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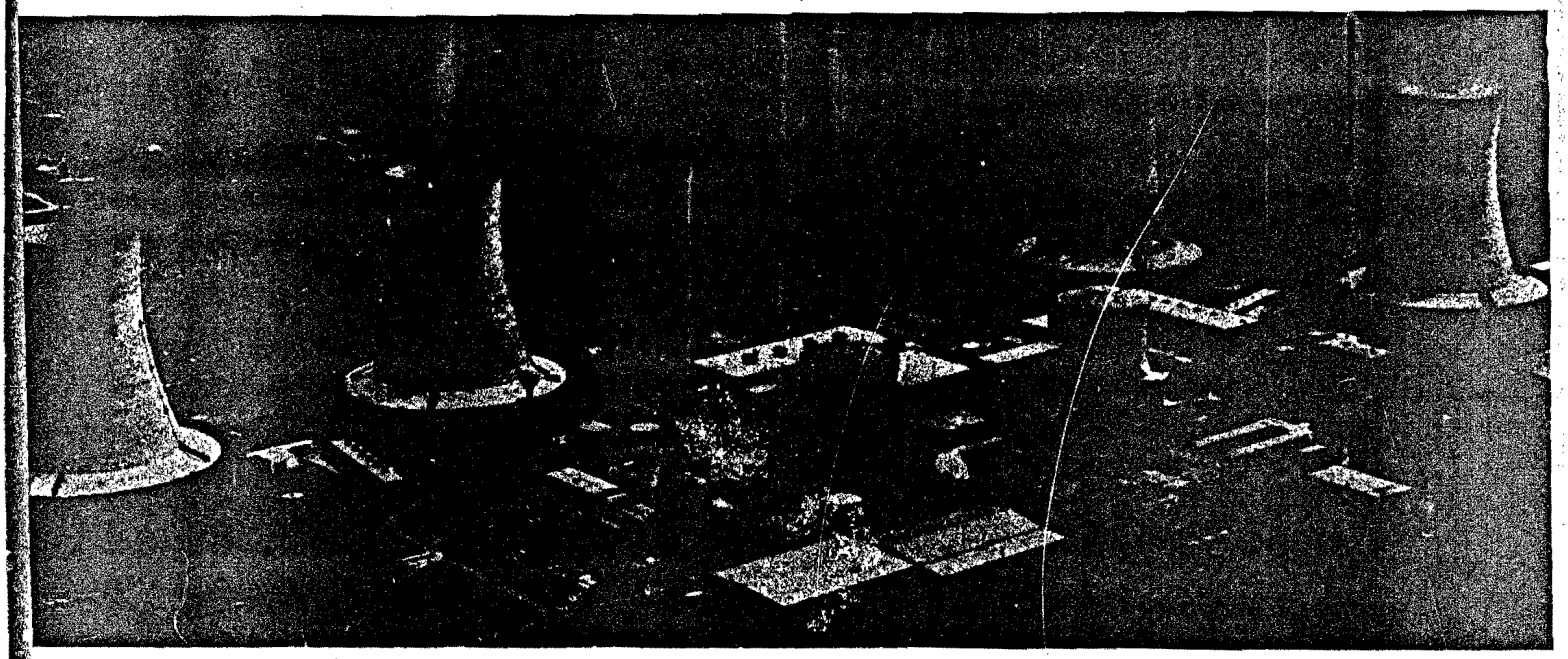

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Field Measurements and Interpretation of TMI-2

Instrumentation: NI-AMP-2

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

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Volume XI

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

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MSW

LIST OF FIGURES

LIST OF TABLES

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 BF_3 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 20-81. 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_3 proportional counter connected to a Bailey system 880 preamplifier. This instrument has a normal range of .1 to 10^6 counts per second producing an output of 0 to 2 volts. The functional diagram of the preamplifier unit is shown in Figure 2-2.

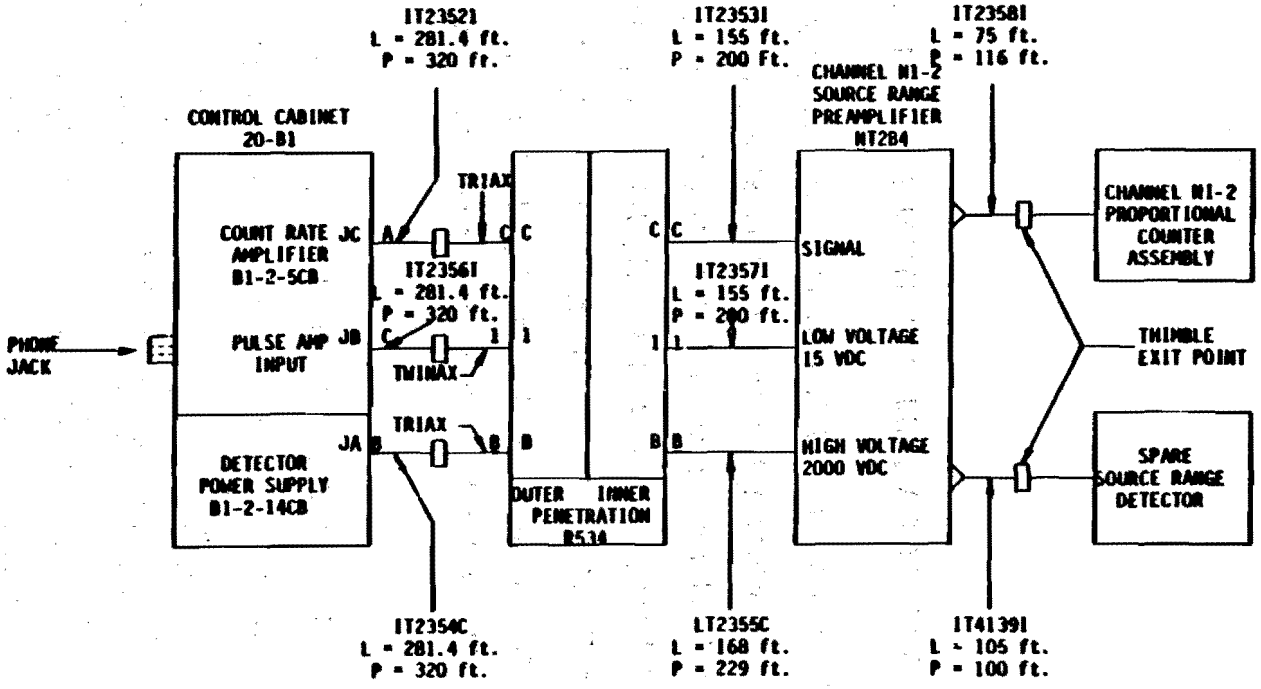


Figure 2-1. Composite Electrical Diagram for NI-AMP-2.

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

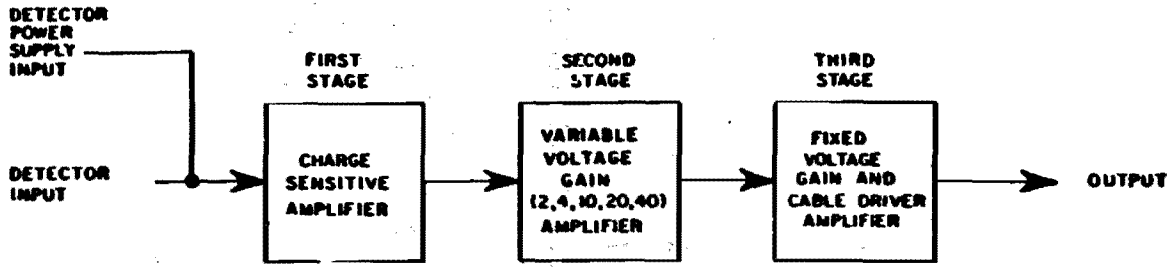


Figure 2-2. Functional Diagram of Preamplifier Assembly.

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

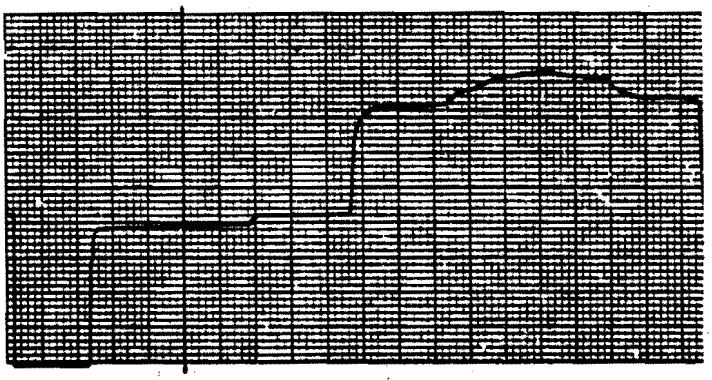
Signal	Capacitance (nF)			Impedance (ohms)			Resistance (ohms)**
	100 Hz	1 kHz	100 kHz	100 Hz	1 kHz	100 kHz	
Signal Signal Return	2 pF	.3 pF	0	OF*	OF	16.5M	OF
Low Voltage Low Voltage Return	20 µF	7.6 µF	-12	119	28	128	731 (727)
High Voltage High Voltage Return	16	6.8	7.8	OF	OF	146	OF
Signal Return Low Voltage Return	25	OF	-18	OF	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 - 500μΩ/div

Range - 52.6 ft/div

Sensitivity - 0.25

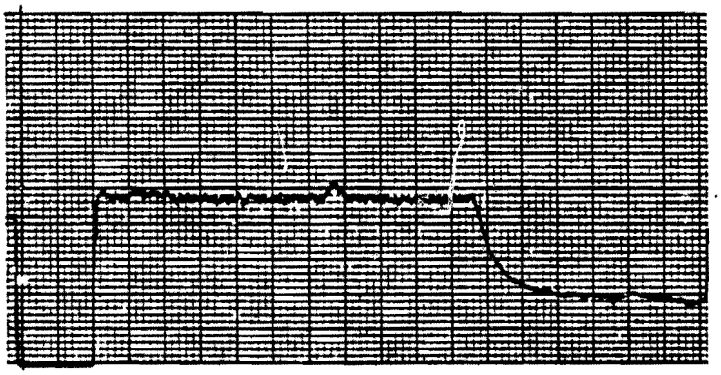
Filter - 15 Hz

Cable dielectric - poly

Figure 4-1. TDR Trace of Signal Cable.

STRIP CHART 105-2

Cable - IT2356 (Low Voltage)



Setting - 500μρ/div

Range - 52.6 ft/div

Sensitivity - 0.25

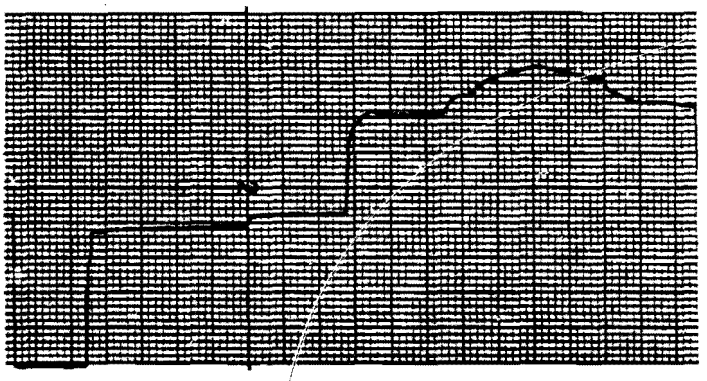
Filter - 15 Hz

Cable dielectric - poly

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

STRIP CHART 105-3

Cable - IT2354C (High Voltage)



Setting - 500μΩ/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

GENERATION CORRECTIVE MAINTENANCE SYSTEM

305-5 JOB TICKET FORM (WOR[illegible] MILE ISLAND UNIT 2

Page A-1

COMPONENT IDENTIFICATION SYS	COMP TYPE	COMP ID	LOCATION, UNIT	JOB TYPE	[illegible] & WEEK	REQUIRED DATE MO	DAY	YR	RECOMMENDED PRIORITY
AI	DEV	0002	036002CM[illegible]	CE	70	09	22	80	2

DESCRIBE MALFUNCTION OR MODIFICATION DESIRED: Perform attached procedure.

CAUSE OF MALFUNCTION (IF KNOWN):

ORIGINATOR'S EMP. NO.	ORIGINATOR'S SIGNATURE	DATE	SUPERVISOR'S EMP. NO.	SUPERVISOR'S SIGNATURE	DATE
0675	J A Brunner	9/22/80	0675	J A Brunner	9/22/80

DOG/EGAE Project

WORK ORDER NUMBER LOCATION	SERIAL	GC CODE	ACCOUNT NUMBER	PLANT CONDITION SU	OP	MO	CO	RF		MS	LR	NPRD FAILURE YR	MO	DAY	START HR	MIN
0360	00197	GA	78760	1	1	1	1	1		1	1					

CHANGE MOD REQ	A N S	NUC SAFETY	NP RD	REG AGENCY CODE	CHG/MOD NUMBER
0	9	1	0		

ENV CODE	OUTAGE CAUSE CODE
X	

STATUS HOLD CODE

S M APPROVAL COMMENCE WORK MO	DAY	YR
09	23	80

PRIORITY	RESP LOCATION OR CONTRACTOR
2	036M

Limits and Precautions:

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

a) Personnel

b) Equipment

c) Environment

d) Nuclear

Post Maintenance Testing required and Acceptance Criteria

ENSURE WORK AREA CLEANED 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 [illegible]

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:

    RE Burkhart Date 9/23/80

11. Maintenance Foreman Assigned: [illegible]

12. Code Inspector Notified. Name: _____ Date _____

13. Shift Foreman's approval to commence work: Jack Harris Date 9/24/80

    _____ Initial if Shift Foreman signature is not required.

WORK REQUEST PROCEDURE

TMI Nuclear Station

Maintenance Proc[illegible] Approval

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 R E Wright Date 9/22/80
Engineering Maint. Coordinator Date 9/22/80

* PORC RECOMMENDS APPROVAL

Unit No. 1 Chairman _____ Date _____ Unit No. 2 Chairman W. F. Lynch Date 9/23/80

* UNIT SUPERINTENDENT APPROVAL

Unit No. 1 _____ Date _____ Unit No. 2 [signature] Date 9/23/80

* Standing Procedure _____ Date _____
Supervisor or Designee

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

TM 84 3-78

TEC 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 M.V. Mathis, Director, Tech. Serv. Div.	DATE 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 integretary measurements on the appropriate instrumentation cables by inserting test signals on appropriate conductors of Cables

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 starti. 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/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 triaxal test adaptor and cable for direct measurements on field wire signals.

TERMINAL	SIGNAL IDENT.
JC (IT2352I)	SIGNAL
JB (IT2356I)	LOW V(15VDC)
JA (IT2354C)	HIGH V(2400VDC)

Q-TS JS 9/24/80
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		
Frequency	100 Hz	1 kHz	100 kHz	100 Hz	1 kHz	100 kHz
a. JC-Sig: JC-Ret	2nF / 10nF	.3nF / 6.8nF	-.008nF / 7.8NF	OF / OF	OF / OF	16.5meg / 179° / 116 / -135°
b. JB-Sig: JB-Ret	20nF	7.6nF	-12NF	119 / -41°	28 / -48°	128 / -77°
c. JA-Sig: JA-Ret	16NF	6.8NF	7.8NF	OF	OF	116 / -135°
d. JC-Sig: JB-Sig	47NF / 80NF	55NF	-1.6NF	OF	2.4K / -57°	476 / 81°
e. JC-Sig: JA-Sig	1NF / 7NF	1.7NF	770 OF	150K / -30°	57K / -38°	1.4K / -67°
f. JB-Sig: JA-Sig	24NF	8NF	-1.7NF	31K / -28°	16K / -54°	856 / 63°
g. JC-Ret: JB-Ret	+.025NF	OF	-18NF	OF	2.3K / -89°	872 / 47°
h. JC-Ret: JA-Ret	68NF	65NF	-109NF	OF	2.5K / -80°	15.9 / 70°
i. JB-Ret: JA-Ret	71NF	68NF	-31NF	OF	2.3K / -85°	61 / 127°

T. S. 9/21/90
Signature/Date

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

Record data below:

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

TSN 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.

20K RANGE

			POLARITY From = +; To = -	POLARITY From = -; To = +
TEST POINT	FROM LINK	TO LINK	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	.7K	.8K
h.	JC-Ret	JA-Ret	~	~
i.	JB-Ret	JA-Ret	~	~

TSN
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 triaxal 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.

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

SIGNAL	READING IN CPS
NI-AMP-2 Readout	

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 ± 1%) measure the DC Voltage or current 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	TEST LEAD	READING
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-2 | NO. TP-105 | REV. 1

SIGNAL†	CABINET 20	PARAMETER	PHOTO #
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.

TERMINAL	SIGNAL IDENT.
JC	SIGNAL
JB	LOW V(15VDC)
JA	HIGH V(2400VDC)

Signature/Date

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)

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 Ampl Range Mult	Strip Chart Number
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.

			POLARITY From = +; To = -	POLARITY 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

COMPONENT DESIGNATOR				LOCATION UNIT	JOB TYPE	WORK AUTHORIZATION NUMBER	REQUEST DATE		
SYS (5–8)	COMP. TYPE (8–12)	COMP. ID. (12–16)	LOOP	(17–22)	(23–24)	(28–32)	MO (33)	DAY	YR (36–38)
NF	DET	0003		036002	CM	C-1-02	09	12	80

TXN CD (1–4)	ACT 4	ECM NUMBER (47–51)
804	A	

TXN CD (1–4)	ACT 4	PRTY (66)	RESP. LOCATION OR CONTRACTOR (67–71)	PRTY	ASSISTING CONTRACTOR	PRTY	ASSISTING CONTRACTOR
805	A		2036N				

TXN CD (1–4)	ACT 4	PURCHASE REQUISITION NUMBER (59–66)	PURCHASE ORDER NUMBER (67–73)
807	A		

TXN (1–4)	ACT 4	STATUS HOLD CODE (39–40)	START DATE (41–45)	RELEASE DATE (47–52)	% COMPL (53–55)	S/M APPROVAL TO COMMENCE WORK MO DAY YR (56–61)	FIELD WORK COMPLETION DATE MO DAY YR (62–67)
810	A						

01	OUTAGE HOLD
02	PART HOLD
03	QUALITY CONTROL PART HOLD
04	QUALITY CONTROL PROCEDURE HOLD
05	OPERATIONS HOLD
06	CHANGE MODIFICATION HOLD
07	ENGINEERING HOLD
08	PLANNING HOLD
50	MANPOWER NOT AVAILABLE
51	AT PORC
52	AT QUALITY CONTROL
53	AT UNIT SUPERINTENDENT
54	AT READING
55	POST MAINTENANCE TEST HOLD
56	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

ElectroRent

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. Howe 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	0C01556	1-8-81

4408	VALHALLA DMM	TGK 7702	CAL DOTG	8/8/80
177	KEITHLEY DMM	TEC 7906	" "	8/4/80

98

9/24/80

PL

TMI - UNIT #2 HOPPER/SMITH J.

12 EA NEED POMONA FEMALE 3562
" " MALE .3563
" " 1269 BNC TO BANANA

STARTED PROCEDURE 105, NI-AMP-2
HOPPER/~~[illegible]~~ 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 1/1000 PLUG ON H.V. POWER SUPPLY WITH VOLTMETER. READING ≈ .240 VOLT / 1000
3) TURN POWER "OFF"
4) REMOVE H.V. CABLE
5) TURN POWER "ON" (HV)
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 HV MODULE (OK)

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

12) TERMINATED TEST ON NI-AMP-2

13) FROM DOUG WEAVER, I+C FOREMAN SHELF LIFE of BF_3 = ~ 3 YR.

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

(15) TOMORROW ENTERING TO CONTAINMENT. WILL CONNECT SPARE BF_3

POWER OFF ON BOTH DETECTORS ~ 1.5 YR.

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