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RECIP. NAME RECIPIENT AFFILIATION
ADENSAM, E. G. BWR Project Directorate 3

see Prop Rats

SUBJECT: Forwards results of testing of Kaman isolation devices utilized at plant, in response to Questions Q421.13 & Q420.01 (Confirmatory Item 20). Testing should resolve concerns re SPDS. Affidavit encl. Encls withheld (ref 10CFR2.790).

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NIAGARA MOHAWK

NIAGARA MOHAWK POWER CORPORATION/300 ERIE BOULEVARD WEST, SYRACUSE, N.Y. 13202/TELEPHONE (315) 474-1511

April 15, 1986
(NMP2L 0688)

Ms. Elinor G. Adensam, Director
BWR Project Directorate No. 3
U.S. Nuclear Regulatory Commission
7920 Norfolk Avenue
Washington, DC 20555

Dear Ms. Adensam:

Re: Nine Mile Point Unit 2
Docket No. 50-410

Enclosed are the results of the testing of the Kaman isolation devices utilized at Nine Mile Point Unit 2. This testing was performed in response to Questions Q421.13 and Q420.01 (Confirmatory Item 20).

This testing should also resolve the concerns stated in your letter dated January 29, 1986 (from yourself to B. G. Hooten) in regard to the isolation devices utilized in the Nine Mile Point Unit 2 Safety Parameter Display System (Open Item 18).

The information contained in the enclosed test report contains confidential commercial information of Niagara Mohawk Power Corporation. In accordance with Section 2.790 of the Commission's regulations, Niagara Mohawk Power Corporation hereby makes application for the withholding of this test report from public disclosure. An affidavit in support of this application for withholding is attached.

Very truly yours,

CVMangan

C. V. Mangan
Senior Vice President

TRL:ja
1486G
Enclosure

xc: R. A. Gramm, NRC Resident Inspector
Project File (2)

PB01

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of	)	
	)	
Niagara Mohawk Power Corporation	)	Docket No. 50-410
	)	
(Nine Mile Point Unit 2)	)	

AFFIDAVIT

I, C. V. Mangan, being duly sworn depose and state as follows:

1. I am Senior Vice President of Niagara Mohawk Power Corporation and am authorized on the part of said Corporation to make application for withholding from public disclosure of the document discussed in this affidavit.

2. This affidavit is made in support of an application for withholding from public disclosure the report entitled "Maximum Credible Fault Test Report for Kaman Instrumentation KESIM & KEAIM Isolation Devices" which contains information considered by Niagara Mohawk Power Corporation to be confidential commercial information consisting of analyses/results which should be withheld from public disclosure.

3. In support of its averment that the above-mentioned information is confidential commercial information exempt from public disclosure under the provision of Section 2.790 of the Commission's regulations, Niagara Mohawk provides the following reasons:

   a. This information is held and will continue to be held in confidence by its owner, Niagara Mohawk Power Corporation.

   b. This information is of the type customarily held in confidence by the owner, Niagara Mohawk Power Corporation. Release of this information would cause financial harm to Niagara Mohawk Power Corporation.

   c. This information is being transmitted to the Commission in confidence.

   d. This information is not available in any public sources.

e. The information in this report was obtained through substantial expense by Niagara Mohawk Power Corporation incurred in the performance of an extensive testing program of the isolation devices. The accumulated costs of the testing program include the purchase of spare isolation devices, spare control room indication components and electronic testing equipment. Additionally, a large number of man-hours (engineers, technicians, clerical and consultants) and the resultant overhead costs were expended in the preparation of the test, performance of the test and the analysis of the results. The information which resulted from this test is a valuable commercial commodity of interest to other commercial entities. Public release of this information would place Niagara Mohawk in a financially disadvantageous position with regard to the resale of this information and would prevent Niagara Mohawk from recouping a portion of these substantial expenses.

C. Mangan

Subscribed and sworn to before me, a Notary Public in and for the State of New York and County of Onondaga, this 15th day of April, 1986.

Janis M. Macro
Notary Public in and for
Onondaga County, New York

My Commission expires:

JANIS M. MACRO
Notary Public in the State of New York
Qualified in Onondaga County No. 4784553
My Commission Expires March 30, 19 87

TABLE OF CONTENTS

1.0 PURPOSE AND DESCRIPTION

The purpose of this test was to ensure that the two isolators supplied by Kaman for use with the Digital Radiation Monitoring System (DRMS) for Nine Mile Point Nuclear Station - Unit 2 provides the electrical isolation between Class 1E and non 1E circuits following the maximum credible fault (MCF).

The Kaman supplied Analog Isolation Modules (KEAIM or AIM) and the Safety Isolation Modules (KESIM or SIM) are to be used as a portion of the Safety Parameter Display System (SPDS) for providing DRMS information to the operator. As noted at the USNRC SPDS Audit at NMP2 on July 17 and 18, 1985, a detailed assessment by the NRC on type test data for the Kaman isolators wqs required and reflected in FSAR Question F420.01.

The MCF test was performed to demonstrate that the AIM's and SIM's qualify as acceptable isolation devices as defined in the requirements of IEEE 384, 1977, IEEE Standard Criteria for Independence of Class 1E Equipment and Circuits.

2.0 APPLICABLE DOCUMENTS

1.	CPN Z855, Rev. 2	Maximum Credible Fault Test Procedure
2.	IEEE 384, 1977	Criteria for Separation of Class 1E Equipment and Circuits
3.	IEEE 323, 1974	Qualifying Class 1E Equipment for Nuclear Generating Stations
4.	Regulatory Guide	Physical Independence of Electrical Systems
5.	10CFR50 - Appendix B,	Title 10, Code of Federal Regulations, Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Processing Plants", USNRC
6.	10CFR21	Title 10, Code of Federal Regulations, Part 21, "Reporting of Defects and Non Compliance.

3.0 RECORD OF TEST PERSONNEL

1. SIM's Test - 3/24/86

A.	C. Dunham	NMPC I&C Technician
B.	D. Burdick	NMPC I&C Technician
C.	J. Connor	NMPC I&C Technician
D.	S. Ganoung	NMPC I&C Technician
E.	A. Sassani	NMPC Engineering
F.	F. Jensen	Joint Startup & Test Group
G.	B. Newman	SWEC Engineering
H.	R. Connors	SWEC Engineering (Test Coordinator)

2. AIM's Test

A.	C. Dunham	NMPC I&C Technician
B.	D. Burdick	NMPC I&C Technician
C.	J. Connor	NMPC I&C Technician
D.	S. Ganoung	NMPC I&C Technician
E.	A. Sassani	NMPC Engineering
F.	R. Traber	Joint Startup & Test Group
G.	L. Kassakatis	Joint Startup & Test Group
H.	F. Jensen	Joint Startup & Test Group
I.	R. Connors	SWEC Engineering (Test Coordinator)

4.0 TEST EQUIPMENT

All measurement and test equipment (M&TE) used in performing these tests were calibrated as applicable in accordance with Niagara Mohawk Power Corporation's Instrumentation & Control QA procedures for NMP2. All M&TE is traceable to NBS.

Additionally, traceability to this test is available on the Record of Test card located on the M&TE.

5.0 DEVIATIONS FROM TEST PROCEDURE

1. Due to availability of test equipment, Figure 2 of the Test Procedure was modified to reflect that as shown in Figure 2A which is functionally equal to the earlier version.

   PB1 was replaced with S1 and the scope was set up to monitor full current fault pulse and scaled down voltage reading (120VAC = 24VAC) thru use of a transformer.

2. Test equipment used to perform the test was as shown in Attachments 1 & 2 and was equal to that as outlined in the test procedure.

3. Referring to Sections 5.1.1.1 of SIM's and AIM's test respectively.

   The pass/fail criteria of the ICU remaining constant ±1 least significant digit was determined prior to the start of the test to be too severe a criteria. A digital pulse generator was used to simulate a gamma type detector for both tests and its output was held constant. The display on the ICU which was being updated at approximately 1 second intervals was observed to fluctuate with the input to the microcomputer held constant at various time periods to a maximum of plus 5 least significant digits and minus 0 digits before decaying to the normal test setpoint. There was no external interference such as toggling test equipment, turning on motors or lights which could have caused those fluctuations.

   The acceptance criteria of +5/-0 least significant digits was adopted as reasonable.

   JUSTIFICATION:

   A review of Kaman Instrumentation's Microcomputer Software Design Description, Functional Test for Multichannel Area Monitor (MCAM) with Ion Chamber Detector (KNP 18-72), and Functional Test Procedure MCAM with GM tube detector (KNP 18-86) indicates that the units displayed are engineering units, the result of calculations inherent to Kaman's software, not in counts per minutes (CPM).

   A discussion of detector signal acquisition and radiation signal filtering method is as follows:

   Every radiation monitor contains one or more detectors for measuring the level of radiation at the location of the monitor, or in the process of effluent stream being sampled. The type

of radiation detector used depends on the media being monitored, but all detectors measure the radiation from decay processes in terms of the number of events occurring in a certain time interval. These events, counts from GM or scintillation detectors or current levels in the case of ion chamber detectors, are processed through various signal conditioning and interface electronics, and are presented to an event counter at the microcomputer. Each GM or scintillation detector, or channel, has a separate dedicated counter at the microcomputer that is continuously running, counting pulses from the detector. The counters used in the KEM-A and Kem-P microcomputers have a capacity of more than 65 thousand counts (16 bits) before they "roll over". These counters are read by the logic of the microcomputer, without interrupting the counting process approximately every 20 to 100 milliseconds. The maximum count rate for the counters is therefore more than 20 million counts per minute. This is beyond the capability of the detectors and other interface electronics, however, and the practical maximum count rate is on the order of one to ten million counts per minute, depending on the detector type.

For ion chamber detectors, the low-level current signals of the detectors are amplified and conditioned, and the level of the sample activity is determined by passing this signal through an analog to digital converter and other scaling and auto-ranging electronics.

Since radioactive decay is a statistical process, the number of counts measured by the detectors per unit time varies. The radiation rates calculated by the microcomputer are averages over various time periods. In general, radioactive decays follow a "normal" statistical distribution with time, so that at very low count rates (typical background levels, for example) the average radiation rate measured over a short time interval may vary considerably. At high levels of activity, the variation (measured as a fraction of the long term average rate) is much smaller. In order to prevent large oscillations in the display of current rates at low activity levels, where the statistical fluctuations are large, and yet to give rapid and accurate readings at high radiation rates, Kaman uses a continuously variable time constant filtering technique in the radiation rate calculations performed by the microcomputer, as described in the next section.

RADIATION SIGNAL FILTERING METHOD

The counts (or current for ion chamber detectors) accumulated within one second by the microcomputer are converted to engineering

units of activity concentration (microcuries per cubic centimeter, for example), displayed in digital form at both local and remote panels, and checked against the radiation alarm setpoints to determine if an alarm condition exists.

The "raw" or gross counts in a one-second period (Gs) are converted to gross counts per minute (Cgm) by multiplying by 60. This value is then converted to a gross activity concentration in engineering units by multiplying by the detector "linear conversion factor", e, which represents the activity concentration per cpm (or per ampere of current for ion chambers) as determined by detector calibration experiments using known source strengths. If the detector's efficiency factor is not entirely linear over its range of operation (due to "dead time" errors in GM tubes, for example), a second multiplicative factor is then applied to the count rate. This unitless "non-linear correction factor", Cf, is determined by a table lookup procedure. Using this method, any non-linear response characteristics of the detectors are easily accounted for by the software of the microcomputer. the calculations performed in the software of the microcomputer to obtain the effective gross activity concentration, Ag, can be summarixed as:

$$Cgm = Cgs * 60$$

$$Ag = Csm * e * Cf$$

A smoothing or filtering technique is then applied to the gross activity concentration. This technique is the digital equivalent of a simple single pole RC filter.

First, a time constant is computed based on the current count rate, Ag. this time constant is obtained by an interpolation procedure using graphical data and takes on values from one second at count rates above 3000 cpm, to 26 seconds (13 seconds for area detectors) at count rates less than 120 counts per minute (less than 230 cpm for area detectors). Within the range from 120 to 3000 cpm, the time constant continuously decreases with the detector count rate. The time constant found in this manner, Tc, is used to determine the filtered activity concentration by the following equation:

$$RFc = RFp + (RUc - RFp) * (1 - \exp[-Ts/Tc])$$

where:

RFc is the resultant filtered activity concentration, in engineering units such as microcuries per cubic centimeter for the current one second time interval, RF, is the filtered activity concentration in engineering units for the previous one second time interval; RUc is the gross unfiltered activity for the current one second time interval (= Ag in this discussion);

Ts is the sampling time interval (always 1 second);
Tc is the time constant (in seconds) for the count rate of the current one second time interval.

The effect of this filtering technique is to give a "smoothing" effect at low count rates where large statistical variations are expected, but to give a more rapid response to changes in the radiation level at high count rates.

At a count rate of 120 cpm (or below), for example, the filtered radiation rate for a process channel is equal to .96 of the previous filtered rate plus only .04 of the new unfiltered rate. Above 3000 cpm, the filtered rate is equal to .37 of the previous filtered rate plus .63 of the current unfiltered rate.

This filtering method has proven to be a reliable means of processing the raw count rates and preventing unwanted "nuisance" alarms from occurring at low count rates, while allowing fast response to real increases in the rates. The method has been found to be preferable to other means such as testing the number of times the raw count rate exceeds some preset value.

The net activity concentration, An, is then determined by subtracting the background activity concentration, Ab, from the filtered gross activity concentration, RFc. That is:

$$An = RFc = - Ab$$

This background activity may be specified to the microcomputer via the DCS or the control panel (KELIC or KERIC). In some units where automatic background determination is done by the microcomputer, the background activity is calculated based on the activity during a purge operation. For area channels, which measure only background activity, this subtraction is not done.

It is this net filtered radiation rate, An, that is then used to update the local and remote radiation rate displays. This filtered rate, or activity concentration, is tested against alarm setpoints to determine if an alarm condition exists.

The pulse generator used on these tests was set to yield below 200 HZ.

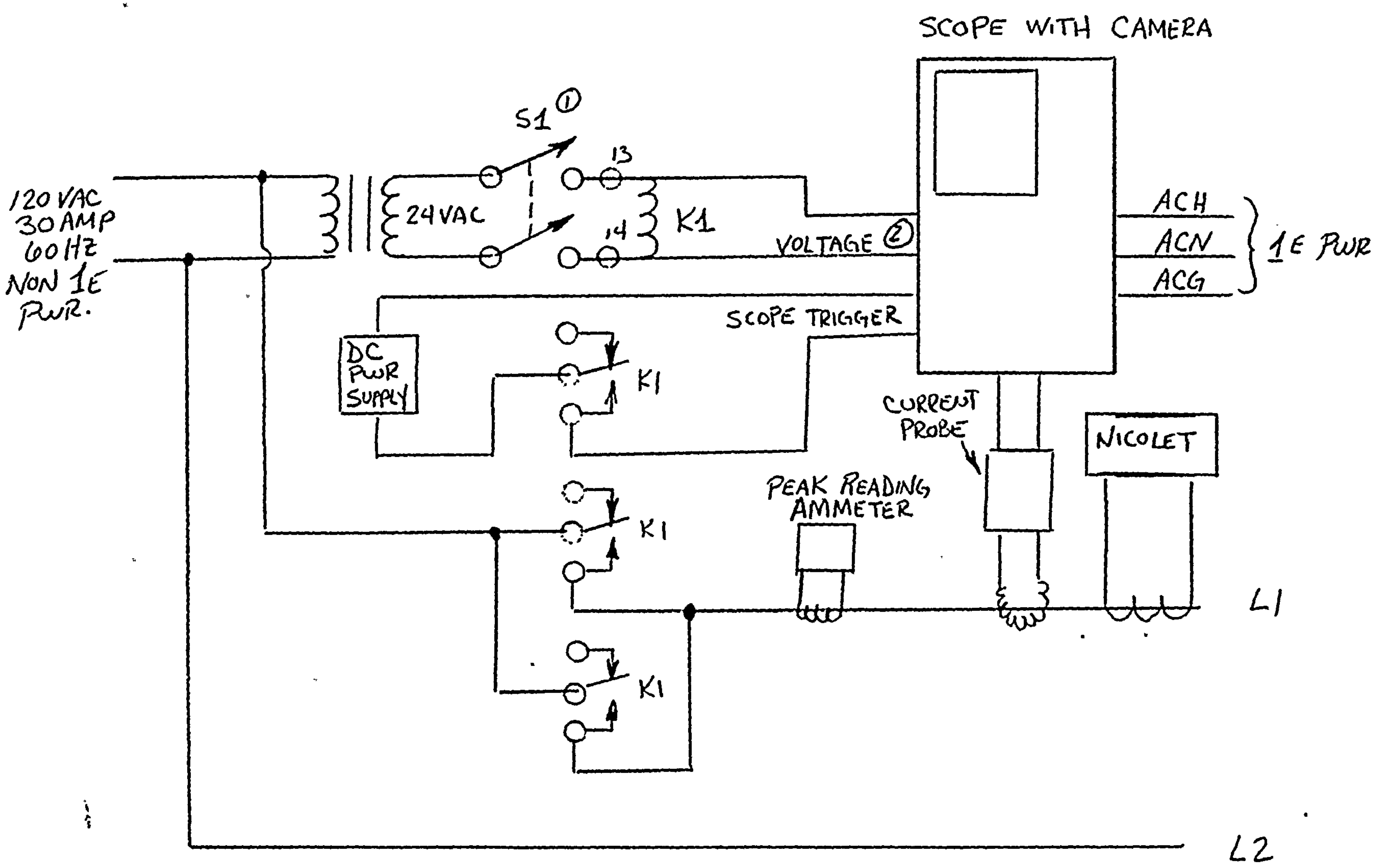


FIGURE 2 (A)
MAXIMUM CREDIBLE FAULT TESTING

NOTES: ① CLOSE & OPEN MOMENTARILY
② 24VAC with SAME PHASE RELATIONSHIP AS 120VAC NON 1E PWR.

6.0 DISCUSSION ON TEST APPROACH

The purpose of MCF testing is to assure that in the event of non 1E MCF conditions, the fault is not propagated through to the Class 1E side. Although the MCF condition of 120VAC at 30amps is very unlikely due to both the structural design, wire routing features, and the limiting impedance of the devices, the test was set up to accomodate such.

Revision 2 to MCF Test Procedure 12177-SK-955 was issued on 3/19/86, prior to the start of the test. This revision specifically deleted the testing of the "From Transmit" port on the SIM's and of the two voltage outputs (0-10 volt and 0-5 volts) on the AIM's as demonstration on a single isolator circuit represents adequate testing while performing a second or third destructive type test on an isolator damaged as a result of initial MCF could not be conclusive. Justification for selection of the circuit which was to be tested on the SIM's is covered in Section 6.1 while circuit selection for the AIM's is addressed in Section 6.2.

6.1 SIMs

The approach for testing the isolator was to ensure that MCF for the device was achieved. Only those faults which could occur outside of the SIM's were considered as the device is a sealed box and all wiring interface is through two 50 pin Amphenol connectors.

A review of the Kaman schematic drawing for the SIMs isolator board #430202 indicated two possible paths for MCF testing: receive and send channels; each containing a Hewlett Packard HCPL-2630 optocoupler as the isolation device.

From the non 1E side of the device looking towards the 1E side, the final non 1E item is the LED on the optocoupler for the send channels. For the receive channels, it is the photodiode with an amplifier circuit on the optocoupler.

As we wanted to verify the electrical isolation property of the SIMs, only the receive channel was selected for testing because the optocoupler in both the send and receive channels is identical. Also, for the receive channel, the amplifier circuit output, considered as an internal power source, coupled with the maximum credible fault, provides a greater current drawing capability, thus creating heat and possible arcing on the board.

Further justification for not testing the send channel where signals originate on the non 1E side is that the circuitry is designed to turn the LED in the optocoupler on and off in a current sink mode, acting as a switch rather than as a power source. With a regulated 5 volt power supply constantly

available to drive the LED, the Advanced Micro Devices AM26LS32DC Quad Differential Line Receiver (QDLR) grounds or opens pin 2 of the HCPL-2630 to switch the LED.

Test data indicates a minimum input impedance of 6000 ohms for the QDLR. The possible breakdown path is through this chip not including the HCPL-2630 via pins 8 and 12 to ground and pins 4 and 16 through the 5 volt supply.

As the HCPL-2630 LEDs are low voltage devices, any surge voltage out of tolerance will result in the destruction of the LED in an open circuit. The impedance of the electrical isolation barrier in the HCPL-2630 will preclude any MCF transfer.

The class 1E device interprets the flash of the LED as information. The DRMS system has been extensively tested at the Integrated System Test (IST) prior to shipment from the vendor to verify that illegal commands or requests which could effect 1E equipment were inhibited.

Requests for information and time checks are performed via a Kaman protocol using RS422 interface. Due to physical data formatting (for security) with constraints such as headers, checksums, deadbands, body, and end of text, an instantaneous surge flash on the transmitting LED cannot be interpretted by the class 1E monitor to represent a high level logic string.

6.2 AIMS

The approach for testing the isolator was to ensure that MCF for the device was achieved. Only those faults which could occur outside of the AIMs were considered as the device is a sealed box and all wiring interface is through two 20 pin Amphenol connectors.

A review of the Kaman schematic drawing for the AIMs isolator board #430402-001 indicates three possible paths for MCF testing; 0-10 volt dc, 0-5 volt dc, and 4-20 mode. The isolation device for providing the non 1E to class 1E separation is an Intronics IA184 isolation amplifier; one for each channel of information.

Open circuit testing on the AIMs was achieved throughout factory testing of the DRMS and into the startup and test phases at NMP2, as no loads were connected to the device and no shorting resistor was required on the current output nor provided.

The typical application of the AIMs at NMP2 is to provide Post Accident Monitoring (PAM) to the Emergency Response Facility (ERF) computer.

It was determined that this 4-20 mode signal be tested as it represents a greater source of current and heat in the device which would make the isolator more susceptible to failure as all components are mounted on the same printed circuit board.

Although the 0-10vdc output is also being used from the AIMs, this output is in series with the current output supply and is considered a part of the test channel after application of the MCF.

Testing of the 0-5vdc output represents a lesser risk for MCF testing as this circuit contains redundant operational and current amplifiers connected in series before connection to the isolation transformer.

7.0 CONCLUSION

7.1 SIM's Communication Device

The Class 1E circuit of the Safety Isolation Module (SIM) is not affected by faults occuring on the non 1E portion of the module; these faults are open circuit, short circuit, line-to-ground and maximum credible fault of 120VAC fused at 30amp transverse mode hot short.

7.2 AIM's Device

The Class 1E circuit of the Analog Isolation Module (AIM) is not affected by faults occurring on the non 1E portion of the module.

The current output circuit on the AIMs was subjected to open and maximum credible fault of 120VAC fused at 30amp transverse mode hot short.

8.0 TEST DESCRIPTION

Refer to Test Procedure under CPN Z855, SWEC procedure #12177-SK-955, Rev. 2 dated 3-19-86 for details (Attachment 5)

NOTE: The test results shown in Attachment 5, Revision 2, MCF Test Procedure were transcribed directly from those notes taken by R. Connors on 3-24-86 and 3-26-86 on a Revision 1 procedure with appropriate Revision 2 items deleted. This copy is available for verification.

9.0 QUALIFICATION

IEEE environmental and seismic qualification for the SIMs and AIMs has been completed by the vendor (Kaman) prior to the start of the MCF test.

This information is available in Kaman's NMP2 Qualification Summary Report #K-84-103u(r) available at NMP2.

10.0 CLARIFICATION

1. Section 5.7.1.1 of the SIMs test (attachment 5) -

   Test set up functioned normally after completion of this step until the power was turned off to disconnect the test equipment.

2. Section 6.0 of the SIMs test (attachment 5) -

   a. 1st paragraph - Hot short is the MCF.

   b. 2nd paragraph - "Unit" referred to is the HCPL-2630 optocoupler. Although this device is rated for 3000vdc isolation, Kaman is claiming 1500vdc isolation in their specification sheet on the SIMs which is reasonable as all isolation is performed on one board in this module.

TEST INSTRUMENT CALIBRATION LIST

M&TE Device Number	Cal. Due Date	EQUIPMENT TYPE		RANGE
2177	N/A	TEKTRONIX TYPE 134 CURRENT AMP.		1A./DIV.
	N/A	TEKTRONIX P6021 CURRENT PROBE		NOTE ①
3203	8/24/86	TEKTRONIX 7623 A Scope	AS A UNIT	
3203 B	8/24/86	7A18 A VERT. AMP.		.05 V & .2V/DIV. (NOTE ②)
3203 A	8/24/86	7B53 A TIME BASE		5mS /DIV.
8586	N/A	H.P. 8116A GENERATOR		30.6 Hz @ 1v pk, 10μS (NOTE ③)
4917	N/A	H.P. POWER SUPPLY		N/A (NOTE ④)
8486	N/A	H.P. POWER SUPPLY		N/A (NOTE ⑤)

NOTES:
①② - P6021 USED with TYPE 34 AMP. ON 1A/DIV. with .2V/DIV. ON SCOPE = 4A/DIV. SCOPE DISPLAY VERT. CHANNEL 2.
② - .05 V./DIV. X 100 P6007 VOLTAGE PROBE = 5V/DIV VERT. SCOPE DISPLAY CHANNEL 1.
③ PULSE GENERATOR SET TO YIELD 2.00 mR/hr FOR SIM'S TEST AND 1.04 E-2 μCi/cc FOR AIM'S TEST.
④ 10V. set by M&TE 8763 TO PROVIDE SCOPE TRIGGER.
⑤ 24V. SET by M&TE 8763 TO PROVIDE SIM POWER.

Robert P Connors 3/26/86 TEST COORDINATOR

CPN 2855

ATTACHMENT 1
PAGE 2 of 2

TEST INSTRUMENT CALIBRATION LIST

M&TE Device Number	Cal. DUE Date	EQUIPMENT TYPE	RANGE
8318	9/14/86	8024B FLUKE	2V./Div (NOTE 6)
2179	8/24/86	Y8100 FLUKE CLAMP-ON CURRENT PROBE	(NOTE 6)
8763	7/8/86	8062A FLUKE	200V./Div.
N/A	N/A	TEKTRONIX P6007 x100 VOLT. PROBE	(NOTE 2)
3209	N/A	TEKTRONIX C5 CAMERA	N/A
7149 (EM-180)	7/27/86	Nicolet 3091 } AS A UNIT	2v/Div. @ 1MS/Div.
EM 186	7/27/86	Nicolet Current Probe } AS A UNIT	2v/Div. @ 1MS/Div.
4438	N/A	KAMAN PORTABLE Indication & CONTROLLER (KEPIC) PN 450567-001 SN 82356-1	N/A
—	—	Relay - AROMAT 24VAC HC3 AP313298 - LR42758	—
—	—	Switch - TOGGLE SPDT	—

NOTE 6: 8024B & 48100 combined to yield 200A/2V.

Robert P Connors 3/27/86 TEST COORDINATOR

CPN 2855

ATTACHMENT 2

KAMAN EQUIPMENT LIST

ACRONYM	DESCRIPTION	KAMAN PART #	KAMAN SERIAL #	REMARKS
KESIM	SAFETY Isolation MODULE	450958-001	83871-4	SPARE
KESRMS	SAFETY INTERface MODULE	450957-001	83869-4	SPARE
KEM-A	MICROCOMPUTER - AREA TYPE	450955-014	81966-4	2RMS-RU11B
KE·AIM	ANALOG Isolation Module	450755-001	83793-1	SPARE
KERIC	REMOTE INdication & CONTROllER	450704-114	83084-5	2SWP*RU223A
KEM-P	MICROCOMPUTER - PROCESS TYPE	450662-031	83409-1	2SWP*RUW23A

Robert P Connors 3/26/86 TEST Coordinator

ATTACHMENT 3

SIM'S TEST PHOTOGRAPHS

ATTACHMENT 3

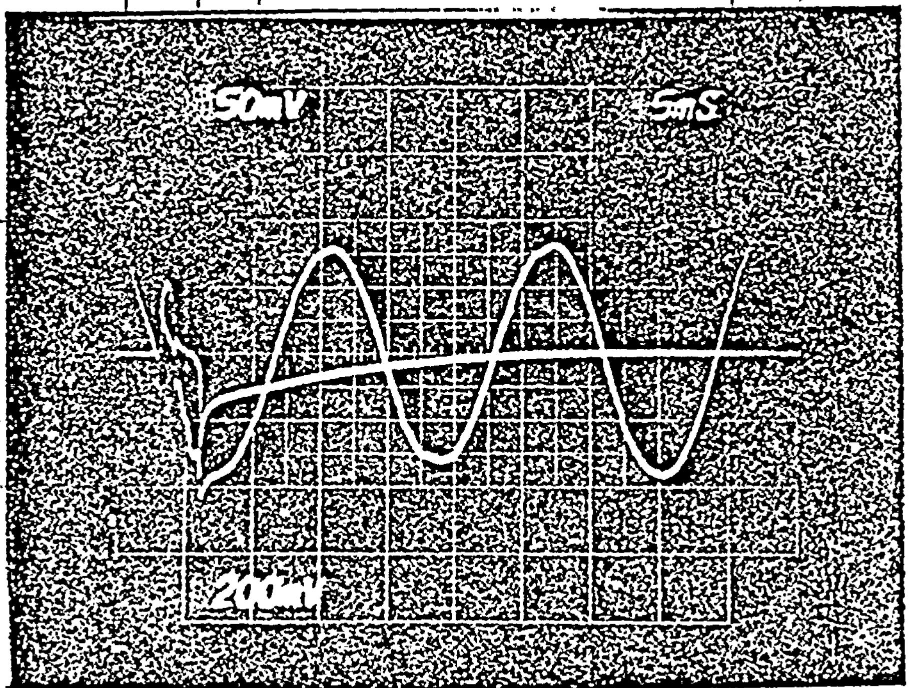


FIGURE 1

Test 5.7.1.1   SIM'S   3/24/86
C. Dunham

Vertical = 5mV. x 100 = 5v./Div. AC volts

Vertical = 200mV = 4A/Div. AC current (amps)

Hor. = 5m Sec/Div.

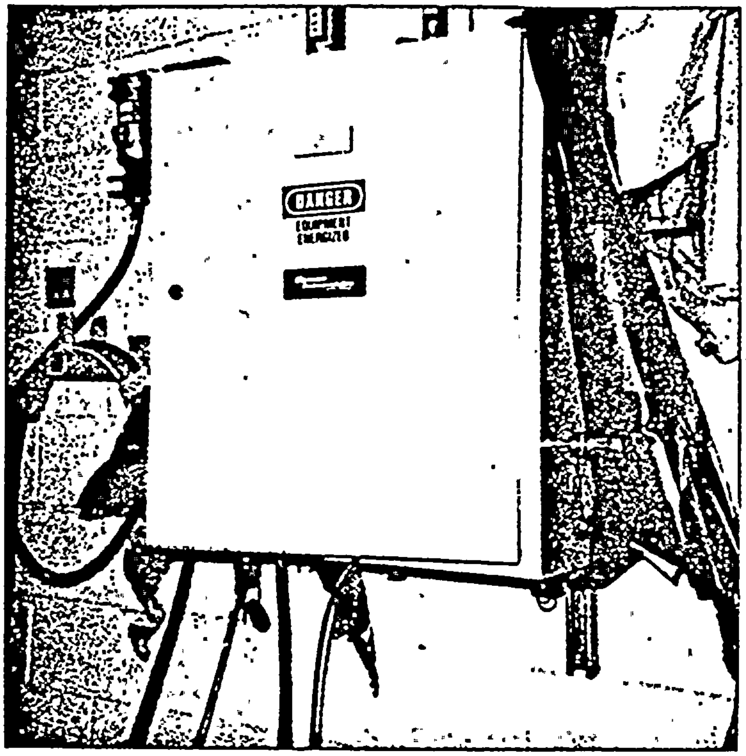


FIGURE 2

2RMS-Ru118 Microcomputer (Kem-A)

Location: Radwaste Sample Room
Turbine Bldg. EL. 261-

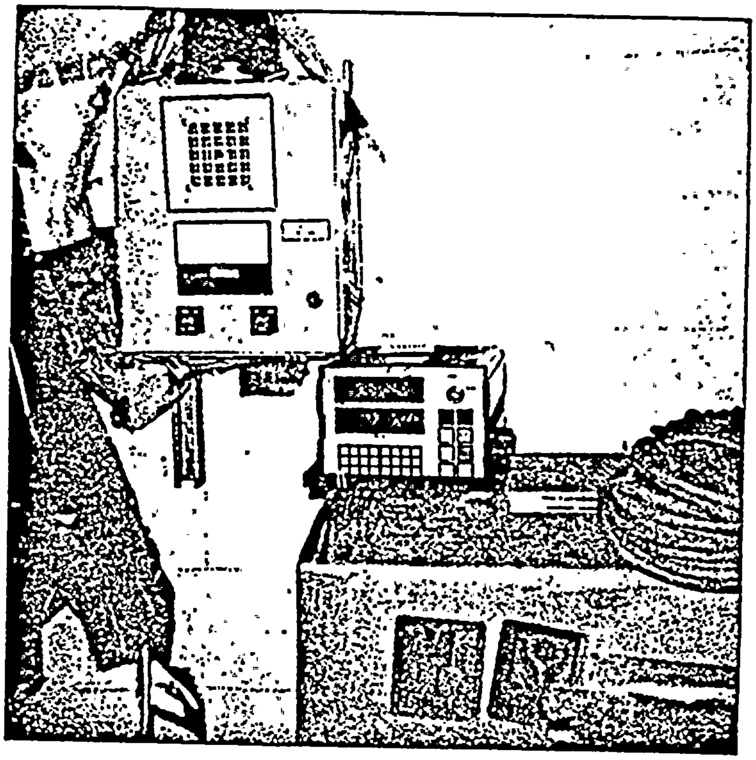


FIGURE 3

2RMS-RAW118 Remote Indication & Alarm (KERIA)
with portable Indicator & Controller (KEPIC)

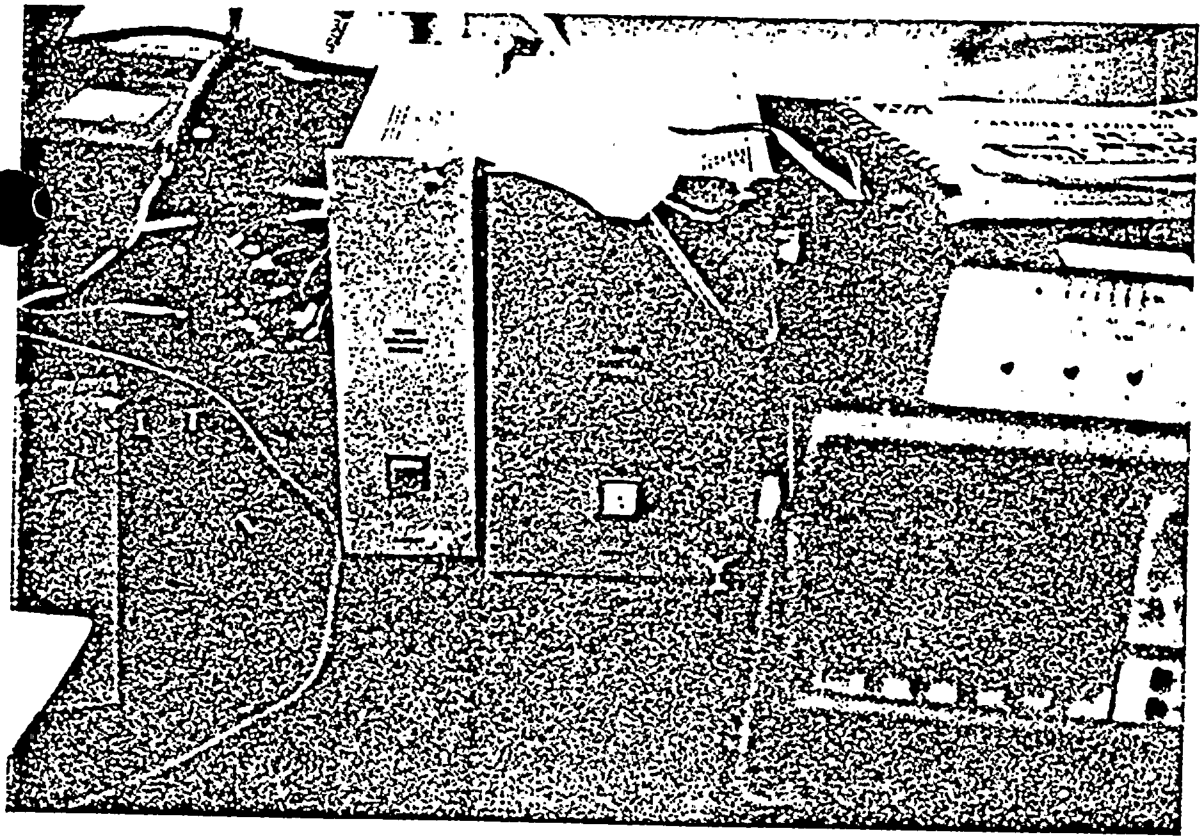


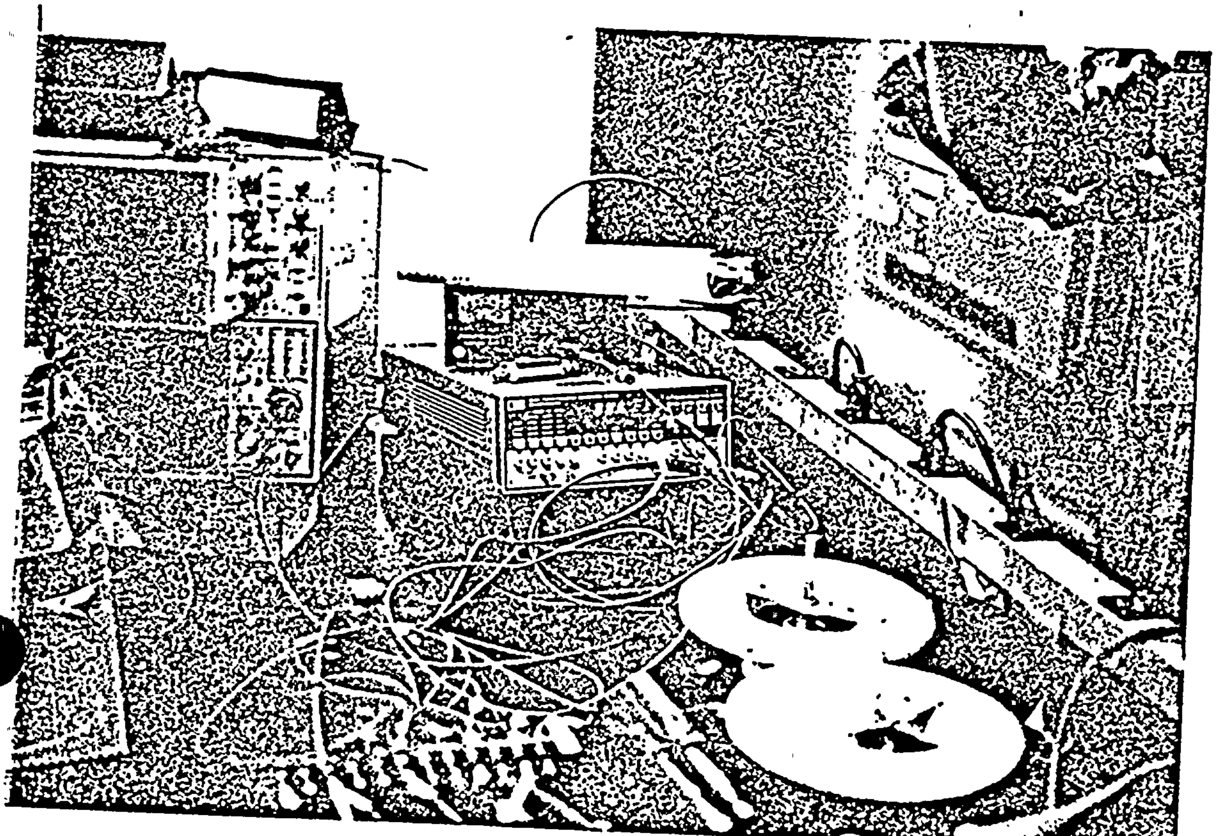
FIGURE 4

SRMS Interface Module with SIM'S Isolator

NOTE: Post test photograph - light on SIM's is off after unit failed.

FIGURE 5

Test equipment (pulse generator & scope)



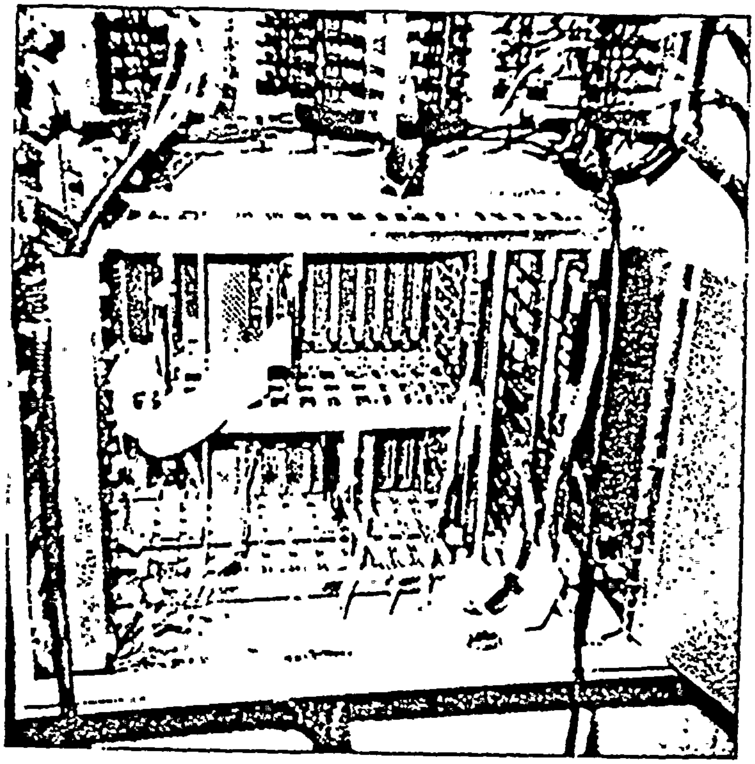
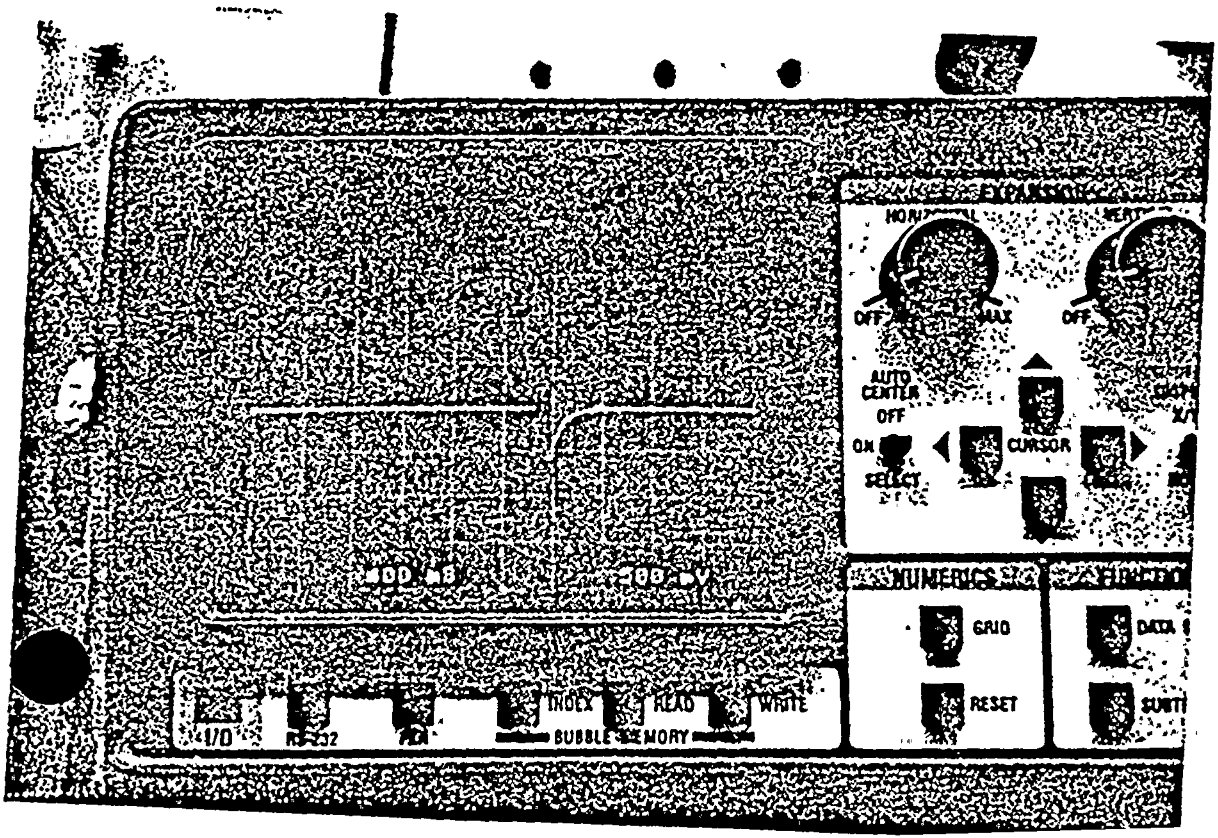


FIGURE 6

Internal view of 2RMS-Ru118

FIGURE 7

Nicolet scope - peak to peak reading



ATTACHMENT 4

AIM'S TEST PHOTOGRAPHS

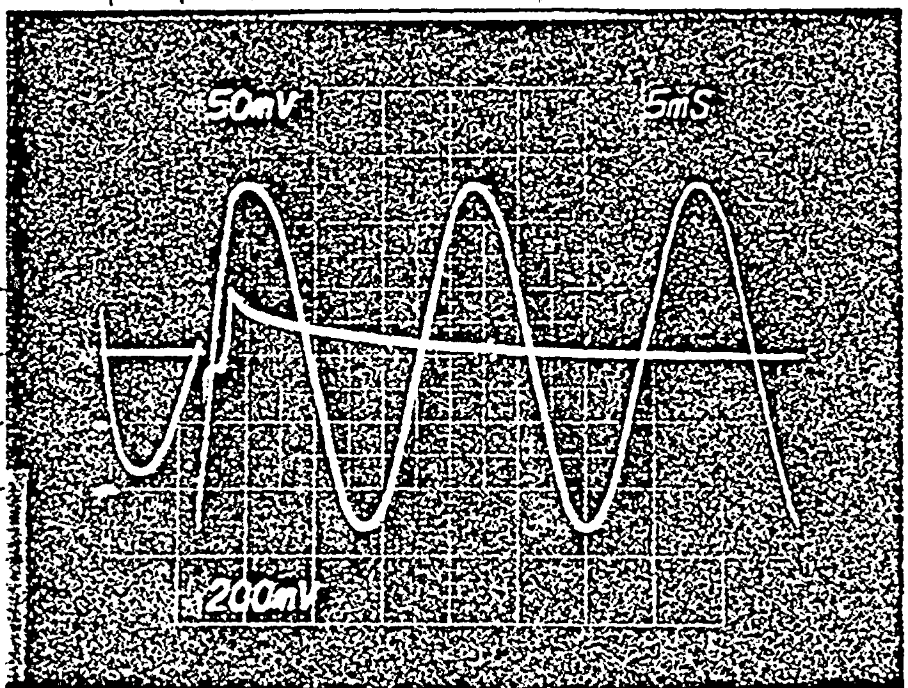


FIGURE 1

Test 5.3.1 - AIM's

3/24/86
C. Dunham

Vertical = 5 volts/Div.
Vertical = 4 amps/Div.
Horizontal = 5mSec/Div.

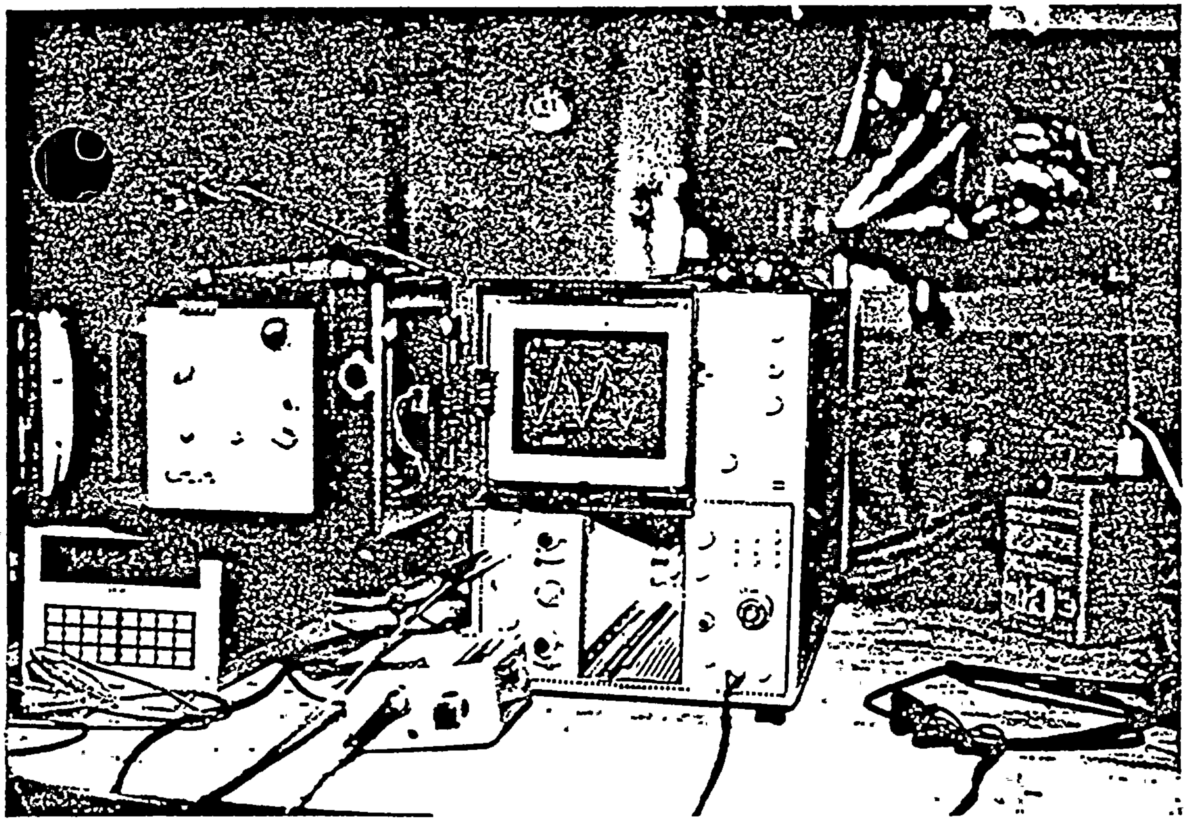
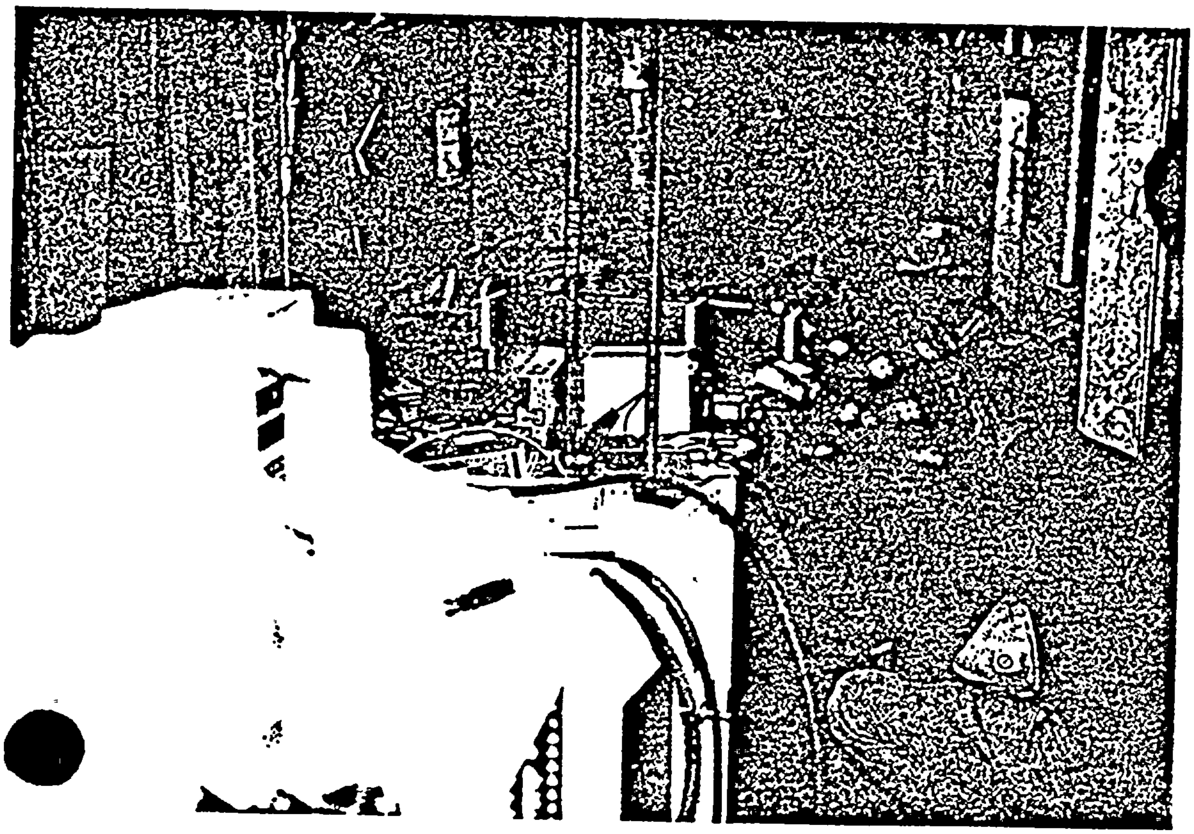


FIGURE 2
AIM's test scope setup - (prior to test)

FIGURE 3
2SWP*CAB23A (KML) - Location: Electrical tunnel north el. 215'



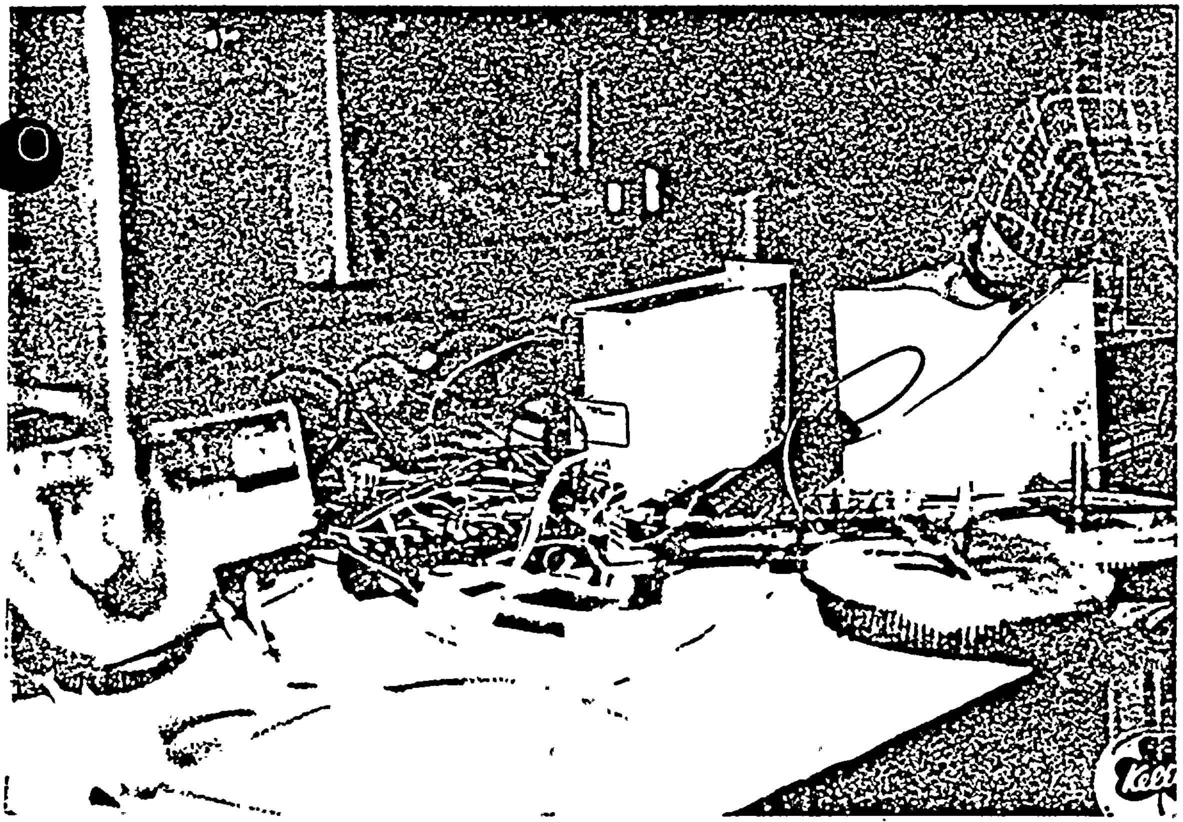


FIGURE 4

AIM's test setup

FIGURE 5

AIM's test setup shown with KERIC

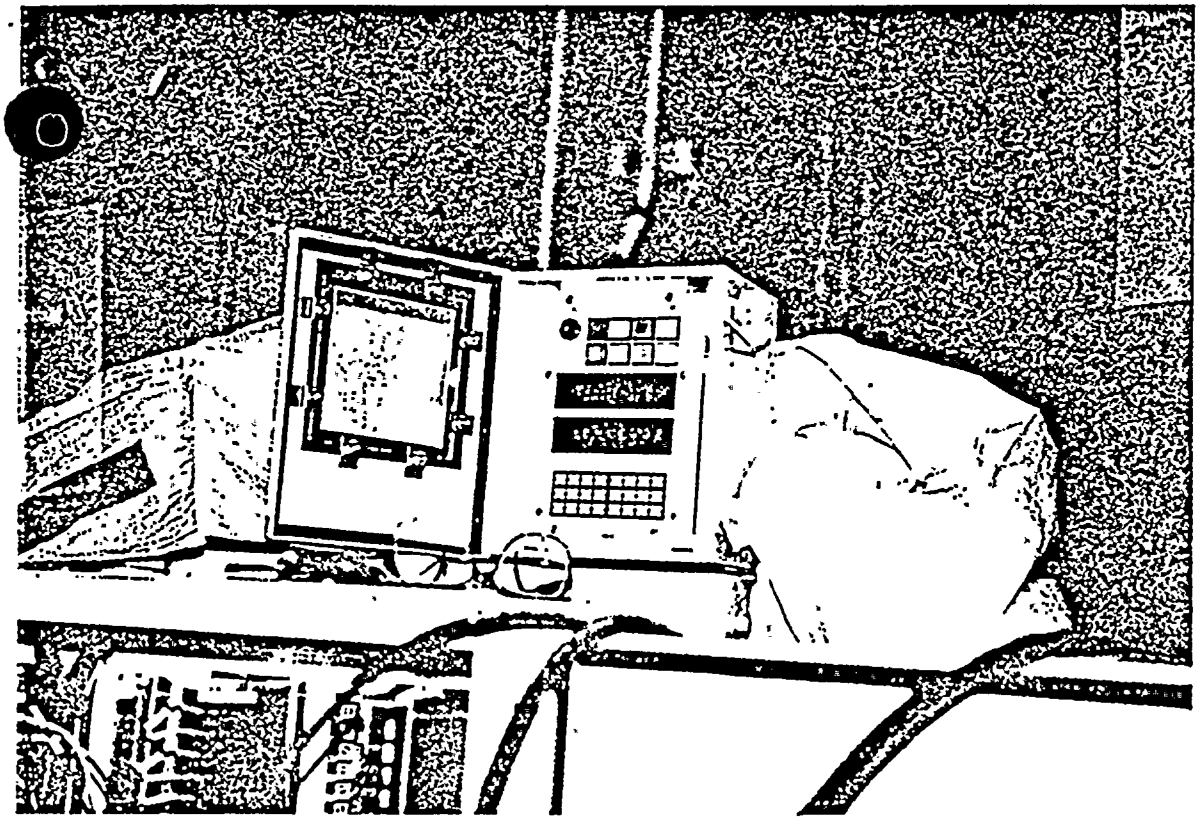


Figure 6

Local Indicator & Controller (KELIC) for 2SWP*CAB23A

Figure 7

Aim's test setup - KERIC and scope