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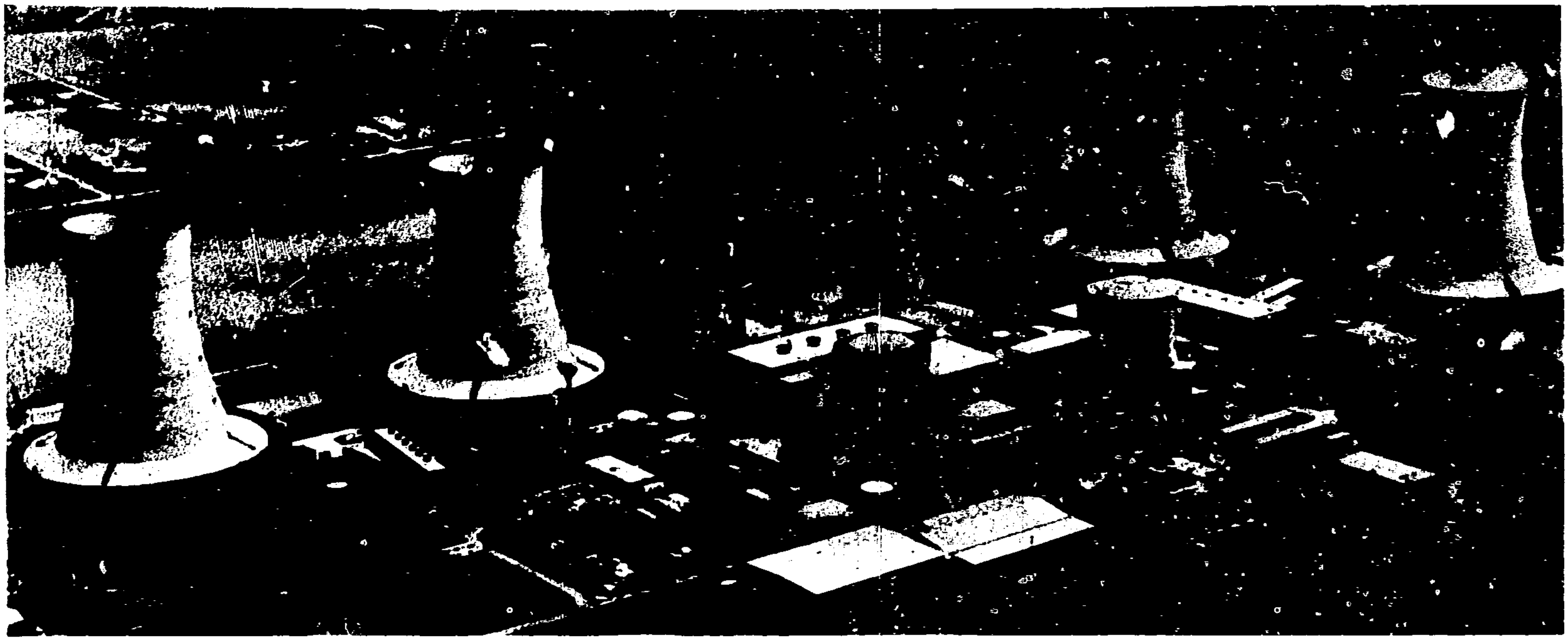
November 1981



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

# FIELD MEASUREMENTS AND INTERPRETATION OF TMI-2 INSTRUMENTATION: CF-1-PT43


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



Prepared for the
U.S. Department of Energy
Three Mile Island Operations Office
Under DOE Contract No. DE-AC07-76IDO1570

GEND-INF-017
Volume II

DISCLAIMER

# FIELD MEASUREMENTS AND INTERPRETATION OF TMI-2 INSTRUMENTATION: CF-1-PT4

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Technology for Energy Corporation/
General Public Utilities Nuclear Corporation

November 1981

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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 on the Core Flood Tank 1B pressure monitor CF-1-PT3. This instrument consists of a Foxboro Model EIIGM-HSAE1 electronic absolute pressure transmitter connected to a readout module by approximately 600 feet of cable through a penetration and an instrument mounting terminal block. This instrument was one of the few primary loop pressure monitors that was believed not failed during the accident. As a result, measurements on this instrument were performed to determine if it was properly functioning or if it had suffered some degradation.

## Section 2

## INSTRUMENT LOCATION, CABLING, AND TERMINATIONS

A review of appropriate drawings from Foxboro and Burns & Roe (itemized in the Appendix in the measurement procedure, page A-5 and A-6) resulted in the composite electrical diagram shown in Figure 2-1. From this information, a list of the appropriate termination points for performing measurements in Control Cabinet 150 was generated and is given in Table 2-1. Figure 2-1 also indicates the cable lengths pulled during instrument installation and lengths after trimming between each termination and/or junction point.

The pressure sensing assembly is a Foxboro Model EIIGM-HSAE1 which is shown in a cross-sectional view in Figure 2-2. This instrument has a normal range of 0-750 psia producing a 10-50 ma current output. The electrical diagram of the detector circuit is also shown in Figure 2-2.

Since measurements were being made in Control Cabinet 150, the effect of the readout meter (attached to the signal line) was also 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.

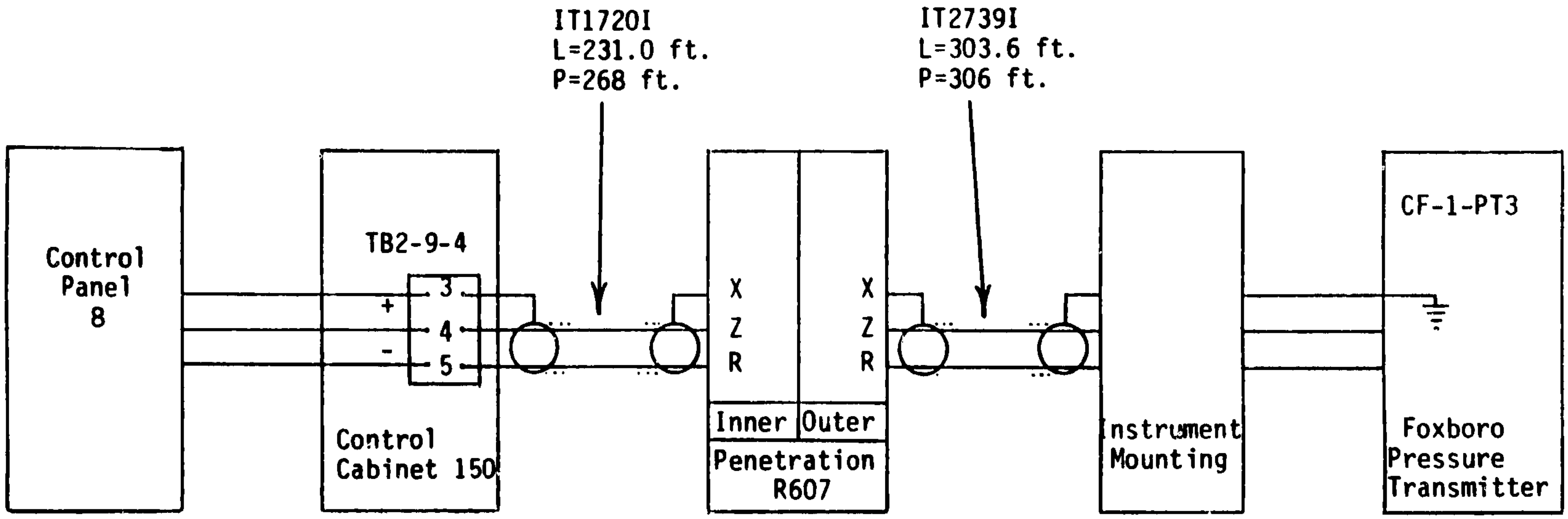


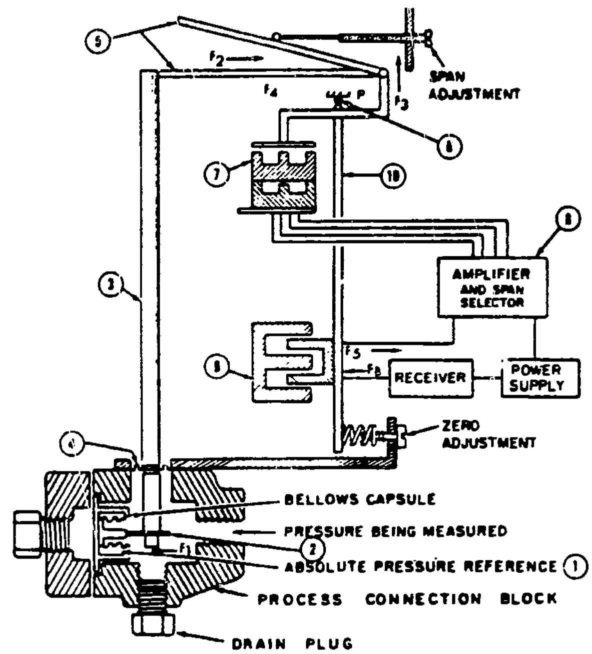

Figure 2-1. CF-1-PT3 Composite Electrical Diagram.

Table 2-1

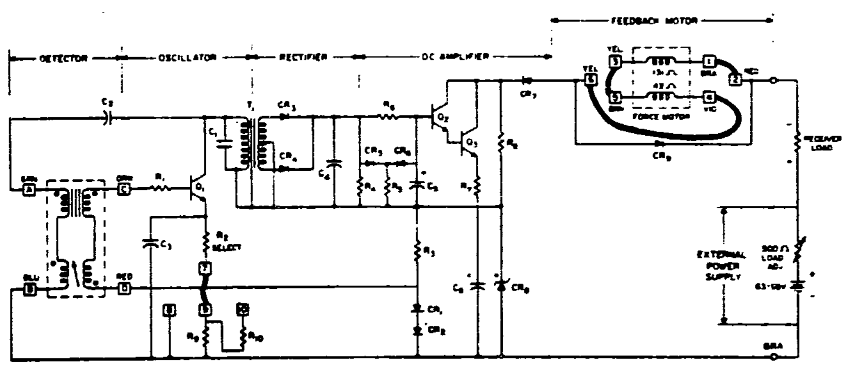
TERMINATION POINTS FOR CF-1-PT3 MEASUREMENTS

| Signal | Cabinet 150 Identification* |
|---|---|
| +Signal | TB2-9-4/4 |
| -Signal | TB2-9-4/5 |
| Shield | TB2-9-4/3 |

*From cable IT1720I




a. Cross Sectional View




b. Electrical Schematic

Figure 2-2. Foxboro Model E11GM Design.

# Section 3

# MEASUREMENT PROCEDURES

As a result of generating the composite electrical diagram and from a review of the Foxboro EIIA Series Electronic Absolute Pressure Transmitters technical information literature, measurements to be performed were identified as:

1. Determine as-found condition of pressure 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 pressure sensing 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.

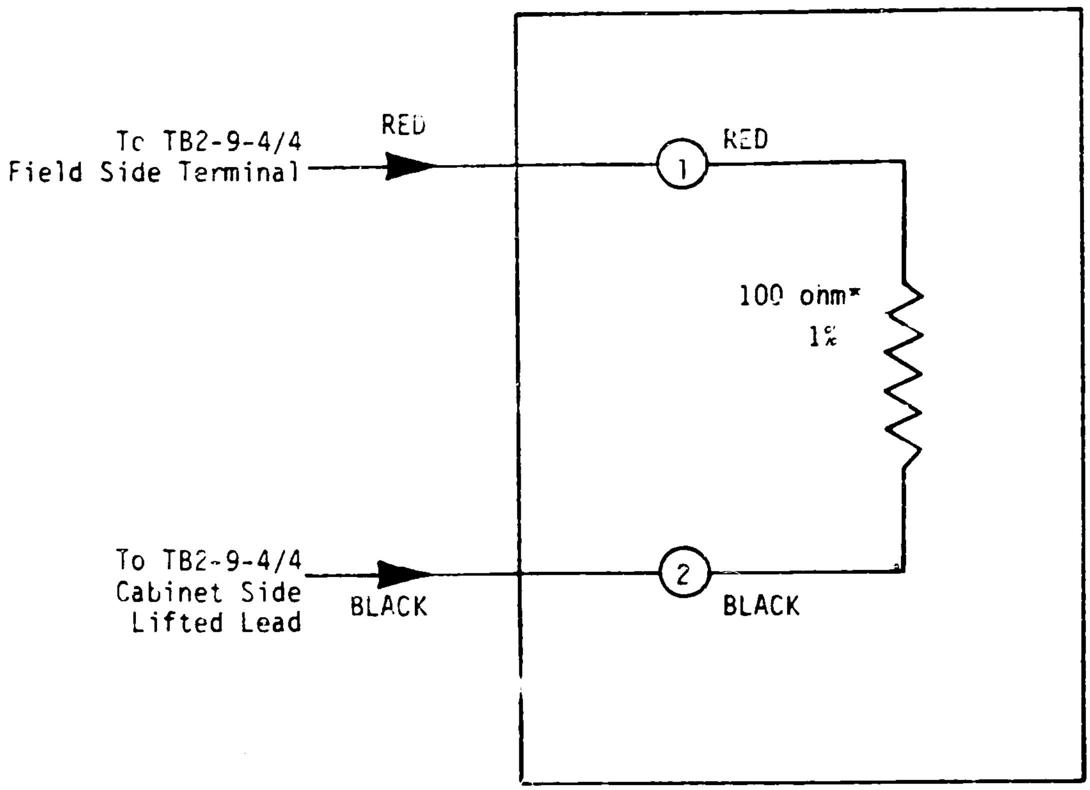
## Section 4

## MEASUREMENTS

Since the pressure signal from CF-1-PT3 was a 10-50 ma current loop, a test fixture was needed to convert this current to voltage for field measurements. A sketch of the test fixture used for this conversion is given in Figure 4-1. However, before insertion of the test fixture into the circuit, the readout of CF-1-PT3 was recorded as 162 psi to insure that the fixture did not affect the device. Following the test fixture insertion, the readout was 170 psi. This difference was probably due to operator interpretation of the meter and was not believed to have been the effect of the fixture because the signal increased rather than decreased with the added load.

After the insertion of the test fixture and verification of CF-1-PT3 output reading, the 1-5 volt signal from the connections on the test fixture was recorded for approximately 10 minutes on a FM recorder. During this recording, the DC voltage was measured (with a Keithley Model 177 DVM) as 1.89 volts, or equivalently 18.9 ma current.

The next measurement consisted of photographing the output waveform from the screen of a storage oscilloscope. Figure 4-2 shows the results of these time trace measurements for two different time scales. Along with the time traces, both high and low frequency spectra (frequency domain) were taken of the signal. Figure 4-3 shows the measured spectrum over a 4 MHz bandwidth, while Figure 4-4 shows spectra over both 100 kHz and 1 kHz ranges.




*Note: 100 ohm resistance converts 10-50 ma range to 1-5 volts for testing.

Figure 4-1. Current-to-Voltage Test Fixture.

Photo 112-1

Time - 20μsec/div

Gain - 20 mV/div

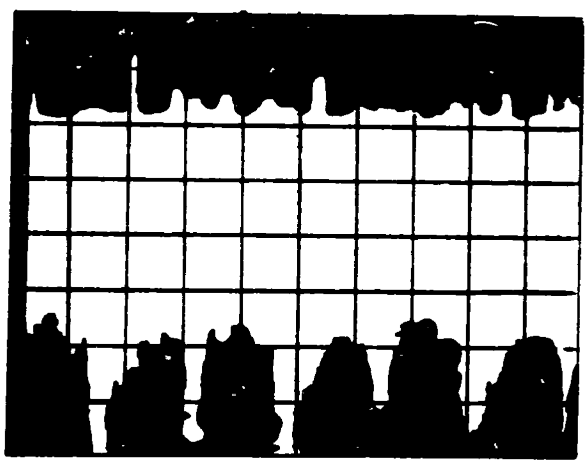


Photo 112-2

Time - 5msec/div

Gain - 20 mV/div

Figure 4-2. Oscilloscope Traces of Pressure Signal.

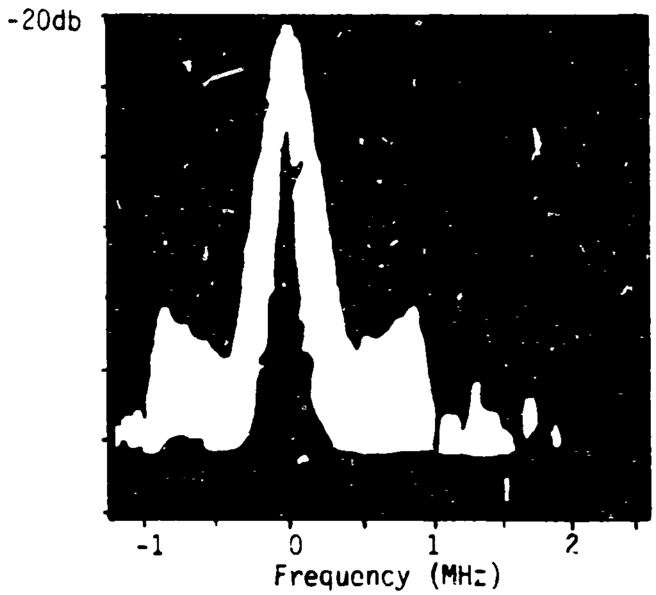


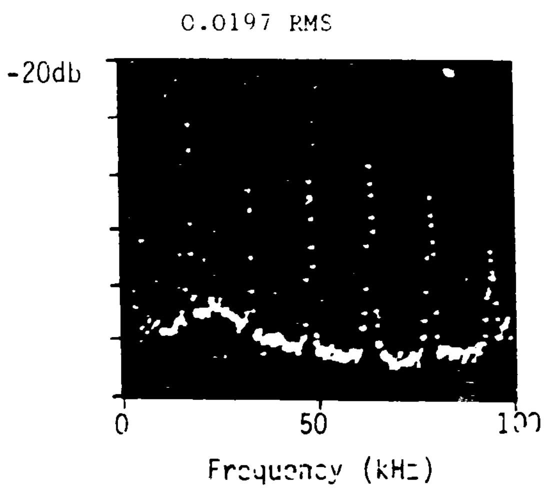

Photo 112-3

BW - 3 KHz

Scan width - 0.5 MHz/div

Scan time - lsec/div

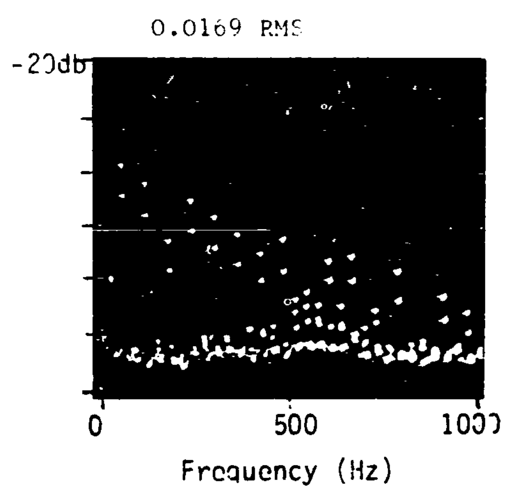
Figure 4-3. High Frequency Spectrum of Pressure Signal.




a) Photo 112-4

100 KHz Range

+20 db Reference




b) Photo 112-5

1 KHz Range

+20 db Reference

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

Following the frequency spectra measurements, electrical calibration was performed on the CF-1-PT3 readout module by a TMI technician. No significant adjustments were noted during this calibration. After electrical calibration, power was removed from CF-1-PT3. The test fixture was removed and all signal lines between cable IT1720I and cabinet 150 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 results of capacitance, impedance, and DC resistance measurements on the field cable lines. A set of TDR measurements were taken on the signal lines to determine possible cable defects. The resulting TDR traces are shown in Figures 4-5 to 4-7.

Table 4-1

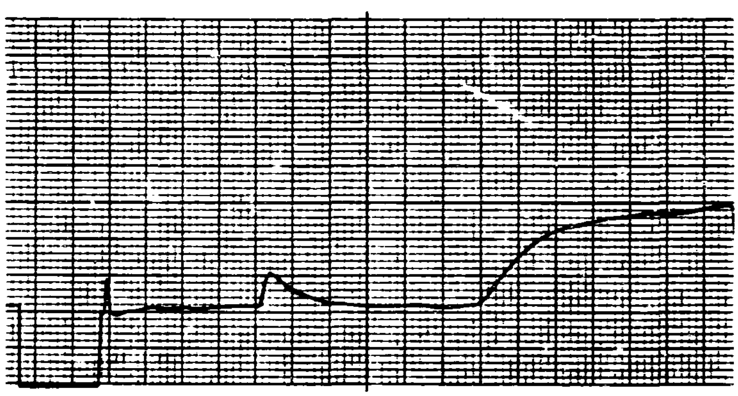
CAPACITANCE, IMPEDANCE, AND RESISTANCE MEASUREMENTS

| | Capacitance (nF) | | | Impedance (ohms) | | | |
|---|---|---|---|---|---|---|---|
| Signal | 100Hz | 1kHz | 100kHz | 100Hz | 1kHz | 100kHz | Resistance |
| +Signal -Signal | 3.5 | 3.3 | -312 | 182K | 46K | 5.3 | OF† |
| +Signal Shield | --* | 28 | 37 | -- | 6K | 43 | OF |
| -Signal Shield | -- | 18 | 34 | -- | 6K | 44 | OF |

*Indicates data was erratic.

†Indicates overflow, i.e., above $20 \times 10^6$ ohms.

STRIP CHART 112-1



Setting - 500μρ/div

Range - 52.6 ft/div

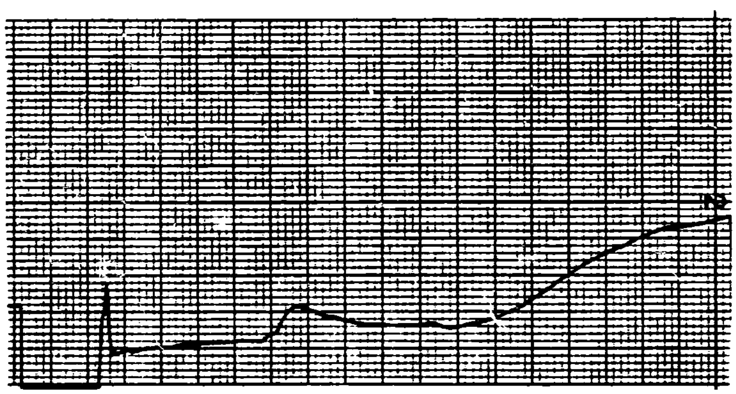
Sensitivity - 0.25

Filter - 5 Hz

Cable dielectric - other

Figure 4-5. TDR Trace of Pressure Signal Lines.

STRIP CHART 112-2



Setting - 500μρ/div

Range - 52.6 ft/div

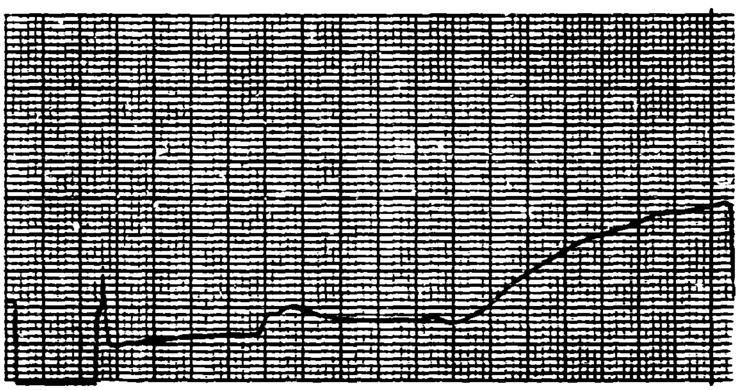
Sensitivity - 0.25

Filter - 5 Hz

Cable dielectric - other

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

STRIP CHART 112-3



Setting - 500$\mu\rho$/div

Range - 52.6 ft/div

Sensitivity - 0.25 V/div

Filter - 5 Hz

Cable dielectric - other

Figure 4-7. TDR Trace of (-) Signal to Shield.

## Section 5

## INTERPRETATION OF MEASUREMENTS

This section presents a summary of the interpretation of the measurements taken on CF-1-PT3. This interpretation is intended to indicate the condition of the device based on observed data.

Since this device varies from 10-40 ma for a 750 psi pressure range, the observation of 170 psi readout indicates that the current should be 19.07 ma. The measured current of 18.9 ma (1.89 volts across 100 ohms) matches within 1% of this expected value, which indicates the readout meter is correctly calibrated.

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 pressure signal. Note that even though up to 1.4 ma 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 0.017 ma RMS value given for the 60 Hz components.

The capacitance, impedance, and resistance data given in Table 4-1 is difficult to quantitatively interpret, but qualitative results are possible. The data indicates very low effective capacitance values, which would be expected from the amplifier section of the current loop driver. Other characteristics expected from the amplifier are extremely high DC resistance values and decreasing impedance at higher frequencies. Since all expected phenomena are present, there is

Table 5-1

MAJOR AC COMPONENTS ON THE PRESSURE SIGNAL

| Frequency | Amplitude | |
|---|---|---|
| 60 Hz and harmonics | 1.7 mV RMS | (0.017 ma RMS) |
| 16 kHz | 70 mV P-P | (0.7 ma P-P) |
| 16 kHz and harmonics | 20 mV RMS | (0.2 ma RMS) |
| 800 kHz | <1 mV RMS | (<0.01 ma RMS) |
| Total Spectrum | 140 mV P-P | (1.4 ma P-P) |

no obvious indication of instrumentation degradation from these measurements.

The results of TDR measurments 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 or insulation type was performed on the TDR instrument. As in other measurements, 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 | 221 | Point R increase | Penetration R607 |
| -Signal | 452 | Point R small decrease | Terminal block |
| | 526 | Large R increase | Electronics |
| +Signal | 221 | Point R increase | Penetration R607 |
| Shield | 452 | Point R small increase | Terminal block |
| | 505 | Large R increase | Electronics |
| -Signal | 221 | Point R increase | Penetration R607 |
| Shield | 442 | Point R small increase | Terminal block |
| | 495 | 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-1-PT3, there is no indication of degradation of the instrument. The only abnormal contamination present in the pressure signal was the 16 kHz component. However, the amplitude of this signal was relatively low and, from other measurements performed at TMI, such a low-level 16 kHz component appears to be present on several unrelated instrument lines. Thus, this component is probably due to some common cause throughout the plant and is not a problem as long as the readout device properly discriminates against such high frequencies. In addition, the readout of another pressure monitor (CF-1-PT4) was noted to agree with the reading taken from CF-1-PT3. Checking the transmitter current output also produced the same current indication. Therefore, it appears that CF-1-PT3 is operational and probably calibrated since an independent monitor is producing the same output.

GENERATION CORRECTIVE MAINTENANCE SYSTEM
JOB TICKET (...T)-THREE MILE ISLAND UNIT 2

Page A-1

| SYS | COMP TYPE | COMP ID | LOCATION/UNIT | JOB TYPE | JOB TICKET NUMBER | ORIGINATE DATE | RECOMMENDED PRIORITY |
|---|---|---|---|---|---|---|---|
| CF | 1 | OFT3 | 036002 | CM | C5730 | 092430 | |

DESCRIBE MALFUNCTION OR MODIFICATION DESIRED: Perform the attached procedure

CAUSE OF MALFUNCTION (IF KNOWN):

ORIGINATOR'S EMP NO: 06175 — ORIGINATOR'S SIGNATURE — DATE 9/-4/80
SUPERVISOR'S EMP NO: 06175 — SUPERVISOR'S SIGNATURE — DATE 9/24/80

DOE/EG&G Project

| WORK ORDER NUMBER LOCATION | SERIAL | QC CODE | ACCOUNT NUMBER | PLANT CONDITION SU | OP | HO | CD | RF | HS | LR | NPRD FAILURE START YR | MO | DAY | HR | MIN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0360 | 0C1E7BD | | X2001 7876019 | / | / | / | / | / | / | / | | | | | |

| | | | | REG AGENCY CODE | CHG/MOD NUMBER | ENV CODE | OUTAGE CAUSE CODE | STATUS HOLD CODE |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | | | X | | |

| SUPERVISOR'S APPROVAL COMMENCE WORK MO | DAY | YR |
|---|---|---|
| 09 | 25 | 80 |

| RESP LOCATION OR CONTRACTOR |
|---|
| 2036U |

Limits and Precautions
a) Personnel — Comply with the Provisions set forth in AP 1002 and Met Ed Safety Manual

b) Equipment

c) Environment

d) Nuclear

Post Maintenance Testing required and Acceptance Criteria — INSURE WORK AREA CLEANED UP AT COMPLETION OF JOB

Performing Procedure Complete

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

COPY 1

JOB TICKET (WORK REQUEST)
REVIEW – CLASS Page A-2 TING CONTROL FORM

JOB TICKET NUMBER C 5220

1. Does work represent a change or modification to an existing system or component? If yes, an approved change modification is required per AP 1021.
   C/M No. NA Yes____ No ✓

2a. Does work requires an RWP? Yes____ No ✓

2b. Is an approved procedure required to minimize personnel exposure? Yes____ No ✓

3a. Is work on a QC component as defined in GP 1008? Yes____ No ✓

3b. If 3a is yes does work have an effect on Nuclear Safety? If 3b is yes, PORC reviewed Superintendent approved procedure must be used. Yes____ No ✓

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

   NA __________
   UNIT SUPERINTENDENT DATE

5a Is the system on the Environmental Impact list in AP 1026? Yes____ No ✓

5b. If 5a is YES, is an approved procedure required to limit environmental impact? Yes____ No ✓

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

   NA __________
   UNIT SUPT./SUPV. OF OPERATIONS DATE

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

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

   NA __________
   QC SUPERVISOR DATE

9. Does work require code inspector to be notified? Yes____ No ✓

10. Supervisor of Maintenance approval to commence work

    [signature] Date 7/25/80

11. Maintenance Foreman Assigned B Gilbert

12. Code Inspector Notified Name __________ Date ______

13 Shift Foreman's approval to commence work B Smith Date 7/ /80

________ Initial if Shift Foreman signature is not required

TMI 154 2 80

# WORK REQUEST PROCEDURE

TMI Nuclear Station

Maintenance Page A-3 t 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 of CF-1-PT3
   Core Flood Tank 1B Pressure String

2. **Purpose:** To determine signal characteristics of instrument string as it exists in plant.

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

   CF-1-PT3 Instrument String.

4. **References:**

   See attached

5. **Special Tools, and Materials required.**

   See attached

6. **Detailed Procedure (attach additional pages as required)**

   See attached

Supervisor of Maintenance recommends approval [signature] Date 9/25/80

Systems Review [signature] Date 9/25/80

• **PORC RECOMMENDS APPROVAL**

Unit No. 1 Chairman ____________ Date ____________ Unit No. 2 Chairman ____________ Date ____________

• **UNIT SUPERINTENDENT APPROVAL**

Unit No. 1 ____________ Date ____________ Unit No. 2 ____________ Date ____________

• **Standing Procedure** ______________________ ____________
Supervisor of QC Date

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

TMI-94 2 78

| Technology for Energy Corporation | TITLE IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM CORE FLOOD TANK 1B PRESSURE CF-1-PT3 | NO. TP-112 |
|---|---|---|
| | Page A-4 | REV. 0 |
| PROCEDURE | APPROVED M.V. Mathis, Director, Tech. Serv. Div. | DATE 9-22-80 |

PURPOSE: The purpose of these measurements is to gather baseline data and information in preparation for removal of the Core Flood Tank 1B Pressure CF-1-PT3 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 not part of the engineered reactor safeguards system and is nuclear safety-related.

2. Environmental Safety. Core Flood Tank 1B Pressure CF-1-PT3 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 IT1720I. Terminations shall be removed and replaced on TB 2-9-4 of Cabinet 150.

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

**References**:

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.

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-PT3 (see attachment).

| SIGNAL | CABLE | CABINET 1560 |
|---|---|---|
| + Sig | IT1720I | TB 2-9-4/4 |
| - Sig | IT1720I | TB 2-9-4/5 |
| SHLD | IT1720I | TB 2-9-4/3 |

STEPS

1. Notify Shift Supervisor/Shift Foreman of start of test on CF-1-PT3.
2. Verify power is applied to CF-1-PT3.
3. Record present reading from CF-1-PT3 Readout Module.

| SIGNAL | READING IN PSI |
|---|---|
| CF-1-PT3 Readout | ~~[illegible]~~ PSI 162 |

4. Remove all power from CF-1-PT3.

[illegible] T S[illegible] [illegible]
Signature/Date

Lift lead on
5. ~~Open link~~ TB 2-9-4/~~4~~ 5 in Cabinet 150.

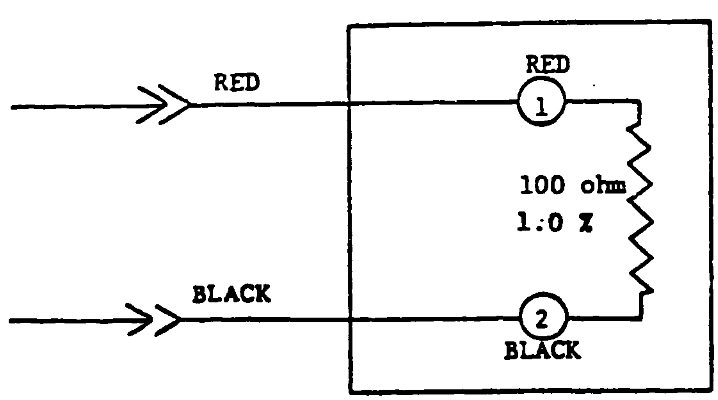
[illegible] T S[illegible] [illegible]
Signature/Date

lifted lead on
6. Insert TEC test fixture (100 ohm, 1.0% resistor) across ~~open link~~ TB 2-9-4/4
and terminal TB 2-9-4/4
per Figure 6-1 to convert 10-50 mA signal to voltage.

FIGURE 6-1.

To TB2-9-4/4
Field ~~Cabinet~~ Side
terminal

To TB2-9-4/4
~~Field~~ Side lifted
Cabinet lead




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

7. Apply power to CF-1-PT3 and wait 10 minutes for instrument warm-up.

8. Record present reading from CF-1-PT3 Reaout Module.

| SIGNAL | READING IN PSI |
|---|---|
| CF-1-PT3 Readout | 170 PSI |

9. Connect* differential Conditioning Amplifier (TEC Model 901) to the Core Flood Tank Pressure (TB 2-9-4/4; in Cabinet 150). Connect Model 901 output to FM Recorder and record Signal for 30 minutes. Remove amplifier and FM 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 at the following test point.

| SIGNAL | CABINET 156 | TEST LEAD | READING |
|---|---|---|---|
| *a. | TB 2-9-4/4<br>TB 2-9-4/4 | (+)<br>(-) | Signal 1.89 VDC |

*Across test 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:

| SIGNAL | CABINET 150 | PARAMETER | | | |
|---|---|---|---|---|---|
| *a. | TB 2-9-4/4<br>TB 2-9-4/4 | +SIG<br>-SIG | Photo 112-1<br>Time Base 20uS<br>Vert Gain 20mV | Photo 112-2<br>Time Base ____<br>Vert Gain ____ | Photo ____<br>Time Base ____<br>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] 9/25/80
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 150 | PARAMETER | PHOTO # |
|---|---|---|---|
| *a. | TB 2-9-4/4<br>TB 2-9-4/4 | SIGNAL | 112-3 |

*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.

PHOTO # 112-3 SPECTRUM IDENT FREQUENCY AMPLITUDE REMARKS

| BANDWIDTH | SCAN WIDTH | INPUT ATTEN | SCAN TIME | LOG REF | SENS |
|---|---|---|---|---|---|
| 3KHz | 0.5 MEGHz/DIV | 0 | 1 SEC | -20db | 0 |

Signature/Date 9/25/80

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

| SIGNAL | CABINET 150 | PARAMETER | PHOTO # |
|---|---|---|---|
| *$a_2$ | TB 2-9-4/4<br>TB 2-9-4/4 | SIGNAL | 112-4<br>112-5 |

100k RANGE

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

Signature/Date 9/25/80

14. Inside Cabinet 150 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-PT3.

Signature/Date 11/25/80

16. Lift the ~~Open links for~~ field wires from Cable IT1720I at TB 2-9-4/3, 4, and 5 (Cabinet 150) and remove test fixture (installed in Step 6).

| TERMINAL | SIGNAL IDENT. |
|---|---|
| TB 2-9-4/4 | (+) SIGNAL |
| TB 2-9-4/5 | (-) SIGNAL |
| TB 2-9-4/3 | SHIELD |

Signature/Date

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 2-9-4/4 (+ Sig) | TB 2-9-4/5 (- Sig) |
| b. | TB 2-9-4/4 (+ Sig) | TB 2-9-4/3 (SHLD) |
| c. | TB 2-9-4/5 (- Sig) | TB 2-9-4/3 (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 2-9-4/4:5 | 3.5 NF | 3.3 NF | -312 NF | 162K/-24° | 46K/-77° | 5.5 [illegible] |
| b. TB 2-9-4/4:3 | ~~33~~ ERRATIC | 28 NF | 37 NF | ERRATIC | 6K/-90° | 43 [illegible] -64° |
| c. TB 2-9-4/5:3 | ERRATIC | 18 NF 25 NF | 34 NF | ERRATIC | 6K/-85° 4K/-105° | 411 [illegible] -56° |

Signature/Date

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

| Test Point | Instrument Settings (Ampl Range Mult) | Strip Chart Number |
|---|---|---|
| a. TB 2-9-4/4:5 (+ Sig: - Sig) | | 112-1 |
| b. TB 2-9-4/4:3 (+ Sig: SHLD) | | 112-2 |
| c. TB 2-9-4/5:3 (- Sig: SHLD) | | 112-3 |

[signature] 9/25/80
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.

20K Range

| TEST POINT | FROM LINK | TO LINK | POLARITY From = +; To = - RESISTANCE | POLARITY From = -; To = + RESISTANCE |
|---|---|---|---|---|
| a. | TB 2-9-4/4 | TB 2-9-4/5 | OPEN | OPEN |
| b. | TB 2-9-4/4 | TB 2-9-4/3 | OPEN | OPEN |
| c. | TB 2-9-4/5 | TB 2-9-4/3 | OPEN | OPEN |

~~20 MEG RANGE~~

[signature] 9/25/80
Signature/Date

20. Reterminate the ~~Close links for~~ field wires from Cable IT1720I at TB 2-9-4, 4, and 5 (Cabinet 150) and restore power.

21. Notify the Shift Supervisor/Shift Foreman of the conclusion of testing CF-1-PT3.

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] 9/25/
Signature/Date

Instrumentation ______________
Signature/Date

# GENERATION CORRECTIVE MAINTENANCE SYSTEM

## CM STATUS ACTIVITY FORM



| COMPONENT DESIGNATOR: SYS (5) | COMP TYPE (8) | COMP ID (12) | LOOP (16) | LOCATION UNIT (17–22) | JOB TYPE (23–24) | WORK AUTHORIZATION NUMBER (28–32) | REQUEST DATE MO (33) | DAY | YR (36) |
|---|---|---|---|---|---|---|---|---|---|
| CF | 1 | 0PT3 | | 036002 | CM | C5730 | 09 | 24 | 80 |

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

| TXN CD (1) | ACT (4) | PRTY (66) | RESP LOCATION OR CONTRACTOR (67–71) | PRTY | ASSISTING CONTRACTOR | PRTY | ASSISTING CONTRACTOR |
|---|---|---|---|---|---|---|---|
| 805 | A | 2 | 036N | | | | |

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

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

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