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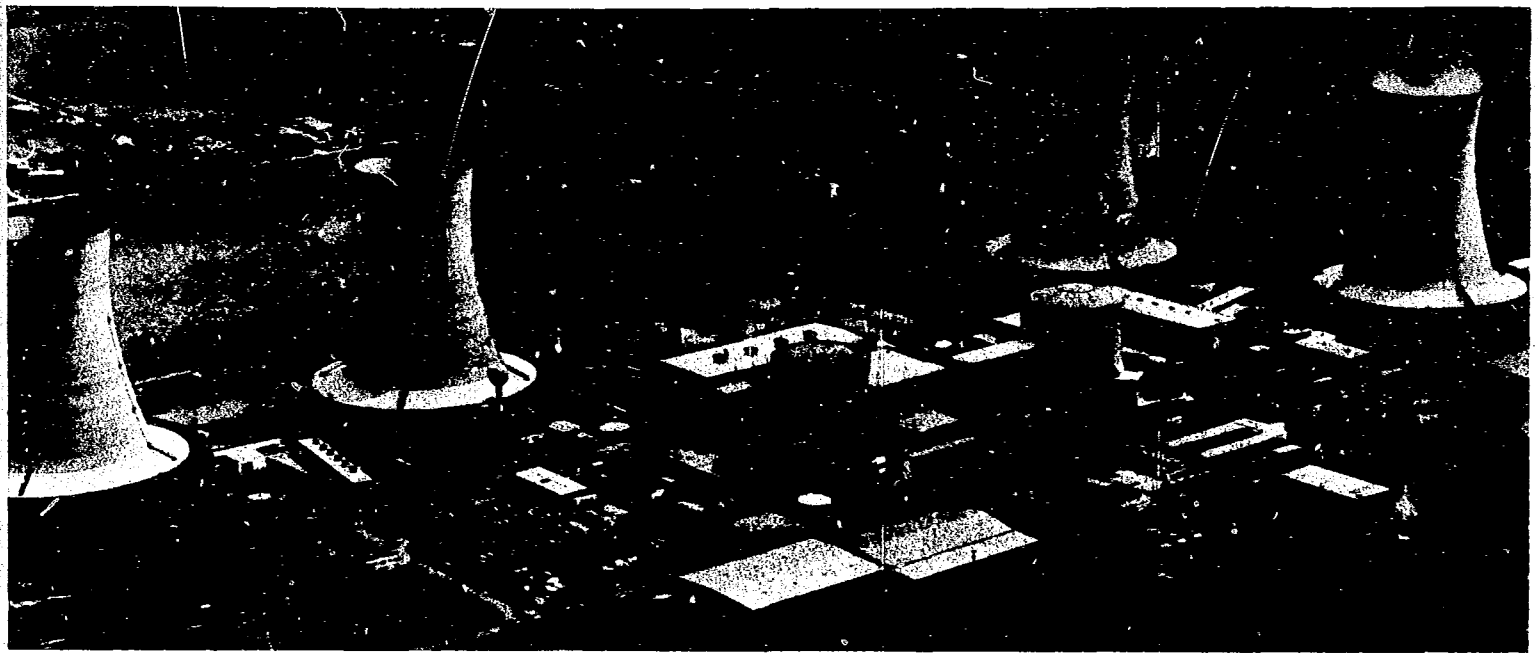

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Field Measurements and Interpretation of TMI-2

Instrumentation: HP-R-214

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

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FIELD MEASUREMENTS AND INTERPRETATION OF TMI-2 INSTRUMENTATION: HP-R-214

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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) 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 provides the information gathered by TEC on the area radiation monitor HP-R-214. This detector was located at 372' 7" elevation inside containment (dome monitor). This instrument consisted of a Victoreen Model 847-1 detector assembly housed inside a 2-inch lead shield connected to a Victoreen Model 846-1 panel alarm and approximately 250 feet of interconnecting cable. This instrument was believed to have failed due to an erratic 1 to 10 mR/hr radiation level indication and due to a lack of response to the manually activated checksource in the detector. As a result of this failure, the detector was a candidate for early replacement to provide long-term radiation monitoring capability inside containment.

2. INSTRUMENT LOCATION, CABLING, AND TERMINATIONS

A review of appropriate drawings from Victoreen and Burns & Roe (itemized in the Appendix in the measurement procedure, page A-5) resulted in the composite electrical diagram shown in Figure 2-1. From this information, Table 2-1 gives a list of the appropriate termination points for performing measurements in the Control Room in Cabinet 12. Also noted in Figure 2-1 are the cable lengths pulled during instrument installation (before final trimming) between each termination and/or junction point.

The detector assembly is a Victoreen Model 847-1 with required interfacing connections to the readout module. Figure 2-2 shows the functional layout of the detector and associated readout module. This assembly has a range of 0.1 to 10^7 mR/hr when enclosed in its associated 904120 lead housing. Electrical diagrams of the detector circuit are shown in Figures 2-3 and 2-4.

The Model 846-1 Readout Module, located in the control room, was not specifically considered to be a source of instrumentation problems except in its function of supplying power to the detector assembly.

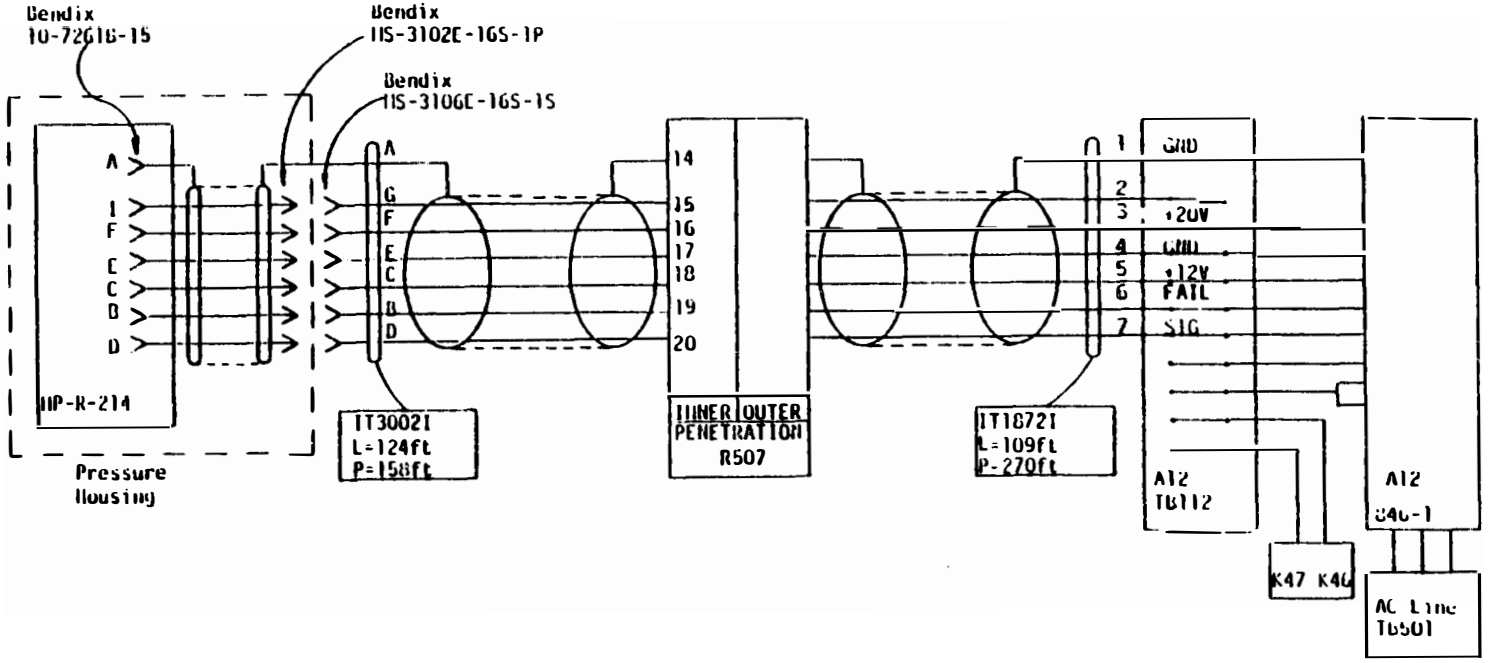


Figure 2-1. HP-R-214 Composite Electrical Diagram

Table 2-1

TERMINATION POINTS FOR HP-R-214 MEASUREMENTS

Signal	Cabinet 12 Identification*
GND	TB112-1
+20 V	TB112-3
SIG GND	TB112-4
+14 V	TB112-5
FAIL IN	TB112-6
SIG	TB112-7

*From cable IT1872I.

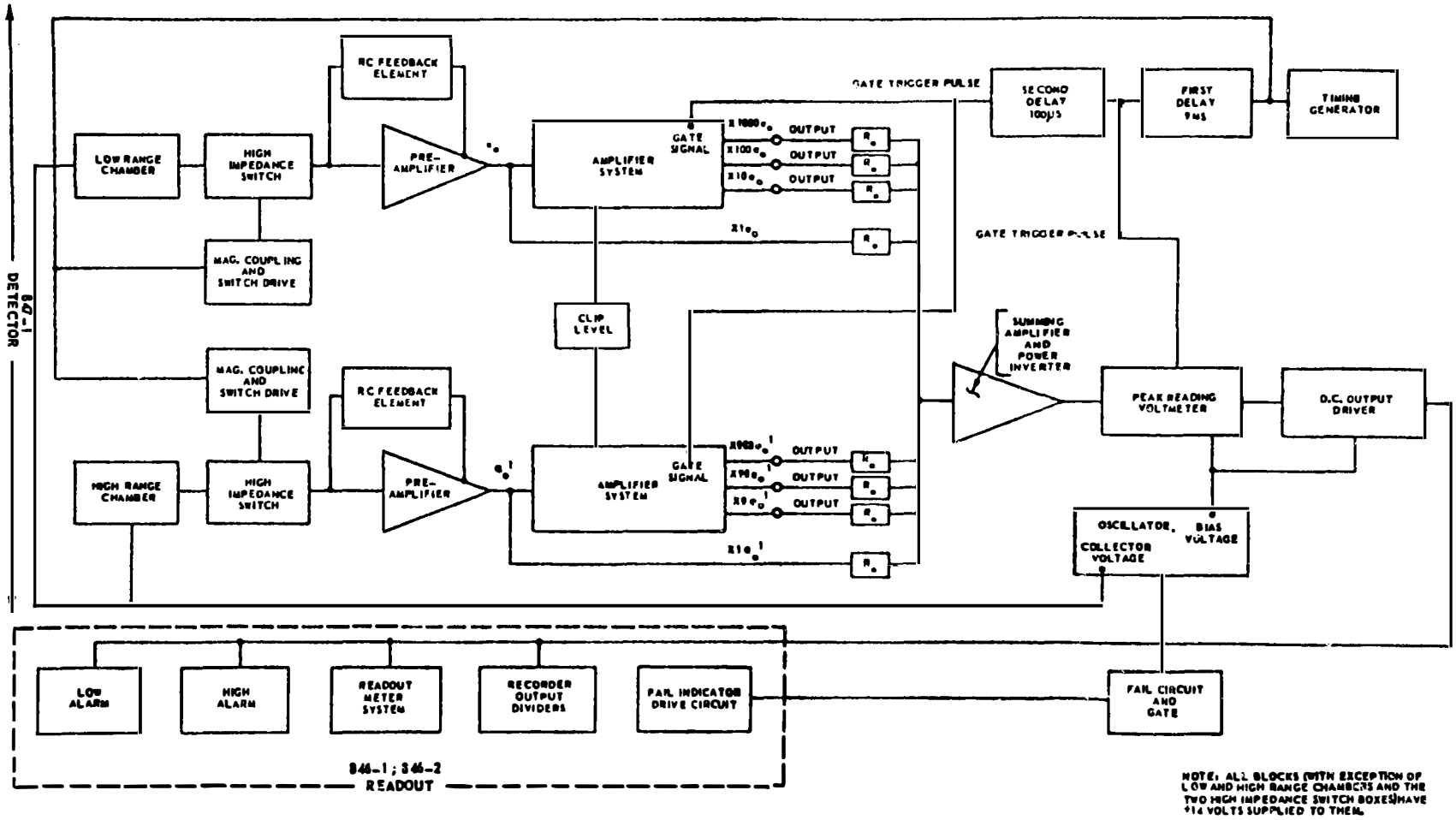


Figure 2-2. Functional Layout of Detector and Readout Module.

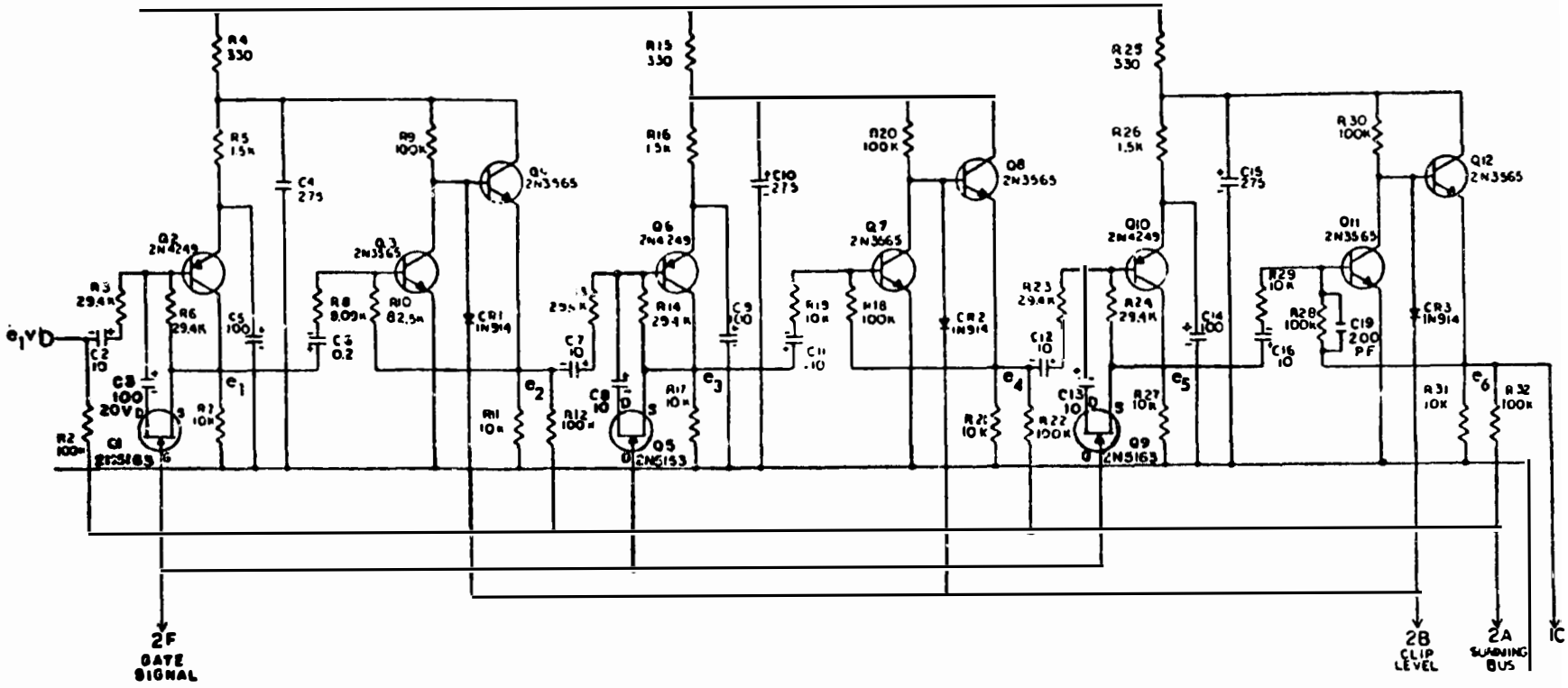


Figure 2-3. Circuit of Detector Pre-Amplifier.

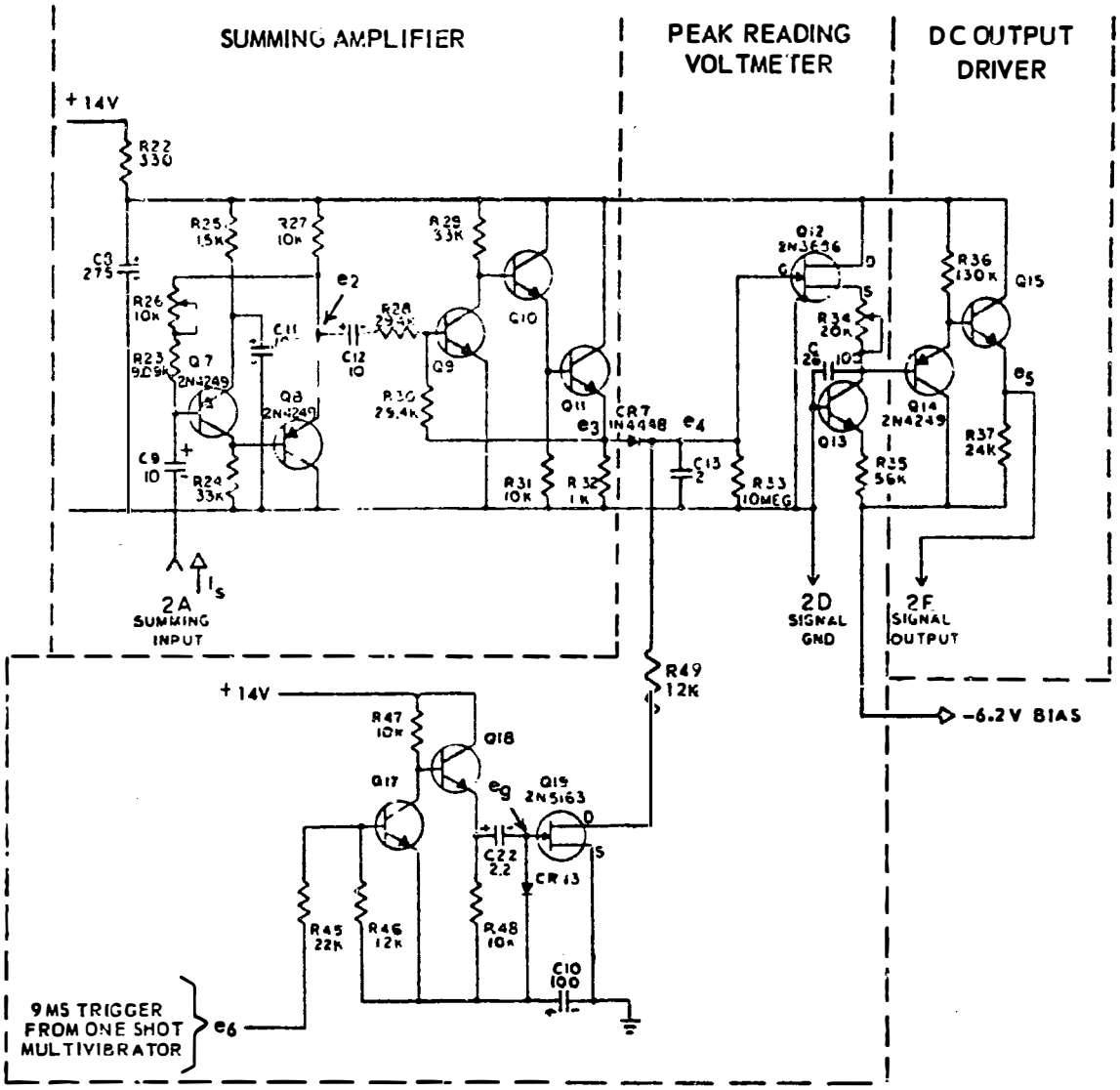


Figure 2-4. Circuit for Signal Amplification and Output Driver.

3. PREPARATION OF MEASUREMENT PROCEDURES

As a result of generating the composite electrical diagram and from a review of the Victoreen Area Monitor Operation Manual, TEC identified the major types of measurements to be performed:

1. Determine as-found condition of Readout Module and Remote Meter and record signal output;

2. On each electrical connection perform passive measurements (i.e., passively monitor signals) consisting of time domain waveforms, very-high frequency spectrum analysis (i.e., MHz region), and frequency spectra below 100 kHz; and

3. Perform resistance, capacitance, impedance, and Time Domain Reflectometry (TDR) active measurements (i.e., actively introducing a test signal).

These measurements were designed to verify the operation of the Readout Module (especially the power supplies), but the focus of the measurement was on the detector 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.

4. MEASUREMENTS

Since the output of HP-R-214 was designed to cover the range of 0 to 8 volts, the signal could be measured directly without amplification. Before performing measurements, the readout of HP-R-214 indicated a variable value of .1 to 1 mR/hr for the gamma dose inside containment. Activation of the checksource had no effect on the output reading. The Signal In was then recorded for approximately 10 minutes on an FM recorder and various outputs measured with a DVM. These measurements yielded the following results:

20 V power Supply @ 20.4 VDC

Signal Out @ .6 to 2.3 VDC (pulsing)

14 V Power Supply @ 14.7 VDC

Fail IN @ 2.9 VDC.

The next measurements consisted of photographing the output waveforms of the Fail In, Signal In, and power supplies from a storage oscilloscope. Figures 4-1 to 4-5 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 Fail In, Signal In, and power supplies. Figures 4-6 to 4-10 show the measured spectra over high frequency bandwidths (>1 MHz), while Figures 4-11 to 4-15 show spectra over bandwidths below 100 kHz.

Following the frequency spectra measurements, electrical calibration was requested on the HP-R-214 readout module. Due to other more important tasks needing the attention of TMI technicians, this calibration was not

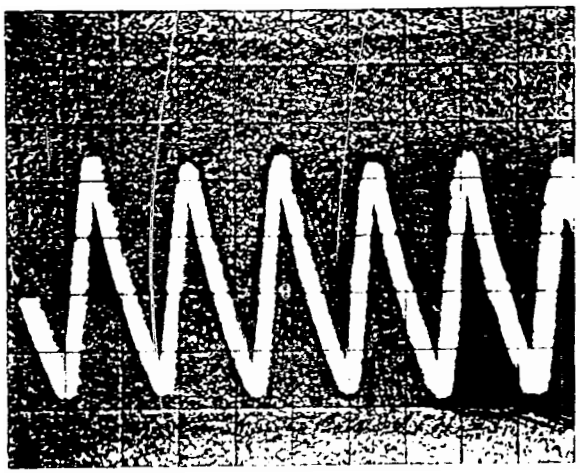


Photo 104-1

Time: 5msec/div

Gain: 0.5V/div

Signal: +20V

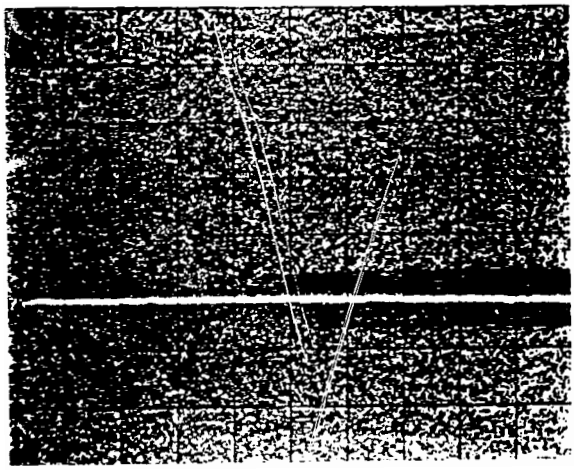


Photo 104-2

Time: 1μsec/div

Gain: 0.5V/div

Signal: +20V

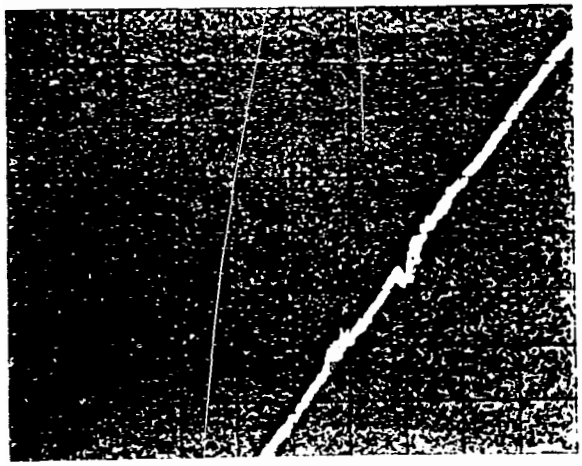


Photo 104-3

Time: 10μsec/div

Gain: 10mV/div

Signal: +20V

Figure 4-1. Oscilloscope Traces of 20V Power Supply.

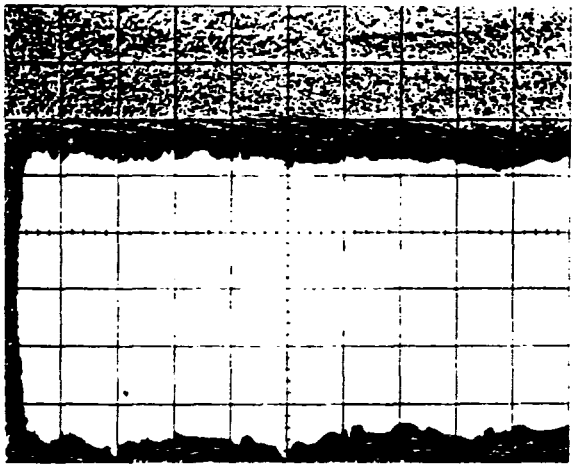


Photo 104-4

Time: 5msec/div

Gain: 2mV/div

Signal: SIG GND

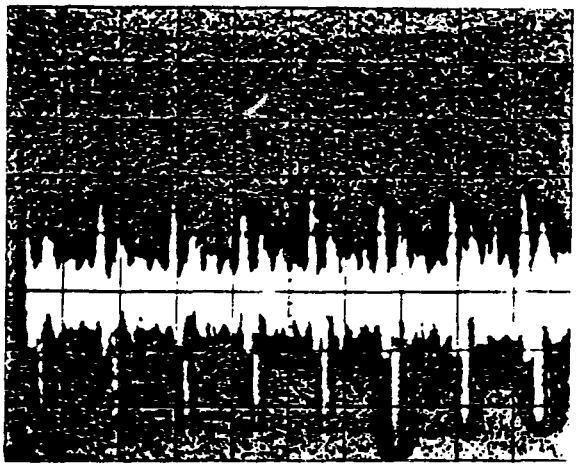


Photo 104-5

Time: 50µsec/div

Gain: 2mV/div

Signal: SIG GND

Figure 4-2. Oscilloscope Traces of Signal Ground.

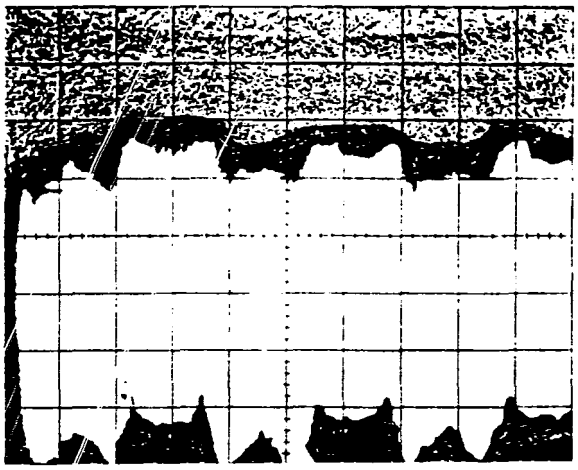


Photo 104-6

Time: 5msec/div

Gain: 2mV/div

Signal: +14V

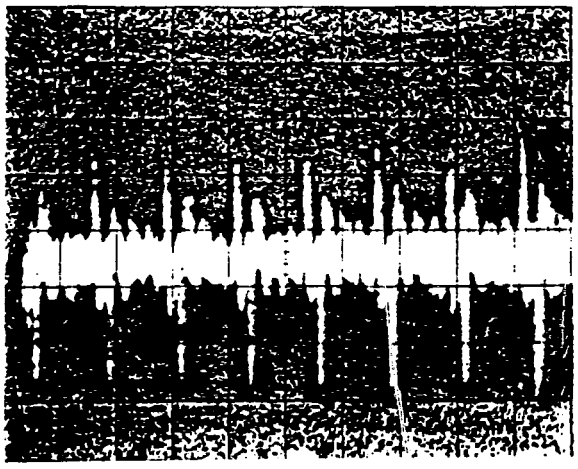


Photo 104-7

Time: 50μsec/div

Gain: 2mV/div

Signal: +12V

Figure 4-3. Oscilloscope Traces of 14V Power Supply.

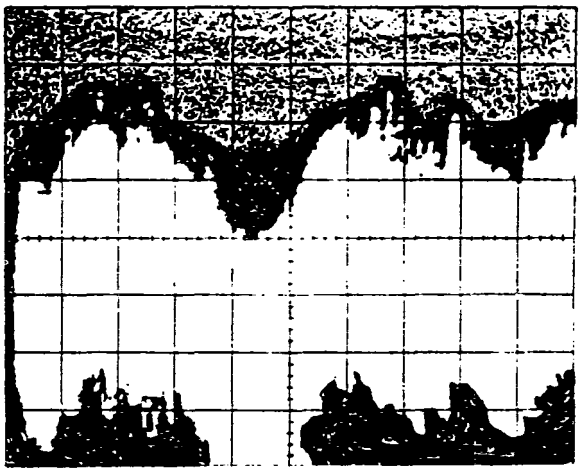


Photo 104-8

Time: 2msec/div

Gain: 2mV/div

Signal: Fail In

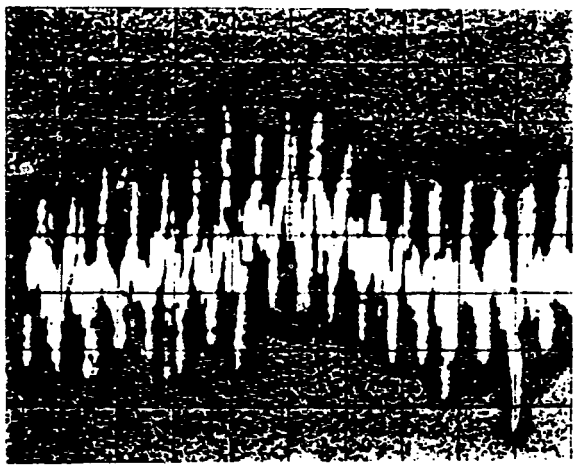


Photo 104-9

Time: 50µsec/div

Gain: 2mV/div

Signal: Fail In

Figure 4-4. Oscilloscope Traces of FAIL IN Line.

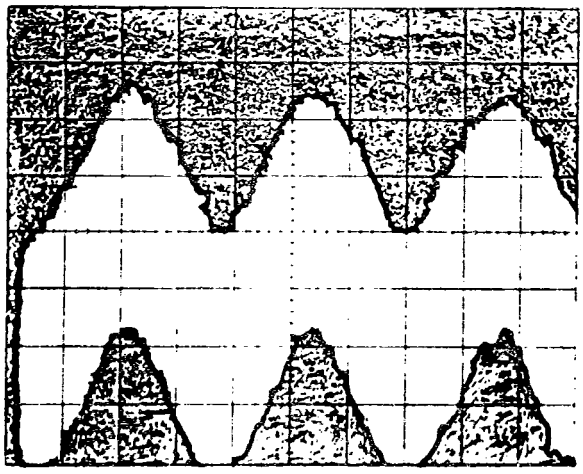


Photo 104-10

Time: 5msec/div

Gain: 10mV/div

Signal: SIGNAL

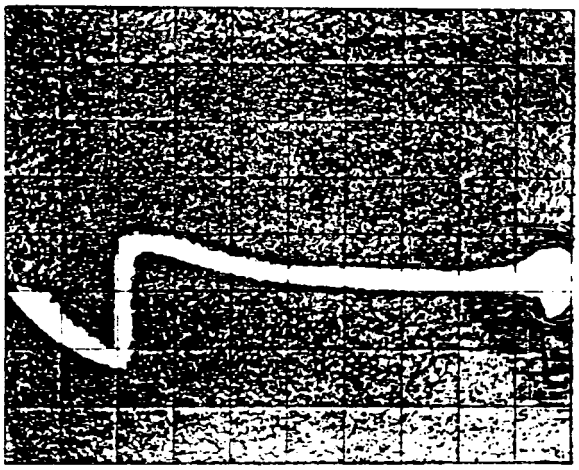


Photo 104-11

Time: 5msec/div

Gain: 0.5V/div

Signal: SIGNAL

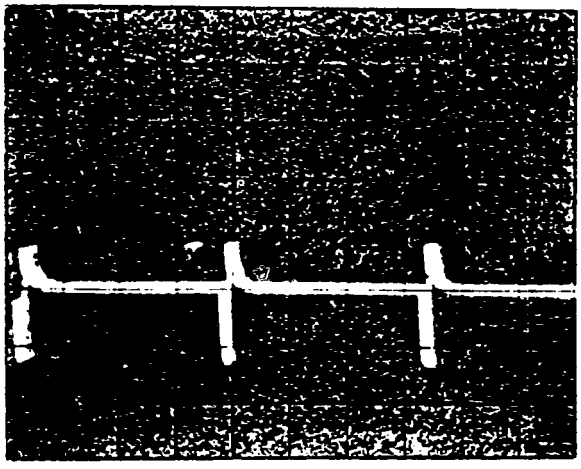


Photo 104-12

Time: 0.1sec/div

Gain: 0.5V/div

Signal: SIGNAL

Figure 4-5. Oscilloscope Traces of SIGNAL Line.

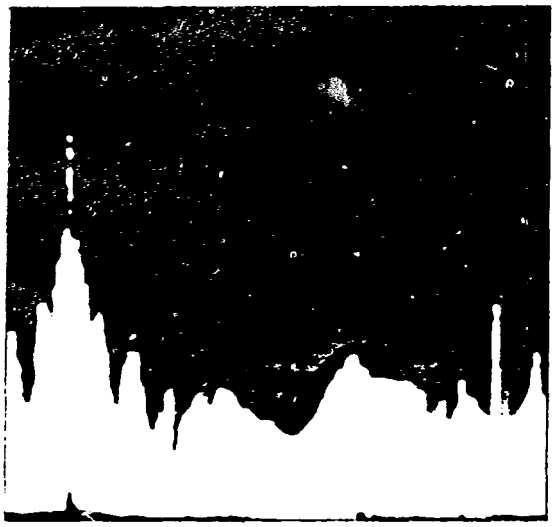


Figure 4-6. High Frequency Spectrum of 20V Supply.

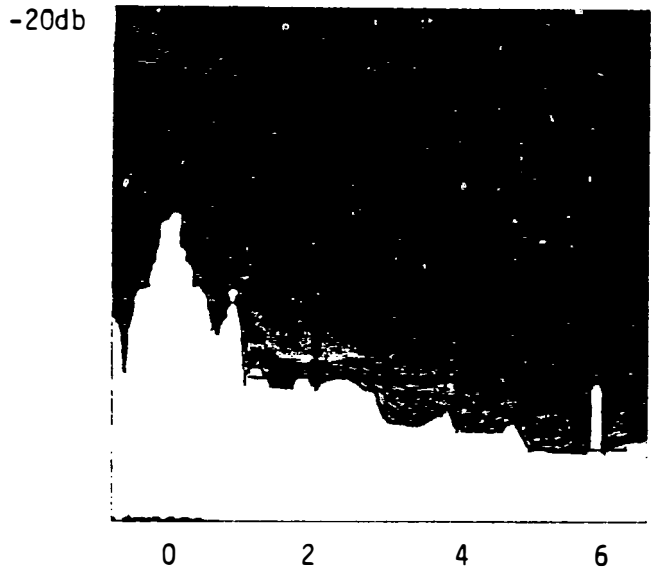


Figure 4-7. High Frequency Spectrum of 14V Supply.

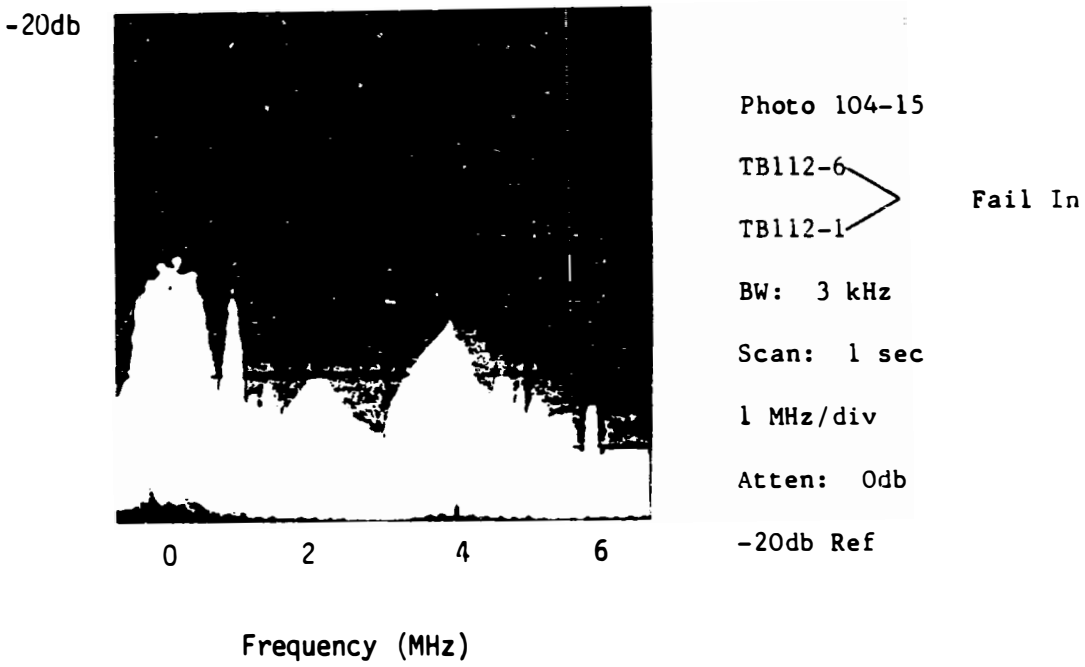


Figure 4-8. High Frequency Spectrum of FAIL IN Line.

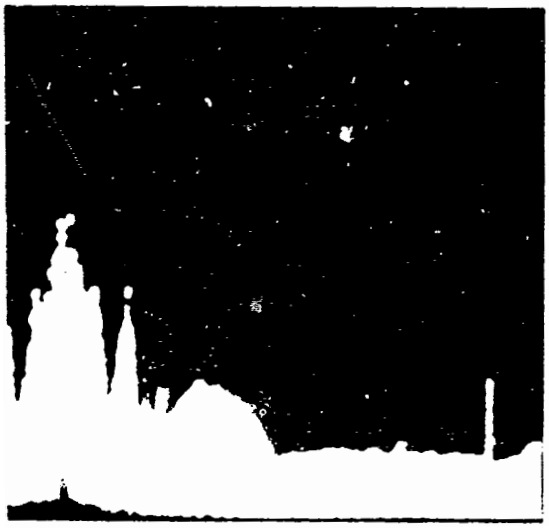


Figure 4-9. High Frequency Spectrum of Signal Ground.

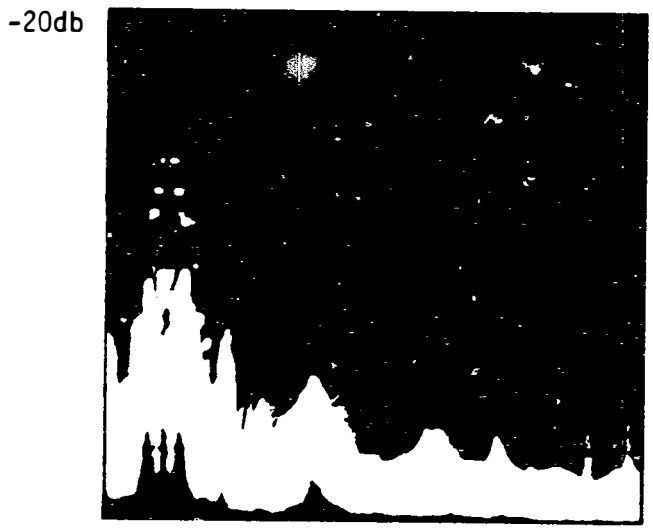


Figure 4-10. High Frequency Spectrum of SIGNAL Line.

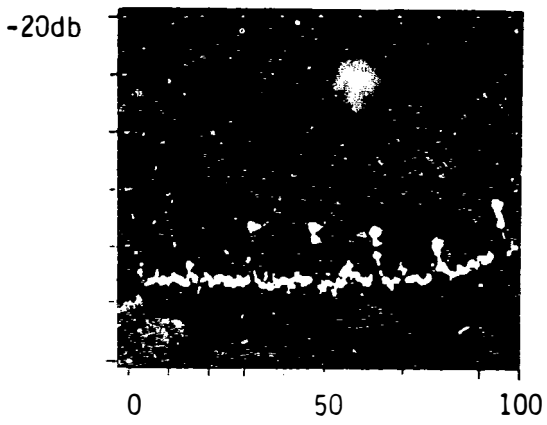


Photo 104-18

TB112-3 > 20V

TB112-1

100 kHz Range

15.7 kHz Harmonics

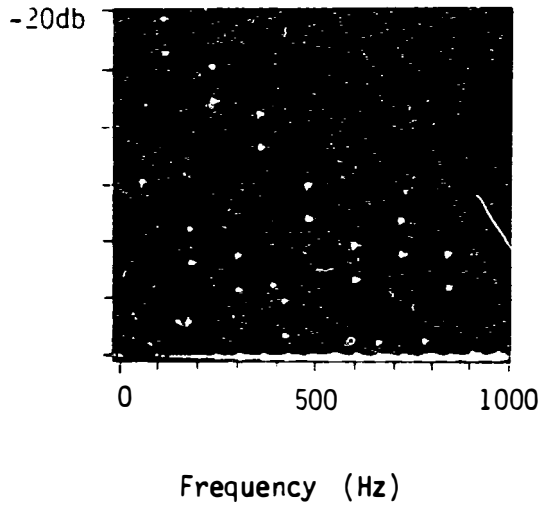


Photo 104-19

1 kHz Range

60 Hz Harmonics

Figure 4-11. Low Frequency Spectra of 20V Power Supply.

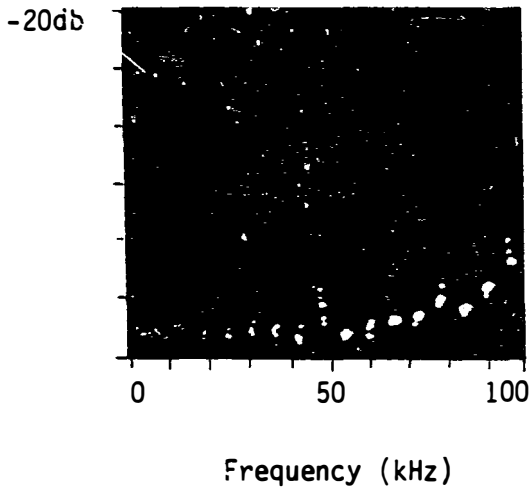


Photo 104-20

TB112-6 > Fail In

TB112-1

100 kHz Range

6 kHz Harmonics

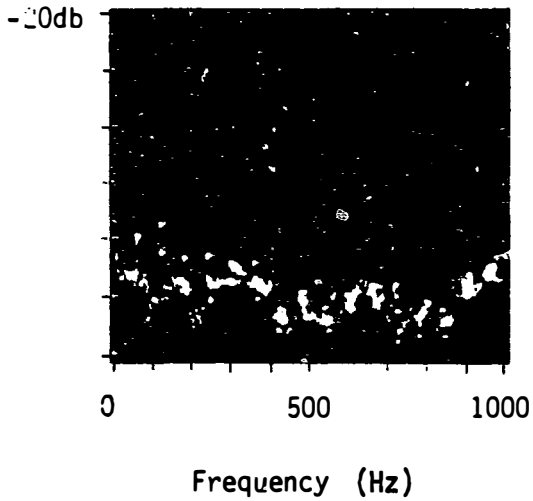


Photo 104-21

1 kHz Range

60 Hz Harmonics

Figure 4-12. Low Frequency Spectra of FAIL IN Lines.

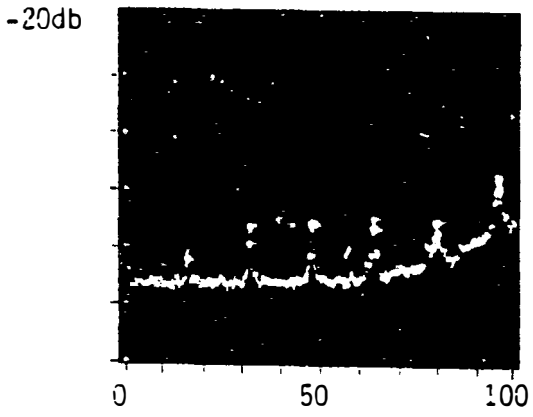


Photo 104-22

TB112-5 > 14V

TB112-1

100 kHz Range

15.7 kHz Harmonics

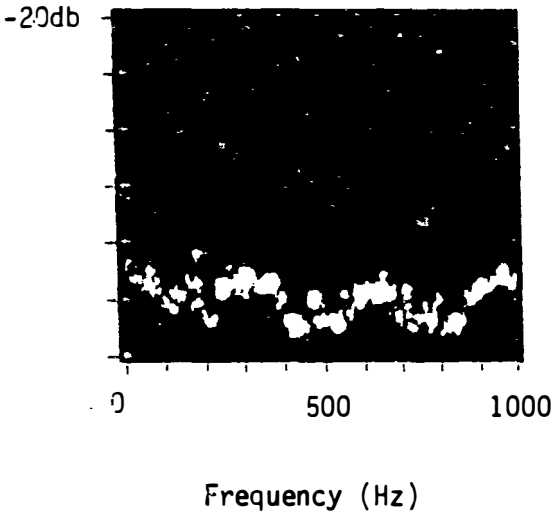


Photo 104-23

1 kHz Range

60 Hz Harmonics

Figure 4-13. Low Frequency Spectra of 14 V Power Supply.

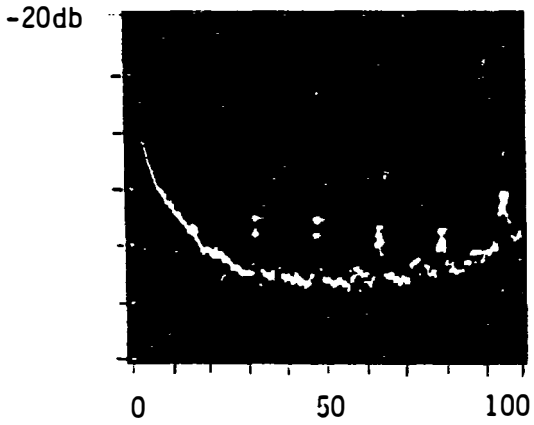


Photo 104-24

TB112-7 > SIGNAL

TB112-4

100 kHz Range

15.7 Harmonics

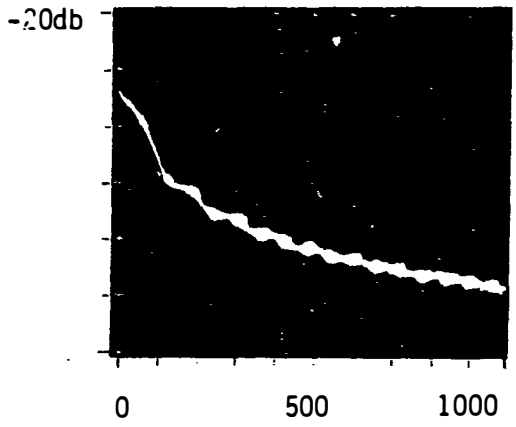


Photo 104-25

1 kHz Range

Figure 4-14. Low Frequency Spectra of SIGNAL Line.

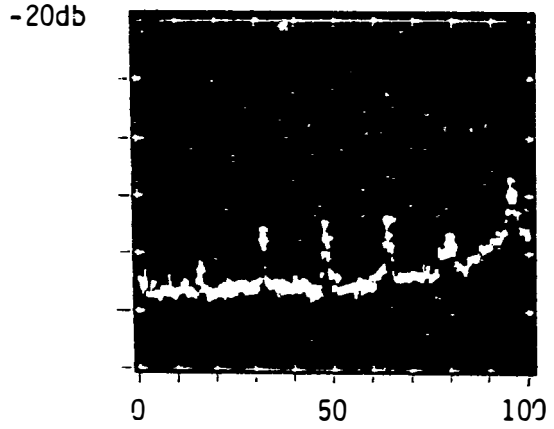


Photo 104-26

TB112-4 > SIG GND

TB112-1

100 kHz Range

15.7 kHz Harmonics

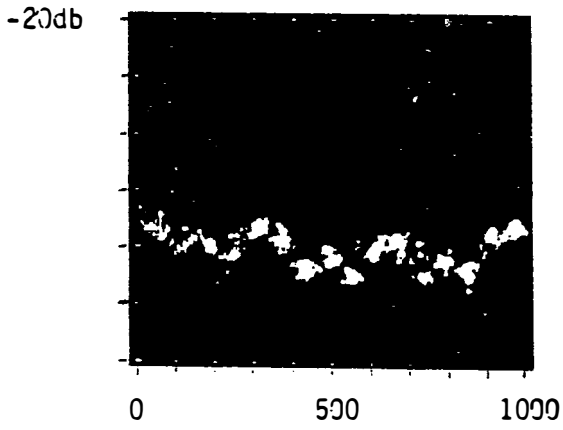


Photo 104-27

1 kHz Range

60 Hz Harmonics

Figure 4-15. Low Frequency Spectra of Signal Ground.

performed, but was not critically neded since the power supplies appeared to be fully operational. Power was then removed from HP-R-214. The test fixture was removed and all signal lines from cable IT1872I to cabinet 12 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 was taken on the signal lines to determine possible cable defects. These TDR traces are shown in Figures 4-16 to 4-20.

Table 4-1

CAPACITANCE, IMPEDANCE, AND RESISTANCE MEASUREMENTS

Signal	Capacitance (nF)			Impedance (ohms)			Resistance (ohms)*
	100 Hz	1 kHz	100 kHz	100 Hz	1 kHz	100 kHz	
GND +20	11	13	-154	1.08k	1.07k	14	1k (1k)
GND SIG GND	108 µF	148 µF	454	15.2	3.4	3.7	11.1 (11.5k)
GND +14V	OF†	OF	342	28	28	5	3.6k (3.6k)
SIG GND FAIL IN	19	18	VAR**	53k	8.7k	VAR	>2M
SIG GND SIG	24	18	OF	9.3k	6.4k	OF	>2M (13.7k)

*Values in parentheses are reverse polarity values.

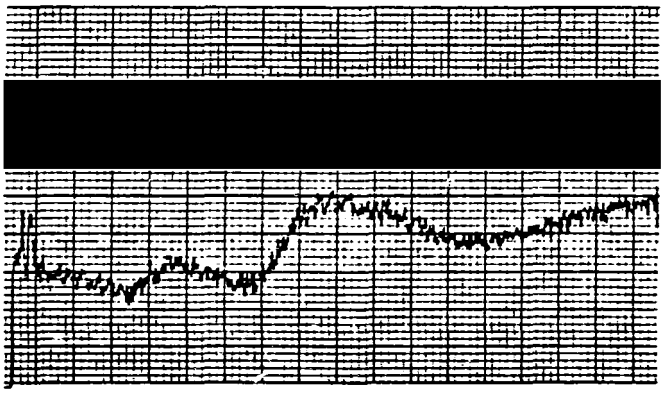
**Indicates variable response.

†Indicates off-scale or excessive noise.

STRIP CHART 104-1

TB112: 1 to 3

Signal: +20V



Setting - 500mΩ/div

Range - 52.6 ft/div

Sensitivity - 0.25

15 Hz filter

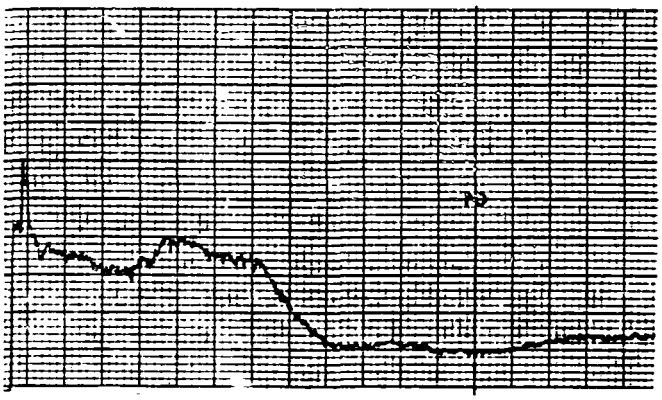
Cable dielectric - other

Figure 4-16. TDR Trace of 20V Power Supply.

STRIP CHART 104-2

TB112: 1 to 4

Signal: Shield GND to Signal GND



Setting - 500mρ/div

Range - 52.6 ft/div

Sensitivity - 0.25

15 Hz filter

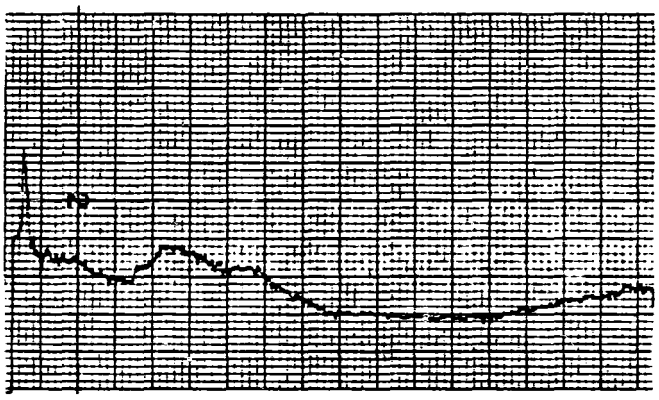
Cable dielectric - other

Figure 4-17. TDR Trace of Signal Ground.

STRIP CHART 104-3

TB112: 1 to 5

Signal: +14V



Setting - 500mp/div

Range - 52.6 ft/div

Sensitivity - 0.25

15 Hz filter

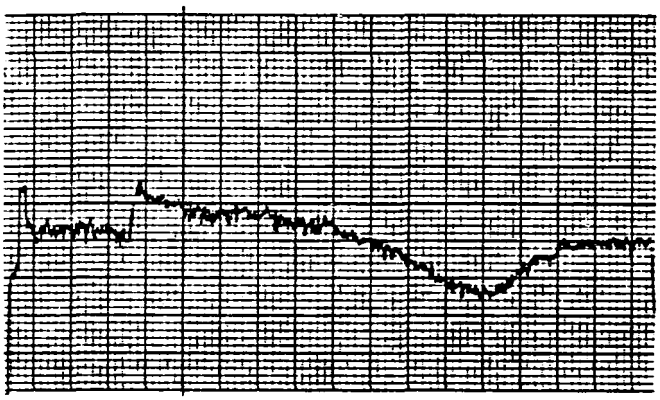
Cable dielectric - other

Figure 4-18. TDR Trace of 14V Power Supply.

STRIP CHART 104-4

TB112: 4 to 6

Signal: Fail In



Setting - 500mρ/div

Range - 52.6 ft/div

Sensitivity - 0.25

15 Hz filter

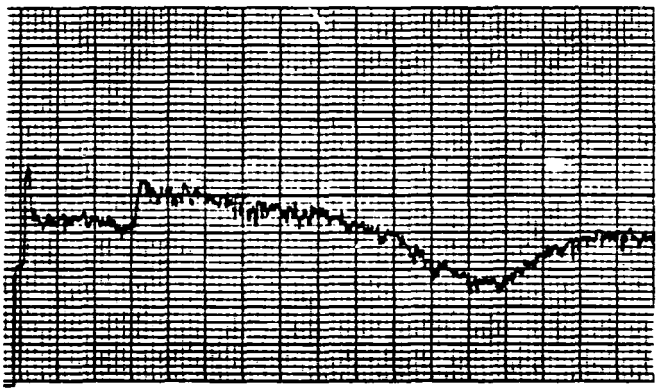
Cable dielectric - other

Figure 4-19. TDR Trace of FAIL IN.

STRIP CHART 104-5

TB112: 4 to 7

Signal: Signal In



Setting - 500mρ/div

Range - 52.6 ft/div

Sensitivity - 0.25

15 Hz filter

Cable dielectric - other

Figure 4-20. TDR Trace of SIGNAL IN.

5. SUMMARY AND INTERPRETATION OF MEASUREMENTS

This section presents a summary of the interpretation of the measurements taken on HP-R-214. This interpretation is intended to indicate the condition of the device based on observed data.

5.1 SUMMARY OF MEASUREMENTS

The 20V power supply measurement indicated a 20.4 VDC level, and the 14V power supply indicated 14.07 VDC. Both readings are within the expected range, but the 14V supply may need to be adjusted for instrument calibration purposes. The Signal In measured 0.6 to 2.3 VDC pulsing, rather than the expected slowly varying or steady dc level. The Fail In measured 2.9 VDC which is the expected level if the detector power supplies are functioning. However, the green light on the readout module, which indicates proper supply voltages in the detector, was not illuminated.

The time traces and frequency spectra were used to summarize the major characteristics of the measured waveforms. Results of this summary are presented in Table 5-1. The 14V power supply exhibits normal characteristics when compared to other TMI-2 measurements. However, the 20V supply shows a large 2V P-P 120 hertz ripple. This is not unexpected, since the 20V is used to drive the checksource and is not required to be well regulated. The Signal In consists of .6 V to 2 V pulses occurring at a very precise 3 hertz frequency.

Table 5-1

CHARACTERISTICS OF MAJOR SIGNAL LINES

Signal	Frequency	Amplitude
Signal In	60 Hz	50 mV P-P
	16 kHz and Harmonics	3 mV RMS
	[Pulses .6 V to 2 V @ 3 hertz]	
600 V Supply	120 Hz and Harmonics	0.6 V RMS
	16 kHz and Harmonics	<1 mV RMS
	Total Spectrum	2 V P-P
10 V Supply	60 Hz and Harmonics	<1 mV RMS
	16 kHz and Harmonics	9 mV RMS
	Total Spectrum	12 mV P-P

The Signal In waveform would normally be a voltage level proportional to the radiation present.

The capacitance and impedance data given in Table 4-1 is difficult to quantitatively interpret due to active components in the circuitry, but qualitative results are possible. Very low effective capacitance values would be expected from most signal lines. Impedance data is reasonable and exhibits major trends expected from the circuitry, such as reducing values at higher frequency. Resistance data does not show any unexpected results except for the resistance between 20V and ground. According to Victoreen drawings, a 2 k-ohm resistor should be present, but a 1 k-ohm value was indicated. The value of the fixed resistor was probably changed in the instrument and not updated on the drawings.

The results of TDR measurements performed on the cable (shown in Figures 4-16 to 4-20) 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 this is not unusual due to the noise levels observed on the TDR responses. No unusual inflections occurred on any lines measured.

5.2 INTERPRETATION OF MEASUREMENTS

Based upon the observation of approximately 1.4 V P-P pulses on the Signal In occurring at 0.33 second intervals, it appears that either the Peak Reading Voltmeter or the DC Output Driver stage of the detector

Table 5-2

SUMMARY OF TDR MEASUREMENTS

Signal Lines	Distance (feet)*	Probable Cause
GND +20 V	126 315	Penetration R507 Detector
GND SIG GND	137 326	Penetration R507 Detector
GND +14 V	137 315	Penetration R507 Detector
SIG GND FAIL IN	147	Penetration R507
SIG GND SIG	142	Penetration R507

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; all lines exhibited large noise levels which made interpretation difficult.

circuitry has failed. This is allowing the internal oscillator frequency (3 V hertz) to be passed into the output instead of periodically updating the dc output as designed. The cause of this failure was not obvious from the measurements, but the Fail In level implies that proper power is being supplied to the instrument.

Resistance measurements on the 20 V supply indicate that either a resistor has been reduced from 2 to 1 k-ohm due to aging and radiation, or that the Victoreen drawings have not been updated to show a change to a 1 k-ohm resistor.

The absence of the "Safe" indication on the readout module indicates a problem with the light circuitry or a failed bulb, since the measured Fail In indicated proper operation.

6. CONCLUSIONS

Based on the measurements, data reduction, and circuit analysis of HP-R-214, there is an indication of failure of the instrument. The observed output signal indicates a failure in the detector circuitry, either in the Peak Voltmeter or DC Driver Stages. The operability of the ion chamber cannot be determined since all signals must pass through the suspected stages of the amplifier. The periodic pulses present on the signal line are interpreted as varying radiation levels by the readout module which results in the observed variation in the readout meter.

206-35

GENERATION CORRECTIVE MAINTENANCE SYSTEM
JOB TICKET FORM (\ Page A-1 E MILE ISLAND UNIT 2

COMPONENT DESIGNATION SYS	COMP TYPE	COMP. ID.	LOOP	LOCATION / UNIT	JOB TYPE	JOB TICKET NUMBER	REQUEST DATE MO	DAY	YR	RECOMMENDED PRIORITY
HP	R	0214		036002	CM	C56780	9	18	80	2

DESCRIBE MALFUNCTION OR MODIFICATION DESIRED

Perform the attached procedure.

CAUSE OF MALFUNCTION (IF KNOWN)

ORIGINATOR'S EMP. NO.	ORIGINATOR'S SIGNATURE	DATE	SUPERVISOR'S EMP. NO.	SUPERVISOR'S SIGNATURE	DATE
0175	J.H. Brunner	9/18/80	0175	J.H. Brunner	9/18/80

xcodi A6732

WORK ORDER NUMBER LOCATION	SERIAL	GC CODE	ACCOUNT NUMBER	PLANT CONDITION SU	OP	MD	CD	RF	HS	LR	NPRD FAILURE YR	MO	DAY	START HR	MIN
0360	001877	D	787 6019	/	/	/	/	/	/	/					

CHANGE MOD REQ'D	R A D	NUC SAFETY	NP	REG AGENCY CODE	CHG/MOD NUMBER	ENV CODE	OUTAGE CAUSE CODE	STATUS HOLD CODE
0	0	0	0			X		

S M APPROVAL COMMENCE WORK MO	DAY	YR	PRIORITY	RESP LOCATION OR CONTRACTOR
			2	0261

Location Control Room elev. 331'

Limits and Precautions:

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

a) Personnel

b) Equipment

c) Environment

d) Nuclear

Post Maintenance Testing required and Acceptance Criteria:

INSURE WORK AREA CLEANED UP AT COMPLETION OF JOB

MEETS PROCEDURE REQUIREMENTS.

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

COPY 1

WORK REQUEST PROCEDURE

TMI Nuclear Station

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.:

   Cable and Detector Measurements on HPR-214

2. Purpose: To determine the condition of the signals being generated by HPR-214.

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

   HPR-214

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 _____ Date _____

Engineering Review _____ Date 9/18/80

* 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.

Technology for Energy Corporation	TITLE IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM AREA RADIATION MONITOR HP-R-214	NO. TP-104
		REV. 0
	APPROVED	DATE
PROCEDURE	M.V. Mathis, Director, Tech. Serv. Div.	9-12-80

PURPOSE: The purpose of these measurements is to gather baseline data and information in preparation for possible removal of Area Radiation Monitor HP-R-214 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-214 is part of a redundant ARM system at elevation 372'7". 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-214 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

integretary measurements on the appropriate instrumentation cables by inserting test signals on appropriate conductors of Cable IT1872I (terminations shall be removed and replaced on TB112 of Cabinet 12). Should these tests reveal cable integretary problems further verification measurements will be made at TB3 of outer penetration R507.

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	---

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

References:

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. 3345, Sh. 266B.
5. Burns & Roe Dwg. 3043, Sh. 16D.
6. Burns & Roe Dwg. 3045, Sh. 26E.
7. Burns & Roe Dwg. 3045, Sh. 26F.
8. Burns & Roe Dwg. 3045, Sh. 34.
9. Burns & Roe Dwg. 3045, Sh. 34A.
10. Burns & Roe Dwg. 3045, Sh. 34B.
11. Burns & Roe Dwg. 3347, Sh. 6J.
12. Instruction Manual, Tektronix model 1502 Time Domain Reflectometer.
13. Instruction Manual, Hewlett Packard Model 4274 Multifrequency LCR Meter.
14. Instruction Manual, Hewlett Packard Spectrum Analyzer (Model 141T, 8553B, 8552B Modules).
15. Instruction Manual, Nicolet Model 444A-26 Spectrum Analyzer.
16. Instruction Manual, Tektronix Model 335 Oscilloscope.
17. Instruction Manual, Lockheed Store-4 Recorder.

TEC	TITLE: IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM AREA RADIATION MONITOR HP-R-214	NO. TP-104
		REV. 0

18. Instruction Manual, Tektronix SC502 Oscilloscope.

19. TEC Composite Electrical Connection Diagram, HP-R-214 (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-214 as follows:

Signal	Cable IT1872I	Cabinet 12
GND		TB112-1
+20V		TB112-3
SIG GND		TB112-4
~~+12~~ +14V		TB112-5
FAIL IN		TB112-6
SIG		TB112-7

Note change throughout procedure →

STEPS

1. Notify Shift Supervisor/Shift Forman of start of test on HP-R-214.

2. Verify power is applied to HP-R-214.

Signature/Date

3. Record present signals, readings, and indications on 846-1 Readout Module (Local). Record Signal-in at TB112-7/4 for 30 minutes on FM Tape Recorder. Remove recorder when finished.

TEC

TITLE IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM AREA RADIATION MONITOR HP-R-214

NO. TP-104

REV. 0

Meter/Indicator/Switch	Local
mR/hr Meter Reading	1 TO 10^{10} MR
Off-Operate-Alarm Function Switch	OPERATE
Fail Safe Indicator	On ___ Off ✓
High Alarm-Reset Indicator	On ___ Off ✓

SEPTIC

ALL MODE

J. TS 9/19/80
Signature/Date

4. Using a Keithley Model 177 DMM (or equivalent) measure the DC voltage or current at the following test points.

TEC

TITLE IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM AREA RADIATION MONITOR HP-R-214

NO. TP-104

REV. 0

SIGNAL	CABINET 12	TEST LEAD	READING
a.	TB112-3 TB112-1	(+) (-)	+20V 20.4 VOLT
b.	TB112-5 TB112-1	(+) (-)	+12V 14.07 VOLT
c.	TB112-6 TB112-1	(+) (-)	Fail In 2.9 VOLT
d.	TB112-7 TB112-1	(+) (-)	SIG .6 TO 2.3 VDC

Signature/Date 9/19/80

TEC TITLE: IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM AREA RADIATION MONITOR HP-R-214 | NO. TP-104 | REV. 0

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

SIGNAL	CABINET 12	PARAMETER			
a.	TB112-3 TB112-1	+20V	Photo 104-1 Time Base 5MS Vert Gain .5V	Photo 104-2 Time Base 1MS Vert Gain .5V	Photo 104-3 Time Base 10MS Vert Gain 10MV
b.	TB112-4 TB112-1	SIG GND	Photo 104-4 Time Base 5MS Vert Gain 2MV	Photo 104-5 Time Base 50MS Vert Gain 2MV	Photo _____ Time Base ____ Vert Gain ____
c.	TB112-5 TB112-1	+19V (+12V)	Photo 104-6 Time Base 5MS Vert Gain 2MV	Photo 104-7 Time Base 50MS Vert Gain 2MV	Photo _____ Time Base ____ Vert Gain ____
d.	TB112-6 TB112-1	FAIL IN	Photo 104-8 Time Base 2MS Vert Gain 2MV	Photo 104-9 Time Base 50MS Vert Gain 2MV	Photo _____ Time Base ____ Vert Gain ____
e.	TB112-7 TB501-36	SIG ACGND	Photo 104-10 Time Base 5MS Vert Gain 10MV	Photo 104-11 Time Base 5MS Vert Gain .5V	Photo 104-12 Time Base 0.1SEC Vert Gain .5V

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

TEC TITLE: IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM AREA RADIATION MONITOR HP-R-214 | NO. TP-104 | REV. 0

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.	TB112-3 TB112-1	+20V GND	104-13
b.	TB112-5 TB112-1	+12V GND	104-14
c.	TB112-6 TB112-1	FAIL IN GND	104-15
d.	TB112-4 TB112-1	SIG GND GND	104-16
e.	TB112-7 TB112-4	SIG SIG GND	104-17

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	
BANDWIDTH / SCAN WIDTH	INPUT ATTEN	SCAN TIME	LOG REF	SENS
3KHz / 1 MEGHz/DIV	0	1 SEC/DIV	-20 10 db LOG	0

T. S. H 9/19/80
Signature/Date

TEC TITLE: IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM AREA RADIATION MONITOR HP-R-214 | NO. TP-104 | REV. 0

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.	TB112-3 TB112-1	+20V GND	104-18 104-19	0 TO 100 KHz 0 TO 1K
b.	TB112-6 TB112-1	FAIL IN GND	104-20 104-21	0 TO 100 KHz 0 TO 1K
c.	TB112-5 TB112-1	+12V GND	104-22 104-23	0 TO 100 KHz 0 TO 1 KHz
d.	TB112-7 TB112-4	SIG SIG GND	104-24 104-25	0 TO 100 KHz 0 TO 1 KHz
e.	TB112-4 TB112-1	SIG GND	104-26 104-27	0 TO 100 KHz 0 TO 1 KHz

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:

TEC

TITLE IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM AREA RADIATION MONITOR HP-R-214

NO. TP-104

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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 HP-R-214 (Tag Open TB501 links 34, 35, and 36 per procedure AP 1002).

9/20/80
Signature/Date

10. Open links for all field wires from Cable IT1872I at TB112 (Cabinet 12).

TEC

TITLE IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM AREA RADIATION MONITOR HP-R-214

NO. TP-104

REV. 0

TERMINAL	SIGNAL IDENT.
TB112-1 ✓	GND (SHIELD)
TB112-3 ✓	+20V
TB112-4 ✓	SIG GND
TB112-5 ✓	+12V
TB112-6 ✓	FAIL IN
TB112-7 ✓	SIG

Signature/Date 9/19/80

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

TEC TITLE: IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM AREA RADIATION MONITOR HP-R-214

NO. TP-104

REV. 0

Record the data required below:

Test Point	Capacitance			Impedance		
Frequency	100 Hz	1 kHz	100 kHz	100 Hz	1 kHz	100 kHz
a. TB112-(1/3)	11 nf	13 nf	-154 nf	1.08K/-.6°	1.07K/-5°	14Ω/132°
b. TB112-(1/4)	108 nf	148 nf	454 nf	15.2Ω/-75°	3.4Ω/-17°	3.7/-71°
c. TB112-(1/5)	OF	OF	342 nf	28Ω/-.82°	28Ω/-.6°	5Ω/-113°
d. TB112-(4/6)	19 nf	18 nf	ERROR 4	53K/-40°	8.7K/-78°	ERROR 4
†e. TB112-(4/7)	24 nf	18 nf	OF	9.3K/-8°	6.4K/-46°	OF

*Numbers in parentheses refer to TB112 FROM/TO terminal numbers on field side.

†Field side/Cabinet side across open link.

[signature] 9/19/20
Signature/Date

TEC TITLE: IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM AREA RADIATION MONITOR HP-R-214 | NO. TP-104 | REV. 0

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)			500-e	52.6	1	104-1
b. TB112-(1/4)						104-2
c. TB112-(1/5)						104-3
d. TB112-(4/6)						104-4
e. TB112-(4/7)						104-5

[signature] 9/19/80
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.

TEC TITLE: IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM AREA RADIATION MONITOR HP-R-214

NO. TP-104

REV. 0

ALL READING ON 20K RANGE

TEST POINT	FROM LINK	TO LINK	POLARITY From = +; To = - RESISTANCE	POLARITY From = -; To = + RESISTANCE
a. +20	TB112-1 com	TB112-3 20v	1KΩ	1KΩ
b. GND-GND	TB112-1 com	TB112-4 com	* 11.1K	* 11.5KΩ ✓
c. +12	TB112-1 com	TB112-5 14v	* 3.6K	* 3.6K ✓
d. fail in	TB112-1 com	TB112-6 FO	~	* 19.2K
e. sig	TB112-1 com	TB112-7 SO	64.9	51K
f. -20	TB112-3 -20v	TB112-4 com	12.K	* 12.6K
g. +20-+12	TB112-3 20v	TB112-5 14v	* 4.7K	* 4.6K
h. +20 fail in	TB112-3 20v	TB112-6 FO	~	~
i. +20 sig	TB112-3 20v	TB112-7 SO	~	~
j. gnd +12	TB112-4 GND	TB112-5 14v	* 10K	* ~
k. gnd fail in	TB112-4 GND	TB112-6 FO	~	~
l. gnd sig	TB112-4 GND	TB112-7 SO	* ~	* GND 13.7K
m. +12 fail in	TB112-5 14v	TB112-6 FO	~	15.KΩ
n. +12 sig	TB112-5 14v	TB112-7 SO	* ~	6.8KΩ ✓
o. fail in - sig	TB112-6 FO	TB112-7 SO	110KΩ	~

***NOTE:
Close all links on TB112 (opened in Step 10) when finished with this step.

* VERY SLOW CHARGE RATE

** 200KΩ RANGE

GND = SIG GND
FO = Fail out
SO = SIG OUT

T.S.H
Signature/Date

TEC	TITLE: IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM AREA RADIATION MONITOR HP-R-214	NO. TP-104
		REV. 0

15. Notify Shift Supervisor/Shift Foreman of end of test on HP-R-214.

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 _____ 9/14/80
Signature/Date

Instrumentation _____
Signature/Date

JOB TICKET (WORK REQUEST)
REVIEW – CLASSIFICATION – ROUTING CONTROL FORM

JOB TICKET NUMBER 05478

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:
    DEWEAVER ITS NA Date 9/19/80

11. Maintenance Foreman Assigned: ____

12. Code Inspector Notified. Name: ____ Date ____

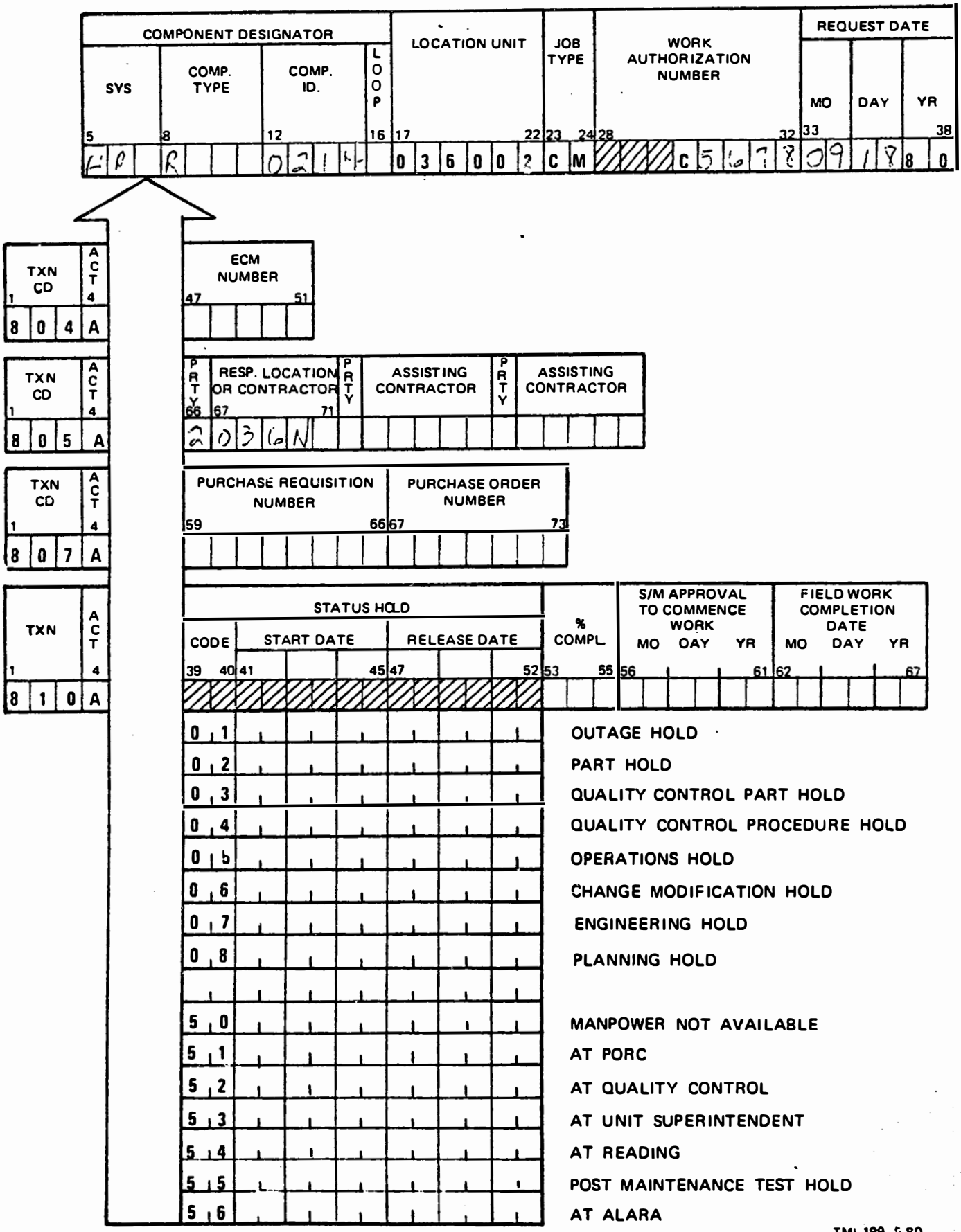
13. Shift Foreman's approval to commence work: James [illegible] Date 9/19/80

____ Initial if Shift Foreman signature is not required.

TMI-154 2-80

GENERATION CORRECTIVE MAINTENANCE SYSTEM

CM STATUS ACTIVITY FORM



TMI 199 5 80