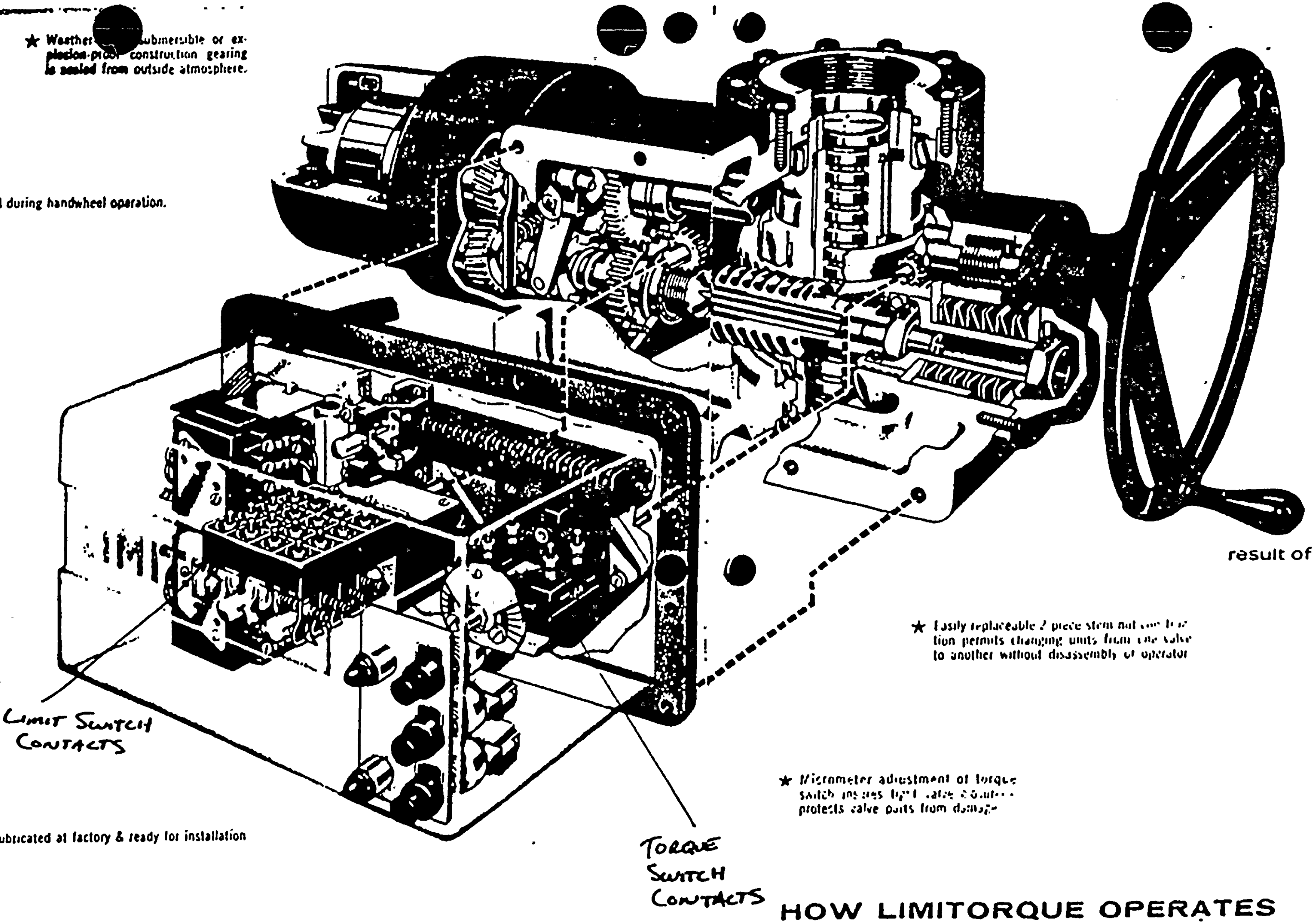


FIGURE AS-2-2

ESSENTIAL SERVICE WATER SYSTEM DIAGRAM



QUE

ibility. Basically, it is a
d device. It controls all
shipboard water-tight

any position or location and can readily be adapted to existing equipment. It can be actuated by many power sources including electricity, hydraulic pressure, air, or

HOW LIMITORQUE OPERATES

■ Limitorque is far more than a valve actuator. It also controls and limits the opening and closing travel of the valve. Proper valve seating is very important in automatic valve operation because most valves are damaged when they are improperly seated, or by meeting a foreign obstruc-

The
nects
be met
source
this m

LOCATION (22)

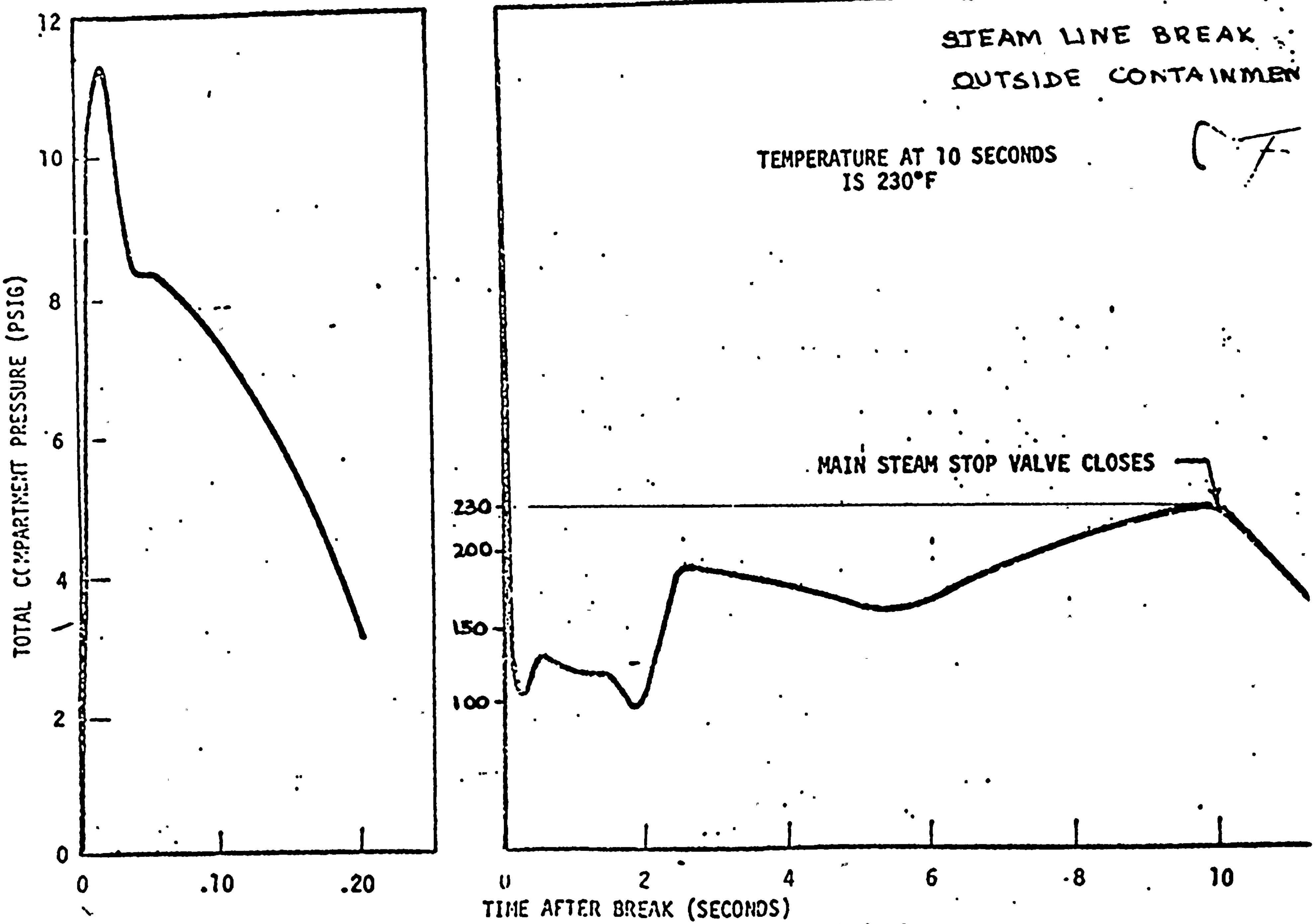


Figure 9-27 West Steam Enclosure Main Steam Line Break (Element 3), Pressure

FSAR Appendix

AMERICAN ELECTRIC POWER *Service Corporation*

AEP

1 Riverside Plaza *(614) 223-1000*
P.O. Box 16631
Columbus, Ohio 43216-6631

May 6, 1986

Mr. Joe Drab
Limitorque Corporation
5114 Woodall Road
Lynchburg, Virginia 24506

Dear Mr Drab:

As we have previously discussed, one of the latest environmental qualification uncertainties involves the use of "T-drains" on Limitorque actuator motors. Needed from Limitorque is a clarification on the qualification requirements for the use of T-drains. Specifically, the following concerns need to be addressed:

1. In which Limitorque environmental qualification test reports were T-drains installed on motors?

2. What are the T-drain requirements with respect to inside versus outside containment building valve motor operators?

3. We understand that Limitorque has qualified actuators with and without T-drains installed in the motors. Do you consider the T-drains to be an absolute qualification requirement or a design enhancement, especially since some actuators were qualified without T-drains? If required, do you recommend that all actuator motors have T-drains installed, even where T-drain holes are not available?

4. What are the specific technical reasons for the installation of T-drains? Can there be plant-specific actuator configurations in which T-drains are not required. For example, would it be possible for the condensate to drain off through other avenues.

Please provide us with as much detail as possible in your response. If you have any questions, give me a call at (614) 223-2158.

K. J. Munson
Assoc. Engineer
AEPSC

Approved ______________
R. C. Carruth

KJM:rd:50.62
cc. T. O. Argenta/S. H. Horowitz
L. F. Caso/J. V. Ruparel
D. N. Turnberg/J. R. Anderson
A. A. Blind - Bridgman
J. Allard/L. Van Ginhaven - Bridgman
M. Marracco - MED

Attachment 9 to AEP:NRC:0775AE

Cable Acceptance Criteria

AMERICAN ELECTRIC POWER SERVICE CORPORATION

DATE: May 16, 1986

SUBJECT: Insulation Resistance on EQ Instrument Cables

FROM: M. J. Finissi

TO: R. L. Shoberg/E. K. Legg, Jr.

As a result of the recent NRC audit on our Equipment Qualification (EQ) files, we must document the minimum insulation resistance on our EQ instrument cables to ensure that the leakage current will not adversely affect the current loop during an accident. The Electrical Generation Section is supplying the I & C Section with the insulation resistances such that the effects from the leakage current can be determined. Attached is a table containinig the minimum insulation resistances gathered from the appropriate EQ test reports. This listing of instrument cables is not complete and as the information is obtained, it will be forwarded to the I & C Section for review.

If you have any questions, please call.

M. J. Finissi

Approved J. R. Anderson

Approved R. C. Carruth

MJF:rd:52.9
cc. T. O. Argenta/S. H. Horowitz
L. F. Caso/J. V. Ruparel
D. N. Turnberg/J. R. Anderson
K. J. Munson

DATE 5/13/86 BY MJF CK.
COMPANY I&M G.O.
PLANT DCCNP

ENGINEERING DEPT.
AMERICAN ELECTRIC POWER SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OHIO

SUBJECT I.R. on EQ Inst. Cables

Device	Cable no.	Cable length (ft)	Length of test specimen (ft)	min I.R. for specimen (M Ω)	Min I.R. for Loop (K Ω)	TEST Report Referenced.	
FFI-210	5152-2	530	1000	.500	943	12	
FFI-220	5150-2	300	25			10	
FFI-230	5151-2	275	25			10	
FFI-240	5153-2	570	1000	.500	877	12	
NPS-121	9765CO-2	155	25			10	
NPS-122	9766CY-2	125	25			10	
NTP-110	8708CO-2	185	1000	.500	2703	12	
NTP-111	8710CO-2	185	1000	.500	2703	12	
NTP-120	8720CG-2	200	1000	.500	2500	12	
NTP-121	8722CG-2	200	1000	.500	2500	12	
NTP-130	8721CY-2	265	1000	.500	1887	12	
NTP-131	8723CY-2	265	1000	.500	1887	12	
NTP-140	8732CW-2	215	1000	.500	2326	12	
NTP-141	8734CW-2	215	↓	↓	2326	↓	
NTP-210	8709CO-2	225	↓	↓	2222	↓	
NTP-211	8711CO-2	225	↓	↓	2222	↓	
NTP-220	8721CG-2	205	↓	↓	2439	↓	
NTP-221	8723CG-2	205				8	
NTP-230	8722CY-2	280	1000	.500	1786	12	
NTP-231	8724CY-2	280	↓	↓	1786	↓	
NTP-240	8733CW-2	220	↓	↓	2273	↓	
NTP-241	8735CW-2	225	↓	↓	2222	↓	
NTR-110	8725CO-2	165	25			10	

7222(9-83)
FORM GE-8(C)

AMERICAN ELECTRIC POWER SERVICE CORP.
ENGINEERING DEPT.
1 RIVERSIDE PLAZA
COLUMBUS, OHIO

SHEET 2 OF 6
DATE 5/13/86 BY MJF CK.
COMPANY I&M G.O.
PLANT DCCNP

SUBJECT I.R. on EQ Inst. Cables

Device	Cable no.	Cable length (ft)	Length of test specimen (ft)	min I.R. for specimen (MΩ)	Min I.R. for Loop (KΩ)	TEST Report Referenced.	
NTR-120	8726C0-2	405	25			10	
NTR-130	8727C0-2	405	25			10	
NTR-140	8728C0-2	180	25			10	
NTR-210	8729C6-2	350	25			10	
NTR-220	8730C6-2	235	25			10	
NTR-230	8731C6-2	320	25			10	
NTR-240	8732C6-2	320	25			10	
NLP-151	8734C0-2	240	25			10	
NLP-152	8737CB-2	135	25			10	
NLP-153	9601CY-2	280	25			10	
NPP-151	8733C0-2	240	25			10	
NPP-152	8736C6-2	135	25			10	
NPP-153	9600CY-2	280	25			↓	
NPS-153	9602CW-2	45	25				
BLP-110	8584CW-2	230	25				
BLP-111	8558C6-2	230	25				
BLP-112	8584CY-2	125	25				
BLP-120	8585CW-2	170	25				
BLP-121	8558C0-2	325	25				
BLP-122	8585CY-2	395	25				
BLP-130	8586CW-2	115	25				
BLP-131	8559C0-2	260	25				
BLP-132	8581CY-2	385	25			↓	

7221(9-83) FORM GE-6(C)

ENGINEERING DEPT.
AMERICAN ELECTRIC POWER SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OHIO

SHEET 3 OF 6
DATE 5/13/86 BY MJF CK.
COMPANY I+M G.O.
PLANT DCCNP

SUBJECT I.R. on EQ Inst. Cables

Device	Cable No.	Cable length (ft)	Length of test specimen (ft)	Min I.R. for Specimen (M-Ω)	Min I.R. for Loop (K-Ω)	TEST Report Referenced.	
BLP-140	8587CW-2	110	25			10	
BLP-141	8559CB-2	225	25			10	
BLP-142	8587CY-2	180	25			10	
FFC-210	90700-2	375	25			10	
FFC-211	9064B-2	500	1000	.500	1000	12	
FFC-220	90716-2	200	25			10	
FFC-221	9070B-2	380	.			17,18	
FFC-231	9065B-2	400				8	
FPC-230	90640-2	170	25			10	
FFC-240	90650-2	445	1000	.500	1124	12	
FPC-241	9071B-2	420				17,18	
MFC-110	9072CO-2	35	25			10	
MFC-111	9066CB-2	340	25			10	
MFC-120	9072CB-2	125	25			10	
MFC-121	9073CO-2	360	25			10	
MFC-130	9067CB-2	100	25			10	
MFC-131	9066CO-2	380	25			10	
MFC-140	9067CO-2	80	25			10	
MFC-141	9073CB-2	320	25			10	
MPP-210	90740-2	400	1000	.500	1250	12	
MPP-211	9068B-2	530	1000	.500	943	12	
MPP-220	90750-2	400	1000	.500	1250	12	
MPP-221	9074B-2	400	1000	.500	1250	12	

7222(9-83)
FORM GE-8(C)

7222(9-83) FORM GE-8 (C)

ENGINEERING DEPT.
AMERICAN ELECTRIC POWER SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OHIO

SUBJECT I.R. on EQ inst. Cables

DATE 5/13/86 BY MSF CK. ____

COMPANY I&M G.O. ____

PLANT DCCNP

Device	Cable No.	Cable length (ft)	Length of test specimen (ft)	Min I.R. for specimen (M Ω)	Min I.R. for Loop (K Ω)	TEST Report Referenced.	
MPP-230	90680-2	345	1000	.500	1449	12	
MPP-231	90696-2	300	1000	.500	1667	12	
MPP-240	90690-2	420	1000	.500	1190	12	
MPP-241	90750-2	530	1000	.500	943	12	
QR-107A	20373CW-2	100	25			10	
QR-107B	20374CW-2	60	25			10	
QR-107C	20375CW-2	55	25			10	
QR-107D	20376CW-2	55	25			10	
VRA-2310	9960CB-2	310	15	10	484	138	
VRA-2310	9961CB-2	310	15	10	484	138	
VRA-2410	9960CY-2	165	15	10	909	138	
VRA-2410	9961CY-2	165	15	10	909	138	
NLA-310	8508CY-2	450	25			10	
NLI-311	8505CB-2	180	25			10	
NLI-320	8507CY-2	310	25			10	
NLI-321	8506CB-2	95	25			10	
NLI-110	9639B-2	510	25			10	
NLI-120	9640B-2	510	25			10	
NLI-130	9641B-2	510	25			10	
NLI-111	9632Y-2	485	25			10	
NLI-121	9633Y-2	485	25			10	
NLI-131	9634Y-2	485	25			10	
VRS-2210	9984CY-2	205	25			10	

ENGINEERING DEPT.
AMERICAN ELECTRIC POWER SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OHIO

7222(9-83)
FORM GE-8 (C)

SHEET 5 OF 6
DATE 5/13/86 BY MJF CK. ___
COMPANY I&M G.O. ___
PLANT DCCNP

SUBJECT I.R. on EQ Inst. Cables

Device	Cable no.	Cable length (ft)	Length of test specimen (ft)	min I.R. for specimen (M Ω)	Min I.R. for Loop (K Ω)	TEST Report Referenced.	
VRS-2201	9985CY-2	205	25			10	
VRS-2101	9984CB-2	435	25			10	
VRS-2101	9985CB-2	435	25			10	

7222(9-83)
FORM GE-8 (C)

ENGINEERING DEPT.
AMERICAN ELECTRIC POWER SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OHIO

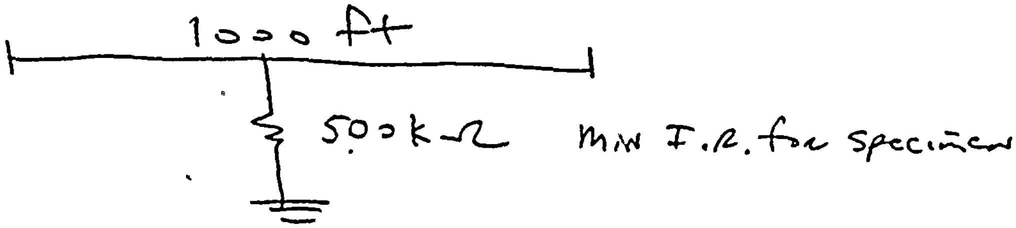
SHEET 6 OF 6
DATE 5/16/86 BY MJF CK.
COMPANY I&M G.O.
PLANT DCCNP

SUBJECT I.R. on EQ inst. Cable

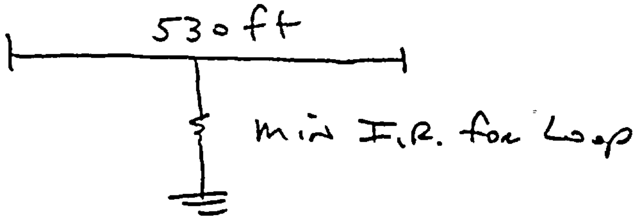
Sample calculation:

FFI-210

length of test specimen



Length of Cable



$$\frac{\text{Cable length}}{\text{test specimen}} = \frac{530}{1000} = .530$$

$$\frac{1}{\text{Min. I.R. Loop}} = .530\left(\frac{1}{R_{specimen}}\right) \Rightarrow \text{Min I.R.}_{Loop} = \frac{R_{spec}}{.530}$$

$$\text{min I.R. for Loop} = \frac{500\,k\Omega}{.530} = 943\,k\Omega$$