SOUTH CAROLINA ELECTRIC & GAS COMPANY
POST OFFICE 764
COLUMBIA, SOUTH CAROLINA 29218

O. W. DIXON, JR.
VICE PRESIDENT
NUCLEAR OPERATIONS

October 15, 1982

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Virgil C. Summer Nuclear Station
Docket No. 50/395
Operating License No. NPF-12
Equipment Qualification

Dear Mr. Denton:

In a recent telephone conversation with members of the NRC Staff, several questions were posed regarding D. G. O'Brien Qualification Report ER-307 for the triaxial plugs for containment penetrations at South Carolina Electric and Gas Company's Virgil C. Summer Nuclear Station. This letter forwards the answers to the questions and explains the process by which the qualification documentation has been accepted.

The D. G. O'Brien containment penetration assembly was qualified for its harsh environment application as documented in D. G. O'Brien Test Report ER-268. The post accident high range radiation monitor system installation required that a triaxial plug be qualified to provide the inside containment interface with the penetration. As documented in D. G. O'Brien Test Report ER-307, during the qualification testing of the plug, a cable failure occurred. At the request of SCE&G, D. G. O'Brien provided a detailed explanation of the cable failure and a justification of the acceptability of the test results (attached letter D. G. O'Brien to SCE&G, dated April 9, 1982).

At about the same time, the high range radiation detector was undergoing qualification testing by Victoreen. During these tests a cable failure occurred as a result of similar steam and caustic spray impingement. After analyzing the situation, Victoreen enclosed the cable in conduit. When the test was repeated, the detector with the cable in conduit successfully passed.



A048

Since the same cable had been used in both tests and Victoreen specfied the cable be installed in conduit, SCE&G proceeded to install the cable in conduit from the detector to the penetration. In addition, D. G. O'Brien was requested to modify the connector to add a mechanical conduit connection. This was accomplished and the model number was revised to R19B1083G02 to indicate the modification.

The attached D. G. O'Brien letter is being forwarded to provide the D. G. O'Brien analysis showing that the cable failure was not a result of plug design or configuration. SCE&G considers that this transmittal provides sufficient information to satisfy NRC concerns that the penetration plug with cable and conduit has successfully demonstrated qualification for its application at the Virgil C. Summer Nuclear Station.

Very truly yours,

O. W. Dixon, Jr.

NEC:OWD/fjc
cc: V. C. Summer
G. H. Fischer
H. N. Cyrus
T. C. Nichols, Jr.
O. W. Dixon, Jr.
M. B. Whitaker, Jr.
J. P. O'Reilly
H. T. Babb
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W. A. Williams, Jr.
R. B. Clary
O. S. Bradham
A. R. Koon
M. N. Browne
G. J. Braddick
J. L. Skolds
J. B. Knotts, Jr.
B. A. Bursey
NPCF
File

D. G. O'Brien, Inc.

N-3482-64001
April 9, 1982

South Carolina Electric & Gas Co.
P.O. Box 764
Columbia, SC 29218

Attn: Mr. John Gesn

Subject: Your letter of March 26, 1982
NE File: 16.210

Gentlemen:

Several investigations have been conducted since we completed DGO ER 307, Qualification of the Triax Plugs. It is our opinion that these additional tests will amplify our conclusions expressed in that report. We will attempt to address your concerns in the same order as defined in the subject letter.

Item 1 As stated in the report, the outside containment cable was responsible for the insulation resistance and dielectric strength problems. A TDR (Time Domain Reflectometry) investigation was applied to the outboard cable. A plot of the cable condition is presented as Fig. 1 of this letter. As indicated, the cable was cut off approximately 3 inches behind the plug and terminated in a "short." The signal was then applied at the better end of the cable between the center conductor and inner shield. The plot does not conclusively indicate any major discontinuity that would justify the low IR and withstanding voltage.

Prior to cutting off the plug, the plug and cable were checked for withstanding voltage. Results verified what had been previously determined as breakdown between the center conductor and inner shield at about 1100 vdc. Next, the plug was cut from the cable

ONE CHASE PARK • SEABROOK, NEW HAMPSHIRE 03874 • 603-474-5571 • TWX 710-366-6424

and electrical checks were made on the two components. The results are recorded on Pages 1 and 2 attached. It is apparent that the electrical integrity of the plug remains high while the cable exhibits low (as compared to the requirements) insulation resistance and withstanding voltage breakdown at 1100 vdc between center conductor and inner shield.

The same investigative steps were applied to the inner cable assembly. Those results are recorded as Fig. 2 and Pages 3-6. The TDR investigation was more difficult to conduct because the problem was occurring between shields. By comparing the traces, center conductor to each shield individually, we conclude that where the traces touch are points of possible cable non-conformance.

Insulation resistance between shields again indicates low resistance (lower than required). It is not surprising that the plug still shows low insulation resistance shield to shield. It is most probably the result of contaminants carried into this area through the cut in the cable jacket. Photographs attached show this problem area.

The signal portion of the plug and cable both remain at the extremely high levels required for intended use.

<u>Item 2</u> We believe the information supplied for Item 1 verifies that the triax plug survived the thermal aging exposure. It would be unlikely that a failure of plug or cable components due to accelerated aging would recover to insulation levels as determined in Item 1.

<u>Item 3</u> The outboard cable was not replaced for two reasons:

1. We were on a tight time schedule to make test periods committed at outside test laboratories.

2. Engineering judgement based on previous experience determined that the next steps in the program would not influence the triax performance. The triax is not involved in either the STOL or Fault Current tests. We were able to monitor the triax assembly during the seismic exposure applied to the secondary penetration. Since no anomalies occurred during that test, we were satisfied that seismic capability had been demonstrated. This left only the exposure of MSLB to the outboard end prior to the removal from the fixture for the final and more severe inboard exposure of MSLB and LOCA. We determined that sufficient integrity was existing to permit monitoring of the triax during this phase.

Item 4 The secondary penetration is an option (in reality it is mandatory) of IEEE 317-76 para 6.4.14 when low voltage power conductors are being qualified. As stated in ER 307, this composite penetration does include five modules designated for low voltage power and control usage.

We have submitted the insulation resistance and withstanding voltage data for the secondary penetration as part of ER 307. Included with this letter is a copy of the seismic test for this specimen to verify our statements in Item 3 above.

Item 5 The triax plug supplied to South Carolina Electric & Gas Co. differs from the qualification unit only in the mechanical terminations of the outer and inner shields. For your assembly, the termination end of the outer shield is configured with a male pipe thread for connection of the flexible metallic conduit in which you will house the coaxial cable. In our opinion, this assembly will maintain better mechanical integrity than the normal jacket materials on typical triax or coax cables.

To terminate the shield of your coax cable, an adapter piece is provided. The cable shield is crimped to this adapter using a crimp ring much the same as is done in the standard triax cable. The adapter then engages the plug in a slip joint similar to the interface connection between plug and module receptacle.

All other components of the triax plug are physically and electrically the same as the qualifying unit. The test data should then be applicable to the triax plug supplied.

Item 6 There are two non-metallic materials in the triax plug--insulators of polysulfone and an O-ring of silicone rubber. Arrhenius plots for these materials are unavailable.

Item 7 During the inboard exposure, the chemical spray was activated for a total of 48 hours. It was initiated at the 315°F temperature level as we began the descent to the next temperature level. Spray volume was 0.3 gal. per sq. ft. per min. Over the first 24 hours, the boron concentration was 1800 ppm and the pH as close to 4.6 as possible. The actual pH was more in the order of 5.1 to 5.6. After the 24-hour period, the pH was raised to between 7 and 10 by the addition of NaOH. The chemical spray was not recycled but fresh batches mixed as required.

Item 8 Both of the cables used for primary and secondary units were supplied from the V.C. Summer station by Mr. Ken Nettles of South Carolina Electric & Gas Co. The cables were manufactured by Boston Insulated Wire as RG-11/U equivalents. However, the construction of each was different:

1. Primary penetration used BIW-XLPE/Hypalon (B/M EKc-2b)
2. Secondary penetration used BIW-XLPE/Tefzel (B/M EKc-2a) The EKc-2a was given top priority by Mr. Nettles in his letter of June 10, 1980--Nuclear Engineering File 4.559.

Since the secondary unit arrived on-line ahead of the primary specimen, the cable was installed in that unit.

Item 9 Continuation of testing is temporarily on hold, so a definite schedule is impossible at this time. We do plan to expose a triax plug minus cable to a seven-day LOCA environment starting approximately April 21, 1982. The cable end of the plug will be sealed with a metal cap to prevent intrusion of moisture and other contaminants. We are expecting this to provide additional information to support the capability of the design.

We trust the additional information supplied in this response will assist you further in your evaluation. As always, DGO, Inc. will provide whatever assistance is necessary to solve problems which are of mutual interest to SCE&G and DGO, Inc.

Very truly yours,

D. G. O'BRIEN, INC.

Harold P. Hilberg
Manager
Energy Components

Philip C. Doringer
Sales Manager

HPH/PCD/ldb
Enclosures

J.C. #62003

TDR TEST

Temp: 73°F
Hum: 41 %
B.P.: 30.65
3/29/82 operator: J.

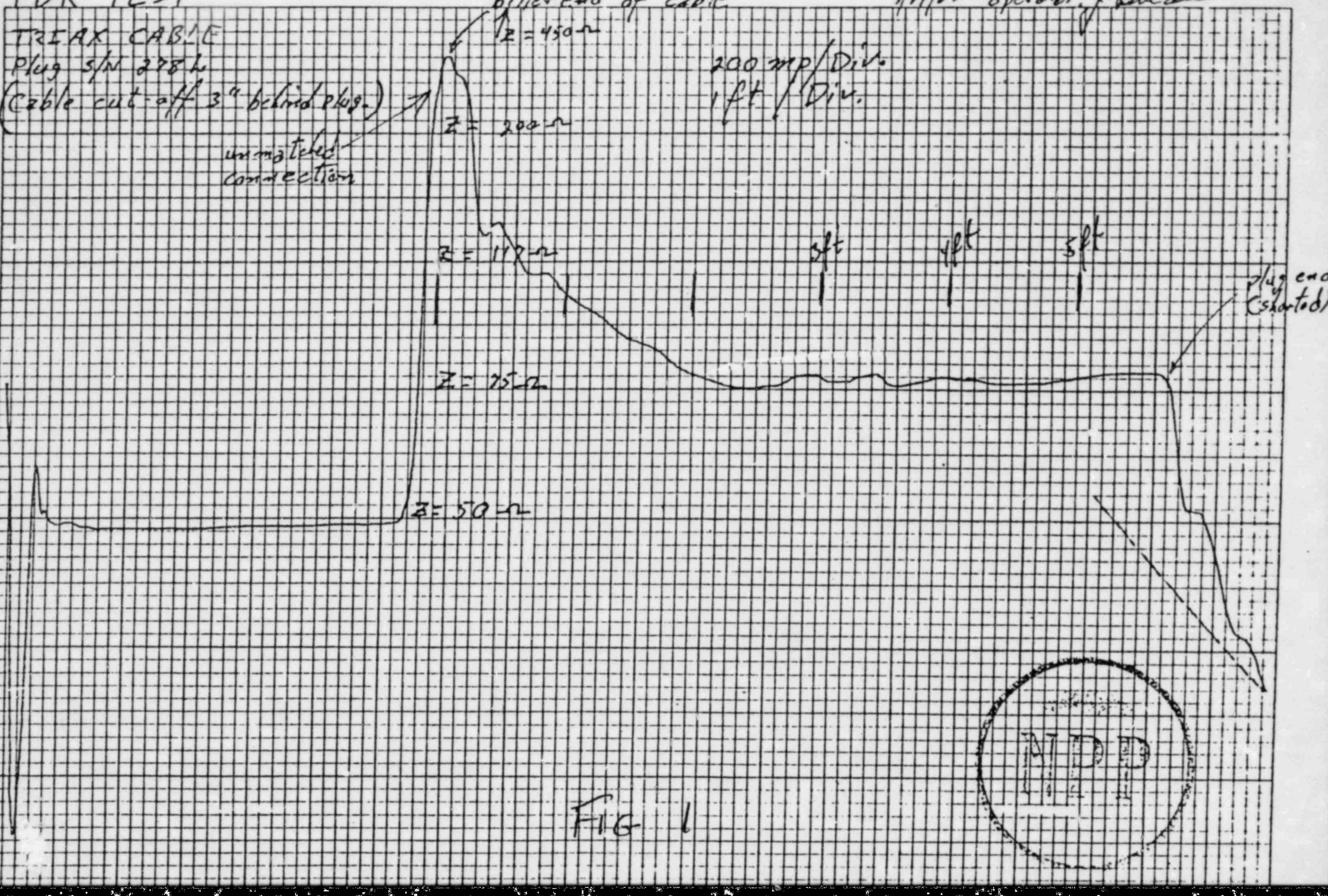


FIG 1

NO. 311-11 DIETZGEN GRAPH PAPER
10 X 10 PER INCH

EUGENE DIETZGEN CO.
MADE IN U. S. A.

3/30/8 –

Temp. 73 °F
Hum: 45 %
B.P. 30.6

TDR TEST: Triax Cable Lot# 013L, Ring Lot # 903M (NSN)

OPERATOR: J. Laban

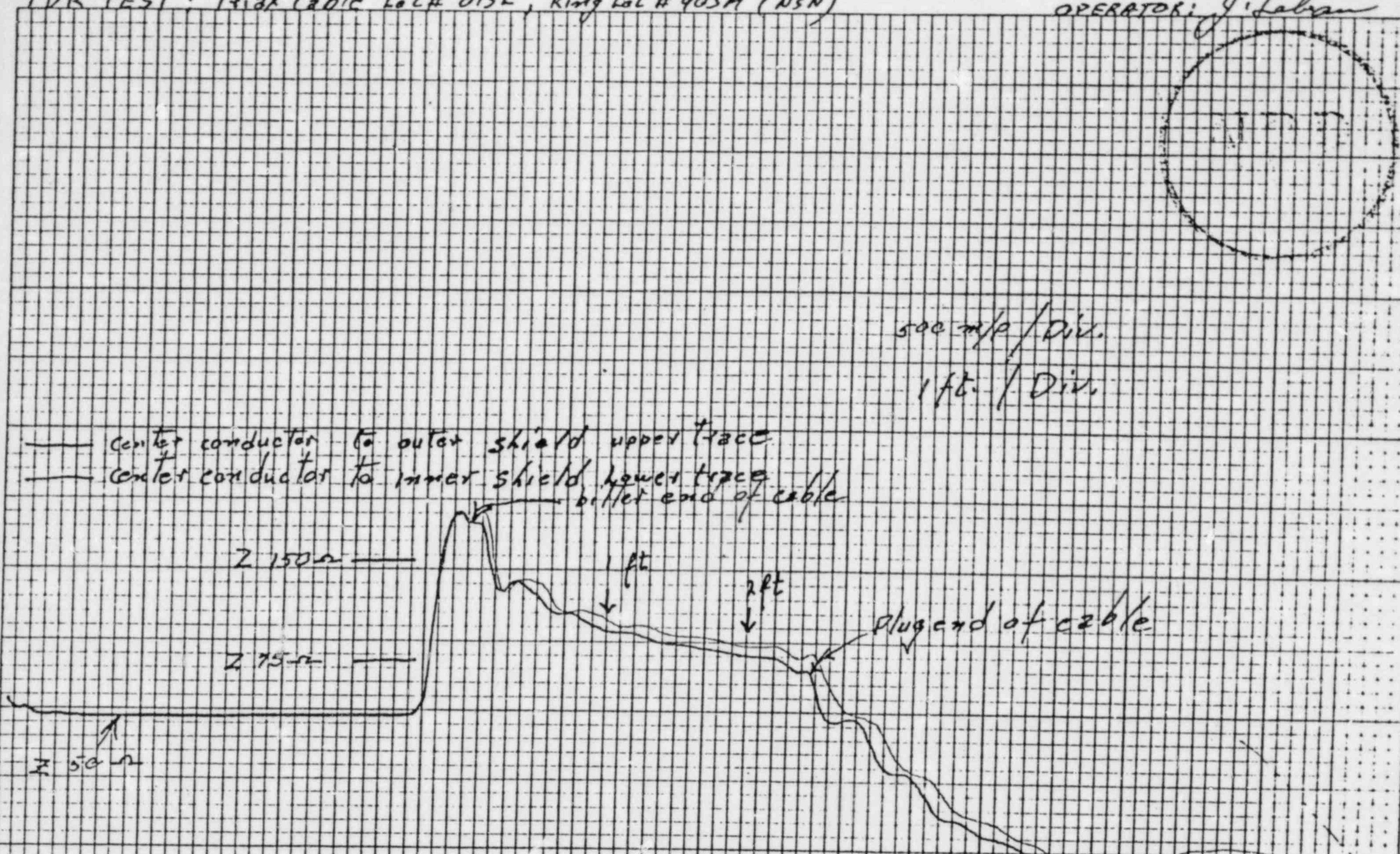


FIG 2

# QUALITY ASSURANCE TEST RECORD SHEET



| | | | |
|---|---|---|---|
| REQUIREMENT | QA-TM-234-1 Rev A | DATE | 3/29/82 |
| PARA. NUMBER | Before to Step 3.2 | JOB NUMBER | 62003-01 |
| PROCEDURE | TP-IN-108 REV. D | OPERATOR | Mark Franceschini |
| DESCRIPTION | Triax Plug and its cut off triax Cable | TEMPERATURE | 75°F B.P. 30.60 |
| SERIAL NUMBER | (Lot 013L) 278L | HUMIDITY | 45% |

Requirement; IR: Outer Shield to Body and Inner Shield to Outer shield > 1000 Megohms at 500VDC. Center Pin to Inner Shield > $10^6$ Megohms at 1000VDC.

| | Triax Plug | Cut off triax Cable |
|---|---|---|
| Outer Shield to Body | 4.5X1MEG Megohms | N/A |
| Inner Shield to Outer Shield | 2.2X1MEG Megohms | 2X1MEG Megohms |
| Center Pin to Inner Shield | 7X1MEG Megohms | 2.5X10 Megohms |

NPP

Equipment Used: Megohmmeter T-177 cal due 4/22/82

Form # QA-206 Rev. A 12/78

Approved J. Leblanc Date 3/30/82
Test Supervisor

D. G. O'Brien, Inc.

QUALITY ASSURANCE TEST RECORD SHEET



| | | | |
|---|---|---|---|
| REQUIREMENT | QA-TM-234-1 Rev A | DATE | 3/29/82 |
| PARA. NUMBER | Refere to Step 3.3 | JOB NUMBER | 62003-01 |
| PROCEDURE | TP-HP-108 REV. E | OPERATOR | Mark Franceschini |
| DESCRIPTION | Triax Plug and its cut off triax Cable | TEMPERATURE | 75°F B.P. 30.60 |
| SERIAL NUMBER | (Lot 013L) 278L | HUMIDITY | 45% |

Requirement: Hypot — Triax Outer Shield to Body and Inner Shield to Outer Shield — 500 VDC. Center Pin to Inner Shield — 3000 VDC.

| | Triax Plug | Cut off triax Cable |
|---|---|---|
| Outer Shield to Body | Good | N/A |
| Inner Shield to Outer Shield | Good | Good |
| Center Pin to Inner Shield | Good | Breakdown 1000 VDC |

NPP

Equipment Used: Hypot T-104 cal due 8/19/82

Form # QA-206 Rev. A 12/78

Approved J. Lebeau Test Supervisor Date 3/30/82

D. G. O'Brien, Inc.

QUALITY ASSURANCE TEST RECORD SHEET

PAGE 3 OF 6

NPP

| | | | |
|---|---|---|---|
| REQUIREMENT | QA-TM-234-1 Rev A | DATE | 3/30/82 |
| PARA. NUMBER | Refer to step 3.2 | JOB NUMBER | 62003 |
| PROCEDURE | TP-IN-105 REV. | OPERATOR | J. Lebeau |
| DESCRIPTION | TRIAX Cable Lot # 013L | TEMPERATURE | 73°F |
| SERIAL NUMBER | Rixig Lot# 903H (NSN) | HUMIDITY | 45% B.P. 30.6 |

Requirement: I.R.; Outer Shield to body and inner to outer shield ≥1000 Megohms at 500VDC. Center pin to inner shield ≥1X10⁶ Megohms at 1000VDC

| | |
|---|---|
| Outer Shield to body | 5X10 Megohms |
| Inner to Outer Shield | 7X1 Megohms |
| Center Cond. to Inner Shield | ∞ X100K Megohms |

IR Meter: T-166, Cal. due; 6/10/82

Form # QA-206 Rev. A 12/78

Approved ______ Test Supervisor Date / /

D. O. O'Brien, Inc.

# QUALITY ASSURANCE TEST RECORD SHEET



NPP

| | | | |
|---|---|---|---|
| REQUIREMENT | QA-TM-234-1 Rev A | DATE | 3/30/82 |
| PARA. NUMBER | Refer to Step 3.7 | JOB NUMBER | 62003 |
| PROCEDURE | TP-HP-105 REV. | OPERATOR | J. Lebon |
| DESCRIPTION | TRIAX Cable Lot # 013L | TEMPERATURE | 73°F |
| SERIAL NUMBER | Ring Lot # 903M (NSN) | HUMIDITY | 45% B.P. 30.6 |

Requirement: Hypot; Outer Shield to Inner Shield and body <1ma. at 500 VDC. Center Cond. to Inner Shield <1ma. at 3000 VDC.

| | |
|---|---|
| Outer Shield to Inner | 1000 VDC, 160 ua. |
| Outer Shield to body | 1000 VDC, 30 ua. |
| Center Cond. to Inner Shield | 3000 VDC, no current showing |

Hypot: T-104, Cal. due; 8/19/82

Form # QA-206 Rev. A 12/78

Approved ____________ Date / /
Test Supervisor

D. G. O'Brien, Inc.

# QUALITY ASSURANCE TEST RECORD SHEET



| | | | |
|---|---|---|---|
| REQUIREMENT | QA-TM-234-1 Rev A | DATE | 3 / 31 / 82 |
| PARA. NUMBER | Refer to Step 3.2 | JOB NUMBER | 62003-01 |
| PROCEDURE | TP-IN-108 REV. D | OPERATOR | Mark Franceschini |
| DESCRIPTION | Plug and Cut of Piece of Cable | TEMPERATURE | 74°F B.P. 30.40 |
| SERIAL NUMBER | R19P1010G04 Lot # 903M-Ring Coupler Lot # 013L - Plug | HUMIDITY | 45 % |

Requirements: IR Outer Shield to Body and Outer Shield to Inner Shield > 1000 Megohms at 500VDC 2 min. Max. Center Pin to Inner Shield > $10^6$ Megohms at 1000VDC 2 min Max.

| | Plug | Piece of Cable |
|---|---|---|
| Outer Shield to Body | 2X100 Megohms | N/A |
| Outer Shield to Inner Shield | 5X10 Megohms | 9X10 Megohms |
| Inner Shield to Center Pin | 20X1MEG Megohms | 4X1MEG Megohms |

NPP

Equipment Used: Megohmmeter T-177 cal due 4/22/82

Form # QA-206 Rev. A 12/78

Approved [signature] Test Supervisor Date 3/31/82

D. G. O'Brien, Inc.

QUALITY ASSURANCE TEST RECORD SHEET



| | | | |
|---|---|---|---|
| REQUIREMENT | QA-TM-234-1 Rev A | DATE | 3 / 31 / 82 |
| PARA. NUMBER | Before to step 3.3 | JOB NUMBER | 62003-01 |
| PROCEDURE | TP-HP-108 REV. E | OPERATOR | Mark Franceschini |
| DESCRIPTION | Plug and Cut of Piece of Cable | TEMPERATURE | 74°F B.P. 30.40 |
| SERIAL NUMBER | B19 P1010G04 Lot # 903M – Ring Coupler Lot # 013L – Plug | HUMIDITY | 45% |

Requirements: Hypot Outer Shield to Body and Outer shield to Inner Shield 500 VDC Hold 1 Minute No breakdown or leakage exceeding 1ma. Center Pin to Inner Shield 3000VDC Hold 1 Minute No breakdown or leakage exceeding 1ma.

| | Plug | Piece of Cable |
|---|---|---|
| Outer Shield to Body | Good | N/A |
| Outer Shield to Inner Shield | Good | Good |
| Inner Shield to Center Pin | Good | Good |

NPP

Equipment Used: Hypot T-104 cal due 8/19/82

Form # QA-206 Rev. A 12/78

Approved [signature] Test Supervisor Date 3 13/182