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RECOMMENDATIONS FOR TMI-2 INSTRUMENTATION SURVEILLANCE PROGRAM

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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) proposed that a surveillance program be implemented to monitor the status of selected TMI-2 instruments during the decontamination process. This monitoring could provide insight into instrumentation degradation under adverse conditions or effects of hostile environments on cable junction points (terminal blocks).

From a review of previous TMI Unit 2 instrumentation and electronic measurements data, the operability or failure of certain plant instrumentation was determined. This review process consisted of discussions with on-site plant personnel, analysis of previous data recordings, and obtaining line drawings of sensor and electronics installations. (A detailed summary of the recorded data available from TMI-2 can be found in TEC Report R-81-002 dated January 1981.)

This report presents a list of recommended instruments to be included in this surveillance program. In addition, a list of recommended test equipment is provided for performing measurements and a set of general measurement procedures is provided for selected instrument types.

2. LIST OF INSTRUMENTS AND ASSOCIATED MEASUREMENTS

As discussed on September 5, 1980, the Measurements Program at TMI-2 was loosely defined as consisting of:

1. Noise analysis of operable and inoperable pressure and level sensors
2. Noise analysis of selected radiation monitors and ex-core instruments
3. Noise analysis measurements on certain loose parts monitoring sensors
4. LCSR time response measurements of certain main coolant loop RTD's
5. Resistance and capacitance tests of selected in-core neutron detectors and thermocouples
6. Temperature readings as a function of resistive load across thermocouples on Unit 2 in-core thermocouples.

Each of these will be defined more completely in the following discussion, particularly with respect to specific instrumentation, types of measurements, and reasons for the selection. Due to unknown conditions and failure modes, measurements may provide information about the sensor or about associated signal conditioning and, as a result, the following discussion may refer to the two interchangeably.

2.1 NOISE ANALYSIS OF OPERABLE AND INOPERABLE PRESSURE AND LEVEL SENSORS

The instruments identified in Table 2.1 were used to monitor levels and pressures during the transient and most have failed--probably due to immersion in water. Comparison of data from failed instruments to those still operating (especially Core Flood Tank instruments) could provide insight into failure modes.

Table 2.1

LIST OF PRESSURE AND LEVEL SENSORS FOR TESTING

Instrument	Description
RC-1-LT1	Pressurizer Level 0-400"
RC-1-LT2	Pressurizer Level 0-400"
RC-1-LT3	Pressurizer Level 0-400"
RC-3A-PT1	RC Hot Leg A Pres 1700-2500 psig
RC-3A-PT2	RC Hot Leg A Pres 1700-2500 psig
RC-3A-PT3	RC Hot Leg A Pres 0-2500 psig
RC-3A-PT4	RC Hot Leg A Pres 0-2500 psig
RC-3B-PT2	RC Hot Leg B Pres 1700-2500 psig
RC-3B-PT3	RC Hot Leg B Pres 0-2500 psig
SP-1A-LT3	Steam Gen A Level 0-291.5"
SP-1A-LT5	Steam Gen A Level 0-291.5"
SP-6A-PT1	Steam Gen A Outlet Pres 0-1200 psig
SP-6A-PT2	Steam Gen A Outlet Pres 0-1200 psig
SP-1B-LT2	Steam Gen B Level 0-291.5"
SP-1B-LT4	Steam Gen B Level 0-291.5"
SP-6B-PT1	Steam Gen B Outlet Pres 0-1200 psig
*IC-10-dPT	Control Rod Driver Bypass Flow
*CF1-PT3	Core Flood Tank Pressure
*CF2-LT4	Core Flood Tank Level
*CF1-PT4	Core Flood Tank Pressure
*CF2-LT2	Core Flood Tank Level

*Note: Some measurements performed during Early Entry Program.

Tests to be performed are similar to those performed during previous early entry measurements. Tests consist of passive measurements (signal recording, time domain output waveforms, frequency analysis) and active measurements requiring removal of instrument power [capacitance, impedance, TDR (time domain reflectrometry), resistance]. These tests require only one instrument at a time to be removed from service, which should present no operations problems (especially since most have failed). Experience gained from early entry measurements will ensure proper precautions are taken to protect plant instrumentation.

2.2 NOISE ANALYSIS OF SELECTED RADIATION MONITORS AND EX-CORE INSTRUMENTS

The instruments identified in Table 2.2 are used to monitor radiation levels of either personnel areas or in the reactor core. The four (4) area radiation monitors were tested during the Early Entry Program, and the need to test additional specimens is not clear. Since NI-ND-1 was used to monitor the core condition during the transient and a NI-ND-2 replacement was attempted during manned entries, it is desirable to compare operating characteristics to determine possible problems in the original NI-ND-2 (or NI-AMP-2). For completeness, the characteristics of the IRM and PRM instrumentation should be measured to determine potential degradation.

Most tests to be performed are similar to early entry tests performed on NI-AMP-2 (signal recording, spectral analysis, capacitance and impedance measurements). One desirable new measurement would be recording noise from the IRM and PRM detectors simultaneously to determine any common

Table 2.2

LIST OF RADIATION MONITORS AND EX-CORE INSTRUMENTS FOR TESTING

Instrument	Description
HP-RT-211	Area Radiation Monitor
HP-RT-212	Area Radiation Monitor
HP-RT-213	Area Radiation Monitor
HP-RT-214	Dome Radiation Monitor
NI-AMP-2	Source Range Detector, Amplifier
NI-ND-1	Source Range Detector
NI-ND-2 (and modification)	Source Range Detector
NI-ND-3	Intermediate Range Detector
NI-ND-4	Intermediate Range Detector
NI-ND-5	Power Range Detector
NI-ND-7	Power Range Detector

*Note: Some measurements performed during Early Entry Program.

signals. Except for the testing of NI-ND-1, these tests should not affect plant operations. Since NI-ND-1 was being used to monitor the core condition, this test could be omitted if the replacement SRM is not operational.

2.3 NOISE ANALYSIS MEASUREMENTS ON CERTAIN LOOSE PARTS MONITORING SENSORS

Vibration preamplifiers YM-AMP-7023 and YM-AMP-7025 were tested during the Early Entry Program and due to the condition of the LPM system (i.e., currently being replaced) further measurements are not considered important at this time.

2.4 LCSR TIME RESPONSE MEASUREMENTS OF CERTAIN MAIN COOLANT LOOP RTD's

The instruments identified in Table 2.3 are all Rosemount RTD's (RC-2 and RC-15 are model 104AFP; RC-4 and RC-5 are model 177HW, dual) and were used to measure hot leg/cold leg temperatures during the transient. Since these instruments have been operating in abnormal conditions for months, are possible candidates for removal and study, and have long term output records available, they could be extremely important indications of RTD behavior under severe conditions.

The tests to be performed consist of:

1. Recording background signals from functioning temperature circuits (passive test) at a convenient test point
2. Removal of RTD from service and measurements of wire-to-wire resistances of both elements, where applicable (active test)
3. Removal of RTD from service and performing at least five (5) LCSR tests utilizing TEC 1100-series instrumentation (active test).

Table 2.3

LIST OF MAIN COOLANT LOOP RTD'S FOR TESTING

Instrument	Description
RC-4A-TE2	Hot Leg A Temp 520-620°F RTD
RC-4A-TE4	Hot Leg A Temp 520-620°F RTD
RC-4B-TE1	Hot Leg B Temp 520-620°F RTD
RC-4B-TE3	Hot Leg B Temp 520-620°F RTD
RC-5A-TE2	Cold Leg A Temp RTD
RC-5A-TE4	Cold Leg A Temp RTD
RC-5B-TE1	Cold Leg B Temp RTD
RC-5B-TE3	Cold Leg B Temp RTD
RC-2-TE1	Pressurizer Temperature 0-800°F RTD
C-2-TE2	Pressurizer Temperature 0-800°F RTD
RC-15A-TE1	Hot Leg A Temp 0-800°F RTD
RC-15B-TE1	Hot Leg B Temp 0-800°F RTD
RC-15A-TE2 (or TE3)	Cold Leg A Temp 0-800°F RTD
RC-15B-TE2 (or TE3)	Cold Leg B Temp 0-800°F RTD

These tests will require that only one RTD at a time be removed from service and should not present a problem to plant operation. Protection of plant instrumentation shall be provided by proper isolation and/or control of test signals to be defined in final test procedures.

2.5 TEMPERATURE READINGS AS A FUNCTION OF RESISTIVE LOAD ACROSS THERMOCOUPLES ON UNIT 2 AND RESISTANCE AND CAPACITANCE TESTS OF SELECTED IN-CORE NEUTRON DETECTORS AND THERMOCOUPLES

The thermocouples identified in Table 2.4 were used to monitor the core temperatures during the transient and many experienced extremely high temperatures. This list represents about half of the total and includes those which do not seem to be reading correctly as well as surrounding thermocouples. During the transient, the SPND's identified in Table 2.5 exhibited off-scale behavior which is still unexplained, and measurements would be valuable in understanding the phenomena. The first six (6) SPND locations were not failed when tested on April 4, 1979, and should provide contrasting data.

Tests to be performed will require removing one instrument at a time from service during testing and should not present a plant operations problem. Tests will consist of measurements of resistance and capacitance on the instruments as well as applying a loading resistance to thermocouples and measuring the indicated temperature response. During these tests, a TDR measurement should also be performed. To enable comparison with a non-degraded thermocouple/SPND assembly, tests on a spare assembly mock-up would be desirable.

Table 2.4

LIST OF THERMOCOUPLES FOR TESTING

Instrument	Location
Thermocouple	B-7
Thermocouple	B-8
Thermocouple	D-10
Thermocouple	E-4
Thermocouple	E-7
Thermocouple	E-11
Thermocouple	F-7
Thermocouple	F-8
Thermocouple	F-12
Thermocouple	F-13
Thermocouple	G-5
Thermocouple	G-6
Thermocouple	G-9
Thermocouple	H-8
Thermocouple	H-9
Thermocouple	K-5
Thermocouple	K-12
Thermocouple	L-6
Thermocouple	L-13
Thermocouple	M-9
Thermocouple	M-10
Thermocouple	M-14
Thermocouple	N-8
Thermocouple	R-10

Table 2.5

LIST OF SPND'S FOR TESTING

Instrument	Location	Levels
SPND	E-4	1, 2, 6, 7
SPND	H-9	1, 5, 7
SPND	R-10	1, 4, 6, 7
SPND	N-8	3, 4, 6
SPND	H-8	8 (BKG), 1, 5, 6
SPND	C-13	5, 7
SPND	G-5	1, 3, 5, 8
SPND	L-13	2, 4, 7, 8
SPND	E-11	1, 4, 6, 7, 8
SPND	F-8	2, 5, 6, 8
SPND	M-9	1, 3, 6, 7, 8

3. TESTING INTERVALS

The schedule for performing measurements should consist of an initial series of tests on the entire list of instrumentation to obtain a current data base. Periodically, on a six month cycle, measurements should be repeated to determine any changes in instrument behavior with time. In addition to this periodic schedule, specific tests should be performed both before and after any procedure which alters the environment in which the instrument is operating. (An example of such a change would be decontamination of the area in which the cabling, junction box, or sensor is located.) From discussions with plant personnel, this surveillance plan would be helpful to the TMI-2 staff while providing necessary information concerning instrumentation degradation.

4. RECOMMENDED TEST EQUIPMENT

To perform the surveillance measurements on the TMI-2 instrumentation, a set of test equipment is needed. To carry out similar measurements, TEC has used the following test equipment:

1. Tektronix Model 1502 Time Domain Reflectometer with strip chart recorder.
2. Hewlett Packard Model 4274 Multifrequency LCR Meter.
3. Hewlett Packard Spectrum Analyzer (Model 141T with 8553B and 8552B modules).
4. Nicolet Model 444A-26 Spectrum Analyzer with plotter output and platter.
5. Tektronix Model SC502 Oscilloscope with matching scope camera.
6. Lockheed Store-4 Recorder with both FM and Direct record modules.
7. Keithley Model 177 DMM.

This list of equipment is not the only possible choice, but any substitutions should be made with equipment of equal or better quality. If substitutions are made, replacement equipment for passive measurements (spectral analyzer, oscilloscope) should have at least 10^6 ohms input resistance to prevent loading on the signal lines. Similarly the active measurements (i.e. introduction of a test signal into the instrument being tested) should have characteristics equal to or better than the values listed in Table 4-1.

Table 4-1

RECOMMENDED CHARACTERISTICS OF ACTIVE MEASUREMENTS

Active Signal Parameter	Time Domain Reflectometry	Impedance
Voltage	225 mV nominal (into 50 ohm base)	≤ 5V rms
Frequency	---	1000Hz, lkHz, 100kHz
Current	≤ 10mA	≤ 100 mA
Other (TDR)	225mV, 110 picosecond pulses	---

5. INTERPRETATION OF MEASUREMENTS

Interpretation of the measurements taken on field instruments are difficult to discuss due to the variety of problems that may arise. However, general guidelines can be stated to assist in a field assessment of potential problems. Detailed analysis of the instrumentation circuitry may be required to predict the possible causes of a problem, but such analysis is beyond the intent of this discussion.

The major steps required in the interpretation of measurements (and in the procedure preparation) can be summarized as:

1. Develop a composite electrical diagram for the instrument being tested that shows the cabling and junctions from the sensing assembly to the final readout modules.

2. Review the manufacturer's technical explanation of the theory of operation of the instrumentation and identify power supply requirements as well as expected output signal(s).

3. If possible, obtain a similar instrument (fully operational) and perform measurements to obtain a reference set of expected responses. (This is particularly important on complex circuits when attempting to understand resistance measurements).

4. Measure signal characteristics on the selected instrument. Measurements should consist of at least the following:

   a. Readout module indication
   b. Power supply and signal levels
   c. Time domain waveforms of signal and lines
   d. Frequency domain spectra of signal and supply lines
   e. Resistance (possibly capacitance and impedance) of signal and supply leads
   f. Time Domain Reflectometry (TDR) measurements on cables.

5. Compare observed values to expected values for all measurements to determine if there is any indication of a significant change. If there is, perform a review of the instrument operation manual to determine if the change is a possible aging effect or some degradation.

For the steps described above, all are easily understood except for the final analysis to determine a potential failure indication. Guidelines that have been developed during previous TMI-2 instrument measurements provide an overall indication of "what-to-look-for" in the field data:

1. Excessive AC fluctuations or out-of-range measurements on the power supply. Most supplies will have a low level 60 Hz or 120 Hz variation with amplitudes of the order of 10-20 mV RMS. However, excessive variation amplitudes or out-of-range measurements could be an indication of a power supply problem.

2. A change in the characteristics from the expected signal described in the instrument operations manual. If the proper power is being supplied to the instrument, any variation in the output character indicates instrument degradation. The extent of the problem could then be determined by more detailed analysis.

3. A change in the resistance (or capacitance or impedance). This information is useful only if the circuitry of the instrument is simple enough to easily describe the expected response or if measurements have been previously made on a similar instrument. Note that some variation would be expected in these values due to cabling differences and aging effects (environmental).

4. A large resistance change or unexpected resistance change measured by the TDR. As before there will be a natural change in cable resistance due to aging, so some interpretation of what represents a "large" resistance change must be made. However, an unexpected change in resistance of even small amplitudes can indicate a defective cable if no junction normally exists at that point.

Much more analysis will be required to predict the cause of a suspected failure, but the above guidelines can help in performing a fast field evaluation of the data. In addition, if a regular surveillance program is implemented on an instrument, a comparison of newly acquired data to previous data will provide an excellent field interpretation of degradation just by checking for any changes in the data.

6. MEASUREMENT PROCEDURES

This section presents measurement procedures for instrument types identified for surveillance. Several of these procedures are detailed due to their use in previous measurements made on selected TMI-2 instruments. Others are more general, but include a step-by-step summary of the necessary measurements.

6.1 Procedure for Performing Measurements on an Area Radiation Monitor

IN-SITU MEASUREMENTS OF CABLES AND
SIGNALS FROM AREA RADIATION MONITOR
HP-R-213

M.V. Mathis, Director, Tech. Serv. Div.

PURPOSE: The purpose of these measurements is to gather baseline data and information in preparation for possible removal and replacement of Area Radiation Monitor HP-R-213 from the reactor building TMI Unit 2. The tests specified in this procedure are designed to assess the condition of the in-containment instrument module (gamma detector), associated cabling, and readout devices. This assessment will require the use of Time Domain Reflectometry (TDR), Impedance (Z), Spectral Analysis (frequency domain), special calibration measurements, and general oscilloscope observations (with recording) of waveforms from/to the unit under test (UUT).

PROCEDURE (ADMINISTRATIVE):

A. Limitations and Precautions

1. Nuclear Safety. Area radiation monitor HP-R-213 is part of a redundant ARM system at elevation 347'. The unit is not considered part of the engineered reactor safeguards system thus has no nuclear safety relevance.

2. Environmental Safety. Area radiation monitor HP-R-213 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 calibrations and tests.

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

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM AREA RADIATION MONITOR HP-R-213

integretary measurements on the appropriate instrumentation cables by inserting test signals on appropriate conductors of Cable IT1871I (terminations shall be removed and replaced on TB111 of Cabinet 12). Should these tests reveal cable integretary problems further verification measurements will be made at TB1 of the appropriate Remote Alarm/Meter (Victoreen Model 858-3) located in the anteroom.

Table 4-1 Active Measurements

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

d. In the calibration verification measurements section, baseline data on the as-found condition will be recorded prior to the performance of any adjustments or electronic calibrations.

B. Prerequisites

1. The Shift Supervisor/Shift Foreman shall be notified for concurrance prior to the performance of those 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 starting and upon completion of the measurements.

C. Procedure for Performing Measurements

<u>References</u>:

1. Victoreen Dwg. No. 904550, Wiring Diagram Area Monitors Channels HP-R-213 & HP-R-214 (Sheet 6 of 11).

2. Instruction Manual for G-M Area Monitoring Systems, Model 855 Series Victoreen Part No. 855-10-1.

3. Burns & Roe Dwg. 3024, Sh. 304.

4. Burns & Roe Dwg. 3347, Sh. 6K.

5. Burns & Roe Dwg. 3043, Sh. 16D.

6. Burns & Roe Dwg. 3045, Sh. 26B.

7. Burns & Roe Dwg. 3045, Sh. 34.

8. Burns & Roe Dwg. 3045, Sh. 26F.

9. Burns & Roe Dwg. 3034, Sh. 34B.

10. Instruction Manual, Tektronix model 1502 Time Domain Reflectometer.

11. Instruction Manual, Hewlett Packard Model 4274 Multifrequency LCR Meter.

12. Instruction Manual, Hewlett Packard Spectrum Analyzer (Model 141T, 8553B, 8552B Modules).

13. Instruction Manual, Nicolet Model 444A-26 Spectrum Analyzer.

14. Instruction Manual, Tektronix Model 335 Oscilloscope.

15. Instruction Manual, Lockheed Store-4 Recorder.

16. Instruction Manual, Tektronix SC502 Oscilloscope.

17. TEC Composite Electrical Connection Diagram, HP-R-213 (see attached).

Victoreen Instrument Company Dwg. 904550 (Ref. 1) and B&R Drawings 3024 (Ref. 3) show the appropriate termination points for passive measurements of signals from HP-R-213 as follows:

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM AREA RADIATION MONITOR HP-R-213

Signal	Cable IT1871I		Cabinet 12
+10V			TB111-8
600V			TB111-5
SIG			TB111-6
GND			TB111-10
CS			TB111-1
CS			TB111-2

NOTE

Selected steps will be completed on an identical Victoreen Area Radiation Monitor Detector with attached interface connector and terminal block to characterize signals and gather baseline data before the performance of this measurement.

STEPS

1. Notify Shift Supervisor/Shift Foreman of start of test on HP-R-213.

2. Verify power is applied to HP-R-213.

____
Signature/Date

3. Record present signals and readings and indications on 856-2 Readout Module (Local). Record Signal-in at TB111-6/7 and record output for 30 minutes on FM Tape Recorder. Remove recorder when finished.

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM AREA RADIATION MONITOR HP-R-213

Meter/Indicator/Switch	Local
mR/hr Meter Reading	________
Off-Operate-Alarm Function Switch	________
Fail Safe Indicator	On____Off____
High Alarm-Reset Indicator	On____Off____

____
Signature/Date

4. Using a Keithley Model 177 DMM (or equivalent) and an electrostatic voltmeter ($Z_i \geq 10^{12}$ OHMS, Range 0-2000 V, Precision = $\pm$ 1%) measure the DC voltage or current at the following test points.

NOTE: For signal d. it will be necessary to depress Fail-Safe Check Source push button during the measurement.

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM AREA RADIATION MONITOR HP-R-213

SIGNAL	CABINET 12	TEST LEAD	READING
a.	TB111-8 TB111-10	(+) (-)	(10V) ________
b.	TB111-6 TB111-7	(+) (-)	(SIG IN) ______ ______ CS OUT CS IN
*c.	TB111-5 TB111-10	(+) (-)	(600V) ________
**d.	TB111-1 (open field side) TB111-1 (cabinet side)	(+) (-)	(≤500 mA est.) _______

*Use electrostatic voltmeter
**Link closed after measurement

Signature/Date

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM AREA RADIATION MONITOR HP-R-213

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

SIGNAL	CABINET 12	PARAMETER			
a.	TB111-1 TB111-10	CS	Photo ____ Time Base ____ Vert Gain ____	Photo ____ Time Base ____ Vert Gain ____	Photo ____ Time Base ____ Vert Gain ____
b.	TB111-2 TB111-10	CS	Photo ____ Time Base ____ Vert Gain ____	Photo ____ Time Base ____ Vert Gain ____	Photo ____ Time Base ____ Vert Gain ____
*c.	TB111-5 TB111-10	+600V	Photo ____ Time Base ____ Vert Gain ____	Photo ____ Time Base ____ Vert Gain ____	Photo ____ Time Base ____ Vert Gain ____
d.	TB111-6 TB111-7	SIG	Photo ____ Time Base ____ Vert Gain ____	Photo ____ Time Base ____ Vert Gain ____	Photo ____ Time Base ____ Vert Gain ____
e.	TB111-8 TB111-10	+10V	Photo ____ Time Base ____ Vert Gain ____	Photo ____ Time Base ____ Vert Gain ____	Photo ____ Time Base ____ Vert Gain ____
f.	TB111-10 TB501-33	GND ACGND	Photo ____ Time Base ____ Vert Gain ____	Photo ____ Time Base ____ Vert Gain ____	Photo ____ Time Base ____ Vert Gain ____

*Decouple DC Voltage.

Sync the oscilloscope and photograph the waveform using up to three time base and vertical gain settings. (The necessity of 3 photographs will be determined by visual analysis by the field engineer.) Mark the back of the photographs with the instrument tag number and parameter measured.

____
Signature/Date

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM AREA RADIATION MONITOR HP-R-213

6. Using a Hewlett-Packard Spectrum Analyzer (Models 141T, 8553B, and 8552, or equivalent) perform an analysis of the following signals for spectral content:

SIGNAL	CABINET 12	PARAMETER	PHOTO #
a.	TB111-8 TB111-10	+10V GND	______
b.	TB111-6 TB111-7	SIG IN GND	______
*c.	TB111-5 TB111-10	+600V GND	______

*Decouple DC voltage max input to Spectrum Analyzer (50VDC)

Before photographing each scope display adjust analyzer for best spectral resolution. Record critical analyzer parameters e.g., RF bandwidth, RF band-width and sweep speed on rear of photograph as well as parameter analyzed.

SPECTRUM IDENT	FREQUENCY	AMPLITUDE	REMARKS

Signature/Date

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM AREA RADIATION MONITOR HP-R-213

7. Using the Nicolet Model 444 FFT Analyzer (or equivalent) perform FFT analysis of signals from the following test points:

SIGNAL	CABINET 12	PARAMETER	PHOTO #
*a.	TB111-5 TB111-10	+600V GND	
b.	TB111-6 TB111-7	SIG IN GND	
c.	TB111-8 TB111-10	+10V GND	

*Decouple DC voltage input to Spectrum Analyzer (50VDC Max input)

If PSD plots from any one of the three signals show high or unusual amplitudes, utilize the zoom feature to provide finer resolution and obtain PSD data in the frequency band of interest.

Signature/Date

8. Inside Cabinet 12 perform usual electronic calibrations using applicable instrument shop procedures. Attach a copy of the instrument shop calibration data sheet and identify any significant adjustments in the space below:

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM AREA RADIATION MONITOR HP-R-213

Procedure Step	Remarks
See attached instrument shop procedure data sheet.	

Instrument Shop Procedure No. ________

____
Signature/Date

9. Remove all power from HP-R-213 (Tag Open TB501 links 31, 32, and 33 per procedure AP 1002).

____
Signature/Date

10. Open links for all field wires from Cable IT1871I at TB111 (Cabinet 12).

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM AREA RADIATION MONITOR HP-R-213

TERMINAL	SIGNAL IDENT.
TB111-1 (Blue)	C.S.
TB111-2 (Orange)	C.S.
TB111-3 (White)	Rem. Meter
TB111-4 (Yellow) IT3000C	HI N.C.
TB111-5 (RG 59/U, 72 OHM)	600V
TB111-6 (RG 58/U, 50 OHM)	SIG IN
TB111-7 (RG 58/U, 50 OHM)	Shield (for signal)
TB111-8 (Red)	+10V
TB111-9 (Green) IT3000C	Alert N.C.
TB111-10 (Blk) (RG 59/U, 72 OHM)	GND Shield

Signature/Date

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

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM AREA RADIATION MONITOR HP-R-213

TEST POINT	FROM*		TO*	
	CABLE	WIRE COLOR/TYPE [TB111-X]	CABLE	WIRE COLOR/TYPE [TB111-X]
a.	IT1871I	Blue (1)	IT1871I	Orange (-2)
b.	IT1871I	RG 59/U Center(-5)	IT1871I	RG 59/U Shield (-10)
c.	IT1871I	RG 58/U Center(-6)	IT1871I	RG 58/U Shield (-7)
d.	IT1871I	Red (-8)	IT1871I	Black (-10)
e.	IT1871I	Black (-10)(Field Side)	IT1871I	TB111-10 (Cabinet)

*Numbers in parentheses refer to TB111 terminal numbers (field side).

Record the data required below:

Test Point*	Capacitance			Impedance		
Frequency	100 Hz	1 kHz	100 kHz	100 Hz	1 kHz	100 kHz
a. TB111-(1/2)						
b. TB111-(5/10)						
c. TB111-(6/7)						
d. TB111-(8/10)						
†e. TB111-(10/10)						

*Numbers in parentheses refer to TB111 FROM/TO terminal numbers on field side.

†Field side/Cabinet side across open link.

Signature/Date

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM AREA RADIATION MONITOR HP-R-213

12. Using the Tektronix Model 1502 (or equivalent) TDR unit perform TDR measurements on the five test points given in Step 11. Record data below:

Test Point	High R @ N ft.	Low R @ N ft.	Instrument Settings Ampl Range Mult	Strip Chart Number
a. TB112-(1/3)				
b. TB112-(1/4)				
c. TB112-(1/5)				
d. TB112-(4/6)				
e. TB112-(4/7)				

Signature/Date

13. Using the Keithley Model 144 (or equivalent DMM) perform resistance measurements on the Test Points specified and record value in space provided.

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM AREA RADIATION MONITOR HP-R-213

			POLARITY From = +; To = -	POLARITY From = -; To = +
TEST POINT	FROM LINK (field side)	TO LINK (field side)	RESISTANCE	RESISTANCE
a.	TB111-1	TB111-2		
b.	TB111-1	TB111-5		
c.	TB111-1	TB111-6		
d.	TB111-1	TB111-7		
e.	TB111-1	TB111-8		
f.	TB111-1	TB111-10		
g.	TB111-2	TB111-5		
h.	TB111-2	TB111-6		
i.	TB111-2	TB111-7		
j.	TB111-2	TB111-8		
k.	TB111-2	TB111-10		
l.	TB111-5	TB111-6		
m.	TB111-5	TB111-7		
n.	TB111-5	TB111-8		
o.	TB111-5	TB111-10		
p.	TB111-6	TB111-7		
q.	TB111-6	TB111-8		
r.	TB111-6	TB111-10		
s.	TB111-7	TB111-8		
t.	TB111-7	TB111-10		
u.	TB111-8	TB111-10		

NOTE:
Close all links on TB111 (opened in Step 10) when finished with this step.

Signature/Date

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM AREA RADIATION MONITOR HP-R-213

15. Notify Shift Supervisor/Shift Foreman of end of test on HP-R-213.

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

6.2 Procedure for Performing Measurements on a Source Range Detector/Preamplifier

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

____
M.V. Mathis, Director, Tech. Serv. Div.

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 (Proportioanl 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 nulcear safety-related.

2. Environmental Safety. Source Range Detector Preamplifier NI-AMP-2 can be taken out-of and restored to services 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

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

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 cable tests.)

Table 4-1 Active Measurements

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

B. Prerequisites

1. The Shift Supervisor/Shift Foreman shall be notified for concurrence prior to the performance of those 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 starting 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-23682123682A.

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

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 and insert GPU triaxial test adaptor and cable on appropriate conductors of Cables IT2352I, IT2356I, and IT2354C.

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

Signature/Date

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

3. Remove field wires from Cables IT2352I, IT2356I, and IT2354C at JA, JB, and JC (Cabinet 20) leaving GPU triaxial test adaptor and cable attached for direct measurements on field wire signals (attached in Step 2).

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

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)

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

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

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

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

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

6. 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

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

***** ***** ***** *****

STOP

***** *****

Notify Unit-2 I&C Engineer

Before Proceeding

***** ***** ***** *****

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

7. Connect field wires from Cables IT2352I, IT2356I, and IT2354C at JA, JB, and JC (Cabinet 20) while leaving the GPU triaxial test adaptor and cable (inserted in Step 2) attached for further testing.

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	

10. Connect the FM Recorder by a Phone Jack Connector* to the Count Rate Amplifier in Control Cabinet 20-B1 and record Signal-in for 30 minutes.

*Phone Jack Adaptor and Cabling to connect the FM Recorder with the Count Rate Amplifier will be provided by GPU I&C Department.

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.

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

SIGNAL†	CABINET 20	TEST LEAD	READING
a.	JC	(+) (-)	Signal ________
b.	JB	(+) (-)	Low V (15VDC) ______
*c.	JA	(+) (-)	High V (2400VDC) ______

*CAUTION: 2400 VDC

†All measurements using GPU triaxial test adaptor and cable (see Step 2)

Signature/Date

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

NOTE: The TEC DC Decoupling Circuit is to be connected with test point JC using a GPU provided adaptor and remain connected until finishing Step 14 to insure the integrity of instrumentation; see diagram 12-1.

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

SIGNAL†	CABINET 20	PARAMETER			
a.	JC	SIG	Photo ____ Time Base ____ Vert Gain ____	Photo ____ Time Base ____ Vert Gain ____	Photo ____ Time Base ____ Vert Gain ____
b.	JB	Low Voltage (15VDC)	Photo ____ Time Base ____ Vert Gain ____	Photo ____ Time Base ____ Vert Gain ____	Photo ____ Time Base ____ Vert Gain ____
*c.	JA	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 triaxial test adaptor and cable (see Step 2).

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:

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

SIGNAL†	CABINET 20	PARAMETER	PHOTO #
a.	JC	SIGNAL	________
b.	JB	Low Voltage (15VDC)	________
*c.	JA	High Voltage (2400 VDC)	________

*CAUTION High Voltage: Use Decoupling Circuit.

†All measurements using GPU triaxial test adaptor and cable (see Step 2).

Before photographing each scope display adjust analyzer for best spectral resolution. Record critical analyzer parameters e.g., RF bandwidth, RF bandwidth and sweep speed on rear of photograph as well as parameter analyzed.

SPECTRUM IDENT	FREQUENCY	AMPLITUDE	REMARKS

____
Signature/Date

14. Using the Nicolet Model 444 FFT Analyzer (or equivalent) perform FFT annalysis fo signals for the following test points:

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

SIGNAL†	CABINET 20	PARAMETER	PHOTO #
a.	JC	SIGNAL	______
b.	JB	Low Voltage (15VDC)	______
*c.	JA	High Voltage (2400 VDC)	______

*CAUTION High Voltage: Use Decoupling Circuit.

†All measurements using GPU triaxial test adaptor and cable (see Step 2).

____
Signature/Date

NOTE: DC Decoupling Circuit is to be removed when Step 12 is finished.

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~~ ______________________

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

***** ***** *****

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) leaving GPU triaxial test adaptor and cable attached for direct measurements on field wire signals (attached in Step 2).

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

Signature/Date

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

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)

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

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 peform TDR measurements on three test points.

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

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. b. c.	JC-Sig JB-Sig JA-Sig	JC-Ret JB-Ret JA-Ret		
d. e. f.	JC-Sig JC-Sig JB-Sig	JB-Sig JA-Sig JA-Sig		
g. h. i.	JC-Ret JC-Ret JB-Ret	JB-Ret JA-Ret JA-Ret		

Signature/Date

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

21. Connect field wires from Cables IT2352I, IT2356I, and IT2354C at JA, JB, and JC (Cabinet 20) and remove GPU triaxial test adaptor and cable (inserted in Step 2).

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

6.3 Procedure for Performing Measurements on a Loose Parts Monitor Charge Converter

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM LOOSE PARTS MONITOR CHARGE CONVERTER YM-AMP-7025

M.V. Mathis, Director, Tech. Serv. Div.

PURPOSE: The purpose of these measurements is to gather baseline data and information in preparation for removal of Loose Parts Monitor Charge Converter YM-AMP-7025 from the Reactor Building TMI Unit 2. The tests specified in this procedure are designed to assess the condition of the in-containment instrument module (accelerometer, charge converter), 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. Loose Parts Monitor Charge Converter YM-AMP-7025, located at elevation 347', is part of the overall Loose Parts Surveillence System. The unit is a part of the engineered reactor safeguards system and is nulcear safety-related.

2. Environmental Safety. Loose Parts Monitor Charge Converter YM-AMP-7025 can be taken out-of and restored to services 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 by inserting test signals on appropriate conductors of Cable IT3606I.

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM LOOSE PARTS MONITOR CHARGE CONVERTER
YM-AMP-7025

Table 4-1 Active Measurements

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

B. Prerequisites

1. The Shift Supervisor/Shift Foreman shall be notified for concurrance prior to the performance of those 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 starting and upon completion of the measurements.

C. Procedure for Performing Measurements

References:

1. Endevco Dwg. No. AE-E0401, Specifications for Model 2652M4 Charge Converter YM-AMP-7025 (Sheet 3 of 3).

2. Specification Manual for Endevco Model 2276 Accelerometer.

3. Burns & Roe Dwg. 3024, Sh. 105.

4. Burns & Roe Dwg. 3343, Sh. 2.

5. Burns & Roe Dwg. 3045, Sh. 17.

6. Burns & Roe Dwg. 3314, Rev. 8.

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM LOOSE PARTS MONITOR CHARGE CONVERTER
YM-AMP-7025

7. Burns & Roe Dwg. 3174, Sh. 7.

8. Burns & Roe Dwg. 3045, Sh. 17.

9. Instruction Manual, Tektronix model 1502 TDR.

10. Instruction Manual, Hewlett Packard Model 4274 Multifrequency LCR Meter.

11. Instruction Manual, Hewlett Packard Spectrum Analyzer (Model 141T, 8553B, 8552B Modules).

12. Instruction Manual, Nicolet Model 444A-26 Spectrum Analyzer.

13. Instruction Manual, Tektronix Model 335 Oscilloscope.

14. Instruction Manual, Lockheed Store-4 Recorder.

15. Instruction Manual, Tektronix SC502 Oscilloscope.

16. TEC Composite Electrical Connection Diagram, YM-AMP-7025 (see attachment).

STEPS

1. Notify Shift Supervisor/Shift Foreman of start of te[illegible] on YM-AMP-7025.

2. Remove all power from YM-AMP-7025.

3. Open TBM links 4, 13.

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.	Cable IT3606I (4)	Cable IT3606I (13)
b.	Cable IT3606I (13; field side)	Cable IT3606I (13; cabinet side)

*Numbers in parentheses refer to Control Panel 8 TBM terminal numbers.

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM LOOSE PARTS MONITOR CHARGE CONVERTER
YM-AMP-7025

Record the data required below:

TEST POINT*	CAPACITANCE			IMPEDANCE		
Frequency	100 Hz	1 kHz	100 kHz	100 Hz	1 kHz	100 kHz
a. (4/13)†						
b. (13/13)†						

*Numbers in parentheses refer to Control Panel 8 TBM terminal numbers.

†Field side/Cabinet side across open link.

5. Using the Tektronix Model 1502 (or equivalent TDR unit) perform TDR measurements on the test points given in Step 4.

Record the data below:

Test Point*	High R @ N ft.	Low R @ N ft.	Instrument Settings Ampl Range Mult	Strip Chart Number
a. (4/13)				
b. (13/13)†				

*Numbers in parentheses refer to Control Panel 8 TBM terminal numbers.

†Field side/Cabinet side across open link.

6. Using the keithley Model 177 (or equivalent DMM) perform resistance measurements on the test points specified and record values in the space provided.

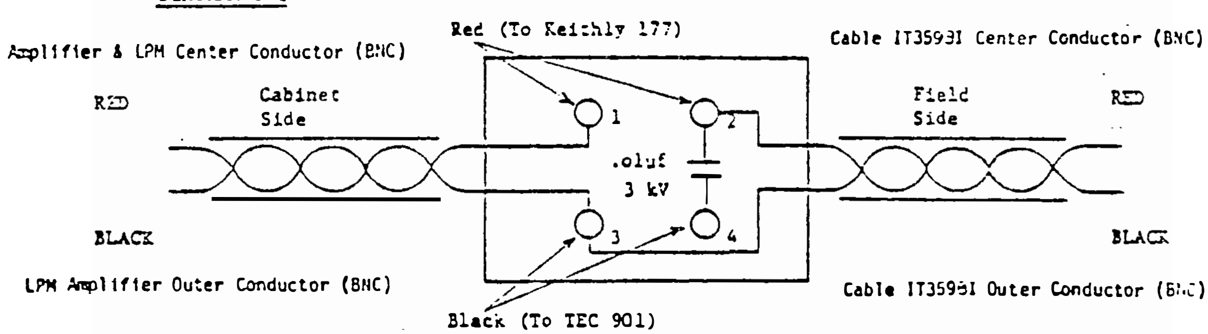
IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM LOOSE PARTS MONITOR CHARGE CONVERTER
YM-AMP-7025

			POLARITY From = +; To = -	POLARITY From = -; To = +
TEST POINT	FROM LINK	TO LINK	RESISTANCE	RESISTANCE
a.	TBM-4	TBM-13		

7. Close TBM link 13.

8. Connect the TEC Current Monitor/AC Coupling Test Fixture to TBM-4 and TBM-13 per the following diagram:

DIAGRAM 8-1



TEC CURRENT MONITOR/AC COUPLING
TEST FIXTURE

NOTE: This circuit provides additional access to signals and charge converter current

1) Series connection of an ammeter by connecting a BNC with plugs 1 (signal of BNC connector)* and 2 (ground of BNC connector).*
2) Access to the signal through a decoupling capacitor is provided by a BNC connecting plugs 4 (signal of BNC) and 3 (ground of BNC).*

* Connections provide for proper polarity.

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM LOOSE PARTS MONITOR CHARGE CONVERTER
YM-AMP-7025

9. Connect a Kiethly Model 177 DMM (or equivalent) in series with TBM-4 by connecting a BNC across plugs 1 (signal) and 2 (ground) (the two red plugs) of the TEC Current Monitor/AC Coupling Test Fixture.

10. Connect a TEC 901 Isolation Amplifier with a BNC to plugs 3 (ground) and 4 (signal) (the two black plugs) of the TEC Current Monitor/AC Coupling Test Fixture.

11. Connect an FM Recorder to the output of the 901 Amplifier (the TEC 901 operating in differential mode) and start the recorder.

    NOTE: Recording will continue through Step 18.

12. Apply power to YM-AMP-7025 by closing all power supply links (opened in Step 2) and verify operation through normal instrumentation procedures.

13. Using the Kiethly Model 177 DMM (or equivalent; Precesion = $\pm$ 1%) measure the current at the signal test point.

SIGNAL	CONTROL PANEL 8	TEST LEAD	SCALE	READING
a.	TBM-4 TBM-13	(+) (-)		

Signature/Date

14. Using the Kiethly Model 177 DMM (or equivalent; Z; $\geq 10^{12}$ OHMS, Range 0-2000V, Precesion = $\pm$ 1%) measure the DC Voltage at the signal test point.

SIGNAL	CONTROL PANEL 8	TEST LEAD	SCALE	READING
a.	TBM-4 TBM-13	(+) (-)		

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM LOOSE PARTS MONITOR CHARGE CONVERTER
YM-AMP-7025

15. Using a Tektronix Model SC502 (or equivalent) oscilloscope observe the waveform at the signal test point:

SIGNAL	CONTROL PANEL 8	PARAMETER			
a.	TBM-4 TBM-13	SIG	Photo ____ Time Base ____ Vert Gain ____	Photo ____ Time Base ____ Vert Gain ____	Photo ____ Time Base ____ Vert Gain ____

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

16. Using a Hewlett-Packard Spectrum Analyzer (Models 141T, 8553B, and 8552, or equivalent) perform an analysis of the test signal for spectral content:

SIGNAL	CONTROL PANEL 8	PARAMETER	PHOTO #
a.	TBM-4 TBM-13	SIG GND	____

Before photographing each scope presentation adjust analyzer for best spectral resolution. Record critical analyzer parameters e.g., RF bandwidth, RF bandwidth and sweep speed on rear of photograph as well as parameter analyzed.

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM LOOSE PARTS MONITOR CHARGE CONVERTER
YM-AMP-7025

SPECTRUM IDENT	FREQUENCY	AMPLITUDE	REMARKS

Signature/Date

17. Using the Nicolet Model 444 FFT Analyzer (or equivalent) perform FFT analysis of signals from the signal test point:

SIGNAL	CONTROL PANEL 8	PARAMETER	PHOTO # OR PLOT
*a.	TBM-4 TBM-13	SIG GND	

If PSD plots from any one of the three signals show high or unusual amplitudes, utilize the zoom feature to provide finer resolution and obtain PSD data in the frequency band of interest.

Signature/Date

18. Continue recording the output signal from YM-AMP-7025 for a period of 10 additional minutes.

19. Remove all power from YM-AMP-7025 (same procedure as Step 2).

20. Remove the TEC Current Monitor/AC Coupling Text Fixture from connections with TBM-4 and TBM-13.

21. Notify the Shift Supervisor/Shift Foreman of the conclusion of testing on YM-AMP-7025.

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

6.4 Procedure for Performing Measurements on a Pressure Transmitter

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM CORE FLOOD TANK PRESSURE CF-1-PT4

M.V. Mathis, Director, Tech. Serv. Div.

PURPOSE: The purpose of these measurements is to gather baseline data and information in preparation for removal of the Force Balance Transmitter CF-1-PT4 from the Reactor Building TMI Unit 2. The tests specified in this procedure are designed to assess the condition of the in-containment transmitter 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. The unit is part of the engineered reactor safeguards system and is nulcear safety-related.

2. Environmental Safety. Force Balance Transmitter CF-1-PT4 can be taken out-of and restored to services 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 Cable IT1722I. Terminations shall be removed and replaced on TB 8-9-3 of Cabinet 156.

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM CORE FLOOD TANK PRESSURE CF-1-PT4

Table 4-1 Active Measurements

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

d. In the calibration verification measurements section, baseline data on the as-found condition will be recorded prior to the performance of any adjustments or electronic calibrations.

B. Prerequisites

1. The Shift Supervisor/Shift Foreman shall be notified for concurrence prior to the performance of those 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 starting and upon completion of the measurements.

C. Procedure for Performing Measurements

<u>References</u>:

1. Burns & Roe Dwg. 3024, Sh. 20.

2. Service Manual for Foxboro Series E10 Force-Balance Transmitter.

3. Burns & Roe Dwg. 3304, Sh. 24.

4. Burns & Roe Dwg. I.C. 3343, Sh. 4.

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM CORE FLOOD TANK PRESSURE CF-1-PT4

5. Burns & Roe Dwg. 3343, Sh. 4.
6. Burns & Roe Dwg. 3304, Sh. 26.
7. Burns & Roe Dwg. 3304, Sh. 23.
8. Burns & Roe Dwg. 3024, Sh. 20.
9. Instruction Manual, Tektronix Model 1502 Time Domain Reflectometer.
10. Instruction Manual, Hewlett Packard Model 4274 Multifrequency LCR Meter.
11. Instruction Manual, Hewlett Packard Spectrum Analyzer (Model 141T, 8553B, 8552B Modules).
12. Instruction Manual, Nicolet Model 444A-26 Spectrum Analyzer.
13. Instruction Manual, Tektronix Model 335 Oscilloscope.
14. Instruction Manual, Lockheed Store-4 Recorder.
15. Instruction Manual, Tektronix SC502 Oscilloscope.
16. TEC Composite Electrical Connection Diagram, CF-1-PT4 (see attachment).

SIGNAL	CABLE	CABINET 156
+ Sig	IT1722I	TB 8-9-3/4
- Sig	IT1722I	TB 8-9-3/5
SHLD	IT1722I	TB 8-9-3/3

STEPS

1. Notify Shift Supervisor/Shift Foreman of start of test on CF-1-PT4.
2. Verify power is applied to CF-1-PT4.
3. Record present reading from CF-1-PT4 Readout Module.

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM CORE FLOOD TANK PRESSURE CF-1-PT4

SIGNAL	READING IN PSI
CF-1-PT4 Readout	

4. Remove all power from CF-1-PT4.

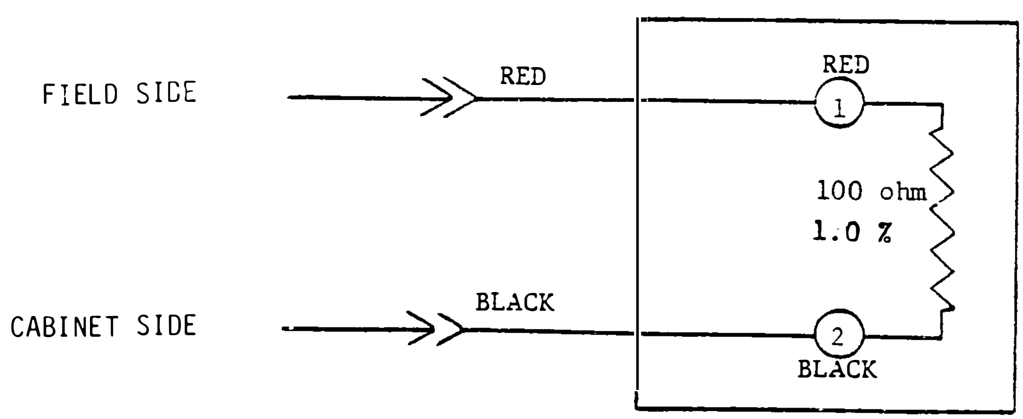
Signature/Date

5. Open link TB 8-9-3/4 in Cabinet 156.

Signature/Date

6. Insert TEC test fixture (100 ohm, 1.0% resistor) across open link TB 8-9-3/4 per Figure 6-1 to convert 10-50 mA signal to voltage.

FIGURE 6-1.



NOTE: This circuit converts the 10-50 ma signal to 1-5 V for testing.

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM CORE FLOOD TANK PRESSURE CF-1-PT4

7. Apply power to CF-1-PT4 and wait 10 minutes for instrument warm-up.

8. Record present reading from CF-1-PT4 Reaout Module.

SIGNAL	READING IN PSI
CF-1-PT4 Readout	

9. Connect* differential Conditioning Amplifier (TEC Model 901) to the Force Balance Transmitter (TB 8-9-3/4; in Cabinet 156). Connect Model 901 output to FM Recorder and record Signal for 30 minutes. Remove recorder when completed.

   *NOTE: Connection across banana jacks 1&2 of current-to-voltage text fixture (see Step 6).

10. Using a Keithley Model 177 DMM (or equivalent, Range 0-2000 V, Precision ± 1%) measure the DC Voltage or current at the following test point.

SIGNAL	CABINET 156	TEST LEAD	READING
*a.	TB 8-9-3/4 TB 8-9-3/4	(+) (-)	Signal ________________

*Across text fixture banana jacks 1&2 (see Step 6).

Signature/Date

11. Using a Tektronix Model SC502 (or equivalent) oscilloscope observe the waveform at the following test point:

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM CORE FLOOD TANK PRESSURE CF-1-PT4

SIGNAL	CABINET 156	PARAMETER			
*a.	TB 8-9-3/4 TB 8-9-3/4	SIG	Photo ____ Time Base ____ Vert Gain ____	Photo ____ Time Base ____ Vert Gain ____	Photo ____ Time Base ____ Vert Gain ____

*Across test fixture banana jacks 1&2 (see Step 6).

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

12. Using a Hewlett-Packard Spectrum Analyzer (Models 141T, 8553B and 8552 or equivalent) perform an analysis of the following signal for spectral content:

SIGNAL	CABINET 156	PARAMETER	PHOTO #
*a.	TB 8-9-3/4 TB 8-9-3/4	SIGNAL	____

*Across test fixture banana jacks 1&2 (see Step 6).

Before photographing each scope display adjust analyzer for best spectral resolution. Record critical analyzer parameters e.g., RF bandwidth, RF bandwidth and sweep speed on rear of photograph as well as parameter analyzed.

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM CORE FLOOD TANK PRESSURE CF-1-PT4

SPECTRUM IDENT	FREQUENCY	AMPLITUDE	REMARKS

____
Signature/Date

13. Using the Nicolet Model 444 FFT Analyzer (or equivalent) perform FFT analysis of signals for the following test point:

SIGNAL	CABINET 156	PARAMETER	PHOTO #
*a.	TB 8-9-3/4 TB 8-9-3/4	SIGNAL	________

*Across test fixture banana jacks 1&2 (see Step 6).

____
Signature/Date

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM CORE FLOOD TANK PRESSURE CF-1-PT4

14. Inside Cabinet 156 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

15. Remove all power from CF-1-PT4.

____
Signature/Date

16. Open links for field wires from Cable IT1722I at TB 8-9-3/3, 4, and 5 (Cabinet 156) and remove test fixture (installed in Step 6).

TERMINAL	SIGNAL IDENT.
TB 8-9-3/4	(+) SIGNAL
TB 8-9-3/5	(-) SIGNAL
TB 8-9-3/3	SHIELD

____
Signature/Date

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM CORE FLOOD TANK PRESSURE CF-1-PT4

17. 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.	TB 8-9-3/4 (+ Sig)	TB 8-9-3/5 (- Sig)
b.	TB 8-9-3/4 (+ Sig)	TB 8-9-3/3 (SHLD)
c.	TB 8-9-3/5 (- Sig)	TB 8-9-3/3 (SHLD)

Record the data required below:

Test Point	Capacitance			Impedance		
Frequency	100 Hz	1 kHz	100 kHz	100 Hz	1 kHz	100 kHz
a. TB 8-9-3/4:5						
b. TB 8-9-3/4:3						
c. TB 8-9-3/5:3						

Signature/Date

18. Using the Tektronix Model 1502 (or equivalent) TDR unit peform TDR measurements on three test points and record the data below.

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM CORE FLOOD TANK PRESSURE CF-1-PT4

Test Point	Instrument Settings Ampl Range Mult	Strip Chart Number
a. TB 8-9-3/4:5 (+ Sig: - Sig)		
b. TB 8-9-3/4:3 (+ Sig: SHLD)		
c. TB 8-9-3/5:3 (- Sig: SHLD)		

Signature/Date

19. 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.	TB 8-9-3/4	TB 8-9-3/5		
b.	TB 8-9-3/4	TB 8-9-3/3		
c.	TB 8-9-3/5	TB 8-9-3/3		

Signature/Date

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM CORE FLOOD TANK PRESSURE CF-1-PT4

20. Close links for field wires from Cable IT1722I at TB 8-9-3, 4, and 5 (Cabinet 156) and restore power.

21. 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

6.5 Procedure for Performing Measurements on a Differential Pressure Transmitter

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM CORE FLOOD TANK LEVEL TRANSMITTER CF-2-LT4

M.V. Mathis, Director, Tech. Serv. Div.

PURPOSE: The purpose of these measurements is to gather baseline data and information in preparation for removal of the Core Flood Tank Level Transmitter CF-2-LT4 from the Reactor Building TMI Unit 2. The tests specified in this procedure are designed to assess the condition of the in-containment instrumentation (Level Transmitter), 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. Core Flood Tank Level Transmitter CF-2-LT4 is part of a Redundant Level Monitoring System located at elevation 305'. The unit is part of the engineered reactor safeguards system and is nulcear safety-related.

2. Environmental Safety. Core Flood Tank Level Transmitter CF-2-LT4 can be taken out-of and restored to services 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

IT1730I and IT2751C (Terminations shall be removed) and replaced on TB 8-9-3 of Cabinet 156).

Table 4-1 Active Measurements

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

B. Prerequisites

1. The Shift Supervisor/Shift Foreman shall be notified for concurrence prior to the performance of those 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 starting and upon completion of the measurements.

C. Procedure for Performing Measurements

References:

1. Bailey Meter Company Transmitter #BY-8231X-A.

2. Bailey Product Instruction E 21-17.

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM CORE FLOOD TANK TANK LEVEL TRANSMITTER
CF-2-LT4

3. Burns & Roe Dwg. 3343, Sh. 4.

4. Burns & Roe Dwg. 3024, Sh. 20.

5. Burns & Roe Dwg. 3045, Sh. 36F.

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, CF-2-LT4 (see attachment).

SIGNAL	CABLE	CABINET 156
+ Signal	IT1730I	TB 8-9-3/19
- Signal	IT1730I	TB 8-9-3/18
118 VAC (H)	IT2751C	TB 8-9-3/16
118 VAC (L)	IT2751C	TB 8-9-3/16
Shield (Signal)	IT1730I	TB 8-9-3/17

STEPS

1. Notify Shift Supervisor/Shift Foreman of start of test on CF-2-LT4.
2. Verify power is applied to CF-2-LT4.
3. Record present readings from CF-2-LT4 Readout Module.

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM CORE FLOOD TANK LEVEL TRANSMITTER
CF-2-LT4

SIGNAL	LEVEL
CF-2-LT4 Readout	

3. Connect differential conditioning amplifier TEC Model #901 across TB 8-9-3/19 (+) and /18 (-). Connect output from TEC Model #901 to FM Recorder and record for 30 minutes.

4. Using a Keithley Model 177 DMM (or equivalent, Range 0-2000 V, Precision ± 1%) measure the DC Voltage or current at the following test points.

SIGNAL	CABINET 156	TEST LEAD	READING
a.	TB 8-9-3/19 TB 8-9-3/18	(+) (-)	Signal ________
b.	TB 8-9-3/16 TB 8-9-3/17	(+) (-)	118 VAC ________

*CAUTION: 118 VAC

Signature/Date

5. Using a Tektronix Model SC502 (or equivalent) oscilloscope observe the de-coupled waveform at the following test points:

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM CORE FLOOD TANK LEVEL TRANSMITTER
CF-2-LT4

SIGNAL	CABINET 156	PARAMETER			
a.	TB 8-9-3/19 TB 8-9-3/18	(+) SIG (-) SIG	Photo ____ Time Base ____ Vert Gain ____	Photo ____ Time Base ____ Vert Gain ____	Photo ____ Time Base ____ Vert Gain ____
*b.	TB 8-9-3/16 TB 8-9-3/17	118 VAC Power	Photo ____ Time Base ____ Vert Gain ____	Photo ____ Time Base ____ Vert Gain ____	Photo ____ Time Base ____ Vert Gain ____

*CAUTION 118 VAC; Use X10 Probe.

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

6. Using a Hewlett-Packard Spectrum Analyzer (Models 141T, 8553B and 8552 or equivalent) perform an analysis of the following signal for spectral content:

SIGNAL†	CABINET 156	PARAMETER	PHOTO #
a.	TB 8-9-3/19 TB 8-9-3/18	(+) SIG (-) SIG	____

Before photographing each scope display adjust analyzer for best spectral resolution. Record critical analyzer parameters e.g., RF bandwidth, RF bandwidth and sweep speed on rear of photograph as well as parameter analyzed.

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM CORE FLOOD TANK LEVEL TRANSMITTER
CF-2-LT4

SPECTRUM IDENT	FREQUENCY	AMPLITUDE	REMARKS

Signature/Date

7. Using the Nicolet Model 444 FFT Analyzer (or equivalent) perform FFT annalysis of signals for the following test point:

SIGNAL	CABINET 156	PARAMETER	PHOTO #
a.	TB 8-9-3/19 TB 8-9-3/18	(+) SIG (-) SIG	______

Signature/Date

8. Inside Cabinet 156 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.

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM CORE FLOOD TANK LEVEL TRANSMITTER
CF-2-LT4

Procedure Step	Remarks
See attached instrument shop procedure data sheet.	

Instrument Shop Procedure No. ________

Signature/Date

9. Remove all power from CF-2-LT4.

Signature/Date

10. Remove field wires (in table below) from Cables IT2751C and IT1730I (Cabinet 156) leaving test connections attached for direct measurements on field wire signals (from Step A.4.C).

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM CORE FLOOD TANK LEVEL TRANSMITTER
CF-2-LT4

CABINET 156	SIGNAL IDENT.
TB 8-9-3/19	(+) SIGNAL
TB 8-9-3/18	(-) SIGNAL
TB 8-9-3/16	(H) 118 VAC
TB 8-9-3/17	(L) 118 VAC
TB 8-9-3/20	SHIELD (Signal)

Signature/Date

11. 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.	TB 8-9-3/19 (+) Signal	TB 8-9-3/18 (-) Signal
b.	TB 8-9-3/19 (+) Signal	TB 8-9-3/20 Shield (Signal)
c.	TB 8-9-3/18 (-) Signal	TB 8-9-3/20 Shield (Signal)
d.	TB 8-9-3/16 118 VAC (H)	TB 8-9-3/17 118 VAC (L)
e.	TB 8-9-3/16 118 VAC (H)	TB 8-9-3/19 (+) Signal
f.	TB 8-9-3/16 118 VAC (H)	TB 8-9-3/18 (-) Signal
g.	TB 8-9-3/16 118 VAC (H)	TB 8-9-3/20 Shield (Signal)

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM CORE FLOOD TANK LEVEL TRANSMITTER
CF-2-LT4

Record the data required below:

Test Point	Capacitance			Impedance		
Frequency	100 Hz	1 kHz	100 kHz	100 Hz	1 kHz	100 kHz
a. TB 8-9-3/19-18						
b. TB 8-9-3/19-20						
c. TB 8-9-3/18-20						
d. TB 8-9-3/16-17						
e. TB 8-9-3/16-19						
f. TB 8-9-3/16-18						
g. TB 8-9-3/16-20						

Signature/Date

12. Using the Tektronix Model 1502 (or equivalent) TDR unit peform TDR measurements at the following test points.

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM CORE FLOOD TANK LEVEL TRANSMITTER
CF-2-LT4

Record data below:

Test Point	Instrument Settings Ampl Range Mult	Strip Chart Number
a. TB 8-9-3/19-18 (±) Signal		
b. TB 8-9-3/19-20 (+) Signal/SHLD		
c. TB 8-9-3/16-17 (118 VAC)		
d. TB 8-9-3/16-20 (118 VAC/SHLD)		

Signature/Date

13. 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.	TB 8-9-3/19	TB 8-9-3/18		
b.	TB 8-9-3/19	TB 8-9-3/20		
c.	TB 8-9-3/18	TB 8-9-3/20		
d.	TB 8-9-3/16	TB 8-9-3/17		
e.	TB 8-9-3/16	TB 8-9-3/19		
f.	TB 8-9-3/16	TB 8-9-3/18		
g.	TB 8-9-3/16	TB 8-9-3/20		

Signature/Date

IN-SITU MEASUREMENTS OF CABLES AND SIGNALS
FROM CORE FLOOD TANK LEVEL TRANSMITTER
CF-2-LT4

14. Connect field wires from Cables IT2751C and IT1730I at Cabinet 156 (see Step 10) and apply power.

15. Notify the Shift Supervisor/Shift Foreman of the conclusion of testing CF-2-LT4.

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