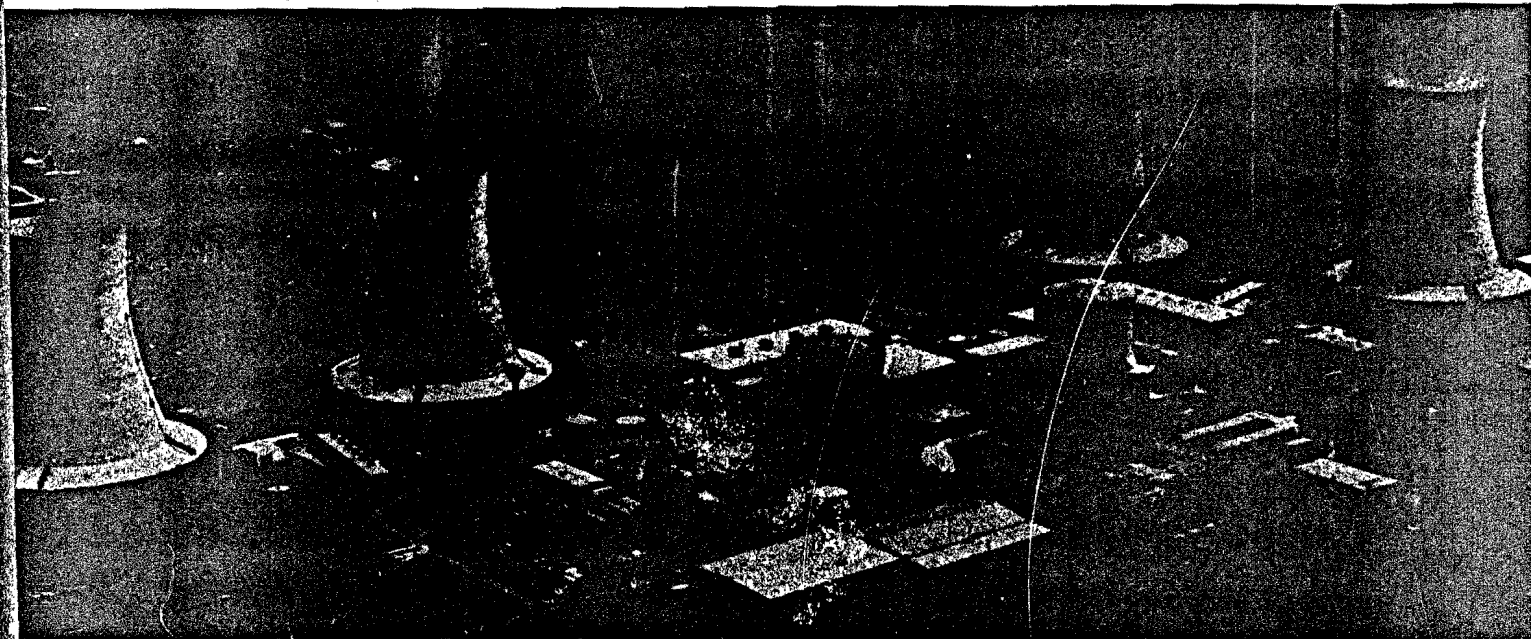


MASTER

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Volume XI

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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

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LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
2-1. Composite Electrical Diagram for NI-AMP-2	2-2
2-2. Functional Diagram of Preamplifier Assembly	2-4
4-1. TDR Trace of Signal Cable	4-3
4-2. TDR Trace of Low Voltage Cable	4-4
4-3. TDR Trace of High Voltage Cable	4-5

LIST OF TABLES

<u>Table</u>	<u>Page</u>
2-1. Termination Points for CF-2-LT2 Measurements	2-3
4-1. Capacitance, Impedance, and Resistance Measurements	4-2
5-2. Summary of TDR Measurements	5-2

1. INTRODUCTION

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 BF₃ 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 BF₃ proportional counter connected to a Bailey system 880 preamplifier. This instrument has a normal range of .1 to 10⁶ counts per second producing an output of 0 to 2 volts. The functional diagram of the preamplifier unit is shown in Figure 2-2.

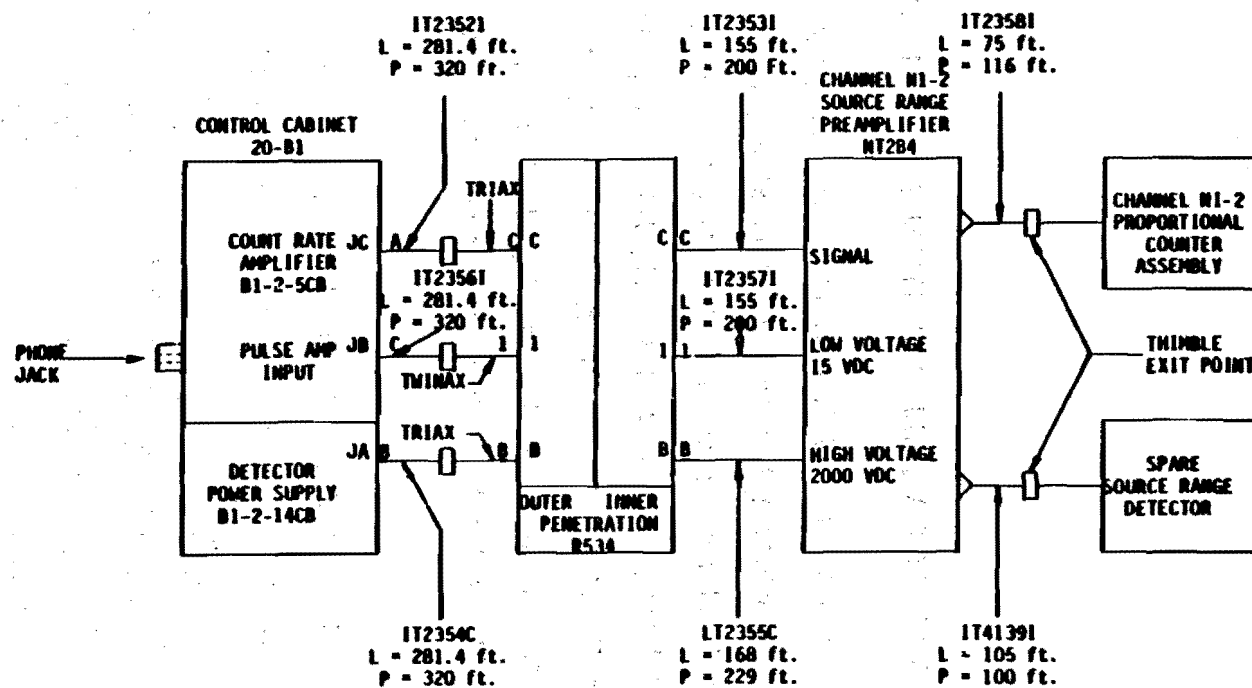


Figure 2-1. Composite Electrical Diagram for NI-AMP-2.

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

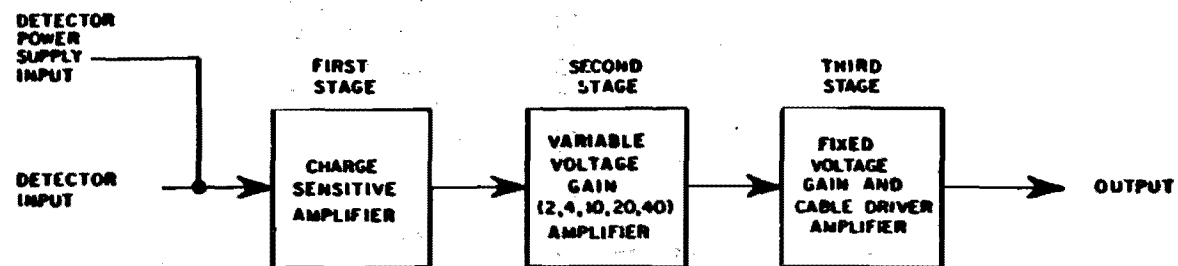


Figure 2-2. Functional Diagram of Preamplifier Assembly.

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 Signal Return	2 pF	.3 pF	0	0F*	0F	16.5M	0F
Low Voltage Low Voltage Return	20 μ F	7.6 μ F	-12	119	28	128	731 (727)
High Voltage High Voltage Return	16	6.8	7.8	0F	0F	146	0F
Signal Return 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 μ p/div

Range - 52.6 ft/div

Sensitivity - 0.25

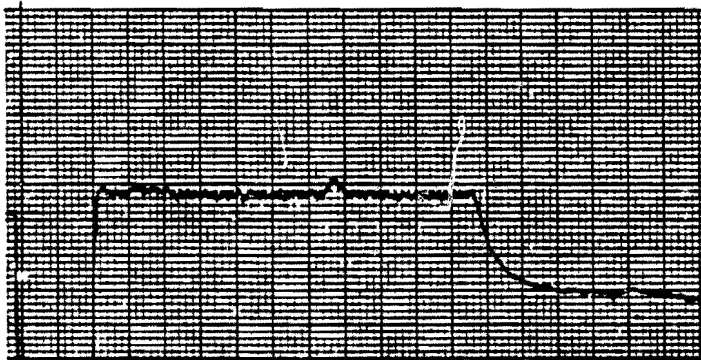
Filter - 15 Hz

Cable dielectric - poly

Figure 4-1. TDR Trace of Signal Cable.

STRIP CHART 105-2

Cable - IT2356 (Low Voltage)



Setting - 500 μ P/div

Range - 52.6 ft/div

Sensitivity - 0.25

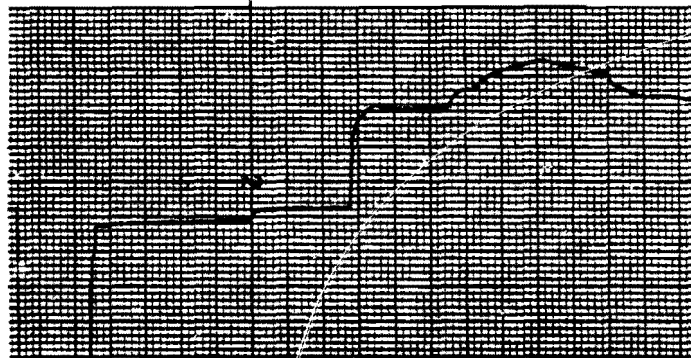
Filter - 15 Hz

Cable dielectric - poly

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

STRIP CHART 105-3

Cable - IT2354C (High Voltage)



Setting - 500 μ 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 (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.

APPENDIX

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

208-5 GENERATION CORRECTIVE MAINTENANCE SYSTEM
 JOB TICKET FORM (WORK) Page A-1 E. MILE ISLAND UNIT 2

COMPONENT IDENTIFICATION				LOCATION UNIT		JOB TYPE		RECOMMENDED PRIORITY	
SYS	COMP TYPE	COMP ID	UNIT	LOCATION	UNIT	JOB TYPE	RECOMMENDED PRIORITY	RECOMMENDED PRIORITY	RECOMMENDED PRIORITY
11	DET	0002		03600	02C	CE707	67	22	0

DESCRIBE
MALFUNCTION
OR
MODIFICATION
DESIRED

CAUSE OF
MALFUNCTION
(IF KNOWN)

P	r	e	f	e	r	m	a	t	t	a	c	h	e	d	p	r	e	c	e	d	u	r	e	.
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

ORIGINATOR'S EMP. NO.	ORIGINATOR'S SIGNATURE	DATE	SUPERVISOR'S EMP. NO.	SUPERVISOR'S SIGNATURE	DATE
04175	<i>J. Brunner</i>	9/22/81	06175	<i>J. Brunner</i>	9/24/81

DOG/EST Project

WORK ORDER NUMBER		GC CODE	ACCOUNT NUMBER	PLANT CONDITION								NPRD FAILURE			START		
LOCATION	SERIAL			SV	OP	NO	CD	RF	MS	LR		YR	MO	DAY	HR	MIN	
03600	001946A		7876419	1	1	1	1	1	1	1							

CHANGE W/O NO	REG AGENCY CODE	CHG/MOD NUMBER
0910		

ENV CODE	OUTAGE CAUSE CODE
X	

STATUS HOLD CODE

S. M. APPROVAL COMMENCE WORK		
VC	DAY	VR
09	23	90

RESP. LOCATION OR CONTRACTOR
2036W

Com ly with the Provisions
s.t forth n 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 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. NA

Yes 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, PORC reviewed Superintendent approved procedure must be used.

Yes ✓ No

4. Agreement that a PORC 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.

[Signature] 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:

[Signature] Date 9/23/80

11. Maintenance Foreman Assigned: *[Signature]*

12. Code Inspector Notified. Name:

Date

13. Shift Foreman's approval to commence work:

[Signature] Date 9/24/80

 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

[Signature]

Date *9/22/80*

Unit No. 1 Chairman

Date

Unit No. 2 Chairman

[Signature]

Date

9/23/80

• UNIT SUPERINTENDENT APPROVAL

Unit No. 1

Date

Unit No. 2

[Signature]

Date

9/23/80

• Standing Procedure

[Signature]

Supervisor of QC

9/23/80

Date

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

 Technology for Energy Corporation	TITLE IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM SOURCE RANGE DETECTOR PREAMPLIFIER NI-AMP-2	NO. 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, 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 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)

J. T. S. 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	2.2 nF 10 nF	.3 nF 6.8 nF	-.008 nF 7.8 nF	OF OF	OF OF	16.5 MEG 111 nF 179° -135°
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	OF	OF	116 nF -135°
d. JC-Sig: JB-Sig	47 nF 80 nF	55 nF	-1.6 nF	OF	2.4 K -57°	476 nF -81°
e. JC-Sig: JA-Sig	1 nF 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	+.025 nF	OF	-18 nF	OF	2.3 K -88°	872 nF -47°
h. JC-Ret: JA-Ret	68 nF	65 nF	-109 nF	OF	2.5 K -80°	15.9 nF -70°
i. JB-Ret: JA-Ret	71 nF	60 nF	-31 nF	OF	2.3 K -88°	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. 7/29/80
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 Ω	727 Ω
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	.7 K	.8 K
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 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 Amplifier Input	(+) (-)	Signal _____
b.	Auxiliary Power Supply	(+) (-)	Low V (15VDC) _____
*c.	High Voltage Power	(+) (-)	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 [†]	CABINET 20	PARAMETER			
a.	Count rate Amplifier Input	SIG	Photo _____ Time Base _____ Vert Gain _____	Photo _____ Time Base _____ Vert Gain _____	Photo _____ Time Base _____ Vert Gain _____
b.	Auxiliary Power Supply	Low Voltage (15VDC)	Photo _____ Time Base _____ Vert Gain _____	Photo _____ Time Base _____ Vert Gain _____	Photo _____ Time Base _____ Vert Gain _____
*c.	High Voltage Power	High Voltage (2400V)	Photo _____ Time Base _____ Vert Gain _____	Photo _____ Time Base _____ Vert Gain _____	Photo _____ Time Base _____ Vert Gain _____

*CAUTION High Voltage: Use TEC DC Decoupling Circuit.

[†]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, 8553B 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 Settings	Strip Chart 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> From = +; To = -	<u>POLARITY</u> 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 RepresentativeSignature/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	28	32	33	38
NT	DET	0000		036002	CM					09	28

TXN CD	ACT
804	A

ECM NUMBER
47

TXN CD	ACT
805	A

PRTY	RESP. LOCATION OR CONTRACTOR	PRTY	ASSISTING CONTRACTOR	PRTY	ASSISTING CONTRACTOR
66	67	71			
	036N				

TXN CD	ACT
807	A

PURCHASE REQUISITION NUMBER	PURCHASE ORDER NUMBER
59	66 67

TXN	ACT
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.

Douglas M. Howle 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 DMM

TEX 7702
TEC 7906

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

98

9/24/80

TMI - UNIT #2

PL

HOPPER/SMITH J.

12th

"

"

NEED Pomano Female 3562

" MALE 3563

" 1269 BNL TO BANANA

STARTED PROCDURE 105, NI-AMP-2

HOPPER/~~SMITH~~ 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) ≈ 1600 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
SHOULD LIFE OF BF₃ ~ 3 YR.

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

(15) TOMORROW ENTRY TO CONTAINMENT.
WILL CONNECT SPARE BF₃

* POWER OFF ON BOTH DETECTORS ~ 1.5 YR.

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