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FIELD MEASUREMENTS AND INTERPRETATION OF TMI-2 INSTRUMENTATION: CF-2-LT4

J. E. Jones
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M. V. Mathis

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

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Technology for Energy Corporation

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Prepared for the
U.S. Department of Energy
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Section 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 results of the Core Flood Tank 1B level monitor CF-2-LT4. This instrument consists of a Bailey Type BY Process Computer Transmitter connected to a readout module by approximately 500 feet of cable through a penetration junction and an instrument mounting junction. The status of this instrument is uncertain, but it was producing a reasonable output reading which implied it had not failed. As a result, measurements on this instrument were designed to determine if it was properly functioning.

Section 2

INSTRUMENT LOCATION, CABLING, AND TERMINATIONS

A review of appropriate drawings from Bailey Meter Company and Burns & Roe (itemized in the Appendix in the measurement procedure, pages A-5 and A-6) 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 Control Cabinet 156. 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 level sensing assembly is a Bailey Type BY which consists of a differential pressure LVDT, temperature compensation, and calibration adjustment for conversion of pressure difference to level. This instrument has a normal range of 0-14 feet, producing an output of -10 to +10 volts. The functional diagram of the unit is shown in Figure 2-2.

Since measurements were being made in Control Cabinet 156, the effect of the readout meter (attached to the signal line) was present on the observed instrument response. However, since this readout was located outside containment, it did not experience severe operating environments, and thus was not considered to have failed.

Figure 2-1. Composite Electrical Diagram for Core Flood Tank Level Transmitters CF-2-LT2 and CF-2-LT4.

Table 2-1

TERMINATION POINTS FOR CF-2-LT4 MEASUREMENTS

Signal	Cabinet 156 Identification*
+Signal	TB8-9-3/19
-Signal	TB8-9-3/18
Shield	TB8-9-3/20
118 VAC (H)	TB8-9-3/16
118 VAC (L)	TB8-9-3/17

*From cables IT1730I (signal lines) and IT2751C (118 VAC).

Figure 2-2. Functional Diagram of Bailey Type BY Differential Pressure Transmitter.

Section 3

PREPARATION OF MEASUREMENT PROCEDURES

As a result of generating the composite electrical diagram and from a review of the Bailey Meter Product Instruction E21-17 Manual, the major types of measurements to be performed were identified as:

1. Determine as-found condition of level indication and record signal output.
2. Perform passive measurements (i.e., passively monitor signals) on each electrical connection consisting of time domain waveforms, very-high frequency spectrum analysis (i.e., MHz region), and frequency spectra below 100 kHz.
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 measurement 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.

Section 4

MEASUREMENTS

Since the output of CF-2-LT4 was designed to cover the range of -10 to +10 volts, the signal could be directly measured without amplification. Before performing measurements, the readout of CF-2-LT4 indicated 11 feet for the core flood tank level. The level indication signal was then recorded for approximately 10 minutes on an FM recorder and the voltage outputs measured (with a DVM). The output of the level signal was 5.72 VDC, and the power supply was 116 VAC.

The next measurements consisted of photographing the output waveforms of the level signal and line voltage from a storage oscilloscope. Figures 4-1 and 4-2 show the results of these time trace measurements. Along with the time traces, both high and low frequency spectra (frequency domain) were taken of the level signal. Figure 4-3 shows the measured spectra over both a 6 MHz and 500 kHz bandwidth, while Figure 4-4 shows spectra over both a 100 kHz and 1 kHz range.

Following the frequency spectra measurements, electrical calibration was performed on the CF-2-LT4 readout module by a TMI technician. No significant adjustments were noted during this calibration. After electrical calibration, power was removed from CF-2-LT4. The test fixture was removed and all signal lines from cables IT1730I and IT2751IC to cabinet 156 were disconnected.

A series of active measurements (i.e., actively introducing a test signal into the circuit) was then performed. Table 4-1 shows the

Photo 109-1

Time - 2msec/div

Gain - 10 mV/div

Photo 109-2

Time - 0.5msec/div

Gain - 20 mV/div

Figure 4-1. Oscilloscope Traces of Level Signal.

Photo 109-3

Time - 0.5msec/div

Gain - 10 V/div

Figure 4-2. Oscilloscope Trace of 118 VAC Supply.

Photo 109-4

BW - 3 KHz

Scan width - 1 MHz/div

Scan time - 1 sec/div

Photo 109-5

BW - 3 KHz

Scan width - 100 KHz/div

Scan time - 1 sec/div

Figure 4-3. High Frequency Spectra of Level Signal.

Photo - 109-6

100 KHz Range

Photo 109-7

1 KHz Range

Figure 4-4. Low Frequency Spectra of Level Signal.

Table 4-1

CAPACITANCE, IMPEDANCE, AND RESISTANCE MEASUREMENTS

Signal	Capacitance (nF)*			Impedance (ohms)			Resistance (ohms)
	100Hz	1kHz	100kHz	100Hz	1kHz	100kHz	
+Signal -Signal	23	18	12	4.4K	3.2K	124	7.1K (8.8K)
+Signal Shield	50	42	34	OF [†]	3.6K	48	OF
-Signal Shield	50	44	37	OF	3.5K	44	OF
118 VAC (H) 118 VAC (L)	-120	17	52	12K	9K	30	105 (105)
118 VAC (H) -Signal	--	.2	8.7	OF	OF	109	OF
118 VAC (H) Shield	--	.2	28	OF	OF	66	OF

* nF = Nano-farads.

** Values in parentheses are reverse polarity values.

[†]OF indicates overflow condition.

results of capacitance, impedance, and DC resistance measurements on some of the field cable lines (see Appendix page A-12 for a complete set). A set of TDR measurements were taken on the signal lines to determine possible cable defects. These TDR traces are shown in Figures 4-5 to 4-8.

STRIP CHART 109-1

Setting - 500 μ p/div

Range - 52.6 ft/div

Sensitivity - 0.25

Filter - 5 Hz

Cable dielectric - other

Figure 4-5. TDR Trace of Level Signal Lines

STRIP CHART 109-2

Setting - 500 μ p/div

Range - 52.6 ft/div

Sensitivity - 0.25

Filter - 5 Hz

Cable dielectric - other

Figure 4-6. IDR Trace of (+) Signal to Shield

STRIP CHART 109-3 & 4

Setting - 500 μ p/div

Range - 52.6 ft/div

Sensitivity - 0.25

Filter - 5 Hz

Cable dielectric - other

2nd plot begins @500 ft

Figure 4-7. TDR Trace of 118 VAC Lines

STRIP CHART 109-5,6, & 7

Setting - 500up/div

Range - 52.6 ft/div

Sensitivity - 0.25

Filter - 5 Hz

Cable dielectric - other

2nd plot begins @500 ft

3rd plot begins @1000 ft

Figure 4-8. TDR Trace of 118 VAC (H) to Shield

Section 5

INTERPRETATION OF MEASUREMENTS

This section presents a summary of the interpretation of the measurements taken on CF-2-PT4. This interpretation is intended to indicate the condition of the device based on observed data.

Since this device varies from -10 to +10 volts for a 0 to 14 foot level range, the observation of 11 foot level readout indicates that the voltage should be 5.71 volts. The measured value of 5.72 volts matches within 1% of this expected value, which indicates the readout meter is correctly calibrated. The 116 VAC value on the power supply line is also well within a normal operating range.

The time traces and frequency spectra do not indicate any serious contamination which would affect the DC readout. Table 5-1 lists the low level AC components present on the level signal. Note that even though up to 60 mV P-P fluctuations are present, readout devices normally respond at low frequencies. As a result, the worst-case effect of these AC variations is likely to be less than the 0.5 mV RMS value given for the 60 Hz components.

One feature of the frequency spectrum of the level signal gives an indication that the differential pressure LVDT (see Figure 2-2) is operating. Since the LVDT AC output is "demodulated" by a full-wave rectifier and Resistance-Capacitance (RC) smoothing, a low level ripple must be present at the frequency of the internal oscillator. The oscillator for this type device operates at 1000 hertz and the component

5-2

Table 5-1

MAJOR AC COMPONENTS ON THE LEVEL SIGNAL

Frequency	Amplitude
60 Hz and harmonics	0.5 mV RMS
1 kHz and harmonics	6 mV RMS
48 kHz	<1 mV RMS
64 kHz	<1 mV RMS
96 kHz	1 mV RMS
150 kHz (broadband)	<1 mV RMS
Total Spectrum	60 mV P-P

values of the RC smoothing circuit ($R = 100\text{k ohms}$, $C = 0.68 \mu\text{F}$) would produce a ripple factor (fraction of AC RMS fluctuations) of 0.001. With the device producing a five volt output (15 volts above base output of -10V), the expected RMS ripple would be approximately 5 mV (15 mV). From Table 5-1, this AC ripple value was measured to be 6 mV, which is in close agreement. Also, the reduction in amplitude of the higher harmonics (see Figure 4-4) is consistent with the expected attenuation of a rectified signal.

The capacitance, impedance, and resistance data given in Table 4-1 is difficult to quantitatively interpret, but qualitative results are possible. Most of the data indicates very low effective capacitance values, which would be expected from the amplifier section of the transmitter. However, the 118 VAC (H) to 118 VAC (L) measurement passes through the primary of a transformer. This creates an inductance which appears as negative capacitance at the 100 hertz measurement.

The presence of a 10,000 ohm resistor in the transmitter amplifier and the absence of other direct electrical paths indicates that a resistance measurement near this value should be obtained. The measured values for the level signal were 7100 and 8800 ohms for two polarities. The variation would be caused by active electrical components, and the values are of the magnitudes expected. Since the expected responses are present, there is no obvious indication of instrumentation degradation from these measurements.

The results of TDR measurements performed on the cable (shown in Figures 4-5 to 4-7) are summarized in Table 5-2. 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. Some junction points were not identified by these measurements, but no indication of cabling problems is present in this data.

Table 5-2

SUMMARY OF TDR MEASUREMENTS

Signal Lines	Distance (ft)	Description**	Probable Cause
+Signal	211	Point R increase	Penetration R607
-Signal	489	Large R increase	Electronics
+Signal	200	Point R increase	Penetration R607
Shield	416	Point R small increase	Terminal block
	464	Large R increase	Electronics
118 VAC (H)	263	Point R increase	Penetration R607
118 VAC (L)	716	Large R increase	Electronics

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.

Section 6
CONCLUSIONS

Based on the measurements, data reduction, and circuit analysis of CF-2-LT4, there is no indication of degradation of the instrument. The only significant contamination present in the pressure signal that appeared to be abnormal was the 96 kHz component. However, the amplitude of this signal was relatively low and, from other measurements performed at TMI, this low-level 96 kHz component is probably due to a widespread 16 kHz (with harmonics) signal found in various circuits. In addition to the observation of no abnormal characteristics of the instrument, the low level oscillator ripple on the level signal indicates that the LVDT is working. Therefore, it appears that CF-2-LT4 is operating correctly, but these measurements could not determine if it is calibrated.

APPENDIX

ORIGINAL FIELD PROCEDURES AND DATA SHEETS FOR CF-2-LT4

208-11 GENERATION C JOB TICKET FORM (Page A-1 NCE SYSTEM EE MILE ISLAND UNIT 2

COMPONENT DESIGNATION				LOCATION / UNIT	JOB TYPE	JOB TICKET NUMBER	REQUEST DATE			RECOMMENDED PRIORITY
SYS	COMP. TYPE	COMP ID	MO				DAY	YR		
CF	2	OLT4		036002	CM	C5713	09	22	80	2

DESCRIBE MALFUNCTION OR MODIFICATION DESIRED

CAUSE OF MALFUNCTION (IF KNOWN)

P	e	r	f	e	r	m	e	n	t	e	d	p	r	o	c	e	d	u	r	e

ORIGINATOR'S EMP. NO.	ORIGINATOR'S SIGNATURE	DATE	SUPERVISOR'S EMP. NO.	SUPERVISOR'S SIGNATURE	DATE
06175	<i>J. B. [Signature]</i>	9/22/80	06175	<i>J. B. [Signature]</i>	9/22/80

DOE/EG 46 Project

WORK ORDER NUMBER		GC CODE	ACCOUNT NUMBER	PLANT CONDITION								NPRD FAILURE			START	
LOCATION	SERIAL			SU	OP	HD	CD	RF	HS	LP	YR	MO	DAY	HR	MIN	
036000	1873D		X0001	1	1	1	1	1	1							

CHARGE VOLT REG	R	W	NO SAFETY	REG AGENCY CODE	CHG/MOD NUMBER
0000					

ENV CODE	OUTAGE CAUSE CODE
X	

STATUS HOLD CODE

S M APPROVAL COMMENCE WORK		
MO	DAY	YR
09	23	80

RESP LOCATION OR CONTRACTOR	
P	1036U

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

Limits and Precautions:

- a) Personnel
- b) Equipment
- c) Environment
- d) Nuclear

INSURE WORK AREA CLEANED UP AT COMPLETION OF JOB

Post Maintenance Testing required and Acceptance Criteria

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

COPY 1

JOB Page A-2 QUEST
REVIEW - CLASSIFICATION - MAINTAINING CONTROL FORM

JOB TICKET NUMBER C5713

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. N/A

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).

N/A
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).

N/A
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.

N/A
QC SUPERVISOR

DATE

9. Does work require code inspector to be notified?

Yes _____ No ✓

10. Supervisor of Maintenance approval to commence work: -

[Signature] Date 9/23/80

11. Maintenance Foreman Assigned: _____

12. Code Inspector Notified. Name: _____ Date _____

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

_____ Initial if Shift Foreman signature is not required.

WORK I Page A-3 PROCEDURE
Maintenance Procedure Format and 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 on CF-2-LT4

2. Purpose: *To determine signal characteristics on CF-2-LT4.*

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

CF-2-LT4

4. References:

See attached

5. Special Tools, and Materials required.

See attached

6. Detailed Procedure (attach additional pages as required)

See attached

Supervisor of Maintenance recommends approval

[Signature] Date *9/23/88*

* PORC RECOMMENDS APPROVAL

Engineering Review [Signature] Date 9/22/88

Unit No. 1 Chairman _____ Date _____ Unit No. 2 Chairman _____ Date _____

* UNIT SUPERINTENDENT APPROVAL

Unit No. 1 _____ Date _____ Unit No. 2 _____ Date _____

* Standing Procedure _____
Supervisor of QC _____ Date _____

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

Technology for Energy Corporation

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

Page A-4

NO.
TP-109

REV. 0

APPROVED

DATE

PROCEDURE

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 nuclear 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 integrity measurements on the appropriate instrumentation cables by inserting test signals on appropriate conductors of Cables

TEC

TITLE

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

NO. TP-109

REV. 0

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)	$\leq 5V$ -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 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.

TEC

TIT-E

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

NC
TP-109

REV. 0

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-25 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.

TEI

TITLE

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

NO. TP-109

REV. 0

SIGNAL	LEVEL
CF-2-LT4 Readout	11' FT.

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 $\pm 1\%$) measure the DC Voltage or current at the following test points.

SIGNAL	CABINET 156	TEST LEAD	READING
a.	8-9-3/19 TB 8-9-3/18	(+) (-)	Signal <u>5.719 VDC</u>
b.	TB 8-9-3/16 TB 8-9-3/17	(+) (-)	118 VAC <u>116.1 VAC</u>

*CAUTION: 118 VAC

Q. T. S. H.
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

NC
TP-109

REV. 0

SIGNAL	CABINET 156	PARAMETER			
a.	TB 8-9-3/19 TB 8-9-3/18	(+) SIG (-) SIG	Photo <u>109-1</u> Time Base <u>2ms</u> Vert Gain <u>10mV</u>	Photo <u>109-2</u> Time Base <u>5ms</u> Vert Gain <u>20mV</u>	Photo _____ Time Base _____ Vert Gain _____
*b.	TB 8-9-3/16 TB 8-9-3/17	118 VAC Power	Photo <u>109-3</u> Time Base <u>5ms</u> Vert Gain <u>10V</u>	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.

J. T. S. H.
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	<u>109-4</u> <u>109-5</u>

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.

TEC

TITLE

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

NO. TP-109

REV. 0

<u>SPECTRUM IDENT</u>	<u>FREQUENCY</u>	<u>AMPLITUDE</u>	<u>REMARKS</u>
BANDWIDTH	SCAN WIDTH	INPUT RANG	SCAN TIME
3KHz	1MHz 12/ DIV	0	1 SEC
			LOG REF SENS
			10db LOG
			-20db 0 109-4
1K	100KHz DIV	0	11 11 1095

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

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

<u>SIGNAL</u>	<u>CABINET 156</u>	<u>PARAMETER</u>	<u>PHOTO #</u>
a.	TB 8-9-3/19 TB 8-9-3/18	(+) SIG (-) SIG	109-6 109-7

100K RANGE
1K RANGE

J. T. S. H 9/24/80
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.

TEL

TITLE

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

NC
TP-109

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Procedure Step	Remarks
See attached instrument shop procedure data sheet.	

Instrument Shop Procedure No. _____

Signature/Date _____

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

Q. T. S. 9/24/80
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).

TEI

TTE

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

NO.

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0

<u>CABINET 156</u>	<u>SIGNAL IDENT.</u>
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)

P. T. S. 9/24/80
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)

TITLE

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

NO.

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Record the data required below:

Test Point	Capacitance			Impedance		
	100 Hz	1 kHz	100 kHz	100 Hz	1 kHz	100 kHz
a. TB 8-9-3/19-18	23nf	18nf	12nf	4.4K/-30°	3.2K/-20°	1245/-78°
b. TB 8-9-3/19-20	50nf	42nf	34nf	OF	3.6K/-76°	485/-77°
c. TB 8-9-3/18-20	50nf	44nf	37nf	OF	3.5K/-78°	445/-77°
d. TB 8-9-3/16-17	-120nf	17nf	52nf	12K/-50°	9K/-80°	305/-84°
e. TB 8-9-3/16-19	-.8nf 2nf	.2nf	8.7nf	OF	OF	109/-143°
f. TB 8-9-3/16-18	-1.2nf 1.9nf	.2nf	10nf	OF	OF	101/-141°
g. TB 8-9-3/16-20	-.8nf 2nf	.2nf	28nf	OF	OF	665/-121°

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

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

TEC

TITLE

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

NO. TP-109

REV. 0

Record data below:

Test Point	Instrument Settings	Strip Chart Number
	Ampl Range Mult	
a. TB 8-9-3/19-18 (+) Signal		109-1
b. TB 8-9-3/19-20 (+) Signal/SHLD		109-2
c. TB 8-9-3/16-17 (118 VAC)		109-3, 109-4
d. TB 8-9-3/16-20 (118 VAC/SHLD)		109-5, 109-6, 109-7

Q-TS 9/24/80
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.

			<u>POLARITY</u> From = +; To = -	<u>POLARITY</u> From = -; To = +
TEST POINT	FROM LINK	TO LINK	RESISTANCE	RESISTANCE
a.	TB 8-9-3/19	TB 8-9-3/18	7.1 K	8.8 K
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	105 Ω	105 Ω
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	~	~

Q-TS 9/24/80
Signature/Date

TEC

TITLE

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

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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

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

Page A-15

COMPONENT DESIGNATOR				LOCATION UNIT	JOB TYPE	WORK AUTHORIZATION NUMBER	REQUEST DATE				
SYS	COMP. TYPE	COMP. ID.	LOOP				MO	DAY	YR		
5	8	12	16	17	22	23	24	28	32	33	38
CF	2	OLT	4	03600	2	C	M		C	5713	092280

TXN CD	ACT
1	4
804	A

TXN CD	ACT
1	4
805	A

TXN CD	ACT
1	4
807	A

TXN	ACT
1	4
810	A

ECM NUMBER
47 - 51

P R T Y	RESP. LOCATION OR CONTRACTOR	P R T Y	ASSISTING CONTRACTOR	P R T Y	ASSISTING CONTRACTOR
66	67	71			
	2036M				

PURCHASE REQUISITION NUMBER	PURCHASE ORDER NUMBER
59	66 67 73

STATUS HOLD										% COMPL	S/M APPROVAL TO COMMENCE WORK			FIELD WORK COMPLETION DATE		
CODE	START DATE			RELEASE DATE							MO	DAY	YR	MO	DAY	YR
39	40	41		45	47		52	53	55	56		61	62		67	

0 1																	OUTAGE HOLD
0 2																	PART HOLD
0 3																	QUALITY CONTROL PART HOLD
0 4																	QUALITY CONTROL PROCEDURE HOLD
0 5																	OPERATIONS HOLD
0 6																	CHANGE MODIFICATION HOLD
0 7																	ENGINEERING HOLD
0 8																	PLANNING HOLD
5 0																	MANPOWER NOT AVAILABLE
5 1																	AT PORC
5 2																	AT QUALITY CONTROL
5 3																	AT UNIT SUPERINTENDENT
5 4																	AT READING
5 5																	POST MAINTENANCE TEST HOLD
5 6																	AT ALARA