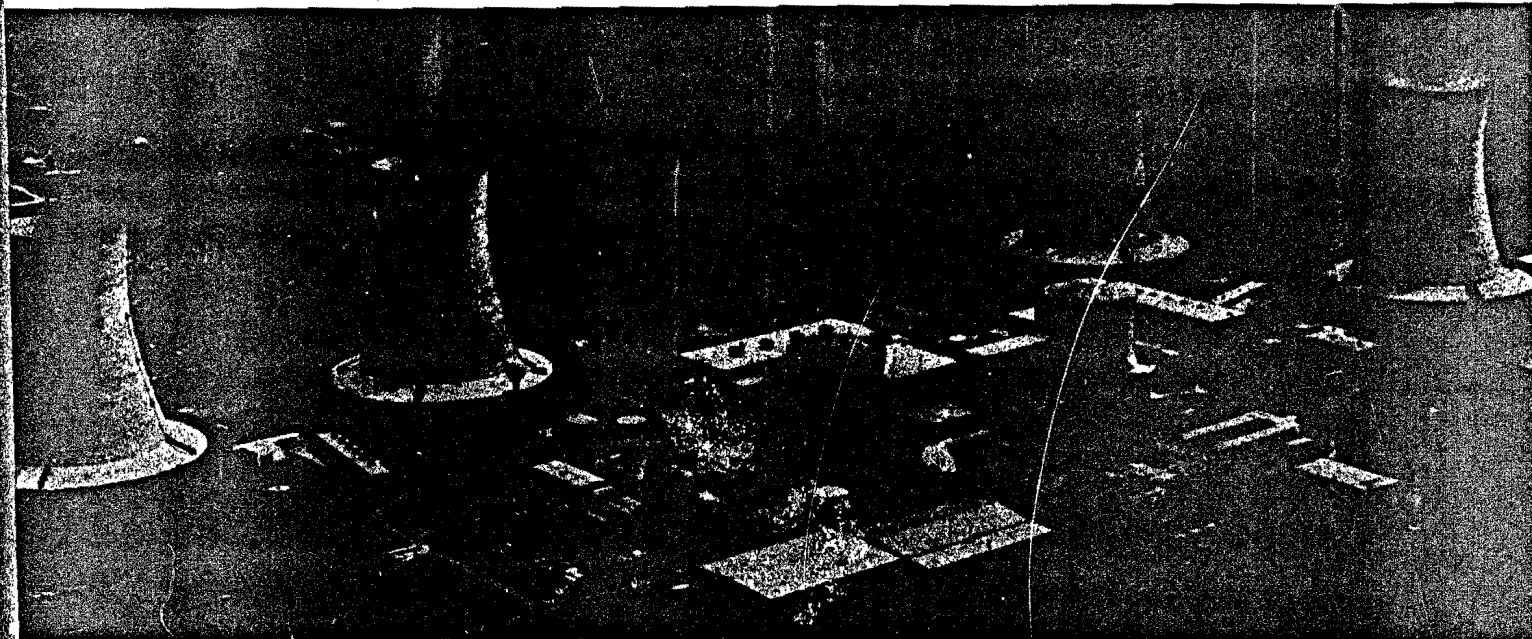


**MASTER**

**GEND-INF- 017**  
Volume XI

Apr 11 1982



This is an Informal report intended for use as a preliminary or working document

**GEND**

General Public Utilities • Electric Power Research Institute • U.S. Nuclear Regulatory Commission • U.S. Department of Energy

Field Measurements and Interpretation of TMI-2

Instrumentation: NI-AMP-2

J.E. Jones  
J.T. Smith  
M.V. Mathis

U.S. Department of Energy  
Three Mile Island Operations Office  
Under DOE Contract No. DE-AC07-76ID01570

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**GEND-INF-017  
Volume XI**

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**FIELD MEASUREMENTS AND INTERPRETATION  
OF TMI-2 INSTRUMENTATION: NI-AMP-2**

**J.E. Jones  
J.T. Smith  
M.V. Mathis**

**GEND-INF--017 Vol. 11  
DE82 013782**

**Technology for Energy Corporation  
10770 Dutchtown Road  
Knoxville, Tennessee 37922**

**Published April 1982**

**Published on Behalf of the GEND Group  
by  
EG&G Idaho, Inc.  
Idaho Falls, Idaho 83415**

**Prepared for the  
U.S. Department of Energy  
Three Mile Island Operations Office  
Under DOE Contract No. DE-AC07-76ID01570**

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*MSW*

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## 1. INTROOUCTION

During and following the TMI-2 accident, a number of instruments failed or were suspected of providing erroneous readings. Because of this problem, industry concerns were focused upon the behavior of instrumentation under adverse conditions. To better understand failure mechanisms, the Technical Integration Office (TIO) contracted Technology for Energy Corporation (TEC) to perform field measurements on a set of selected TMI-2 instruments to determine in-situ operating characteristics. For some instruments, these measurements were to be performed prior to removal (and replacement with new instruments) in order to have a cross reference with post-removal observations. For other instruments, an indication of the condition of the instrument (i.e., fully operational or failed) was desired.

This report describes the measurements and test results for the Source Range Monitor Amplifier NI-AMP-2. This instrument consists of a Westinghouse BF<sub>3</sub> proportional counter and Bailey system 880 amplifier connected to a readout module by approximately 500 feet of cable through a penetration junction and an instrument mounting junction. This instrument is believed to be failed and was not in a powered condition when measurements began.

## 2. INSTRUMENT LOCATION, CABLING, AND TERMINATIONS

A review of appropriate drawings from Victoreen and Burns & Roe (itemized in the Appendix in the measurement procedure, page A-5) resulted in the composite electrical diagram shown in Figure 2-1. From this information, Table 2-1 gives a list of the appropriate termination points for performing measurements in Cabinet 20-B1. Also noted in Figure 2-1 are the cable lengths pulled during instrument installation and lengths after trimming between each termination and/or junction point.

The Source Range Detector consists of a Westinghouse BF<sub>3</sub> proportional counter connected to a Bailey system 880 preamplifier. This instrument has a normal range of .1 to 10<sup>6</sup> counts per second producing an output of 0 to 2 volts. The functional diagram of the preamplifier unit is shown in Figure 2-2.

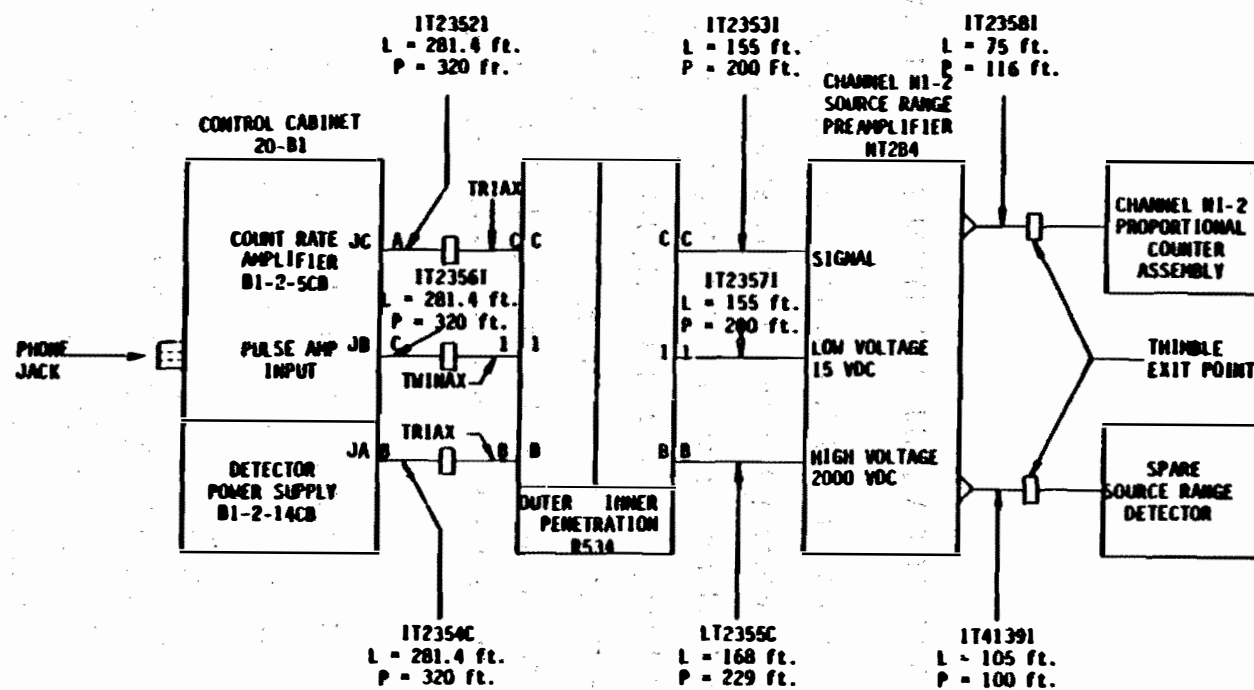


Figure 2-1. Composite Electrical Diagram for NI-AMP-2.

2-3

Table 2-1

TERMINATION POINTS FOR NI-AMP-2 MEASUREMENTS

| Signal       | Cabinet 20-B1 Identification* |
|--------------|-------------------------------|
| High Voltage | IT2354C-A                     |
| Low Voltage  | IT2356I-JB                    |
| Signal       | IT2352I-JC                    |



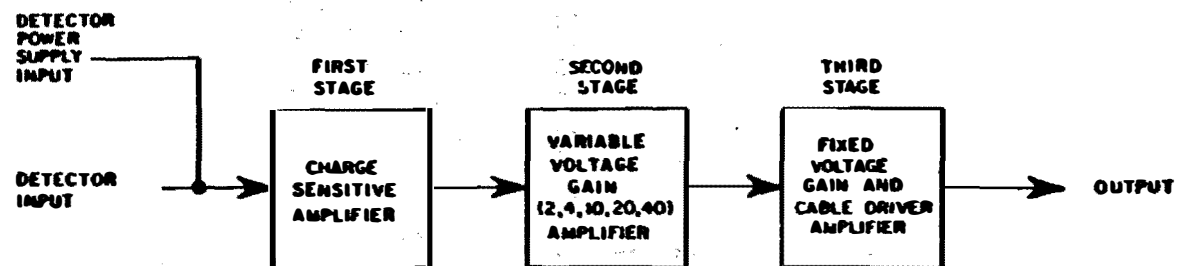


Figure 2-2. Functional Diagram of Preamplifier Assembly.

### 3. PREPARATION OF MEASUREMENT PROCEDURES

As a result of generating the composite electrical diagram and from a review of the Bailey Meter Product Instruction E92-311 Manual, the major types of measurements to be performed were identified as:

1. Determine as-found condition of Readout Module and Remote Meter and record signal output;
2. On each electrical connection, perform passive measurements (i.e., passively monitor signals) consisting of time domain waveforms, very-high frequency spectrum analysis (i.e., MHz region), and frequency spectra below 100 kHz; and
3. Perform resistance, capacitance, impedance, and Time Domain Reflectometry (TDR) active measurements (i.e., actively introducing a test signal).

These measurements were designed to verify the operation of the Readout Module and the power supplies, but the focus of the measurements was on the level measurement assembly, cabling, and terminations/connections to the assembly. The Appendix contains the detailed procedure which was followed during the measurement program, and a summary of measurements is presented in the next section.

In addition to performing measurements on the existing Source Range system, measurements to verify the operation of a scheduled replacement were planned. This replacement was to be performed immediately following the measurements on the original instrument while the test equipment was readily available.

#### 4. MEASUREMENTS

Since NI-AMP-2 was not in an operating condition when measurements began, a series of active measurements (i.e., actively introducing a test signal into the circuit) was performed first. Table 4-1 shows the results of capacitance, impedance, and resistance measurements on some of the field cable lines (see Appendix pages A-8 and A-9 for a complete set). TDR measurements were also taken on the power supply and signal lines to determine possible cable defects. These TDR traces are shown in Figures 4-1 to 4-3.

Following active measurements, power was applied to NI-AMP-2, but the high voltage meter indicated that high voltage was not present. Attempts to activate the high voltage supply to the instrument were not successful, but are described in the Appendix on pages A-25 and A-26.

Scheduled measurements on the replacement detector were not performed due to an indefinite postponement of the new detector installation.

Table 4-1  
CAPACITANCE, IMPEDANCE, AND RESISTANCE MEASUREMENTS

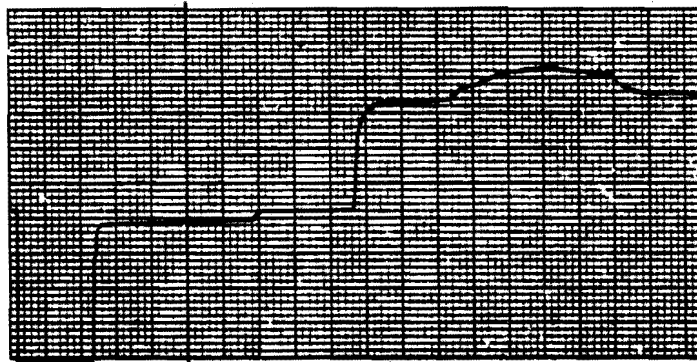
| Signal                              | Capacitance (nF) |             |         | Impedance (ohms) |       |         | Resistance (ohms)** |
|-------------------------------------|------------------|-------------|---------|------------------|-------|---------|---------------------|
|                                     | 100 Hz           | 1 kHz       | 100 kHz | 100 Hz           | 1 kHz | 100 kHz |                     |
| Signal<br>Signal Return             | 2 pF             | .3 pF       | 0       | 0F*              | 0F    | 16.5M   | 0F                  |
| Low Voltage<br>Low Voltage Return   | 20 $\mu$ F       | 7.6 $\mu$ F | -12     | 119              | 28    | 128     | 731 (727)           |
| High Voltage<br>High Voltage Return | 16               | 6.8         | 7.8     | 0F               | 0F    | 146     | 0F                  |
| Signal Return<br>Low Voltage Return | 25               | 0F          | -18     | 0F               | 2.3k  | 87      | 700 (800)           |

\*Indicates off-scale (open) or noisy cable.

\*\*Values in parentheses are reverse polarity measurements.

STRIP CHART 105-1

Cable - IT2352I (Signal)



Setting - 500 $\mu$ p/div

Range - 52.6 ft/div

Sensitivity - 0.25

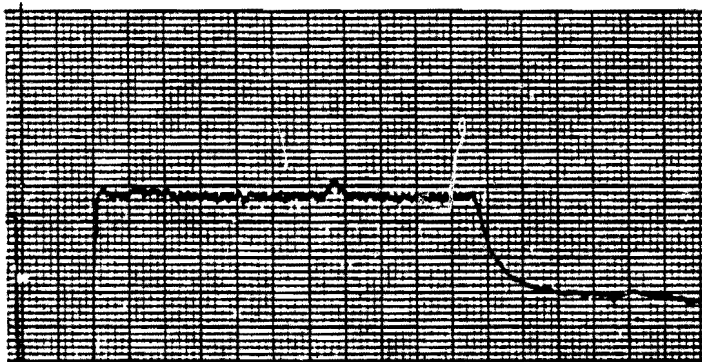
Filter - 15 Hz

Cable dielectric - poly

Figure 4-1. TDR Trace of Signal Cable.

STRIP CHART 105-2

Cable - IT2356 (Low Voltage)



Setting - 500 $\mu$ P/div

Range - 52.6 ft/div

Sensitivity - 0.25

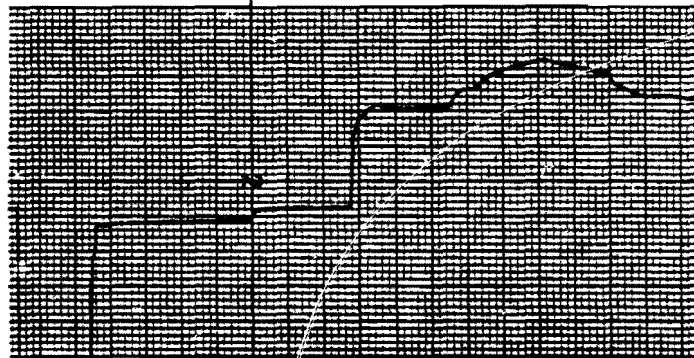
Filter - 15 Hz

Cable dielectric - poly

Figure 4-2. TDR Trace of Low Voltage Cable.

STRIP CHART 105-3

Cable - IT2354C (High Voltage)



Setting - 500 $\mu$ P/div

Range - 52.6

Sensitivity - 0.25

Filter - 15 Hz

Cable dielectric - poly

Figure 4-3. TDR Trace of High Voltage Cable.

## 5. INTERPRETATION OF MEASUREMENTS

This section presents a summary of the interpretation of the measurements taken on NI-AMP-2. This interpretation is intended to indicate the condition of the device based on observed data.

Since measurements were not made on the active condition of the instrument, only general observations can be made. The capacitance and impedance data given in Table 4-1 are extremely difficult to quantitatively interpret, but do not indicate any major problem. The resistance data indicate open-circuit (i.e., resistance greater than 2 M-ohm) for all lines except the low voltage power supply and the returns for the signal-low voltage. The measured values indicate a reasonable resistive load across the low voltage.

The results of TDR measurements performed on the cables (shown in Figures 4-1 to 4-3) are summarized in Table 5-1. Note that the lengths identified in the table are only approximate, since no calibration of the cable resistance and material composition was performed on the TDR instrument. All major junction points can be identified on the TDR traces, and no cable defects are apparent.



Table 5-1

## SUMMARY OF TDR MEASUREMENTS

| Signal Line        | Distance<br>(ft)* | Description**    | Probable Cause |
|--------------------|-------------------|------------------|----------------|
| Signal Cable       | 231               | Cable R Change   | Penetration    |
|                    | 379               | Cable R Change   | Preamp         |
|                    | 526               | Increase R       | Detector       |
| Low Voltage Cable  | 337               | Point R Increase | Penetration    |
|                    | 557               | Reduced R        | Preamp         |
| High Voltage Cable | 231               | Cable R Change   | Penetration    |
|                    | 379               | Cable R Change   | Preamp         |
|                    | 526               | Increase R       | Detector       |

Note: Distances are not calibrated due to lack of prior information on the cable type which prevented calibration tests.

\*TDR to terminal block test cable (15 ft) not included in distance.

\*\*R is the abbreviation for resistance.

†Extremely noisy signal prevents most interpretations.

## 6. CONCLUSIONS

Based on the limited measurements and the attempts to activate the high voltage power supply, the Source Range Monitor which includes NI-AMP-2 is not operating. Since there appears to be an excessive load on the high voltage, it appears that either the detector or cable is defective. However, TDR measurements did not indicate a significant problem with the cable using low level test signals.

ORIGINAL FIELD PROCEDURES AND  
DATA SHEETS FOR NI-AMP-2

## UNIT 2

| COMPONENT IDENTIFICATION |           |         |     |   | LOCATION, UNIT |   | JOB TYPE |   | SUBSTRATE NUMBER |    | RECEIPT DATE |    |   |
|--------------------------|-----------|---------|-----|---|----------------|---|----------|---|------------------|----|--------------|----|---|
| SYS                      | COMP TYPE | COMP ID | LOG |   |                |   |          |   |                  | MO | DAY          | YR |   |
| 11                       | DET       | 0002    |     | 0 | 3              | 6 | 0        | 0 | 2                | C  | 5            | 7  | 0 |

ACCELERATED  
PRIORITY

2

DESCRIBE  
MALFUNCTION  
OR  
MODIFICATION  
DESIRED

**CAUSE OF  
MALFUNCTION  
(IF KNOWN)**

|                          |   |                      |    |                        |  |                          |   |                      |   |         |                        |
|--------------------------|---|----------------------|----|------------------------|--|--------------------------|---|----------------------|---|---------|------------------------|
| ORIGINATOR'S<br>EMP. NO. |   | <i>J. B. Brunner</i> |    | 9/22/80                |  | SUPERVISOR'S<br>EMP. NO. |   | <i>J. B. Brunner</i> |   | 9/22/80 |                        |
| 0                        | 6 | 1                    | 75 | ORIGINATOR'S SIGNATURE |  | DATE                     | 0 | 6                    | 1 | 75      | SUPERVISOR'S SIGNATURE |
|                          |   |                      |    |                        |  |                          |   |                      |   |         |                        |

DOE/EB16 Project.

|                      |   |        |               |          |                       |                |                   |   |             |                 |                         |    |    |    |                        |    |    |              |     |    |     |       |  |  |  |  |  |  |
|----------------------|---|--------|---------------|----------|-----------------------|----------------|-------------------|---|-------------|-----------------|-------------------------|----|----|----|------------------------|----|----|--------------|-----|----|-----|-------|--|--|--|--|--|--|
| WORK ORDER NUMBER    |   |        |               | GC CODE  |                       | ACCOUNT NUMBER |                   |   |             | PLANT CONDITION |                         |    |    |    |                        |    |    | NPRD FAILURE |     |    |     | START |  |  |  |  |  |  |
| LOCATION             |   | SERIAL |               |          |                       |                |                   |   |             | SL              | OP                      | WD | CD | RF | MS                     | LR | YR | MO           | DAY | HR | MIN |       |  |  |  |  |  |  |
| 0                    | 3 | 6      | 0             | 00       | 1                     | 97             | GA                | 7 | 8           | 7               | 6                       | 0  | 1  | 9  | 1                      | 1  | 1  | 1            |     |    |     |       |  |  |  |  |  |  |
| CHANGE<br>W/O<br>REQ |   | A<br>B | NUC<br>SAFETY | NP<br>NO | REG<br>AGENCY<br>CODE |                | CHG/MOD<br>NUMBER |   | ENV<br>CODE |                 | OUTAGE<br>CAUSE<br>CODE |    |    |    | STATUS<br>HOLD<br>CODE |    |    |              |     |    |     |       |  |  |  |  |  |  |
| 0                    | 9 | 1      | 0             |          |                       |                |                   |   |             |                 | X                       |    |    |    |                        |    |    |              |     |    |     |       |  |  |  |  |  |  |

|               |     |    |
|---------------|-----|----|
| S. APPROVAL   |     |    |
| COMMENCE WORK |     |    |
| VC            | DAY | VR |
| 09            | 23  | 90 |

|                                |  |  |  |  |  |
|--------------------------------|--|--|--|--|--|
| RESP LOCATION<br>OR CONTRACTOR |  |  |  |  |  |
| 2036N                          |  |  |  |  |  |

**Comply with the Provisions  
set forth in AP 1002 and  
Met-Ed Safety Manual**

### Limits and Precautions:

a) Personnel

### b) Equipment

### c) Environment

**d) Nuclear**

**INSURE WORK AREA CLEANED**

**Post Maintenance Testing required and Acceptance Criteria UP AT COMPLETION OF JOB**

PROCEDURE PERFORMED

ORIGINATOR—SUPERVISOR—SUPERVISOR OF MAINTENANCE—MAINTENANCE FOREMAN—  
JOB PERFORMER—MAINTENANCE FOREMAN—SUPERVISOR OF MAINTENANCE

**COPY 1**

# **JOB TICKET (WORK REQUEST)** **REVIEW - CLASSIFICATION - ROUTING CONTROL FORM**

JOB TICKET NUMBER 05507

1. Does work represent a change or modification to an existing system or component? If yes, an approved change modification is required per AP 1021.

C/M No. NAYes ☐ No ☒

- 2a. Does work requires an RWP?

Yes ☐ No ☒

- 2b. Is an approved procedure required to minimize personnel exposure?

Yes ☐ No ☒

- 3a. Is work on a QC component as defined in GP 1008?

Yes ☒ No ☐

- 3b. If 3a is yes does work have an effect on Nuclear Safety? If 3b is yes, PCRC reviewed Superintendent approved procedure must be used.

Yes ☒ No ☐

4. Agreement that a PCRC reviewed, Superintendent approved procedure is not required for this work because it has no effect on nuclear safety. (Applies only if 3a is Yes and 3b is No).

TP105 ATTACHED  
 UNIT SUPERINTENDENT DATE

- 5a. Is the system on the Environmental Impact list in AP 1026?

Yes ☐ No ☒

- 5b. If 5a is YES, is an approved procedure required to limit environmental impact?

Yes ☐ No ☒

6. Agreement that 5b is No. (Required only if 5a is Yes).

NA  
 UNIT SUPT. / SUPV. OF OPERATIONS DATE

7. Plant status or prerequisite conditions required for work. (Operating and/or shutdown)

8. QC Dept. review, if required in item No. 3.

3-PCRC Review 9/23/80  
 QC SUPERVISOR DATE

9. Does work require code inspector to be notified?

Yes ☐ No ☒

10. Supervisor of Maintenance approval to commence work:

RC Boylston Date 9/23/80

11. Maintenance Foreman Assigned: Jack Harrison

12. Code Inspector Notified. Name:

Date

13. Shift Foreman's approval to commence work:

Jack Harrison Date 9/23/80

Initial if Shift Foreman signature is not required.

WORK REQUEST PROCEDURE  
TMI Nuclear Station  
Maintenance Procedure Approval  
Page A-3

Unit No. 2

This form outlines the format and acts as a cover sheet for a maintenance procedure. Due to the limited size of the form, additional pages may be attached as required. Work Request procedure AP 1016 Section 6 should be used as a guide in preparing the maintenance procedure.

1. Procedure Title & No.:

*Sensor / Cable measurements of NI-2 Source Range Detector*

2. Purpose: *To determine signal characteristics prior to removal.*

3. Description of system or component to be worked on.

*NI-2 Instrument String*

4. References:

*See attached*

5. Special Tools, and Materials required.

*See attached*

6. Detailed Procedure (attach additional pages as required)

*See attached*

Supervisor of Maintenance recommends approval

*[Signature]*

Date *9/22/80*

• PORC RECOMMENDS APPROVAL

Unit No. 1 Chairman

Date

Unit No. 2 Chairman

Date

• UNIT SUPERINTENDENT APPROVAL

Unit No. 1

Date

Unit No. 2


Date

• Standing Procedure

*[Signature]*  
Supervisor of OO

Date

\*Note These approvals required only on Nuclear Safety Related/Radiation work permit jobs

|  |  |               |
|--|--|---------------|
| <br>Technology for Energy Corporation | <b>TITLE</b> IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM SOURCE RANGE DETECTOR PREAMPLIFIER NI-AMP-2 | NO.<br>TP-105 |
|  |  | REV. 1        |
| PROCEDURE  | APPROVED   | DATE          |
|  | M.V. Mathis, Director, Tech. Serv. Div.  | 9-12-80       |

**PURPOSE:** The purpose of these measurements is to gather baseline data and information in preparation for removal of the Source Range Monitor Preamplifier from the Reactor Building TMI Unit 2. The tests specified in this procedure are designed to assess the condition of the in-containment instrumentation (Proportional Counter Assembly and the Source Range Preamplifier), associated cabling, and readout devices. This assessment will require the use of Time Domain Reflectometry (TDR), Impedance (Z), Spectral Analysis (frequency domain), and general oscilloscope observations (with recording) of waveforms from/to the unit under test (UUT).

**PROCEDURE (ADMINISTRATIVE):**

**A. Limitations and Precautions**

1. **Nuclear Safety.** Source Range Detector NI-AMP-2 is part of a Redundant Source Range Monitoring System located at elevation 305'. The unit is part of the engineered reactor safeguards system and is nuclear safety-related.
2. **Environmental Safety.** Source Range Detector Preamplifier NI-AMP-2 can be taken out-of and restored to service without producing a hazard to the environment.
3. **Personnel Safety.** The test described herein produces no additional personnel safety hazards other than normally associated with performing instrument testing.
4. **Equipment Protection.** In the performance of each test described herein, care will be taken to insure adequate equipment protection as follows:
  - a. In all cases actual test hookups to the Unit-2 instrumentation shall be made and verified by Instrumentation Personnel.
  - b. All passive measurements (Spectral Analysis and Oscilloscope observations) of waveforms and signals from powered instruments shall be performed using high input impedance probes or inputs ( $Z = \geq 1$  Meg ohm) to prevent loading of signals.
  - c. In all Time Domain Reflectometry and Impedance measurements, power will be removed from the unit under test and low level test signals prescribed in Table 4-1 shall be utilized to perform cable integrity measurements on the appropriate instrumentation cables by inserting test signals on appropriate conductors of Cables

TEC

TITLE

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS  
FROM SOURCE RANGE DETECTOR PREAMPLIFIER  
NI-AMP-2

NO. TP-105

REV. 1

IT2352I, IT2356I, and IT2354C (Terminations shall be removed, an in-line triaxial test adaptor and cable inserted. This triaxial test adaptor and cable will be provided by GPU/I&C division for these tests.)

Table 4-1 Active Measurements

| Active Signal Parameter | Time Domain Reflectometry         | Impedance                     |
|-------------------------|-----------------------------------|-------------------------------|
| Voltage                 | 225 mV nominal (into 50 ohm base) | $\leq 5V$ rms                 |
| Frequency               | ---                               | 100Hz, 1kHz,<br>10kHz, 100kHz |
| Current                 | $\leq 10mA$                       | $\leq 100mA$                  |
| Other                   | 225mV, 110 picosecond pulses      | ---                           |

## B. Prerequisites

1. The Shift Supervisor/Shift Foreman shall be notified for concurrence prior to the performance of these measurements.
2. Instrumentation personnel shall be assigned to assist in the performance of these measurements.
3. All measurements and test instrumentation shall be in current calibration (traceable to NBS).
4. The Shift Supervisor/Shift Foreman shall be notified prior to start and upon completion of the measurements.

## C. Procedure for Performing Measurements

References:

1. Bailey Meter Company Dwg. No. 6012472K, Nuclear Instrumentation and Protection System, Subsystem 8 Cabinet 1, NI-AMP-2.
2. Instruction Manual for Source Range Detector Housing Assembly, Dwg. No. E-2176, WL-23682/23682A.



**TEC****TITLE**IN-SITU MEASUREMENTS OF CABLES AND SIGNALS  
FROM SOURCE RANGE DETECTOR PREAMPLIFIER  
NI-AMP-2**NO.** TP-105**REV.** 1

3. Burns & Roe Dwg. 3310, Sh. 7.
4. Burns & Roe Dwg. 3024, Sh. 42.
5. Burns & Roe Dwg. 3045, Sh. 17.
6. Instruction Manual, Tektronix Model 1502 Time Domain Reflectometer.
7. Instruction Manual, Hewlett Packard Model 4274 Multifrequency LCR Meter.
8. Instruction Manual, Hewlett Packard Spectrum Analyzer (Model 141T, 8553B, 8552B Modules).
9. Instruction Manual, Nicolet Model 444A-26 Spectrum Analyzer.
10. Instruction Manual, Tektronix Model 335 Oscilloscope.
11. Instruction Manual, Lockheed Store-4 Recorder.
12. Instruction Manual, Tektronix SC502 Oscilloscope.
13. TEC Composite Electrical Connection Diagram, NI-AMP-2 (see attachment).

| SIGNAL       | CABLE   | CABINET<br>20-B1 |
|--------------|---------|------------------|
| High Voltage | IT2354C | JA               |
| Low Voltage  | IT2356I | JB               |
| Signal       | IT2352I | JC               |

1. Notify Shift Supervisor/Shift Foreman of start of test on NI-AMP-2.
2. Verify power is removed\* from NI-AMP-2.

\*NOTE: NI-AMP-2 is currently out-of-service and should not be in a powered condition.

*[Signature]* 7/5/88 9/22/88  
Signature/Date

TEC

TITLE

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS  
FROM SOURCE-RANGE DETECTOR PREAMPLIFIER  
NI-AMP-2

NO. TP-105

REV. 1

3. Remove field wires from Cables IT2352I, IT2356I, and IT2354C at JA, JB, and JC (Cabinet 20) and attach GPU triaxial test adaptor and cable for direct measurements on field wire signals.

| TERMINAL        | SIGNAL IDENT.   |
|-----------------|-----------------|
| — JC (IT2352I)✓ | SIGNAL          |
| JB (IT2356I)✓   | LOW V(15VDC)    |
| → JA (IT2354I)c | HIGH V(2400VDC) |

*Q-TS MS 7/24/80*  
Signature/Date

4. Using the Hewlett-Packard Model 4274 (or equivalent) Impedance Bridge, measure the capacitance and impedance at the following test points:

| TEST POINT | FROM                | TO                    |
|------------|---------------------|-----------------------|
| a.         | JC-Sig (Signal)     | JC-Ret (Inner SHLD)   |
| b.         | JB-Sig (15VDC)      | JB-Ret (Inner SHLD)   |
| c.         | JA-Sig (2400 VDC)   | JA-Ret (2400 VDC Ret) |
| d.         | JC-Sig (SIGNAL)     | JB-Sig (15 VDC)       |
| e.         | JC-Sig (SIGNAL)     | JA-Sig (2400 VDC)     |
| f.         | JB-Sig (15 VDC)     | JA-Sig (2400 VDC)     |
| g.         | JC-Ret (Inner SHLD) | JB-Ret (Inner SHLD)   |
| h.         | JC-Ret (Inner SHLD) | JA-Ret (2400 VDC Ret) |
| i.         | JB-Ret (Inner SHLD) | JA-Ret (2400 VDC Ret) |

TEC

TITLE

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS  
FROM SOURCE RANGE DETECTOR PREAMPLIFIER  
NI-AMP-2

NO. TP-105

REV. 1

Record the data required below:

JC SIGNAL  
JB LOW VOLT  
JA HV

| Test Point        | Capacitance              |                             |                                | Impedance             |                       |                                      |
|-------------------|--------------------------|-----------------------------|--------------------------------|-----------------------|-----------------------|--------------------------------------|
|                   | 100 Hz                   | 1 kHz                       | 100 kHz                        | 100 Hz                | 1 kHz                 | 100 kHz                              |
| a. JC-Sig: JC-Ret | <del>2 nF</del><br>10 nF | <del>0.3 nF</del><br>6.5 nF | <del>-0.008 nF</del><br>7.2 nF | <del>6 nF</del><br>OK | <del>6 nF</del><br>OK | <del>111 nF</del><br>16.5 MEG / 179° |
| b. JB-Sig: JB-Ret | 20 nF                    | 7.6 nF                      | -12 nF                         | 119 nF / -41°         | 28 nF / -48°          | 128 nF / 77°                         |
| c. JA-Sig: JA-Ret | 16 nF                    | 6.8 nF                      | 7.8 nF                         | 0/-                   | 0/-                   | 116 nF / -135°                       |
| d. JC-Sig: JB-Sig | 47 nF<br>80 nF           | 55 nF                       | -1.6 nF                        | 0F                    | 2.4 K / -57°          | 176 nF / 81°                         |
| e. JC-Sig: JA-Sig | 1 nF<br>7 nF             | 1.7 nF                      | 770 nF                         | 150 K / -30°          | 57 K / -30°           | 1.4 K / -67°                         |
| f. JB-Sig: JA-Sig | 24 nF                    | 8 nF                        | -1.7 nF                        | 31 K / -28°           | 16 K / -54°           | 856 nF / 63°                         |
| g. JC-Ret: JB-Ret | 1.025 nF                 | 0F                          | -18 nF                         | 0F                    | 2.3 K / -88°          | 872 nF / 47°                         |
| h. JC-Ret: JA-Ret | 68 nF                    | 65 nF                       | -109 nF                        | 0F                    | 2.5 K / -80°          | 15.9 nF / 70°                        |
| i. JB-Ret: JA-Ret | 71 nF                    | 60 nF                       | -31 nF                         | 0F                    | 2.3 K / -85°          | 61 nF / 127°                         |

*T. S. H.* 9/24/80  
Signature/Date

5. Using the Tektronix Model 1502 (or equivalent) TDR unit, perform TDR measurements on the following test points.

TIEC

TITLE

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS  
FROM SOURCE RANGE DETECTOR PREAMPLIFIER  
NI-AMP-2

NO. TP-105

REV. 1

Record data below:

| Test Point                   | Instrument Settings | Strip Chart Number |
|------------------------------|---------------------|--------------------|
|                              | Ampl Range Mult     |                    |
| a. JC-Sig: JC-Ret (Signal)   |                     | 105-1              |
| b. JB-Sig: JB-Ret (15VDC)    |                     | 105-2              |
| c. JA-Sig: JA-Ret (2400 VDC) |                     | 105-3              |

*J. T. S. H.* 7/24/80  
Signature/Date

6. Using the Keithley Model 144 (or equivalent DMM) perform resistance measurements on the test points specified and record values in the space provided.

20 K RANGE

| TEST POINT | FROM LINK | TO LINK | POLARITY         | POLARITY         |
|------------|-----------|---------|------------------|------------------|
|            |           |         | From = +; To = - | From = -; To = + |
|            |           |         | RESISTANCE       | RESISTANCE       |
| a.         | JC-Sig    | JC-Ret  | ~ OPEN           | ~                |
| b.         | JB-Sig    | JB-Ret  | 731 $\Omega$     | 727 $\Omega$     |
| c.         | JA-Sig    | JA-Ret  | ~                | ~                |
| d.         | JC-Sig    | JB-Sig  | ~                | ~                |
| e.         | JC-Sig    | JA-Sig  | ~                | ~                |
| f.         | JB-Sig    | JA-Sig  | ~                | ~                |
| g.         | JC-Ret    | JB-Ret  | ~7K              | ~8K              |
| h.         | JC-Ret    | JA-Ret  | ~                | ~                |
| i.         | JB-Ret    | JA-Ret  | ~                | ~                |

*J. T. S. H.*  
Signature/Date

**TEC**

**TITLE**

**IN-SITU MEASUREMENTS OF CABLES AND SIGNALS  
FROM SOURCE RANGE DETECTOR PREAMPLIFIER  
NI-AMP-2**

**NO.** TP-105

**REV.** 1

\*\*\*\*\*

**STOP**

\*\*\*\*\*

**Notify Unit-2 I&C Engineer**

**Before Proceeding**

\*\*\*\*\*

TEC

TITLE

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS  
FROM SOURCE RANGE DETECTOR PREAMPLIFIER  
NI-AMP-2

NO. TP-105

REV. 1

7. Remove the GPU triaxial test adaptor and connect field wires from Cables IT2352I, IT2356I, and IT2354C at JA, JB, and JC (Cabinet 20).

Signature/Date

8. Apply power to NI-AMP-2 and wait a minimum of 30 minutes for the device to warm-up.

9. Record the reading from NI-AMP-2 Readout Module.

| SIGNAL              | READING IN CPS |
|---------------------|----------------|
| NI-AMP-2<br>Readout |                |

\* Not able to achieve operating conditions on power supplies. See attached logbook pages which describe attempts to activate instrument.

10. Connect the TEC isolation amplifier (Model 901) by a Phone Jack Connector\* to the Count Rate Amplifier in Control Cabiner 20-B1, connect output of Model 901 to FM Recorder, and record Signal-in for 30 minutes.

Remove amplifier and FM Recorder after test.

11. Using a Keithley Model 177 DDM (or equivalent, Range 0-2000 V, Precision  $\pm 1\%$ ) measure the DC Voltage or current at the following test points.

TIE

TITLE

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS  
FROM SOURCE RANGE DETECTOR PREAMPLIFIER  
NI-AMP-2

NO. TP-105

REV. 1

| <u>SIGNAL</u> † | <u>CABINET 20</u>                | <u>TEST LEAD</u> | <u>READING</u>         |
|-----------------|----------------------------------|------------------|------------------------|
| a.              | Count rate<br>Amplifier<br>Input | (+)<br>(-)       | Signal _____           |
| b.              | Auxiliary<br>Power<br>Supply     | (+)<br>(-)       | Low V (15VDC) _____    |
| *c.             | High Voltage<br>Power            | (+)<br>(-)       | High V (2400VDC) _____ |

†All measurements using GPU test cable. \_

Signature/Date \_\_\_\_\_

12. Using a Tektronix Model SC502 (or equivalent) oscilloscope observe the waveform at the following test points.

TEC

TITLE

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS  
FROM SOURCE RANGE DETECTOR PREAMPLIFIER  
NI-AMP-2

NO. TP-105

REV. 1

| SIGNAL <sup>†</sup> | CABINET 20                 | PARAMETER            |   |   |   |
|---------------------|----------------------------|----------------------|---|---|---|
| a.                  | Count rate Amplifier Input | SIG                  | Photo _____<br>Time Base _____<br>Vert Gain _____ | Photo _____<br>Time Base _____<br>Vert Gain _____ | Photo _____<br>Time Base _____<br>Vert Gain _____ |
| b.                  | Auxiliary Power Supply     | Low Voltage (15VDC)  | Photo _____<br>Time Base _____<br>Vert Gain _____ | Photo _____<br>Time Base _____<br>Vert Gain _____ | Photo _____<br>Time Base _____<br>Vert Gain _____ |
| *c.                 | High Voltage Power         | High Voltage (2400V) | Photo _____<br>Time Base _____<br>Vert Gain _____ | Photo _____<br>Time Base _____<br>Vert Gain _____ | Photo _____<br>Time Base _____<br>Vert Gain _____ |

\*CAUTION High Voltage: Use TEC DC Decoupling Circuit.

<sup>†</sup>All measurements using GPU test cable.

Sync the oscilloscope and photograph the waveform using up to three time base and vertical gain settings. Mark the back of the photographs with the instrument tag number and parameter measured.

Signature/Date \_\_\_\_\_

13. Using a Hewlett-Packard Spectrum Analyzer (Models 141T, 85538 and 8552 or equivalent) perform an analysis of the following signals for spectral content:



**TEC****TITLE**IN-SITU MEASUREMENTS OF CABLES AND SIGNALS  
FROM SOURCE RANGE DETECTOR PREAMPLIFIER  
NI-AMP-2NO.  
TP-105

REV. 1

| <u>SIGNAL</u> † | <u>CABINET 20</u>          | <u>PARAMETER</u>        | <u>PHOTO #</u> |
|-----------------|----------------------------|-------------------------|----------------|
| a.              | Count Rate Amplifier Input | SIGNAL                  | _____          |
| b.              | Auxiliary Power Supply     | Low Voltage (15VDC)     | _____          |
| *c.             | High Voltage Power         | High Voltage (2400 VDC) | _____          |

\*CAUTION High Voltage: Use Decoupling Circuit.

†All measurements using GPU test cable.

\_\_\_\_\_  
Signature/Date

15. Inside Cabinet 20 perform usual electronic calibrations using applicable instrument shop procedures. Attach instrument shop calibration data sheet and record any significant adjustments or problems in the space below.

| Procedure Step                                     | Remarks |
|--|---------|
|  |         |
| See attached instrument shop procedure data sheet. |         |

Instrument Shop Procedure No. \_\_\_\_\_

\_\_\_\_\_  
Signature/Date

**TEC****TITLE**

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS  
FROM SOURCE RANGE DETECTOR PREAMPLIFIER  
NI-AMP-2

NO. TP-105

REV. 1

\*\*\*\*\*

NOTE: Notify Unit-2 I&C Engineer of Completion of Powered testing before processing.

\*\*\*\*\*

16. Remove all power from NI-AMP-2.

\_\_\_\_\_  
Signature/Date

17. Remove field wires from Cables IT2352I, IT2356I, and IT2354C at JA, JB, and JC (Cabinet 20) and attach GPU triaxial test adaptor and cable for direct measurements on field wire signals.

| <u>TERMINAL</u> | <u>SIGNAL IDENT.</u> |
|-----------------|----------------------|
| JC              | SIGNAL               |
| JB              | LOW V(15VDC)         |
| JA              | HIGH V(2400VDC)      |

\_\_\_\_\_  
Signature/Date

**TEC**

TITLE

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS  
FROM SOURCE RANGE DETECTOR PREAMPLIFIER  
NI-AMP-2

NO.  
TP-105

REV. 1

18. Using the Hewlett-Packard Model 4274 (or equivalent) Impedance Bridge, measure the capacitance and impedance at the following test points:

| TEST POINT | FROM                | TO                    |
|------------|---------------------|-----------------------|
| a.         | JC-Sig (Signal)     | JC-Ret (Inner SHLD)   |
| b.         | JB-Sig (15VDC)      | JB-Ret (Inner SHLD)   |
| c.         | JA-Sig (2400 VDC)   | JA-Ret (2400 VDC Ret) |
| d.         | JC-Sig (SIGNAL)     | JB-Sig (15 VDC)       |
| e.         | JC-Sig (SIGNAL)     | JA-Sig (2400 VDC)     |
| f.         | JB-Sig (15 VDC)     | JA-Sig (2400 VDC)     |
| g.         | JC-Ret (Inner SHLD) | JB-Ret (Inner SHLD)   |
| h.         | JC-Ret (Inner SHLD) | JA-Ret (2400 VDC Ret) |
| i.         | JB-Ret (Inner SHLD) | JA-Ret (2400 VDC Ret) |

**TEC****TITLE**

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS  
FROM SOURCE RANGE DETECTOR PREAMPLIFIER  
NI-AMP-2

NO.  
TP-105

REV. 1

Record the data required below:

| Test Point        | Capacitance |       |         | Impedance |       |         |
|-------------------|-------------|-------|---------|-----------|-------|---------|
| Frequency         | 100 Hz      | 1 kHz | 100 kHz | 100 Hz    | 1 kHz | 100 kHz |
| a. JC-Sig: JC-Ret |             |       |         |           |       |         |
| b. JB-Sig: JB-Ret |             |       |         |           |       |         |
| c. JA-Sig: JA-Ret |             |       |         |           |       |         |
| d. JC-Sig: JB-Sig |             |       |         |           |       |         |
| e. JC-Sig: JA-Sig |             |       |         |           |       |         |
| f. JB-Sig: JA-Sig |             |       |         |           |       |         |
| g. JC-Ret: JB-Ret |             |       |         |           |       |         |
| h. JC-Ret: JA-Ret |             |       |         |           |       |         |
| i. JB-Ret: JA-Ret |             |       |         |           |       |         |

Signature/Date

19. Using the Tektronix Model 1502 (or equivalent) TDR unit perform TDR measurements on the following points.

TEC

TITLE

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS  
FROM SOURCE RANGE DETECTOR PREAMPLIFIER  
NI-AMP-2

NO.  
TP-105

REV. 1

Record data below:

| Test Point                   | Instrument<br>Settings | Strip<br>Chart<br>Number |
|------------------------------|------------------------|--------------------------|
|                              | Ampl Range Mult        |                          |
| a. JC-Sig: JC-Ret (Signal)   |                        |                          |
| b. JB-Sig: JB-Ret (15VDC)    |                        |                          |
| c. JA-Sig: JA-Ret (2400 VDC) |                        |                          |

Signature/Date

20. Using the Keithley Model 144 (or equivalent DMM) perform resistance measurements on the test points specified and record values in the space provided.

|            |           |         | <u>POLARITY</u><br>From = +; To = - | <u>POLARITY</u><br>From = -; To = + |
|------------|-----------|---------|-------------------------------------|-------------------------------------|
| TEST POINT | FROM LINK | TO LINK | RESISTANCE                          | RESISTANCE                          |
| a.         | JC-Sig    | JC-Ret  |                                     |                                     |
| b.         | JB-Sig    | JB-Ret  |                                     |                                     |
| c.         | JA-Sig    | JA-Ret  |                                     |                                     |
| d.         | JC-Sig    | JB-Sig  |                                     |                                     |
| e.         | JC-Sig    | JA-Sig  |                                     |                                     |
| f.         | JB-Sig    | JA-Sig  |                                     |                                     |
| g.         | JC-Ret    | JB-Ret  |                                     |                                     |
| h.         | JC-Ret    | JA-Ret  |                                     |                                     |
| i.         | JB-Ret    | JA-Ret  |                                     |                                     |

Signature/Date

**TEC****TITLE****IN-SITU MEASUREMENTS OF CABLES AND SIGNALS  
FROM SOURCE RANGE DETECTOR PREAMPLIFIER  
NI-AMP-2****NO.**  
TP-105**REV.** 1

21. Remove GPU triaxial test adaptor and cable and connect field wires from Cables IT2352I, IT2356I, and IT2354C at JA, JB, and JC (Cabinet 20).

22. Notify the Shift Supervisor/Shift Foreman of the conclusion of testing NI-AMP-2.

I hereby certify that this Test Procedure has been completed as written and that all data has been correctly entered and filed as requested.

TEC Representative

\_\_\_\_\_  
Signature/Date

Instrumentation

\_\_\_\_\_  
Signature/Date

**GENERATION CORRECTIVE MAINTENANCE SYSTEM  
CM STATUS ACTIVITY FORM**

Page A-21

| COMPONENT DESIGNATOR |            |           |      | LOCATION UNIT | JOB TYPE | WORK AUTHORIZATION NUMBER | REQUEST DATE |     |    |    |    |
|----------------------|------------|-----------|------|---------------|----------|---------------------------|--------------|-----|----|----|----|
| SYS                  | COMP. TYPE | COMP. ID. | LOOP |               |          |                           | MO           | DAY | YR |    |    |
| 5                    | 8          | 12        | 16   | 17            | 22       | 23                        | 24           | 25  | 32 | 33 | 38 |
| WT                   | DET        | 0008      |      | 036002        | CM       |                           |              |     | CF | 10 | 09 |

| TXN CD | ACT |
|--------|-----|
| 1      | 4   |
| 804    | A   |

| ECM NUMBER |    |
|------------|----|
| 47         | 51 |

| TXN CD | ACT |
|--------|-----|
| 1      | 4   |
| 805    | A   |

| PRTY | RESP. LOCATION OR CONTRACTOR | PRTY | ASSISTING CONTRACTOR | PRTY | ASSISTING CONTRACTOR |
|------|------------------------------|------|----------------------|------|----------------------|
| 66   | 67                           | 71   |                      |      |                      |
|      | 2036N                        |      |                      |      |                      |

| TXN CD | ACT |
|--------|-----|
| 1      | 4   |
| 807    | A   |

| PURCHASE REQUISITION NUMBER | PURCHASE ORDER NUMBER |
|-----------------------------|-----------------------|
| 59                          | 66 67                 |
|                             | 73                    |

| TXN | ACT |
|-----|-----|
| 1   | 4   |
| 810 | A   |

| STATUS HOLD |            |    |  |              |    |  |    |     |    | % COMPL | S/M APPROVAL TO COMMENCE WORK |     |    | FIELD WORK COMPLETION DATE |  |  |
|-------------|------------|----|--|--------------|----|--|----|-----|----|---------|-------------------------------|-----|----|----------------------------|--|--|
| CODE        | START DATE |    |  | RELEASE DATE |    |  | MO | DAY | YR |         | MO                            | DAY | YR |                            |  |  |
| 39          | 40         | 41 |  | 45           | 47 |  | 52 | 53  | 55 | 56      | 61                            | 62  | 67 |                            |  |  |
| 01          |            |    |  |              |    |  |    |     |    |         |                               |     |    |                            |  |  |
| 02          |            |    |  |              |    |  |    |     |    |         |                               |     |    |                            |  |  |
| 03          |            |    |  |              |    |  |    |     |    |         |                               |     |    |                            |  |  |
| 04          |            |    |  |              |    |  |    |     |    |         |                               |     |    |                            |  |  |
| 05          |            |    |  |              |    |  |    |     |    |         |                               |     |    |                            |  |  |
| 06          |            |    |  |              |    |  |    |     |    |         |                               |     |    |                            |  |  |
| 07          |            |    |  |              |    |  |    |     |    |         |                               |     |    |                            |  |  |
| 08          |            |    |  |              |    |  |    |     |    |         |                               |     |    |                            |  |  |
| 50          |            |    |  |              |    |  |    |     |    |         |                               |     |    |                            |  |  |
| 51          |            |    |  |              |    |  |    |     |    |         |                               |     |    |                            |  |  |
| 52          |            |    |  |              |    |  |    |     |    |         |                               |     |    |                            |  |  |
| 53          |            |    |  |              |    |  |    |     |    |         |                               |     |    |                            |  |  |
| 54          |            |    |  |              |    |  |    |     |    |         |                               |     |    |                            |  |  |
| 55          |            |    |  |              |    |  |    |     |    |         |                               |     |    |                            |  |  |
| 56          |            |    |  |              |    |  |    |     |    |         |                               |     |    |                            |  |  |

OUTAGE HOLD  
 PART HOLD  
 QUALITY CONTROL PART HOLD  
 QUALITY CONTROL PROCEDURE HOLD  
 OPERATIONS HOLD  
 CHANGE MODIFICATION HOLD  
 ENGINEERING HOLD  
 PLANNING HOLD  
 MANPOWER NOT AVAILABLE  
 AT PORC  
 AT QUALITY CONTROL  
 AT UNIT SUPERINTENDENT  
 AT READING  
 POST MAINTENANCE TEST HOLD  
 AT ALARA

Test Equipment Used With Procedure TP-105

Test Equipment  
Noun Name

Test Equipment  
Serial No.

Test Equipment  
Calibration Date

Test Equipment Calibration  
Due Date





## Certificate of Calibration

We certify that the equipment listed below was duly tested and inspected prior to shipment and met physical and operating specifications published by the manufacturer(s).

Electro Rent's primary and secondary standards are traceable to the National Bureau of Standards.

*Doug M. Howl* 8-7-80  
DATE

| MANUFACTURER | MODEL | SERIAL NO. | REPORT NUMBER | DUE DATE |
|--------------|-------|------------|---------------|----------|
| NSC          | 444A  | 26142      | B1713         | 2-5-81   |
| HP           | 4274  | 35580      | B1714         | 2-5-81   |
| TEK          | 1502  | 34075      | OC01556       | 1-8-81   |

4408 VALHALLA OMM  
177 KEITHLEY OMM

TGR 7702  
TEC 7906

CAL DATE 8/8/80  
" " 8/4/80

98

9/24/80

TMI - UNIT<sup>2</sup> Z

PL

HOPPER / SMITH J.

12<sup>GA</sup>

"

"

NEED Pomano Female 3562

" MALE 3563

"

1269 BNL TO BANANA

STARTED PROCDURG 105, NI-RMP-2

HOPPER / ~~EDDIE~~ SMITH

ALL TEST ON CABLE LOOKED GOOD (DC RESISTANCE)

CONTACTED J BRUMMER ON RESULTS OF CABLE TEST

J BRUMMER PRESENT DURING POWER UP,

- 1) HIGH VOLTAGE METER (PANEL) DID NOT MOVE
- 2) READ FROM DIVIDE BY 1000 PLUG ON H.V.  
POWER SUPPLY WITH VOLTMETER. READING  $\approx \frac{240 \text{ VOLT}}{1000}$
- 3) TURN POWER "OFF"
- 4) REMOVE H.V. CABLE
- 5) TURN POWER "ON" (H.V.)
- 6) METER (PANEL)  $\approx 1600 \text{ VOLT}$
- 7) CLEANED CABLE CONNECTOR ON H.V. CABLE
- 8) REPLACED CABLE SAME RESULT. (BAD)
- 9) DISCONNECTED ALL CABLE AND REMOVED  
H.V. MODULE
- 10) I+C INSTRUMENT SHOP CHECK OUT  
H.V. MODULE (OK)

11) I+C PLACED 1.5 MEG OHM FOR  
LOAD ON POWER SUPPLY (OK) ~~LS~~

~~12)~~ 12) TERMINATED TEST ON NI-AMP-2

\* 13) FROM DOUG WEAVER, I+C FOREMAN  
STATED LIFE OF BF<sub>3</sub> ~ 3 YR.

(14) FROM BOB GILBERT I+C FOREMAN  
HAVE HAD SOME PROBLEMS WITH  
CONNECTORS QUALTING AND MOISTURE

(15) TOMORROW ENTRY TO CONTAINMENT.  
WILL CONNECT SPARE BF<sub>3</sub>

\* POWER OFF ON BOTH DETECTORS ~ 1.5 YR.

NOTE: NI-AMP-2 test terminated due to cancellation of  
9/25/80 containment entry.