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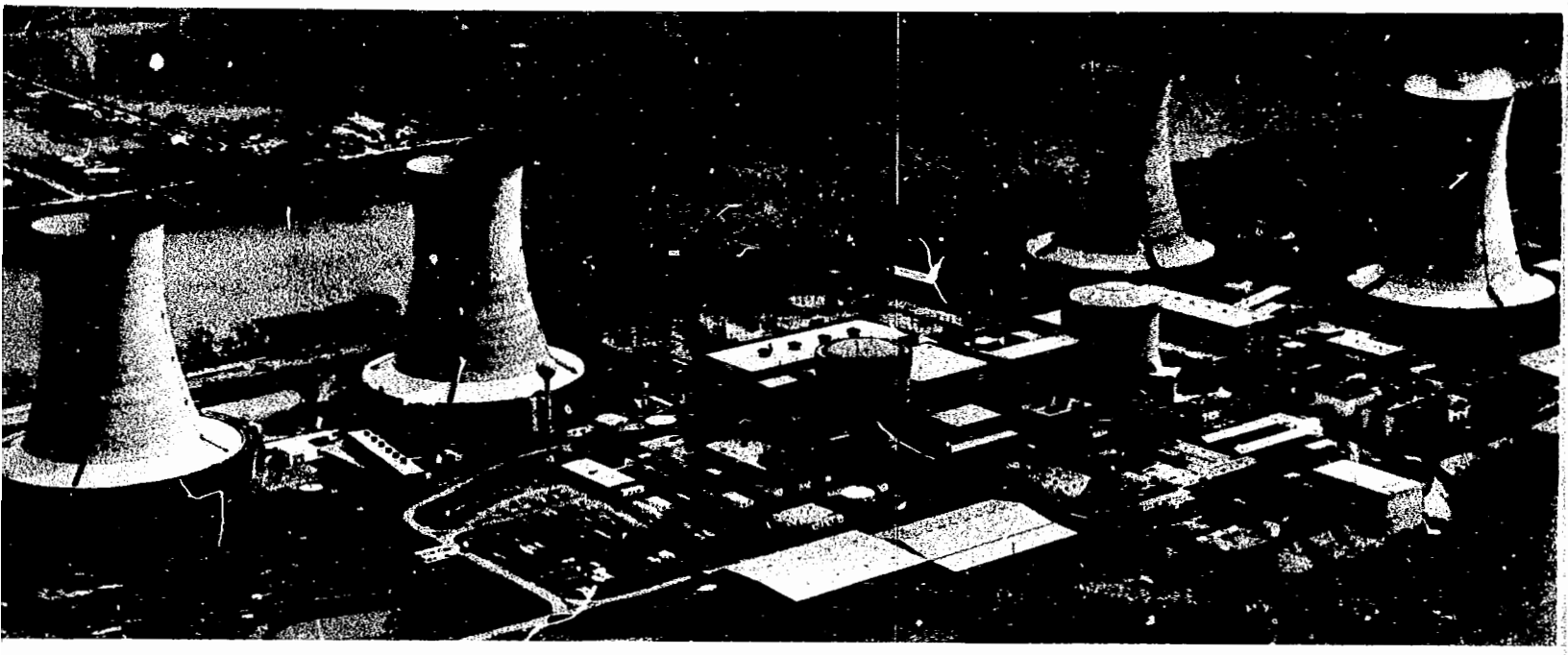
Volume VII
January 1982



This is an informal report intended for use as a preliminary or working document

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FIELD MEASUREMENTS AND INTERPRETATION OF TMI-2 INSTRUMENTATION: YM-AMP-7023 AND YM-AMP-7025

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

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

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MGW

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Section 1

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 measurement and results of the Loose Part Monitor Channels YM-AMP-7023 and YM-AMP-7025. These instruments consist of an Endevco Model 2276 accelerometer and a model 2652M4 charge amplifier connected to the Loose Parts Monitoring System terminals by approximately 400 feet (500 feet for 7025) of cable. The instruments were being incorporated into a B&W supplied system when the measurements were taken; therefore, the equipment was not expected to be fully operational.

Section 2

2. INSTRUMENT LOCATION, CABLING, AND TERMINATIONS

A review of appropriate drawings from Endevco and Burns & Roe (itemized in the Appendices in the measurement procedures) resulted in the composite electrical diagram shown in Figure 2-1. From this information, Table 2-1 gives a list of the appropriate cable identification points for performing measurements in Control Cabinet 216. As noted in Figure 2-1, the cable lengths are approximately 400 feet for YM-AMP-7023 and 500 feet for YM-AMP-7025.

Since the system was in a state of partial operation due to the conversion to a B&W Monitoring System, details of the "as-found" location of signal lines were determined on-site during the measurements.

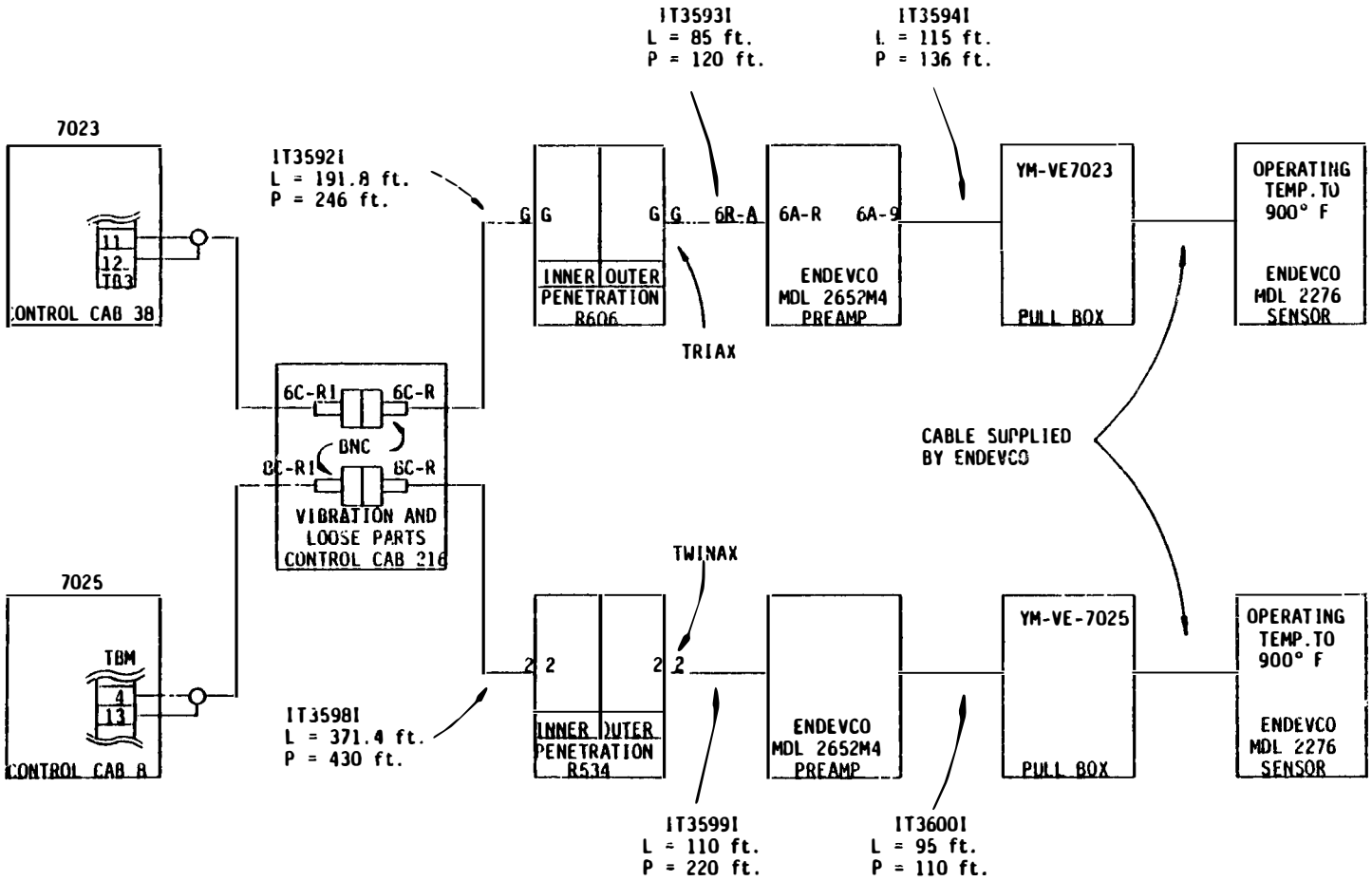


Figure 2-1. YM-AMP Composite Electrical Diagram.

Table 2-1

TERMINATION POINTS FOR YM-AMP MEASUREMENTS

Signal	Identification*
YM-AMP-7023 Signal	Cable IT3592I (coaxial)
YM-AMP-7025 Signal	Cable IT3598I (coaxial)

*Cables connected to Cabinet 216 before testing.

Section 3

3. PREPARATION OF MEASUREMENT PROCEDURES

As a result of generating the composite electrical diagram and from a review of Endevco Product Manuals, TEC identified the major types of measurements to be performed:

1. To determine as-found condition of level indication and to record signal output;

2. On each electrical connection, to 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;

3. To 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 power supplies, the acceleration measurement assembly, cabling, and terminations/connections to the assembly. The Appendices contain the detailed procedures which were followed during the measurement program, and a summary of measurements is presented in the next section.

Section 4

4. MEASUREMENTS

Since the Loose Parts Monitoring System (LPM) was "off" when measurements began, the first data obtained were capacitance, impedance, and resistance data. Table 4-1 shows a comparison of the data obtained for YM-AMP-7023, YM-AMP-7025, and YM-AMP-7025 (after replacement of the charge converter). TDR measurements were also taken on the cables to identify possible defects. The strip chart traces of the results are shown in Figures 4-1 to 4-3.

Following measurements on the powered down state of the channels, power was applied to each instrument. The current and voltage were measured for each channel between the amplifier in Cabinet 216 and the remote charge amplifier. Results are presented in Table 4-2 for each instrument.

The next measurements consisted of photographing the output waveforms of each LPM channel. Figures 4-4 to 4-6 show the resulting time traces. Along with time domain measurements, both high frequency (>1 MHz) and low frequency spectra (<100 kHz) were photographed for each LPM channel. High frequency spectra are shown in Figures 4-7 to 4-9 and low frequency spectra are shown in Figures 4-10 to 4-12.

Following the frequency spectra measurements, the output of each channel was recorded on an FM recorder for approximately 10 minutes.

Table 4-1

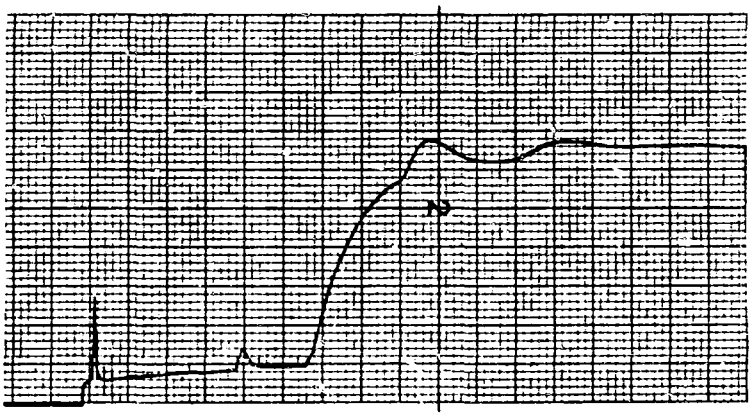
CAPACITANCE, IMPEDANCE, AND RESISTANCE MEASUREMENTS

Instrument	Capacitance			Impedance (ohms)			Resistance*
	100 Hz	1 kHz	100 kHz	100 Hz	1 kHz	100 kHz	
YM-AMP-7023	22nF	10.3nF	10.5nF	7.2k	6.6k	151	10.1k (33.2k)
YM-AMP-7025	28nF	16.4nF	-228nF	7.1k	5.8k	9.11	1.2k (34.2k)
7025 (Replaced)	22nF	16.5nF	-209nF	10.4k	7.2k	9.2	10.8k (37.8k)

*Values in parentheses are the reverse polarity readings.

STRIP CHART 107-1

Cable - IT35921



Setting - 500μρ/div

Range - 52.6 ft/div

Sensitivity - 0.25

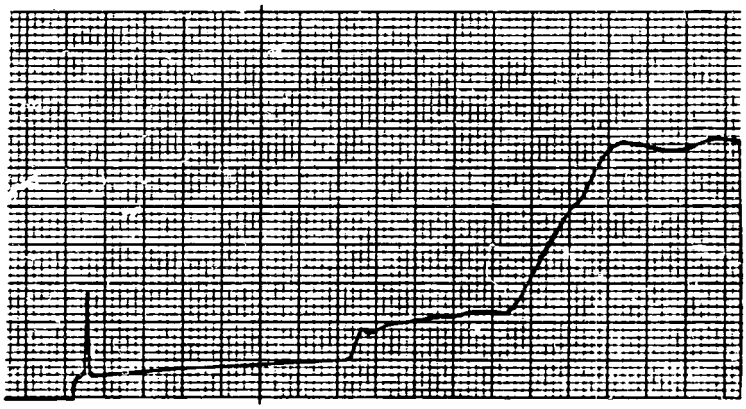
Filter - 15 Hz

Cable dielectric - poly

Figure 4-1. TDR Trace of YM-AMP-7023 Cable.

STRIP CHART 106-1

Cable - IT3598I



Setting - 500μρ/div

Range - 52.6 ft/div

Sensitivity - 0.25

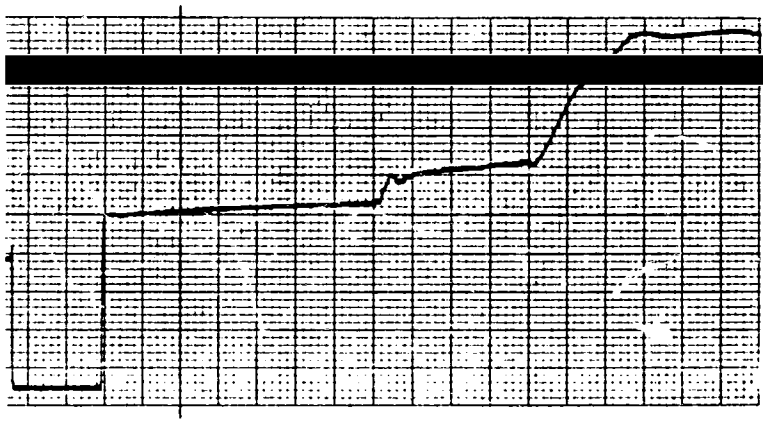
Filter - 15 Hz

Cable dielectric - poly

Figure 4-2. TDR Trace of YM-AMP-7025 Cable.

STRIP CHART 107-51

Cable IT35981



Setting - 500mρ/div

Range - 52.6 ft/div

Sensitivity - 0.25

Filter - 15 Hz

Cable dielectric - poly

Figure 4-3. TDR Trace of YM-AMP-7025 (Replacement) Cable.

Table 4-2

Current and Voltage Measurements*

Instrument	Current	Voltage (VDC)
YM-AMP-7023	4.39 ma	29.6
YM-AMP-7025	0.58 ma	34.7
7025 (replaced)	1.72 ma	35.3

*Measurements between LPM amplifier and cable.

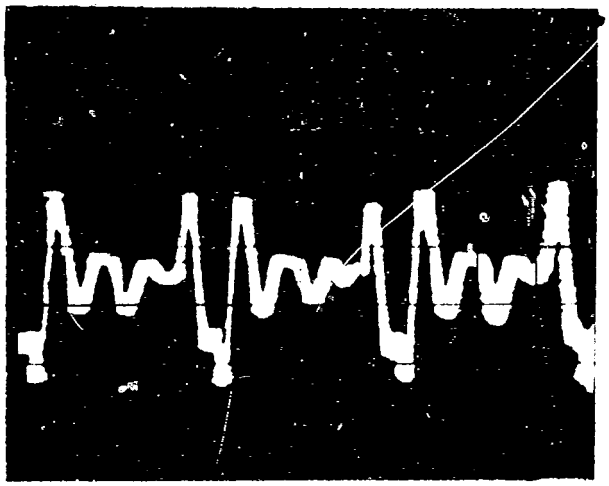


Photo 107-1

Time - 20μsec/div

Gain - 0.2 V/div

Signal - SIG

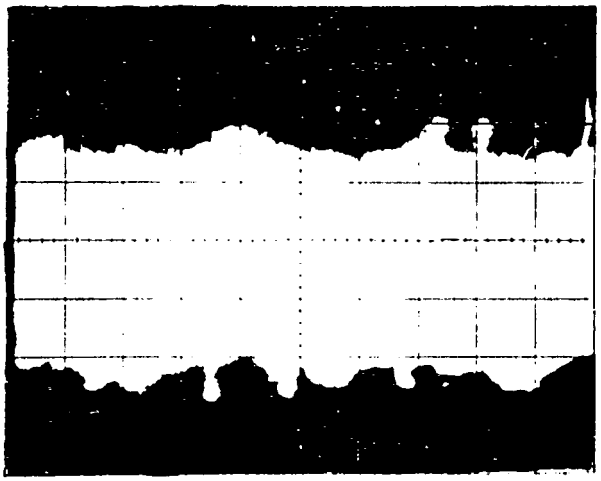


Photo 107-2

Time - 5msec/div

Gain - 0.2 V/div

Signal - SIG

Figure 4-4. Oscilloscope Waveforms from YM-AMP-7023 Signal.

Photo 106-1

Time - 5msec/div

Gain - 2 mV/div

Signal - SIG

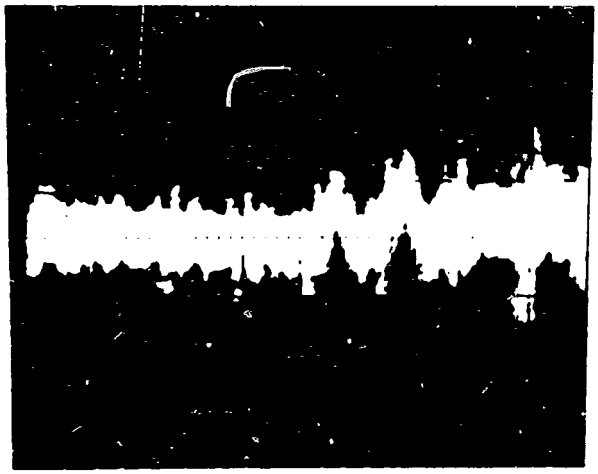


Photo 106-2

Time - 5μsec/div

Gain - 1 mV/div

Signal - SIG

Figure 4-5. Oscilloscope Waveforms from YM-AMP-7025 Signal.

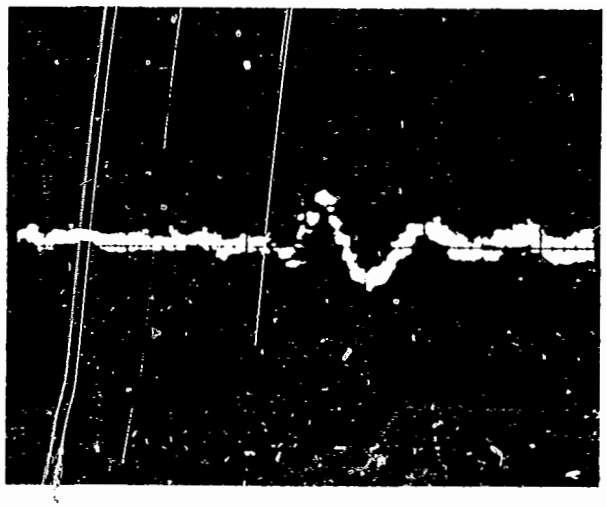


Photo 107-52

Time: 5 μsec/div

Gain: 1 mV/div

Signal: SIG-Shield

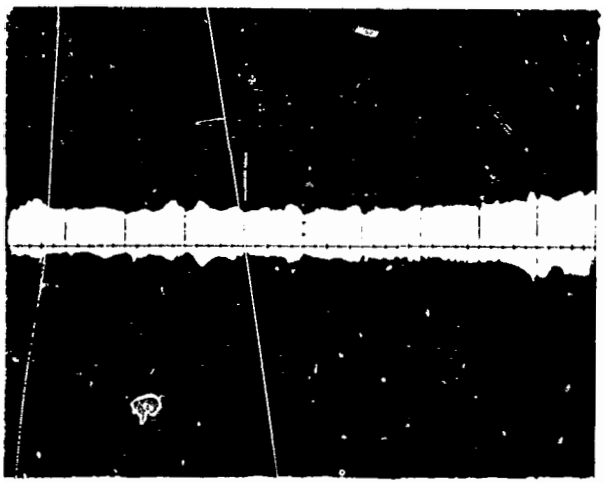


Photo 107-53

Time: 2 msec/div

Gain: 1 mV/div

Signal: SIG-Shield

Figure 4-6. Oscilloscope Waveforms from YM-AMP-7025 (Replacement) Signal.

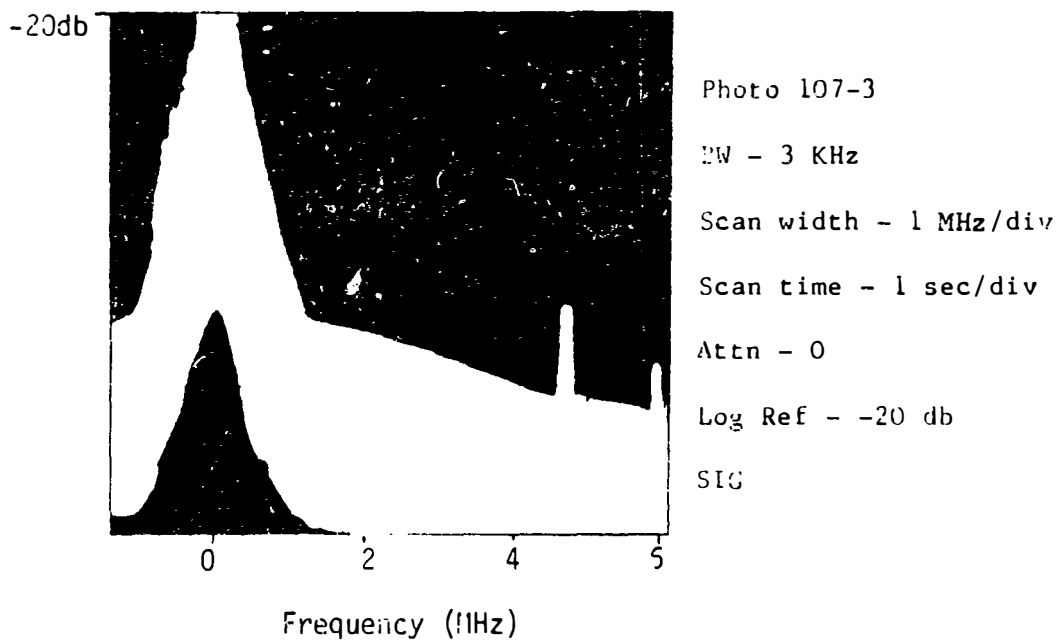


Figure 4-7. High Frequency Spectrum of YM-AMP-7023 Signal.

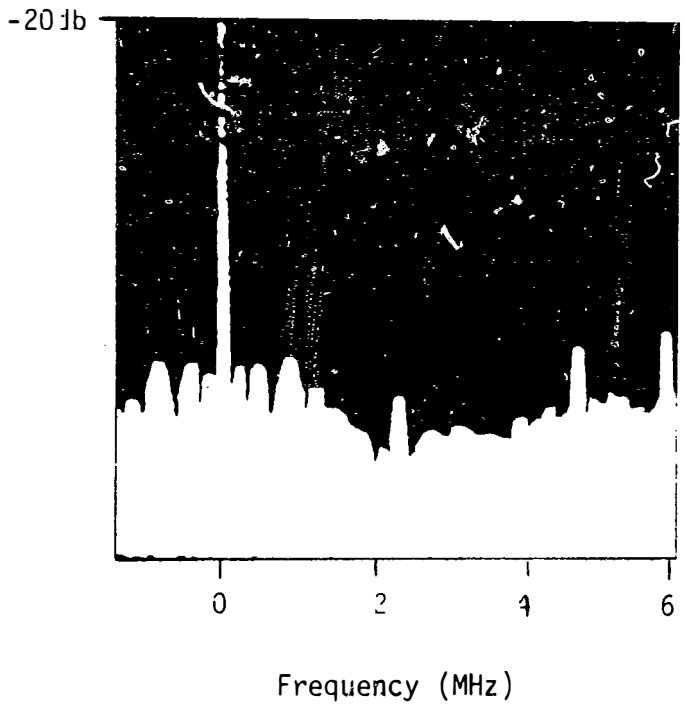


Photo 106-3

BW - 3 KHz

Scan width - 1 MHz/div

Scan time - 1 sec/div

Attn - 0

Log Ref - -20 db

SIG

Figure 4-8. High Frequency Spectrum of YM-AMP-7025 Signal.

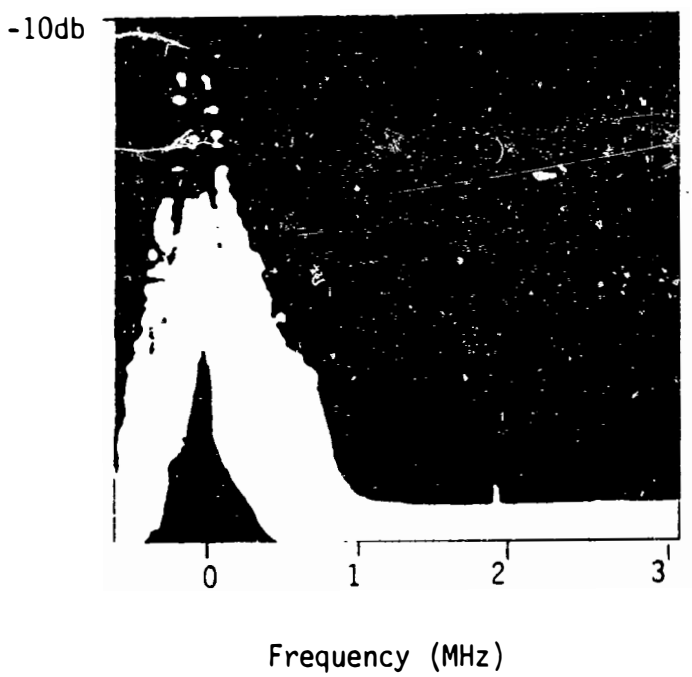


Photo 107-54

BW - 3kHz

Scan width - 0.5 MHz/div

Scan time - 1 sec/div

Attn - 0

Log Ref - -10 db

SIG - Shield

Note: Gain by 20 externally

Figure 4-9. High Frequency Spectrum of YM-AMP-7025 (Replacement) Signal.

0.0307 RMS

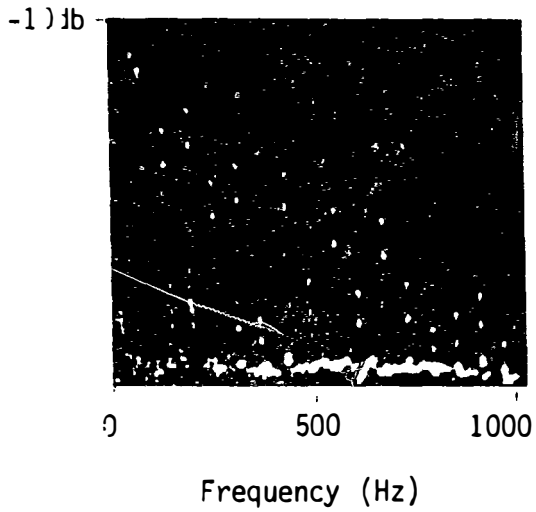


Photo 107-4

1 KHz Range

+10 db Reference

0.00175 RMS

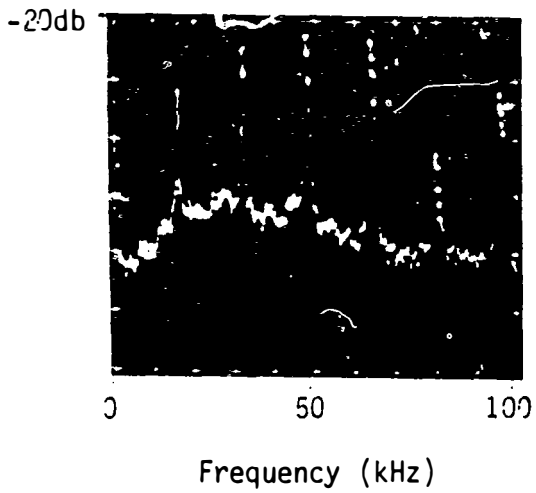


Photo 107-5

100 KHz Range

+20 db Reference

Figure 4-10. Low Frequency Spectra of YM-AMP-7023 Signal.

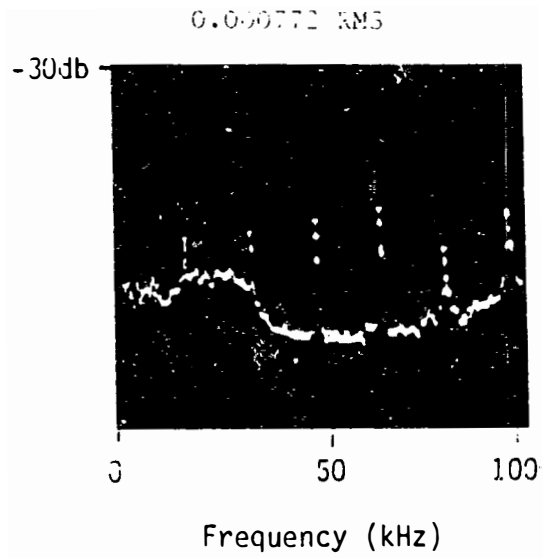


Photo 106-4

100 KHz Range

+30 db Reference

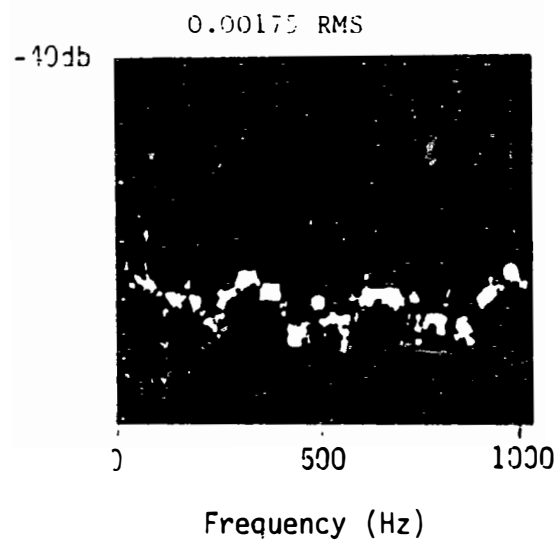


Photo 106-5

1 KHz Range

+40 db Reference

Figure 4-11. Low Frequency Spectra of YM-AMP-7025 Signal.

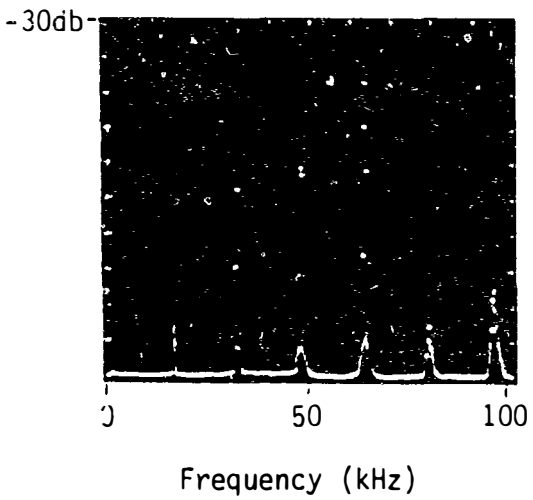


Photo 107-55

100 kHz Range

+30 db Reference

Note: Gain by 20 externally

Figure 4-12. Low Frequency Spectrum of YM-AMP-7025 (Replacement) Signal.

Section 5

5. INTERPRETATION OF MEASUREMENTS

Due to the lack of detailed information concerning the LPM system and the uncertainty caused by replacement of the system, only a summary of the major conclusions can be presented.

The original Rockwell V&LPM in the plant used Endevco accelerometers and charge converters, model 2276 Isobase and model 2652M4 respectively. The Rockwell LPM provided the 18 ma necessary to power the charge converter. The Rockwell system was then replaced by a B&W system without changing the charge amps. This system was designed to provide only 4 ma to the charge converters.

Without proper DC bias, the charge converters probably are not working. However, because of capacitive feedback in the charge converter, accelerometer signals may be present at the V&LPM inputs in a highly attenuated form. This attenuation would be proportional to the length of the cable plus the series capacitance of the feedback capacitor in the charge amp. Because the cable length is approximately 500 feet, the input signals at the LPM may be mostly noise.

About 1 month after the original measurements were made on 7023 and 7025, the charge converter in channel 7025 was replaced. It is not known what type charge converter replaced the 2652M4, but scope photos of the output waveforms show no significant increase of amplitude. After replacement, the output current for channel 7025 only measured

1.7 ma through a 2k resistor attached at the signal input. Even if the new charge converter operated at the 4 ma current level, it still was not being provided enough current. Therefore, the same situation would exist as with the original charge converter.

Section 6

6. CONCLUSIONS

Based on the measurements and an overall interpretation of the measurements, YM-AMP-7023 and YM-AMP-7025 are not operating properly. Part of the problem is due to a change-over from the Rockwell LPM to a B&W system, but there are indications that proper supply currents are not being provided to the preamplifiers (charge amplifiers). With uncertainties in the current hardware configuration, an interpretation of the operability of the system with proper supply currents is not possible.

APPENDIX A

ORIGINAL FIELD PROCEDURES AND DATA SHEETS FOR YM-AMP-7023

A-1

208-7

GENERATION CORRECTIVE MAINTENANCE SYSTEM
JOB TICKET FORM (WORK REQUEST)-THREE 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
YM	AMP	7023		036002	CM	C5710	09	20	80	2

DESCRIBE MALFUNCTION OR MODIFICATION DESIRED: Perform attached procedure for sensor/cable measurements.

CAUSE OF MALFUNCTION (IF KNOWN):

ORIGINATOR'S EMP NO	ORIGINATOR'S SIGNATURE	DATE	SUPERVISOR'S EMP NO.	SUPERVISOR'S SIGNATURE	DATE
06175	J Brunner	9/20/80	06175	J Brunner	9/20/80

DOE/EG&G Project Account

WORK ORDER NUMBER LOCATION	SERIAL	GC CODE	ACCOUNT NUMBER	PLANT CONDITION SU	OP	HO	CO	RF	-S	LR	UNPROFAILURE YR	MO	DAY	START HR	MIN
0360	0187GA		X0001 7876019	/	/	/	/	/	/	/					

				REG AGENCY CODE	CHG/MOD NUMBER
0	0	0	0		

ENV CODE	OUTAGE CAUSE CODE
X	

STATUS HOLD CODE

COMMENCE WORK MO	DAY	YR
09	22	80

RESP LOCATION OR CONTRACTOR
2036

Location: Cable Room, 305' elev. Control Building

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

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

COPY 1

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

JOB TICKET NUMBER C5710

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 9/22/80

11. Maintenance Foreman Assigned: [signature]

12. Code Inspector Notified Name: ____ Date ____

13. Shift Foreman's approval to commence work: [signature] Date 9/23/80

    ____ Initial if Shift Foreman signature is not required.

TMI-154 2-80

WORK REQUEST PROCEDURE
TMI Nuclear Station
Maintenance Procedure Format and Approval

A-3

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 YM-AMP-7023 Steam Generator B Upper Tube Sheet

2. Purpose: To determine current characteristics of signals from YM-AMP-7023.

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

   YM-AMP-7023 and associated instrument string components.

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 9/22/80

Engineering Review [signature] 9/20/80

• 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 LOOSE PARTS MONITOR CHARGE CONVERTER YM-AMP-7023	NO. TP-107 REV. 1
PROCEDURE	APPROVED M.V. Mathis, Director, Tech. Serv. Div.	DATE 9/18/80

PURPOSE: The purpose of these measurements is to gather baseline data and information in preparation for removal of Loose Parts Monitor Charge Converter YM-AMP-7023 from the Reactor Building TMI Unit 2. The tests specified in this procedure are designed to assess the condition of the in-containment instrument module (accelerometer, charge converter), associated cabling, and readout devices. This assessment will require the use of Time Domain Reflectometry (TDR), Impedance (Z), Spectral Analysis (frequency domain), and general oscilloscope observations (with recording) of waveforms from/to the unit under test (UUT).

YM-AMP-7023 — Steam Generator B Upper Tube Sheet

PROCEDURE (ADMINISTRATIVE):

A. Limitations and Precautions

1. Nuclear Safety. Loose Parts Monitor Charge Converter YM-AMP-7023, located at elevation 347', is part of the overall Loose Parts Surveillence System.

2. Environmental Safety. Loose Parts Monitor Charge Converter YM-AMP-7023 can be taken out-of and restored to services without producing a hazard to the environment.

3. Personnel Safety. The test described herein produces no additional personnel safety hazards other than normally associated with performing instrument testing.

4. Equipment Protection. In the performance of each test described herein, care will be taken to insure adequate equipment protection as follows:

   a. In all cases actual test hookups to the Unit-2 instrumentation shall be made and verified by Instrumentation Personnel.

   b. All passive measurements (Spectral Analysis and Oscilloscope observations) of waveforms and signals from powered instruments shall be performed using high input impedance probes or inputs ($Z = \geq 1$ Meg ohm) to prevent loading of signals.

   c. In all Time Domain Reflectometry and Impedance measurements, power will be removed from the unit under test and low level test signals prescribed in Table 4-1 shall be utilized by inserting test signals on appropriate conductors of Cable IT3592I.

Table 4-1 Active Measurements

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

B. Prerequisites

1. The Shift Supervisor/Shift Foreman shall be notified for concurrance prior to the performance of those measurements. [redacted]
2. Instrumentation personnel shall be assigned to assist in the performance of these measurements.
3. All measurements and test instrumentation shall be in current calibration (traceable to NBS).
4. The Shift Supervisor/Shift Foreman shall be notified prior to starting and upon completion of the measurements.

C. Procedure for Performing Measurements

References:

1. Endevco Dwg. No. AE-E0401, Specifications for Model 2652M4 Charge Converter YM-AMP-7023 (Sheet 3 of 3).
2. Specification Manual for Endevco Model 2276 Accelerometer.
3. Burns & Roe Dwg. 3024, Sh. 105.
4. Burns & Roe Dwg. 3343, Sh. 2.
5. Burns & Roe Dwg. 3045, Sh. 17.
6. Burns & Roe Dwg. 3314, Rev. 8.

7. Burns & Roe Dwg. 3174, Sh. 7.
8. Burns & Roe Dwg. 3045, Sh. 17.
9. Instruction Manual, Tektronix model 1502 TDR.
10. Instruction Manual, Hewlett Packard Model 4274 Multifrequency LCR Meter.
11. Instruction Manual, Hewlett Packard Spectrum Analyzer (Model 141T, 8553B, 8552B Modules).
12. Instruction Manual, Nicolet Model 444A-26 Spectrum Analyzer.
13. Instruction Manual, Tektronix Model 335 Oscilloscope.
14. Instruction Manual, Lockheed Store-4 Recorder.
15. Instruction Manual, Tektronix SC502 Oscilloscope.
16. TEC Composite Electrical Connection Diagram, YM-AMP-7023 (see attachment).

STEPS

1. Notify Shift Supervisor/Shift Foreman of start of test on YM-AMP-7023.
2. Remove all power from YM-AMP-7023 (Channel 6).
3. Remove cable IT3592I (Channel 6) in cabinet 216.
4. Using the Hewlett-Packard Model 4274 (or equivalent) Impedance Bridge measure the capacitance and impedance at the following test point.

TEST POINT*	FROM	TO
a.	Cable IT3592I (Center Conductor)	Cable IT3592I (Shield)

* Test Connection in Cabinet 216.

TEC	TITLE	IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM LOOSE PARTS MONITOR CHARGE CONVERTER YM-AMP-7023	NO. TP-107 REV. 1

Record the data required below:

TEST POINT	CAPACITANCE			IMPEDANCE		
Frequency	100 Hz	1 kHz	100 kHz	100 Hz	1 kHz	100 kHz
a. Cable IT 3592I Center Conductor to shield	~~[illegible]~~ 22nf	~~[illegible]~~ 10.3nf	10.5nf	7.2K/-6°	6.6K/-25°	157.5K/-87°

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

Record the data below:

Test Point	High R @ N ft.	Low R @ N ft.	Instrument Settings Ampl Range Mult	Strip Chart Number
a. Cable IT3592I Center Conductor to Shield				107-1

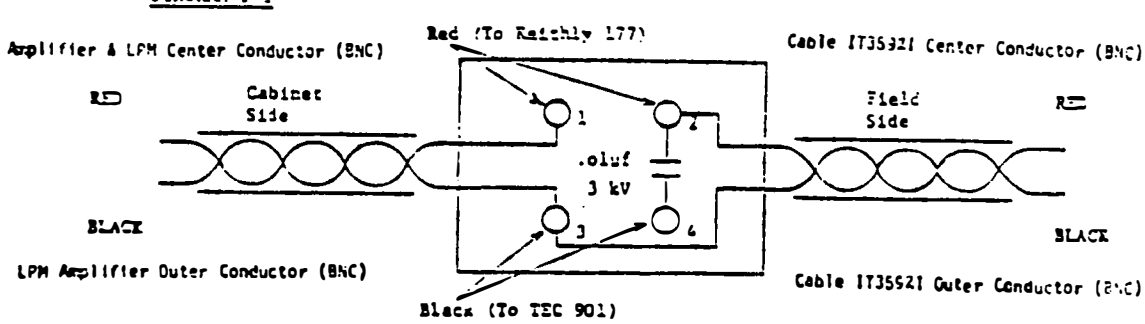
6. Using the Keithley Model 177 (or equivalent DMM) perform resistance measurements on the test points specified and record values in the space provided.

TEC	TITLE	IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM LOOSE PARTS MONITOR CHARGE CONVERTER YM-AMP-7023	NO. TP-107
			REV. 1

			20K RANGE	200K RANGE
			POLARITY From = +; To = -	POLARITY From = -; To = +
TEST POINT	FROM LINK	TO LINK	RESISTANCE	RESISTANCE
a.	Center Conductor (+)	Shield (-)	10.14 K	33.23 K

7. Connect the TEC Current Monitor/AC Coupling Test Fixture between LPM amplifier and Cable IT3592I per the following diagram:

DIAGRAM 8-1



TEC CURRENT MONITOR/AC COUPLING TEST FIXTURE

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

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

* Connections provide for proper polarity.

TEC	TITLE	IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM LOOSE PARTS MONITOR CHARGE CONVERTER YM-AMP-7023	NO. TP-107 REV. 1

8. Connect a Kiethly Model 177 DMM (or equivalent) in series with center conductor of IT3592I (BNC) by connecting across plugs 1 and 2 (the two red plugs) of the TEC Current Monitor/AC Coupling Test Fixture.

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

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

    NOTE: Recording will continue through Step 17.

11. Apply power to YM-AMP-7023(Channel 6 and verify operation through normal instrumentation procedures.

12. Using the Kiethly Model 177 DMM (or equivalent; Precesion = ± 1%) measure the current at the signal test point.

SIGNAL	Cabinet 216	TEST LEAD	SCALE	READING
a.	TEC Current/ Monitor Plug-1 Plug-2	(+) (-)	20mA	4.39mA

* CURRENT READING POWER ON ≈ 12 MIN AND VOLTAGE

Signature/Date 9/23/80

13. Using the Kiethly Model 177 DMM (or equivalent; Z; ≥ 10^7 OHMS, Range 0-200V, Precesion = ± 1%) measure the DC Voltage at the signal test point.

SIGNAL	CABINET 216	TEST LEAD	SCALE	READING
a.	TEC Current/ Monitor Plug-1 Plug-3	(+) (-)	200V	29.6V

TEC	TITLE	IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM LOOSE PARTS MONITOR CHARGE CONVERTER YM-AMP-7023	NO. TP-107 REV. 1

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

SIGNAL	CABINET 216	PARAMETER	107-1	107-2	
a.	TEC Current/ Monitor Plug-4 Plut-3	SIG Shield	Photo 107-1 Time Base 20 ms Vert Gain 0.2V	Photo 107-2 Time Base 5 ms Vert Gain 0.2V	Photo _____ Time Base _____ Vert Gain _____

Sync the oscilloscope and photograph the waveform using up to three time base and vertical gain settings. Mark the back of the photographs with the instrument tag number and parameter measured.

[illegible] 9/23/80
Signature/Date

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

SIGNAL	CABINET 216	PARAMETER	PHOTO #
a.	TEC Current/ Monitor Plug-4 Plug-3	SIG SHIELD	107-3

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

TEC	TITLE	IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM LOOSE PARTS MONITOR CHARGE CONVERTER YM-AMP-7023	NO. TP-107
			REV. 1

SPECTRUM IDENT	FREQUENCY	AMPLITUDE	REMARKS
BANDWIDTH	SCAN WIDTH	INPUT ATTEN	SCAN TIME	LOG REF 10 db LOG
3KHz	1 MEG Hz/DIV	0	1 SEC	-20db

SENS = 0
VAR.

Signature/Date 9/24/12

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

SIGNAL	CABINET 216	PARAMETER	PHOTO # OR PLOT
*a.	TEC Current/ Monitor Plug-4 Plug-3	SIG Shield	107-4 1KHz 107-5 100KHz

If PSD plots from the signal 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 9/23/12

17. Continue recording the output signal from YM-AMP-7023 for a period of 10 additional minutes. Remove amplifier and FM Recorder when complete.

18. Remove all power from YM-AMP- 7023 (same procedure as Step 2).

TEC	TITLE	IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM LOOSE PARTS MONITOR CHARGE CONVERTER YM-AMP-7023.	NO. TP-107 REV. 1

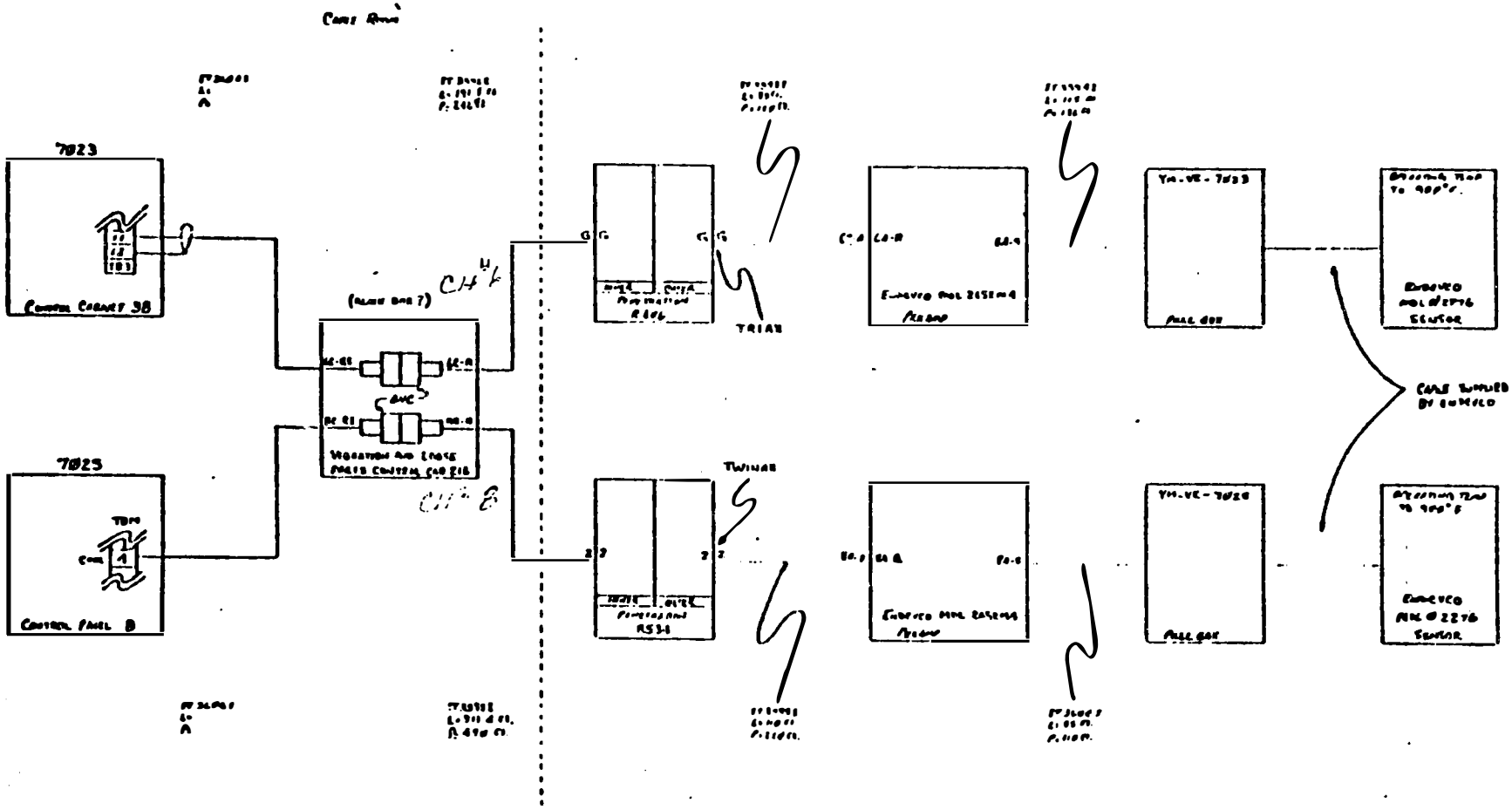
19. Remove the TEC Current Monitor/AC Coupling Text Fixture.

20. Notify the Shift Supervisor/Shift Foreman of the conclusion of testing on YM-AMP-7023.

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 [illegible] 9/25/80
Signature/Date

Instrumentation N.R. Gilbert 9/25/80
Signature/Date



NOTE: L = Length
P = Pull

TEC

YM-AMP-7023 & 7025

GENERATION CORRECTIVE MAINTENANCE SYSTEM

CM STATUS ACTIVITY FORM

A-14

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
YM	AMP	7023		036002	CM	C57/10	09	20	80

TXN CD	ACT
1	4
804	A

ECM NUMBER
47 51

TXN CD	ACT
1	4
805	A

PRTY	RESP. LOCATION OR CONTRACTOR	PRTY	ASSISTING CONTRACTOR	PRTY	ASSISTING CONTRACTOR
66	67 71				
	2036N				

TXN CD	ACT
1	4
807	A

PURCHASE REQUISITION NUMBER	PURCHASE ORDER NUMBER
59 66	67 73

TXN	ACT
1	4
810	A

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	
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

TMI 100 5 83

APPENDIX B

ORIGINAL FIELD PROCEDURES AND DATA SHEETS FOR YM-AMP-7025

208-6

B-1

GENERATION CORRECTIVE MAINTENANCE SYSTEM
JOB TICKET FORM (WORK REQUEST)-THREE 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
YM	AMP	7025		036002	CM	C57110	092080	2

DESCRIBE MALFUNCTION OR MODIFICATION DESIRED: Perform attached procedure for sensor/cable measurements.

CAUSE OF MALFUNCTION (IF KNOWN):

ORIGINATOR'S EMP. NO.	ORIGINATOR'S SIGNATURE	DATE	SUPERVISOR'S EMP. NO.	SUPERVISOR'S SIGNATURE	DATE
06175	J.B. Brunner	9/20/80	06175	J.B. Brunner	9/20/80

DOE/EG&G Project Account #

WORK ORDER NUMBER LOCATION	SERIAL	GC CODE	ACCOUNT NUMBER	PLANT CONDITION SU	OP	HT	CD	RF	HS	CR	NPRO FAILURE YR MO DAY	START HR MIN
0360	0127GA		X0001 78760 19	1	1	1	1	1	1	1		

PRIORITY		NUC SAFETY		REG AGENCY CODE	CHG/MOD NUMBER	ENV CODE	OUTAGE CAUSE CODE	STATUS HOLD CODE
0	0	0	0			X		

SCHEDULED COMMENCE WORK MO DAY YR	RESP LOCATION OR CONTRACTOR
092280	2036M

Location: Cable Room, 305' elev. Control Building

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

Post Maintenance Testing required and Acceptance Criteria.

ENSURE WORK AREA CLEANED UP AT COMPLETION OF JOB

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

COPY 1

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

JOB TICKET NUMBER C 5711

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:
    [illegible] Date 9/22/80

11. Maintenance Foreman Assigned: [illegible]

12. Code Inspector Notified. Name: ____ Date ____

13. Shift Foreman's approval to commence work: C. Gulbine Date 9/23/80

____ Initial if Shift Foreman signature is not required.

TMI-154 2 80

WORK REQUEST PROCEDURE
TMI Nuclear Station
Maintenance Procedure Format and Approval

B-3

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 for YM-AMP-7025
Steam Generator B Upper Tube Sheet Vibration/Loose Parts Sensor

2. Purpose: To determine signal characteristics on this instrument string prior to removal.

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

YM-AMP-7025

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 9/22/90

Engineering Review [signature] Date 9/26/90

• 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 LOOSE PARTS MONITOR CHARGE CONVERTER YM-AMP-7025	NO. TP-106 REV. 1
	APPROVED	DATE
PROCEDURE	M.V. Mathis, Director, Tech. Serv. Div.	9/18/80

PURPOSE: The purpose of these measurements is to gather baseline data and information in preparation for removal of Loose Parts Monitor Charge Converter YM-AMP-7025 from the Reactor Building TMI Unit 2. The tests specified in this procedure are designed to assess the condition of the in-containment instrument module (accelerometer, charge converter), associated cabling, and readout devices. This assessment will require the use of Time Domain Reflectometry (TDR), Impedance (Z), Spectral Analysis (frequency domain), and general oscilloscope observations (with recording) of waveforms from/to the unit under test (UUT).

YM-AMP-7025 – Steam Generator B Upper Tube Sheet

PROCEDURE (ADMINISTRATIVE):

A. Limitations and Precautions

1. Nuclear Safety. Loose Parts Monitor Charge Converter YM-AMP-7025, located at elevation 347', is part of the overall Loose Parts Surveillence System. [redacted]

2. Environmental Safety. Loose Parts Monitor Charge Converter YM-AMP-7025 can be taken out-of and restored to services without producing a hazard to the environment.

3. Personnel Safety. The test described herein produces no additional personnel safety hazards other than normally associated with performing instrument testing.

4. Equipment Protection. In the performance of each test described herein, care will be taken to insure adequate equipment protection as follows:

   a. In all cases actual test hookups to the Unit-2 instrumentation shall be made and verified by Instrumentation Personnel.

   b. All passive measurements (Spectral Analysis and Oscilloscope observations) of waveforms and signals from powered instruments shall be performed using high input impedance probes or inputs (Z = $\geq$ 1 Meg ohm) to prevent loading of signals.

   c. In all Time Domain Reflectometry and Impedance measurements, power will be removed from the unit under test and low level test signals prescribed in Table 4-1 shall be utilized by inserting test signals on appropriate conductors of Cable IT3598I.

Table 4-1 Active Measurements

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

B. Prerequisites

1. The Shift Supervisor/Shift Foreman shall be notified for concurrance prior to the performance of those measurements, [redacted]
2. Instrumentation personnel shall be assigned to assist in the performance of these measurements.
3. All measurements and test instrumentation shall be in current calibration (traceable to NBS).
4. The Shift Supervisor/Shift Foreman shall be notified prior to starting and upon completion of the measurements.

C. Procedure for Performing Measurements

References:

1. Endevco Dwg. No. AE-E0401, Specifications for Model 2652M4 Charge Converter YM-AMP- 7025 (Sheet 3 of 3).
2. Specification Manual for Endevco Model 2276 Accelerometer.
3. Burns & Roe Dwg. 3024, Sh. 105.
4. Burns & Roe Dwg. 3343, Sh. 2.
5. Burns & Roe Dwg. 3045, Sh. 17.
6. Burns & Roe Dwg. 3314, Rev. 8.

7. Burns & Roe Dwg. 3174, Sh. 7.
8. Burns & Roe Dwg. 3045, Sh. 17.
9. Instruction Manual, Tektronix model 1502 TDR.
10. Instruction Manual, Hewlett Packard Model 4274 Multifrequency LCR Meter.
11. Instruction Manual, Hewlett Packard Spectrum Analyzer (Model 141T, 8553B, 8552B Modules).
12. Instruction Manual, Nicolet Model 444A-25 Spectrum Analyzer.
13. Instruction Manual, Tektronix Model 335 Oscilloscope.
14. Instruction Manual, Lockheed Store-4 Recorder.
15. Instruction Manual, Tektronix SC502 Oscilloscope.
16. TEC Composite Electrical Connection Diagram, YM-AMP-7025 (see attachment).

STEPS

1. Notify Shift Supervisor/Shift Foreman of start of test on YM-AMP-7025.
2. Remove all power from YM-AMP-7025 (Channel 8).
3. Remove cable IT3598I (Channel 6 in cabinet 216.
4. Using the Hewlett-Packard Model 4274 (or equivalent) Impedance Bridge measure the capacitance and impedance at the following test point.

TEST POINT *	FROM	TO
a.	Cable IT3598I (Center Conductor)	Cable IT3598I (Shield)

* Test Connection in Cabinet 216.

TEC	TITLE	IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM LOOSE PARTS MONITOR CHARGE CONVERTER YM-AMP- 7025	NO. TP-106 REV. 1

Record the data required below:

TEST POINT	CAPACITANCE			IMPEDANCE		
Frequency	100 Hz	1 kHz	100 kHz	100 Hz	1 kHz	100 kHz
a. Cable IT 3598I Center Conductor to shield	28 nf	16.4 nf	-228 nf	7.1 K / -7°	5.8 K / -36°	9.11 Ω / 132°

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

Record the data below:

Test Point	High R @ N ft.	Low R @ N ft.	Instrument Settings Ampl Range Mult	Strip Chart Number
a. Cable IT3598I. Center Conductor to Shield				106-1

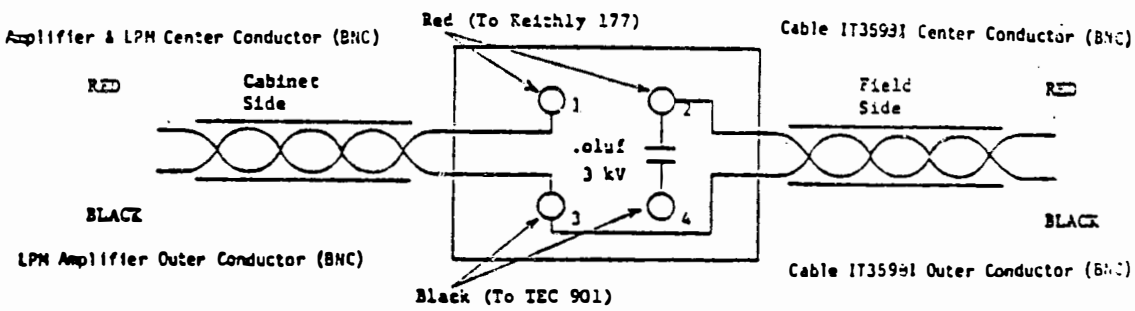
6. Using the Keithley Model 177 (or equivalent DMM) perform resistance measurements on the test points specified and record values in the space provided.

TEC	TITLE	IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM LOOSE PARTS MONITOR CHARGE CONVERTER YM-AMP-7025	NO. TP-103 REV. 1

			20K RANGE	200K RANGE
			POLARITY From = +; To = -	POLARITY From = -; To = +
TEST POINT	FROM LINK	TO LINK	RESISTANCE	RESISTANCE
a.	Center Conductor (+)	Shield (-)	1.2K	34.2K

7. Connect the TEC Current Monitor/AC Coupling Test Fixture between LPM amplifier and Cable IT3598I per the following diagram:

DIAGRAM 8-1



TEC CURRENT MONITOR/AC COUPLING TEST FIXTURE

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

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

* Connections provide for proper polarity.

TEC	TITLE	IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM LOOSE PARTS MONITOR CHARGE CONVERTER YM-AMP-7025	NO. TP-106 / REV. 1

8. Connect a Kiethly Model 177 DMM (or equivalent) in series with center conductor of IJ359 I (BNC) by connecting across plugs 1 and 2 (the two red plugs) of the TEC Current Monitor/AC Coupling Test Fixture.

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

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

    NOTE: Recording will continue through Step 17.

11. Apply power to YM-AMP-7025 Channel 8 and verify operation through normal instrumentation procedures.

12. Using the Kiethly Model 177 DMM (or equivalent; Precesion = ± 1%) measure the current at the signal test point.

SIGNAL	Cabinet 216	TEST LEAD	SCALE	READING
a.	TEC Current/ Monitor Plug-1 Plug-2	(+) (-)	2ma	.58ma

Signature/Date 9/23/80

13. Using the Kiethly Model 177 DMM (or equivalent; Z; $\geq 10^7$ OHMS, Range 0-200V, Precesion = ± 1%) measure the DC Voltage at the signal test point.

SIGNAL	CABINET 216	TEST LEAD	SCALE	READING
a.	TEC Current/ Monitor Plug-1 Plug-3	(+) (-)	200V	34.7V

TEC	TITLE	IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM LOOSE PARTS MONITOR CHARGE CONVERTER YM-AMP-7025	NO. TP-106 REV. 1

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

SIGNAL	CABINET 216	PARAMETER			
a.	TEC Current/ Monitor Plug-4 Plug-3	SIG Shield	Photo 106-1 Time Base 5 or 5 Vert Gain 2MV	Photo 106-2 Time Base 5 MS Vert Gain 1MV	Photo _____ Time Base ____ Vert Gain ____

Sync the oscilloscope and photograph the waveform using up to three time base and vertical gain settings. Mark the back of the photographs with the instrument tag number and parameter measured.

Signature/Date 9/28/80

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

SIGNAL	CABINET 216	PARAMETER	PHOTO #
a.	TEC Current/ Monitor Plug-4 Plug-3	SIG SHIELD	106-3

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

TEC	TITLE	IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM LOOSE PARTS MONITOR CHARGE CONVERTER YM-AMP-7025	NO. TP-106 / REV. 1

SPECTRUM IDENT	FREQUENCY	AMPLITUDE	REMARKS	
BANDWIDTH	SCAN WIDTH	INPUT ATTEN	Scan Time	10 db/div Log Ref	Linear Sens
3 KHz	1 MEG Hz/DIV	0	1 Sec	-20 db	Ø

Signature/Date 9/23/80

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

SIGNAL	CABINET 216	PARAMETER	PHOTO # OR PLOT	
*a.	TEC Current/ Monitor Plug-4 Plug-3	SIG Shield	106-4 106-5	100K SCALE 1K SCALE

If PSD plots from the signal 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 9/23/80

17. Continue recording the output signal from YM-AMP- 7025 for a period of 10 additional minutes. Remove amplifier and FM Recorder when complete.

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

TEC	TITLE	IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM LOOSE PARTS MONITOR CHARGE CONVERTER YM-AMP- 7025	NO. TP-106 REV. 1

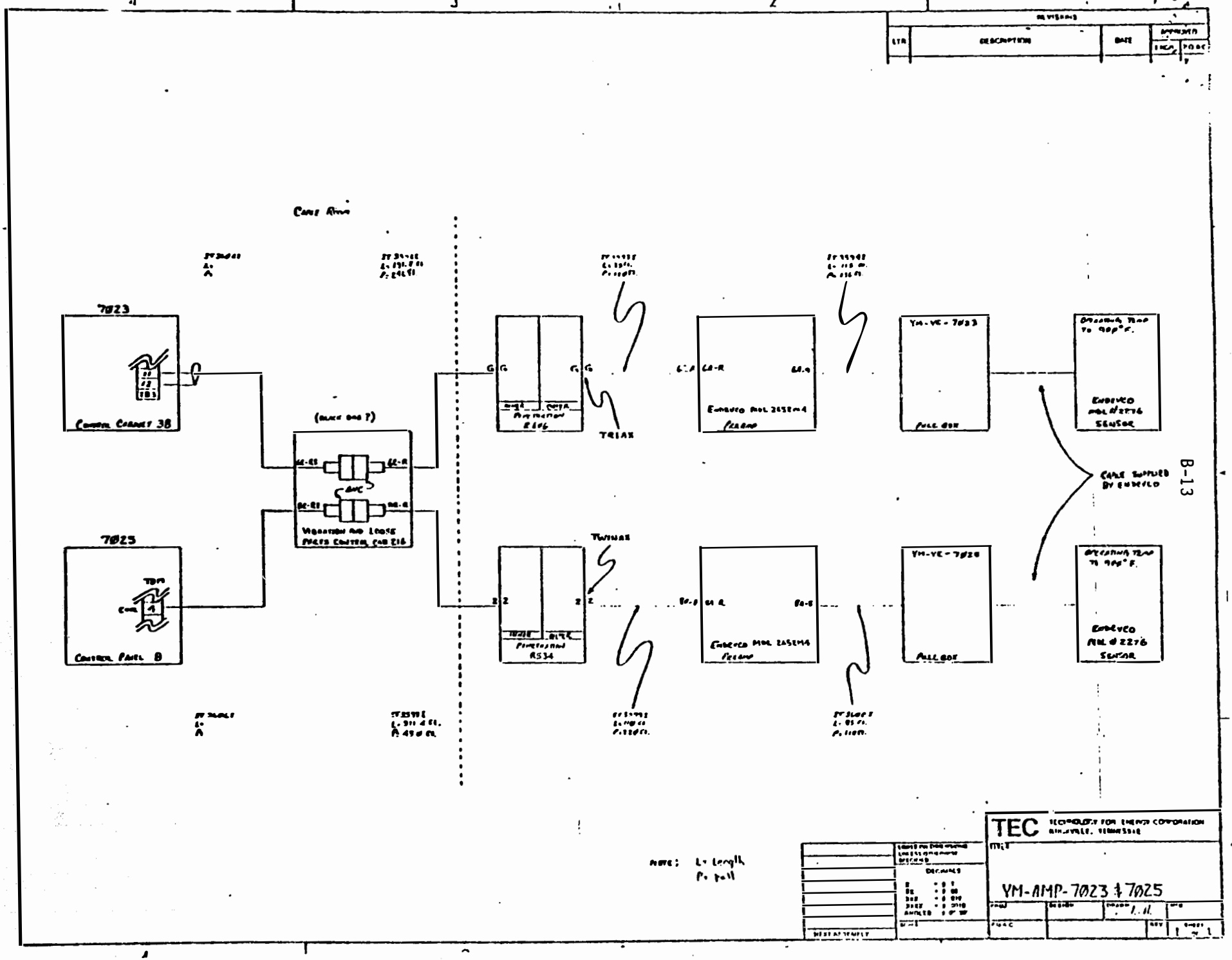
19. Remove the TEC Current Monitor/AC Coupling Text Fixture.

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

I hereby certify that this Test Procedure has been completed as written and that all data has been correctly entered and filed as requested.

TEC Representative _____
Signature/Date

Instrumentation T.R. Gilbert 9-23-80
Signature/Date


REVISIONS
LTR
DESCRIPTION
DATE
APPROVED
7023
CONTROL CABINET 38
7025
CONTROL PANEL B
(BLACK BOX ?)
VIBRATION AND LOOSE PARTS CONTROL CAB 216
TRIAX
TWINAX
RS36
RS34
ENDEVCO MOD 2658M4
ENDEVCO MOD 2658M4
YM-VE-7023
YM-VE-7025
PULL BOX
PULL BOX
ENDEVCO MOD #2276 SENSOR
ENDEVCO MOD #2276 SENSOR
CABLE SUPPLIED BY ENDEVCO
NOTE: L= Length
P= Pull
TEC
YM-AMP-7023 & 7025

GENERATION CORRECTIVE MAINTENANCE SYSTEM

CM STATUS ACTIVITY FORM

COMPONENT DESIGNATOR				LOCATION UNIT	JOB TYPE	WORK AUTHORIZATION NUMBER	REQUEST DATE		
SYS (5)	COMP. TYPE (8)	COMP. ID. (12)	LOOP (16)	(17–22)	(23–24)	(28–32)	MO (33)	DAY	YR (38)
YM	AMP	7025		036002	CM	C5711	09	20	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		2036N				

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						

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

TN: 100-5.80

APPENDIX C

ORIGINAL FIELD PROCEDURES AND DATA SHEETS FOR YM-AMP-7025 AFTER PREAMPLIFIER REPLACEMENT

212-18

GENERATION CORRECTIVE MAINTENANCE SYSTEM
JOB TICKET FORM (WORK REQUEST)-THREE MILE ISLAND

C-1 UNIT 2

COMPONENT DESIGNATION				LOCATION / UNIT	JOB TYPE	JOB TICKET NUMBER	REQUEST DATE	RECOMMENDED PRIORITY
SYS	COMP TYPE	COMP ID	LOOP				MO DAY YR	
YM	AMP	7025		0360	02	CM C-5976	10 30 80	2

DESCRIBE MALFUNCTION OR MODIFICATION DESIRED: INSTALL ATTACHED FACTORY PCK SEASOR / CHARGE MEASUREMENTS

CAUSE OF MALFUNCTION (IF KNOWN):

ORIGINATOR'S EMP. NO.	ORIGINATOR'S SIGNATURE	DATE	SUPERVISOR'S EMP. NO.	SUPERVISOR'S SIGNATURE	DATE
01657	B Ellen	10/30/80	01657	B Ellen	10/30/80

DOE/EGTG PROJECT ACCOUNT / RS

WORK ORDER NUMBER: LOCATION	SERIAL	QC CODE	ACCOUNT NUMBER	PLANT CONDITION: SU	OP	HO	CO	RF	HS	LR	NPRD FAILURE: YR MO DAY	START: HR MIN
0360	00187	GA	X0001 78760 19	1	1	1	1	1	1	1		

				REG AGENCY CODE	CHG/MOD NUMBER	INV CODE	OUTAGE CAUSE CODE	STATUS HOLD CODE
0	0	0	0			X		

SUPV APPROVAL COMMENCE WORK: MO DAY YR	PRIORITY	RESP LOCATION OR CONTRACTOR
10 30 80		2 0360

LOCATION: CABLE ROOM, 305' ELEV. CONTROL BLDG

Limits and Precautions: Comply with the Provisions set forth in TP 1002 and Met Ed Safety Manual

a) Personnel

b) Equipment

c) Environment

d) Nuclear

7025 NEW CHARGE AMP

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

PROCEDURE PERFORMED TO SATISFACTION OF PROJECT ENGINEER

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

COPY 1

GENERATION CORRECTIVE MAINTENANCE SYSTEM

CM STATUS ACTIVITY FORM

C-2

COMPONENT DESIGNATOR				LOCATION UNIT	JOB TYPE	WORK AUTHORIZATION NUMBER	REQUEST DATE		
SYS (5)	COMP. TYPE (8)	COMP. ID. (12)	LOOP (16)	(17–22)	(23–24)	(28–32)	MO (33)	DAY	YR (38)
VM	HMP	7023		036002	CM	C5976	10	30	80

TXN CD (1)	ACT (4)
804	A

ECM NUMBER (47–51)

TXN CD (1)	ACT (4)
805	A

PRTY (66)	RESP. LOCATION OR CONTRACTOR (67–71)	PRTY	ASSISTING CONTRACTOR	PRTY	ASSISTING CONTRACTOR
	2036N				

TXN CD (1)	ACT (4)
807	A

PURCHASE REQUISITION NUMBER (59–66)	PURCHASE ORDER NUMBER (67–73)

TXN (1)	ACT (4)
810	A

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

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

TMI 199 5 80

Technology for Energy Corporation	TITLE IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM LOOSE PARTS MONITOR CHARGE CONVERTER YM-AMP-7023	NO. TP-107 REV. 1
PROCEDURE	APPROVED M.V. Mathis, Director, Tech. Serv. Div.	DATE 9/18/80

PURPOSE: The purpose of these measurements is to gather baseline data and information in preparation for removal of Loose Parts Monitor Charge Converter YM-AMP-7023 from the Reactor Building TMI Unit 2. The tests specified in this procedure are designed to assess the condition of the in-containment instrument module (accelerometer, charge converter), associated cabling, and readout devices. This assessment will require the use of Time Domain Reflectometry (TDR), Impedance (Z), Spectral Analysis (frequency domain), and general oscilloscope observations (with recording) of waveforms from/to the unit under test (UUT).

YM-AMP-7023 — Steam Generator B Upper Tube Sheet

PROCEDURE (ADMINISTRATIVE):

A. Limitations and Precautions

1. Nuclear Safety. Loose Parts Monitor Charge Converter YM-AMP-7023, located at elevation 347', is part of the overall Loose Parts Surveillence System. [redacted]

2. Environmental Safety. Loose Parts Monitor Charge Converter YM-AMP-7023 can be taken out-of and restored to services without producing a hazard to the environment.

3. Personnel Safety. The test described herein produces no additional personnel safety hazards other than normally associated with performing instrument testing.

4. Equipment Protection. In the performance of each test described herein, care will be taken to insure adequate equipment protection as follows:

   a. In all cases actual test hookups to the Unit-2 instrumentation shall be made and verified by Instrumentation Personnel.

   b. All passive measurements (Spectral Analysis and Oscilloscope observations) of waveforms and signals from powered instruments shall be performed using high input impedance probes or inputs (Z = $\geq$ 1 Meg ohm) to prevent loading of signals.

   c. In all Time Domain Reflectometry and Impedance measurements, power will be removed from the unit under test and low level test signals prescribed in Table 4-1 shall be utilized by inserting test signals on appropriate conductors of Cable IT3592I.

Table 4-1 Active Measurements

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

B. Prerequisites

1. The Shift Supervisor/Shift Foreman shall be notified for concurrance prior to the performance of those measurements. [redacted]
2. Instrumentation personnel shall be assigned to assist in the performance of these measurements.
3. All measurements and test instrumentation shall be in current calibration (traceable to NBS).
4. The Shift Supervisor/Shift Foreman shall be notified prior to starting and upon completion of the measurements.

C. Procedure for Performing Measurements

References:

1. Endevco Dwg. No. AE-E0401, Specifications for Model 2652M4 Charge Converter YM-AMP-7023 (Sheet 3 of 3).
2. Specification Manual for Endevco Model 2276 Accelerometer.
3. Burns & Roe Dwg. 3024, Sh. 105.
4. Burns & Roe Dwg. 3343, Sh. 2.
5. Burns & Roe Dwg. 3045, Sh. 17.
6. Burns & Roe Dwg. 3314, Rev. 8.

TEC	TITLE	IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM LOOSE PARTS MONITOR CHARGE CONVERTER YM-AMP-7023	NO. TP-107
			REV. 1

7. Burns & Roe Dwg. 3174, Sh. 7.
8. Burns & Roe Dwg. 3045, Sh. 17.
9. Instruction Manual, Tektronix model 1502 TDR.
10. Instruction Manual, Hewlett Packard Model 4274 Multifrequency LCR Meter.
11. Instruction Manual, Hewlett Packard Spectrum Analyzer (Model 141T, 85533, 85528 Modules).
12. Instruction Manual, Nicolet Model 444A-26 Spectrum Analyzer.
13. Instruction Manual, Tektronix Model 335 Oscilloscope.
14. Instruction Manual, Lockheed Store-4 Recorder.
15. Instruction Manual, Tektronix SC502 Oscilloscope.
16. TEC Composite Electrical Connection Diagram, YM-AMP-7023 (see attachment).

STEPS

1. Notify Shift Supervisor/Shift Foreman of start of test on YM-AMP-7025.
2. Remove all power from YM-AMP-7025 (Channel ~~8~~ 9).
3. Remove cable IT3598I (Channel ~~8~~ 9) in cabinet 216.
4. Using the Hewlett-Packard Model 4274 (or equivalent) Impedance Bridge measure the capacitance and impedance at the following test point.

TEST POINT*	FROM	TO
a.	Cable IT359~~8~~9I (Center Conductor)	Cable IT359~~8~~9I (Shield)

* Test Connection in Cabinet 216.

Record the data required below:

TEST POINT	CAPACITANCE			IMPEDANCE		
Frequency	100 Hz	1 kHz	100 kHz	100 Hz	1 kHz	100 kHz
a. Cable IT 3598I Center Conductor to shield	22 nF	16.5 nF	-209 nF	10.4 kΩ θ = -8.5°	7.15 kΩ -47.8°	9.2 Ω 125.4°

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

Record the data below:

Test Point	High R @ N ft.	Low R @ N ft.	Instrument Settings Ampl Range Mult	Strip Chart Number
a. Cable IT3598I Center Conductor to Shield			100 ft/div 500 mv/div	107-51

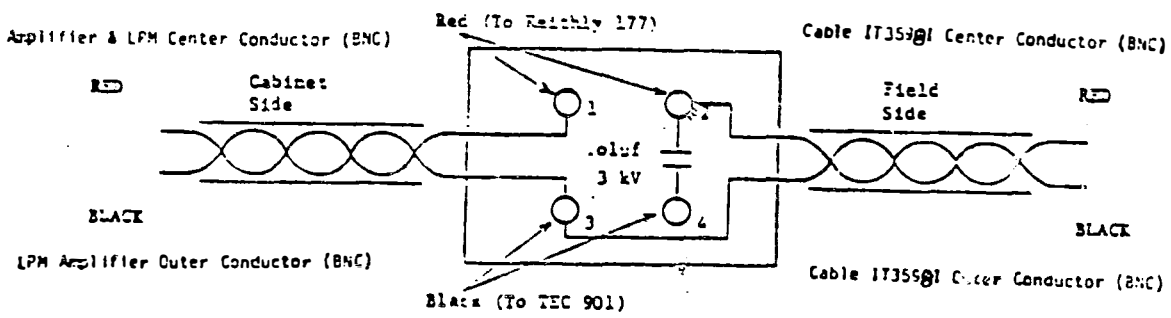
6. Using the Keithley Model 177 (or equivalent DMM) perform resistance measurements on the test points specified and record values in the space provided.

	TITLE	IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM LOOSE PARTS MONITOR CHARGE CONVERTER YM-AMP-7023	NO. [illegible]
			REV. 1

			20K Range POLARITY From = +; To = -	200K Range POLARITY From = -; To = +
TEST POINT	FROM LINK	TO LINK	RESISTANCE	RESISTANCE
a.	Center Conductor (+)	Shield (-)	10.8 kΩ	37.8 kΩ

7. Connect the TEC Current Monitor/AC Coupling Test Fixture between LPM amplifier and Cable IT3592I per the following diagram:

DIAGRAM B-1



TEC CURRENT MONITOR/AC COUPLING TEST FIXTURE

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

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

* Connections provide for proper polarity.

TITLE	IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM LOOSE PARTS MONITOR CHARGE CONVERTER YM-AMP-7023	NO. TP-107 REV. 1

8. Connect a Kiethly Model 177 DMM (or equivalent) in series with center conductor of II3598I (BNC) by connecting across plugs 1 and 2 (the two red plugs) of the TEC Current Monitor/AC Coupling Test Fixture.

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

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

    NOTE: Recording will continue through Step 17.

11. Apply power to YM-AMP-7023(Channel 8 and verify operation through normal instrumentation procedures. Note: system was originally in powered state due to replacement of pre-amp. J E Jones

12. Using the Kiethly Model 177 DMM (or equivalent; Precesion = ± 1%) measure the current at the signal test point.

SIGNAL	Cabinet 216	TEST LEAD	SCALE	READING
a.	TEC Current/ Monitor Plug-1 Plug-2	(+) (-)	20 mA	1.72 ma

* Note: 3.5 V Recorded Across 2kΩ Resist. @ Amp. Source.

* CURRENT READING POWER ON ≈ 12 MIN AND VOLTAGE

J E Jones 10/30/80
Signature/Date

13. Using the Kiethly Model 177 DMM (or equivalent; Z; ≥ 10^7 OHMS, Range 0-2000V, Precesion = ± 1%) measure the DC Voltage at the signal test point.

SIGNAL	CABINET 216	TEST LEAD	SCALE	READING
a.	TEC Current/ Monitor Plug-1 Plug-3	(+) (-)	200 V	35.3 V

TITLE	IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM LOOSE PARTS MONITOR CHARGE CONVERTER YM-AMP-7023	NO. TP-107 REV. 1

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

SIGNAL	CABINET 216	PARAMETER			
a.	TEC Current/ Monitor Plug-4 Plut-3	SIG Shield	Photo 107-52 Time Base 5μsec Vert Gain 1mV	Photo 107-53 Time Base 2msec Vert Gain 1mV	Photo _____ Time Base ____ Vert Gain ____

Sync the oscilloscope and photograph the waveform using up to three time base and vertical gain settings. Mark the back of the photographs with the instrument tag number and parameter measured.

Signature/Date 10/30/80

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

SIGNAL	CABINET 216	PARAMETER	PHOTO #
a.	TEC Current/ Monitor Plug-4 Plug-3	SIG SHIELD	107-54

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

TITLE	IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM LOOSE PARTS MONITOR CHARGE CONVERTER YM-AMP-7023	NO.	
		REV.	1

SPECTRUM IDENT	FREQUENCY	AMPLITUDE	REMARKS
BANDWIDTH	SCAN WIDTH	INPUT ATTEN	SCAN TIME	LOG REF
.5 MHz/Div	3 kHz	0	1 sec/div	10 db LOG -10

note: Gain = 20 from 901 amps
J E Jones

J E Jones 10/30/80
Signature/Date

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

note: Gain = 20 from 901 amps
J E Jones

SIGNAL	CABINET 216	PARAMETER	PHOTO # OR PLOT
*a.	TEC Current/ Monitor Plug-4 Plug-3	SIG Shield	107-55

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

J E Jones 10/30/80
Signature/Date

17. Continue recording the output signal from YM-AMP-7023 for a period of 10 additional minutes. Remove amplifier and FM Recorder when complete.

18. Remove all power from YM-AMP-7023 (same procedure as Step 2).

TEC	TITLE IN-SITU MEASUREMENTS OF CABLES AND SIGNALS FROM LOOSE PARTS MONITOR CHARGE CONVERTER YM-AMP-7023.	NO. [illegible] REV. 1

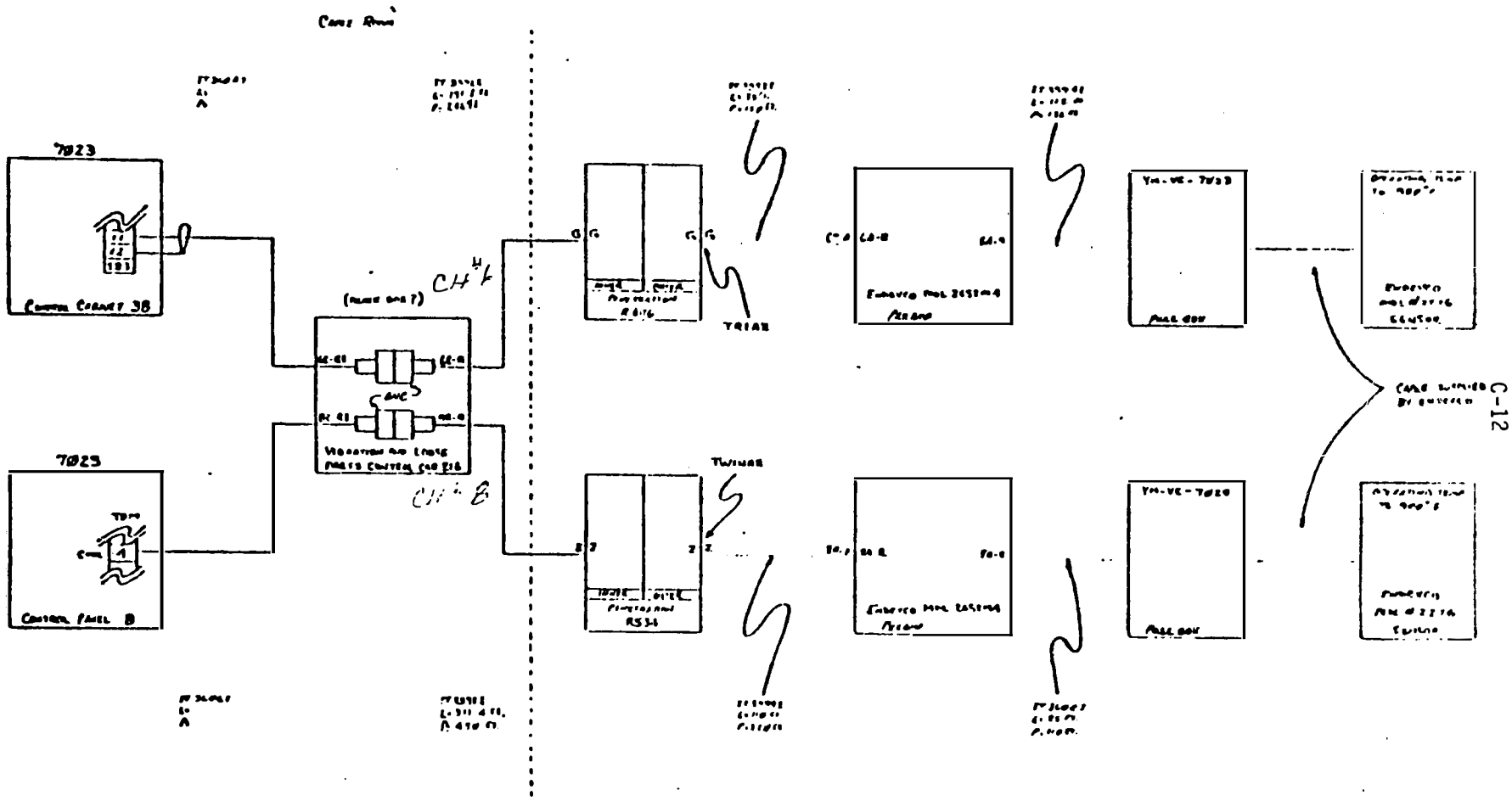
19. Remove the TEC Current Monitor/AC Coupling Text Fixture.

20. Notify the Shift Supervisor/Shift Foreman of the conclusion of testing on YM-AMP-7023.

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 J E Jones 10/30/90
Signature/Date

Instrumentation [illegible] 10/30/80
Signature/Date



NOTE: L = Length
P = Pull

TEC

YM-MUP-7023

FIELD SERVICE DATA SHEET

C-13

PL Name J. E. Jones

Page No. 2

DATA SHEET - PLANT: TMI

UNIT 2 RUN 2 DATE 10/30/80

TIME	TAPE ft	PWR	TAPE 1154
START	150		SPEED 15 ips
STOP			BAND FM & Direct

ROD POSITION: GROUP ___, _____; GROUP ___, _____; GROUP ___, _____.

BORON (ppm) _____ EFPD _____ CYCLE _____

RECORDER CHANNEL	SIGNAL	AMP	BW	GAIN	VDC
1	LPM	3	50k	2x10	
2					
3	LPM	3	50k	2x10	
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					

Serious problem with recorder.

COMMENTS: 230' start 60 IPS → 1350'

470' - 525' operator "touched" channel 3!

1350' - 1450' attempted restart ⇒ ch 3 not working!

1450' - 1500' all channels recorded

1500' - 1620' G = 5x20

1620' - end G = 5x20

TEC Form No.

FIELD SERVICE DATA SHEET

C-14

PL Name [illegible]

Page No. 1

DATA SHEET - PLANT: TMI

UNIT 2 RUN 1 DATE 10/30/80

	TIME	TAPE ft	PWR	TAPE 1154
START	12:55	0	—	SPEED 15 ips
STOP	1:4M	120	—	BAND FM & Direct

ROD POSITION: GROUP ___, _____; GROUP ___, _____; GROUP ___, _____.

BORON (ppm) _____ EFPD _____ CYCLE _____

RECORDER CHANNEL	SIGNAL	AMP	BW	GAIN	VDC
1	CALIBRATION *	1	50KHz	1	
2					
3	CALIBRATION *	2	50KHz	1	
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					

COMMENTS:

* 1000 Hz @ 1.0 V P-P

Chnl 3 - Intermittent problem (Direct)

Chnl 1 - OK

TEC Form No.