SNPO-C

D. Smith

WANL-TME-1422 *ss*

May 20, 1966

RS

Tr J

*RS-1
Document*

Westinghouse Astronuclear Laboratory

Operational Manual for Reactor Safety System

MASTER

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

WANL-TME-1422

TITLE: Operational Manual for Reactor Safety System

DATE: May 20, 1966

AUTHOR:

Harry Kowalcheck

Harry Kowalcheck
Control Equipment Design & Fabrication
Control Systems Engineering
Instrumentation and Control

APPROVED:

F. S. Malick

F. S. Malick, Acting Manager
Control Systems Engineering
Instrumentation and Control

INFORMATION CATEGORY

Unclassified
Ra Fleming 6-1-66
Authorized Classifier Date

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Atomic Energy Commission, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

DISTRIBUTION OF THIS REPORT IS UNLIMITED

SC

TABLE OF CONTENTS

1.0	GENERAL	1
1.1	Introduction	1
1.2	Description	1
1.2.1	Front Panel	1
1.2.2	Chassis	2
1.2.3	Component Panel	3
2.0	INSTALLATION	3
2.1	Incoming Inspection	3
2.2	Mounting	4
2.3	Power Requirements	4
3.0	PRINCIPLES OF OPERATION	5
3.1	Fixed Power Scram	5
3.2	Floating Power Scram	6
3.3	Reactor Period Scram	6
3.4	Actuator Low Pressure Scram	8
3.5	Nuclear Instrumentation AC Power Scram	9
3.6	ECS ± 24 VDC Power Supply Scram	9
3.7	Reset	10
3.8	Reference Power	10
3.9	RSS/ESS ± 16 VDC Power	11
3.10	Checkout	11
3.11	Bypassing	11

TABLE OF CONTENTS (Continued)

3.12	Fuseholders	12
3.13	Lamp Verify	12
4.0	OPERATION	13
4.1	Fixed Power Pot Calibration	13
4.2	Floating Power Pot Calibration	13
4.3	Trigger Module Set Points	14
5.0	MAINTENANCE	14
5.1	Preventive Maintenance	14
5.2	Corrective Maintenance	14
6.0	TEST SPECIFICATION AND PROCEDURE	15
7.0	DRAWING LIST	16
	TEST SPECIFICATION NUMBER 711854	17

OPERATIONAL MANUAL FOR REACTOR SAFETY SYSTEM

1.0 GENERAL

1.1 Introduction

This operational manual covers the Reactor Safety System Chassis that is located in Rack 63 at the Test Cell Building. This chassis contains the fuses, switches, various components, and modules of the Reactor Safety System. Other controls and displays associated with the Reactor Safety System are located on the consoles at the Control Point Building.

1.2 Description

The unit consists of a drawer as shown on Assembly Drawing 937J909 suitable for mounting in a standard 19" rack. Its overall dimensions are 19" wide, 22 1/2" deep, and 7" high.

1.2.1 Front Panel

The front panel of the Reactor Safety System Chassis is 19" in width and 7" in height. A handle is mounted at each side of the panel. The left handle is equipped with a spring-operated mechanical latch to retain the chassis in the closed position in the rack. A button at the upper end of this handle releases the latch when pressed. The right handle is equipped with a

key lock. The key is removable only when the lock is in the LOCK position. Three Master Specialties Series 70E fuse-holders are located along the center of the lower edge of the front panel. One CHECKOUT/OPERATE Master Specialties Series 10E indicator is located at the left-lower edge and one LAMP VERIFY Master Specialties Series 10E switch-indicator is located at the right-lower edge of the front panel. Located near the center of the panel are two Korry 4-button mechanically interlocked, illuminated keyboard push-button switches. The top one is the PERIOD TRIP selector and the lower one is the INTERVAL (SAMPLE TIME) selector.

1.2.2 Chassis

The chassis consists of a frame with chassis slides bolted to the sides. Inside the chassis is the component plate to which the printed circuit board guides and connectors, and components are mounted. On the component plate, provision is made for 3 rows of 11 printed circuit board cards. The left-side and center rows accommodate 35-pin connector boards while the right-side row accommodates 17-pin connector boards. However, not all of the slots of each row are occupied with cards. The left row contains one Trigger Module card, 2 Voltage Sensor Module cards, 2 Period Select Module cards, and 1 Interval Select Module card. The center row contains 4 Relay Module cards.

The right row contains 2 Averaging Amplifier Module cards, 2 Component Module cards, 1 Clock-Pulse Generator Module card, 1 Tracking Amplifier Module card, 1 Holding Amplifier Module card, 1 Relay Module card, and 1 $\pm 24\text{VDC}$ Supply Monitor Module card. In place of the eleventh printed circuit board connector in the right row is a grounding module (E2).

On the rear of the chassis are two connector plates upon which are mounted three multi-pin connectors. One connector is a power connector with 16 pins, while the remaining two connectors have 55 pins.

1.2.3 Component Panel

Bolted across the top of the chassis at the front is the component panel. This panel contains 40 test point tip jacks arranged in 4 rows across the panel, 1 RESET push-button switch, and one OPERATE/CHECKOUT toggle switch.

2.0 INSTALLATION

2.1 Incoming Inspection

The equipment was carefully inspected both mechanically and electrically before shipment. It should be physically free of marks, dents, or scratches and should be in perfect electrical order upon receipt. To confirm this, the equipment should be inspected for physical damage from

3.2 Floating Power Scram

The Floating Power Scram circuit consists of Amplifier A6, Trigger A1B, part of Component Module A9, and part of Relay Module A5, along with a set pot and light indication on the LRE Panel.

The purpose of this circuit is to provide a scram signal to the AGC OR when the ratio of measured log power to power demand is greater than some selected value between 1.5 and 5. The ratio which will provide a scram is determined by the setting on the Floating Power Set Pot on the LRE Panel. If we assume the ratio is set at 2, and that measured log power is less than 2 times the demanded power the amplifier will have a 0 VDC output and the AGC OR and the trigger will both be in the "0" state. When measured log power exceeds 2 times power demand by a few millivolts the amplifier output will go to ± 8 volts D.C. which will put both output devices in the "1" state resulting in reactor scram and Floating Power Scram light indication on the LRE Panel.

3.3 Reactor Period Scram

The Reactor Period Scram circuit consists of Holding Amplifier A18, Tracking Amplifier A17, Trigger A1C, Clock Pulse Generator A12, Period Select Modules A10 and A13, Interval Select Module A16, part of Component Module A9, and part of Relay Module A8, along with the Period and Interval Selector switches and light indication on the LRE Panel.

3.3 Reactor Period Scram (Continued)

WANL-TME-1422

It is the purpose of this circuit to provide a logic "1" to both the AGC OR and the trigger when the measured reactor period becomes shorter than some limit value which is selected at the LRE Panel. One additional parameter which needs to be considered is the power interval which also is selected at the LRE Panel. This parameter, in effect, is involved with the resolution to which the circuit works. In other words, the interval selected determines the increment of power over which the limit comparison will be made. Operation of the Period and Interval Selector switches energize relays which, in turn, control the pulse rate of the Clock Pulse Generator. The output of the Clock Pulse Generator is fed into a field effect transistor which intermittently switches the Hold Amplifier OFF and ON. The input signal to the Hold Amplifier is the measured log power. As a result, the Hold Amplifier produces a staircase output that is proportional to the measured log power and with the step period being determined by the pulse rate of the Clock Pulse Generator.

In the Tracking Amplifier, the staircase output signal from the Hold Amplifier and a bias signal from the Interval Select network is compared to the measured log power signal. When the absolute value of the staircase signal plus the bias signal is larger than the absolute value of the measured log power signal, the amplifier output is approximately 0 VDC which is seen by the AGC OR and the trigger as a logic "0". For example, assume the limit period is one second and the power interval selected is 200%. If the reactor now goes on a 1 1/2 second period, this circuit will make an

3.3 Reactor Period Scram (Continued)

approximate differentiation of the log power signal of a 200% increment in log power. For the conditions assumed, the rate determined will be less than the limit rate and the output amplifier will put out a 0 signal to the AGC OR and the trigger. If, however, during the operating routine of the reactor, the period should decrease to 0.9 seconds, the rate determined at a 200% increment of log power is now greater than the limit period and the output amplifier goes to +8 volts resulting in a "1" state for both the AGC OR and the trigger and, consequently, reactor scram and light indication on the LRE Panel.

3.4 Actuator Low Pressure Switch Scram

The Actuator Low Pressure Scram circuit consists of Trigger A1D and part of Relay Module A8 along with the Actuator Low Pressure switch of the Engine Control System.

Function of this circuit is to provide reactor scram and readout if the pressure of the gas driving the actuators decreases below some safe level. If, for example, actuator pressure is within an acceptable limit the pressure switch will apply a 0 signal to the AGC OR and trigger. When pressure drops below a safe level +16 volts is switched to the input of the AGC OR and the trigger and both will go to their "1" state, resulting in reactor scram and light indication at the Control Point Building.

3.5 Nuclear Instrumentation AC Power Scram

The AC Power Scram circuit consists of Voltage Sensor Modules A4 and A7, Trigger A1E, and part of Relay Module A11.

The purpose of this circuit is to provide reactor scram and readout if all 3 single phase AC feedlines to the nuclear instrumentation racks go to 0 voltage. There is the additional constraint that this condition must persist for longer than 6 cycles on a 60 cycle base. For example, if at least one of the 3 single phase AC feedlines is putting out 117 volts $\pm 5\%$ both the AGC OR and the trigger will be in their "0" state. Should all 3 AC feedlines go to 0 volts for more than 6 cycles, +16 volts is switched to the input of the AGC OR and the trigger resulting in reactor scram and light indication at the Control Point Building.

3.6 ECS ± 24 Volts DC Power Supply Scram

The ± 24 VDC Power Scram circuit consists of a dual Trigger Module A2 and part of Relay Module A11.

The purpose of this circuit is to provide reactor scram and readout if one or both of these supply lines drop below the voltage at which the actuators will operate at their maximum rate. If we assume that both supply lines are above their minimum both the

3.6 ECS +24 Volts DC Power Supply Scram (Continued)

AGC OR and the trigger are in their "0" state. If one or both of these feedlines drops below their minimums, both the AGC OR and the trigger will go to their "1" state, resulting in reactor scram and light indication at the Control Point Building.

3.7 Reset

It will be noted that all the triggers operate into latching relays whose contacts provide readout functions at the Control Point Building. Once a particular trigger input has achieved the "1" state level this state is latched down. When operating personnel have responded to the scram indication, they may press the RESET button on the CTE Console or the Reactor Safety System Chassis which initiates a relay on Relay Module A19 and resets all latched down relays.

3.8 Reference Power

It will be observed from the Schematic 937J841 that a Zener regulated reference of approximately 9.3 volts is provided on Component

Module A9 for the Set pots and Interval Select. This inclusion was made necessary by the fact that no reference power is available within the TSCS Subsystem. Inasmuch as the Zener chosen is purchased to a $\pm 5\%$ tolerance, it is necessary to calibrate in all circuits which use this reference power.

3.9 RSS/ESS ± 16 Volts DC Power Supply Monitor

The ± 16 VDC Power Monitor circuit consists of Relay Module A14. The purpose of the circuit is to provide light indication of the status of the ± 16 VDC Power at the Control Point Building.

It has been decided that the RSS/ESS power available in the RSS will be used exclusively within this subsystem. WANL is committed to provide .75 amps ± 16 Volt power to AGC for use within the ESS. This Power Supply is contained in a separate chassis. Reactor scram for loss of either ± 16 volts is affected within the AGC OR circuit.

3.10 Checkout

The setup of the RSS requires that it be isolated from the rest of the system during this period. This is provided by a multi-contact toggle switch located on the chassis component panel which is known as an OPERATE/CHECKOUT switch. It can be operated only from the RSS chassis and its state is provided by contacts to the chassis front panel light indication.

3.11 Bypassing

Relays are included within the RSS which will allow operating personnel at the setup panel in the control room to bypass any inputs which they feel should be removed from the scram chain. The relays are located

3.11 Bypassing (Continued)

on Relay Modules A5, A8, and A11. It will be noted, however, that all of the triggers are upstream of these bypass contacts, so that all scram conditions will be indicated at the control room regardless of the bypassing which has been accomplished.

3.12 Fuseholders

The fuseholders used on the RSS Chassis are the Master Specialties Series 70E indicating type. These units contain a limiting resistor and lamps in parallel with the fuse, so that they are energized when the fuse opens. In addition, the fuseholders have been modified to include an encapsulated transistor-amplifier circuit attached to the back end of the holder to ensure proper indication of failure in cases where the circuit load is not heavy enough.

All the power required by the RSS Chassis is supplied through the fuses as follows:

F1 = 1/4 amps. +16 VDC

F2 = 1/2 amps. -16 VDC

F3 = 3 amps. 28 VDC

3.13 Lamp Verify

The Lamp Verify test circuit consists of Component Module A15 along with the LAMP VERIFY switch on the front panel of the RSS Chassis.

The purpose of the circuit is to test all the indicator lamps located on the front panel of the chassis. However, the circuit will

3.13 Lamp Verify (Continued)

only function whenever the OPERATE/CHECKOUT switch is in the CHECKOUT position.

4.0 OPERATION

After the chassis has been installed and tested in accordance with the applicable sections of the Test Specification and Procedure, the following procedures are required before setting the adjustment potentiometers on the LRE Console for Fixed Power and Floating Power to their desired set points and choosing the desired Period and Interval Selection.

4.1 Fixed Power Pot Calibration

Measure the output volts DC of amplifier A3 with a digital voltmeter at test point TP24. Refer to the Log Power System operational manuals and apply a set of measured log power input values. Adjust the Fixed Power set pot until the output voltage reads 8.00 volts DC for each input value. Repeat the procedure over the range of log power and plot a curve of Fixed Power pot position versus measured log power.

4.2 Floating Power Pot Calibration

Measure the output volts DC of amplifier A6 with a digital voltmeter at test point TP25. Refer to the Log Power System operational manuals and apply a convenient fixed value of log power demand. Apply a set of measured log power input values to obtain a set of ratios of Power Measured/Power Demand. Adjust the Floating Power set pot until the output voltage reads 8.00 volts DC for each input value. Repeat the procedure over a range of ratios from 1.5 to 5.0 and plot a curve of Floating Power pot

4.2 Floating Power Pot Calibration (Continued)

position versus the ratio of Power Measured/Power Demand

4.3 Trigger Module Set Points

Refer to Section 5 of the Test Procedure to adjust the Trigger Modules to the desired set points by applying an 8.00 volts DC signal to the Trigger input and adjusting the appropriate pot A1R5 to obtain the "ON" set point. Repeat the procedure for each trigger.

5.0 MAINTENANCE

5.1 Preventive Maintenance

The equipment is designed so that no special maintenance procedures are required other than the normal good housekeeping rules used for similar type electronic equipment.

5.2 Corrective Maintenance

Major corrective maintenance is performed at the factory or by a Westinghouse field representative. Alignment and replacement of obviously faulty components may be performed locally by a skilled technician. There are no specially selected or matched components used, therefore, components may be replaced by locally available parts of identical value and tolerance.

If there is any apparent or suspected failure or improper functioning of the equipment, the equipment should be checked out in accordance with the Test Specification and Procedure.

6.0 TEST SPECIFICATION AND PROCEDURE

The proper Test Specification and Procedure is:

T-711854 - Reactor Safety System

7.0

DRAWING LIST

- 937J909 - Reactor Safety System Chassis
- 937J841 - Schematic Diagram - Reactor Safety System
- 937J842 - Wiring Diagram - Reactor Safety System
- 937J149 - Single Line Diagram - Reactor Safety System
- 978D909 - Interval Select Module
- 978D908 - Period Select Module
- 978D913 - Component Module
- 978D866 - Relay Module
- 978D864 - Relay Module
- 979D444 - Trigger Relay Module
- 979D446 - +24VDC Power Supply Monitor Module
- 978D900 - Voltage Sensor Module
- 978D927 - Averaging Amplifier Module
- 978D891 - Tracking Amplifier Module
- 978D893 - Holding Amplifier Module
- 978D926 - Clock Pulse Generator Module
- 979D442 - Fuse, Driven Indicator
- 978D886 - Component Module
- 978D933 - Relay Module

TEST SPECIFICATION NUMBER 711854

ACCEPTANCE TEST SPECIFICATION

XE-1 REACTOR SAFETY SYSTEM

DATE: March 15, 1966

PREPARED BY:

R. A. Schatz
Control Systems Engineering
Instrumentation and Control

APPROVED BY:

R. A. Elmiger
Control Systems Engineering
Instrumentation and Control

Quality Engineering

INFORMATION CATEGORY

R. A. Elmiger 3/15/66

Authorized Classifier Date

ACCEPTANCE TEST SPECIFICATION AND PROCEDURE

XE-1 REACTOR SAFETY SYSTEM

1.0 SCOPE

This document contains the requirements for acceptance testing the XE-1 Reactor Safety System (WANL Drawing 937J909), part of the ETS-1 Test Stand Control System.

2.0 REQUIREMENTS

2.1 The acceptance tests shall consist of the following:

- 2.1.1 Visual Examination - To be performed by Quality Control.
- 2.1.2 Weights and Dimensions - To be performed by Quality Control.
- 2.1.3 Insulation Resistance - To be performed by Quality Control.
- 2.1.4 Operational Test (Functional Test) - To be performed by Instrumentation and Control and witnessed by Quality Control.

2.2 The acceptance test shall be performed in the order of and as specified in this procedure. Discrepancies found during the visual examination shall be corrected and re-inspected before performing the functional test. Failure or inability to obtain a required measurement during formal functional testing shall result in establishing a "hold" on the test. The failure or inadequacy shall be recorded by Quality Control and shall be reviewed by the WANL Engineering review board (ERB). Visual examination shall be performed on the reworked or repaired areas before resuming testing.

3.0 APPLICABLE DOCUMENTS

- 3.1 Drawing 937J909 - Reactor Safety System, XE Control System (TSCS)
- 3.2 Drawing 937J841 - Schematic Diagram, Reactor Safety System, XE Control System (TSCS)
- 3.3 Drawing 937J842 (2 Sheets) - Wiring Diagram, Reactor Safety System, XE Control System (TSCS)
- 3.4 Drawing 937J149 - Single Line Diagram, Reactor Safety System
- 3.5 NDC-118A NERVA Design Criteria ETS-1 TSCS (AGC)

4.0 EQUIPMENT REQUIRED

- 4.1 Multimeter (Simpson 269 or equal)
- 4.2 Digital Voltmeter (0.1% accuracy)
- 4.3 Function Generator (Figure 10)
- 4.4 +16VDC Power Supply, Technipower, (2)P-14.5-.100A or equal
- 4.5 +28VDC Power Supply, Technipower, (2)P-28.0-.100A or equal
- 4.6 Oscilloscope, Tektronic 502 or equal
- 4.7 Megohmmeter - General Radio Megger Type 1862-B or equal
- 4.8 +16VDC Power Supply, John Fluke (2)
- 4.9 Power Stat, 117V/0-135VAC, 60 CPS, 50VA minimum
- 4.10 XE-1, ESS "OR" breadboard (Figure 9)
- 4.11 Two (2) - 55 Wire input cables with connectors
- 4.12 One (1) standard power input cable with connector.
- 4.13 One (1) 5K, 10 turn pot
- 4.14 Two (2) 2K, 10 turn pots

WANL-TME-1422

5.0 ACCEPTANCE TEST PROCEDURE, REACTOR SAFETY SYSTEM

5.1 Visual Examination

The equipment under test shall be presented in its final form together with the applicable schematic, wiring diagram, and assembly drawing. The visual examination shall consist of the following parts:

5.1.1 Workmanship, Assembly, and Fit

The inspector shall inspect the equipment for workmanship to WANL requirements, and to assure that the overall chassis is of the proper dimensions per the assembly drawing, Westinghouse Drawing Number 937J909. Rev. _____

Workmanship OK _____

5.1.2 Materials, Parts, and Finishes

The equipment shall be inspected to assure that the materials, parts, and finishes are in accordance with the applicable assembly drawings. Incoming inspection records on materials, parts, and finishes shall be utilized to determine conformance to the assembly drawings where possible.

Materials OK _____

5.1.3 Treatment for Prevention of Corrosion

The equipment shall be inspected to assure that the coatings for prevention of corrosion have not been impaired during the manufacturing cycle.

5.1.4 Safety Requirements

The equipment shall be inspected to insure that no safety hazard, such as sharp edges, etc., exist on the equipment which are potential hazards to personnel operating or maintaining the equipment.

Safety OK _____

5.1.5 Marking

The markings on the equipment shall be inspected to ensure conformance to the applicable drawings and to assure that they are acceptable as to permanence and readability.

Marking OK _____

5.1.6 Visual Examination Review

After the visual examination of the equipment has been completed, all deficiencies shall be reviewed by WANL Engineering and Quality Control and corrected by one of the following methods:

- a. Drawing changes where drawing deficiencies are noted.
- b. Design changes if necessitated.
- c. Rework of the parts affected.

5.2 Weights and Dimensions

5.2.1 The unit shall be weighed and the weight shall be recorded.

Weight _____ lbs.

5.2.2 The unit shall be measured and the overall dimensions of width, height, and depth recorded.

Width _____ in.

Height _____ in.

5.3 Insulation Resistance

5.3.1 Remove all printed circuit boards. Apply a test voltage of 500 VDC between chassis and circuit common with all external leads tied to circuit common, except the chassis ground, Pin E of Connector J1 using a Megger, General Radio 1862-B or equal. The insulation resistance shall be greater than 10 megohms. Re-insert boards.

Insulation Resistance _____ megohms

5.4 Functional Tests

5.4.1 Relay Checks

5.4.1.1 Connect (6) "Operate/Bypass" relay coils, one at a time, as shown in Figure 1. (All lead identifications shown on Figure 1 are in sets, starting at the top and reading down each column. For example, the leads pertinent to the third relay are: J3-b; J3-h; J3-g; J3-c; J3-v; and J2-e.)

5.4.1.2 With S₁ open, connect multimeter to α_2 and α_4 . Reading shall be < 1 ohm. With S₁, closed reading shall be $\approx \infty$.

Lead Set	S1 Open MM Reading	S1 Closed MM Reading
1		
2		
3		
4		
5		
6		

5.4.1.3 With S₁ open, connect MM (set on highest ohmic scale) to α_0 and α_3 . Reading shall be $\approx \infty$.

NOTE: PC cards A1, A3, A6, A20, and A17 to be removed.

Lead Set	MM Reading
1	
2	
3	
4	
5	
6	

WANL-TME-1422

5.4.1.4

With S_1 closed, connect MM to α_1 and α_4 . Reading shall be < 1 ohm. With S_1 open reading shall be $\approx \infty$ ohm.

Lead Set	S_1 Closed MM Reading	S_1 Open MM Reading
1		
2		
3		
4		
5		
6		

5.4.1.5

With S_1 closed, connect MM (set on lowest ohmic scale) to α_0 and α_3 . Reading shall be < 1 ohm.

Lead Set	MM Reading
1	
2	
3	
4	
5	
6	

5.4.1.6

Re-insert P.C. cards removed. Four (4) power supply monitor relays to be checked per Figure 2. With no power applied to the relay coils, make tests shown below:

MM Connection	Spec Res.	MM Reading
J2-H and J2-C	$\approx \infty$	
J2-J and J2-n	< 1 ohm	
J2-M and J2-W	$\approx \infty$	
J2-G and J2-T	< 1 ohm	

- 5.4.1.7 Connect J3-FF to +16V; J3-DD to -16V;
 α_o to power supply return; and test as
shown below.

MM Connection	Spec Res.	MM Reading
J2-H and J2-C	< 1 ohm	
J2-J and J2-n	$\approx \infty$	

- 5.4.1.8 Connect J3-a to +16V; J3-N to -16V; α_o
to power supply return; and test as shown below:

MM Connection	Spec Res.	MM Reading
J2-M and J2-W	< 1 ohm	
J2-G and J2-T	$\approx \infty$	

- 5.4.1.9 Twelve (12) mode switching relays in the
period scram circuit to be checked per Figure
3. Connect +28V as shown. With checkout
(c/o) switch in "Operate", "Operate" light
on front panel goes on _____. Turn c/o
switch to "c/o". "c/o" light goes on,
"Operate" light goes off _____.
- 5.4.1.10 Depress "Lamp Verify" switch on front panel.
Four "interval select" lights, four "period
trip select" lights and "operate" and "checkout" light
go on _____. Leave c/o switch in "c/o"
for all later tests unless it is stated otherwise
specifically.
- 5.4.1.11 Twelve relays checked as shown below. "Period
trip" and "interval select" lights are mutually
exclusive. Only one light in a group will
be on at a time.

WANL-TME-1422

PERIOD TRIP SELECTED	PERIOD TRIP LIGHT "ON"	INTERVAL SELECTED	INTERVAL LIGHT "ON"	RELAYS ENERGIZED
1.00		--	--	A10K ₁ , A10K ₂
0.50		--	--	A10K ₃ , A10K ₄
0.25		--	--	A13K ₁ , A13K ₂
0.10		--	--	A13K ₃ , A13K ₄
--	--	25%		A16K ₁
--	--	50%		A16K ₂
--	--	100%		A16K ₃
--	--	200%		A16K ₄

5.4.2 Fixed Power Scram Checks (See Figure 4)

5.4.2.1 Connect J1-L to +16V; J1-M to -16V; and J1-F to the Power Supply return. Allow equipment to warm up for a minimum of 30 minutes.

Connect: α_5 of pot P₁ to TP36; α_7 of pot P₁ to TP33; α_6 of pot P₁ to TP23; α_8 of P₂ to -16V; α_9 of P₂ to TP33; α_{10} of P₂ to TP22; and MM (set on lowest ohmic scale) to J3-H and J3-M. Zero balance amplifier using standard test.

5.4.2.2 Set P_2 such that LnNm_1 (at TP22) = -10.00V

_____. Adjust P_1 until E_{o1} , (at TP24) = +9.00V _____. E_B (at TP23) = _____.

Use DVM for all measurements.

5.4.2.3 Set P_2 such that E_{o2} (at TP24) = +2.00V _____.

LnNm_2 (at TP22) = _____. E_B same as in

5.4.2.2. Calculate A_1 from

$$A_1 = \frac{7.00}{\text{LnNm}_2 + 10.00} = \underline{\hspace{2cm}}$$

Calculate B_1 from

$$B_1 = \frac{-9.00 + 10.00 A_1}{E_B} = \underline{\hspace{2cm}}$$

$$\text{Now. } E_o = -A_1 \text{ LnNm} - B_1 E_B \quad (1)$$

Substitute values of E_B , A_1 , B_1 determined above into (1) yielding

$$E_o = - \underline{\hspace{1cm}} \text{ LnNm} - \underline{\hspace{1cm}} \quad (2)$$

Using (2) complete Table I, below:

SET LnNm To	Calculate E_o	TABLE I		(Col. IV $\times$ 10) %	Col. V < +5%
		Measure E_o	Column II -Column III		
-9.80V					_____
-9.85V					
-9.90V					
-9.95V					
-10.00V					

WANL-TME-1422

5.4.2.4 With E_B set at value determined in 5.4.2.2,

Complete Table II, below:

Set LnNm To	Measure E_o	TABLE II	
		All Values in Col. II $< +11.3V$	All Values in Col. II $< -1.00V$
-10.05			_____
-10.10			_____
-10.20			_____
-11.00			_____
-15.00			_____
-9.75		_____	
-9.70		_____	
-9.60		_____	
-9.00		_____	
-0.20		_____	

5.4.2.5 Connect J3-e to +28V, J3-f to 28V return. Connect DVM to TP24 and TP33. Set $E_o = +10.00V$. Adjust pot A1AR5 so A1A trips. MM reads $< 1 \text{ ohm}$ _____. Reduce E_o to 9.0V and reset. Increase E_o slowly. When relay A1AK1 energizes, $E_o =$ _____. If E_o (meas.) = $+10.00V \pm 50mv$, set point of A1A is established _____. If not, reduce E_o and repeat. With A1K1 energized, reduce E_o to zero. MM continues to read $< 1 \text{ ohm}$ _____.

- Relay A1K1 is sealed in. Press "reset" switch on TP panel. MM reads $\approx \infty$ _____.
- 5.4.2.6 Connect DVM to A1ATP1 and TP33. Set $E_o = 9.90V$. DVM reads $> -14.0V$ _____. Set $E_o = +10.10V$. DVM reads $< -0.10V$ ____.
- 5.4.2.7 Connect DVM to TP24 and TP33. Set $E_o = +6.00V$. Adjust pot A1AR5 so A1A trips. MM reads $< 1 \text{ ohm}$ _____. Reduce E_o to $5.0V$ and reset. Increase E_o slowly. When A1K1 energizes, $E_o =$ _____. If E_o (meas.) $= +6.00V \pm 50mv$, set point of A1A is established _____. If not, reduce E_o and repeat. With A1K1 energized, reduce E_o to zero. MM continues to read $< 1 \text{ ohm}$ _____. Relay A1K1 is sealed in. Press "reset" switch. MM reads $\approx \infty$ _____.
- 5.4.2.8 Connect DVM to A1ATP1 and TP33. Set $E_o = +5.90V$. DVM reads $> -14.0V$ _____. Set $E_o = 6.10V$. DVM reads $< -0.10V$ ____.
- 5.4.2.9 Set $E_o = +6.10V$. Connect DVM to J2-e and TP33. DVM reads $+6.10V$ _____.

WANL-TME-1422

5.4.2.10 Connect DVM to TP36 and TP33. E_R reads $9.3V \pm 5\%$.
 $E_R = \underline{\hspace{1cm}}$.

5.4.2.11 Set $E_o = 0.0V$. Connect J2-e to E_{1NA} of Figure 9. Connect: β_1 to +16V; β_o to TP33; MM to β_2 and β_3 , β_4 to -16V and open and close switch S_1 . MM reads $\approx \infty \underline{\hspace{1cm}}$. Connect oscilloscope to TP24 and TP33. Increase E_o until MM reads $< 1 \text{ ohm } \underline{\hspace{1cm}}$. During interval of increasing E_o and trip of test circuit (Figure 9), no appreciable transient in E_o , exempting signal step, is observed $\underline{\hspace{1cm}}$.

5.4.3 Floating Power Scram Checks (Figure 5)

5.4.3.1 Connect J1-L to +16V; J1-M to -16V; and J1-F to the Power Supply return. Allow equipment to warm up for 30 minutes unless this requirement is met by 5.4.2.1. Connect: α_5 of P_1 to +16V; α_7 of P_1 to TP33; α_6 of P_1 to TP14; α_{11} of P_3 to -16V; α_{12} of P_3 to TP33; α_{13} of P_3 to TP22; α_8 of P_2 to J3-n; α_9 of P_2 to J3-i; and α_{10} of P_2 to TP21. Zero balance amplifier. Connect MM to J2-y and J2-z.

- 5.4.3.2 Set: LnNd_1 to $+9.00\text{V}$; LnNm_3 to -9.871V ; pot P_2 to CW limit. Adjust value of P_2 until $E_o = +5.50\text{V} \pm 0.10\text{V}$.
- 5.4.3.3 Set: $\text{LnNd} = +9.00\text{V}$; $\text{LnNm} = -9.220\text{V}$. Adjust P_2 until $E_o = +10.00\text{V}$. E_B (at TP21) = _____.
- 5.4.3.4 Set: $\text{LnNd}_2 = +9.00\text{V}$; $\text{LnNm}_2 = -9.597\text{V}$. Adjust P_2 until $E_o = +10.00\text{V}$. E_B (at TP21) = _____.
- 5.4.3.5 Set: $\text{LnNd}_3 = +9.00\text{V}$; $\text{LnNm}_3 = -9.871\text{V}$. Adjust P_2 until $E_o = +10.00\text{V}$. E_B (at TP21) = _____.
- 5.4.3.6 Complete Table III below for linearity check:

TABLE III

Set E_B To	Set LnNd To	Set LnNm To	Meas. E_o	$E_{o2}-E_{o1}$, $E_{o3}-E_{o2}$ etc.	Ave of Col. V	Col. VI Col. V	(Col. VII x 10) %	Col. VIII < 5%
Use	+9.00V	-9.400		>				
Meas.	"	-9.450		>				
Value of	"	-9.500		>				
5.4.3.4	"	-9.550		>				
	"	-9.600		>				

5.4.3.7 Complete Table IV below for limit check:

TABLE IV

<u>Set E_B To</u>	<u>Set LnNd To</u>	<u>Set LnNm To</u>	<u>Measure E_O</u>	<u>All Value In Col. IV $\leq 11.3V$</u>	<u>All Values In Col. IV $> -1.00V$</u>
Use	+9.00V	-9.500			_____
Meas.	"	-9.600			_____
Value of	"	-9.700			_____
5.4.3.4	"	-10.00			_____
	"	-15.00			_____
	"	-9.20		_____	
	"	-9.10		_____	
	"	-9.00		_____	
	"	-5.00		_____	
	"	-0.00		_____	

5.4.3.8

Connect DVM to TP25 and TP33. Set $E_O =$

$\approx 10.00V$. Adjust pot A1BR5 so A1B trips.

MM reads $< 1 \text{ ohm}$ _____. Reduce E_O to 9.0V

and reset. Increase E_O slowly. When relay

A1BK1 energizes, $E_O =$ _____. If E_O (meas.)

$= +10.00V \pm 50mv$, set point of A1B is

established _____. If not, reduce E_O and

repeat. With A1BK1 energized, reduce E_O

WANL-TME-1422

to zero. MM continues to read < 1 ohm

_____. Relay A1BK1 is sealed in. Press "reset"

switch on TP Panel. MM reads $\approx \infty$ _____

5.4.3.9

Connect DVM to A1BTP1 and TP33. Set E_o

= +9.90V. DVM reads $> 14.0V$ _____.

Set $E_o = +10.10V$. DVM reads $< 0.01V$

_____.

5.4.3.10

Connect DVM to TP25 and TP33. Set $E_o =$

+6.00V. Adjust pot A1BR5 so A1B trips.

MM reads < 1 ohm _____. Reduce E_o to

5.0V and reset. Increase E_o slowly. When

A1BK1 energizes, $E_o =$ _____. If E_o (meas.)

= +6.00V $\pm$ 50mv, set point of A1B is

established _____. If not, reduce E_o and

repeat. With A1BK1 energized, reduce E_o to

zero. MM continues to read < 1 ohm _____.

Relay A1BK1 is sealed in. Press "reset" switch.

MM reads $\approx \infty$ _____.

5.4.3.11

Connect DVM to A1BTP1 and TP33. Set E_o

= +5.90V. DVM reads $> 14.0V$ _____. Set

$E_o = +6.10V$. DVM reads $< 0.10V$ _____.

5.4.3.12

Set $E_o = +6.10V$. Connect DVM to J2-f and

TP33. DVM reads +6.10V _____.

5.4.3.13 Set $E_o = 0.0V$. Connect J2-f to E_{inA} of Figure 9. Connect β_1 to +16V; β_o to TP33; MM to β_2 and β_3 , β_4 to -16V and open and close Switch S1. MM reads $\approx \infty$ _____. Connect oscilloscope to TP25 and TP33. Increase E_o until MM reads $< 1 \text{ ohm}$ _____. During interval of increasing E_o and trip of test circuit (Figure 9), no appreciable transient in E_o , exempting signal step, is observed _____.

5.4.4 Actuator Low Pressure Scram Checks (See Figure 6)

5.4.4.1 Connect J1-L to +16V; J1-M to -16V; and J1-F to the Power Supply return. Allow equipment to warm up for 30 minutes unless this requirement is met by 5.4.2.1 or 5.4.3.1. Connect α_{11} of P_3 to +16V; α_{12} of P_2 to TP33; α_{13} of P_3 to TP13; and MM to J2-w and J2-U. Turn P_3 to CCW limit. MM reads $\approx \infty$ _____. Press "reset" button on TP Panel if required.

5.4.4.2 Connect DVM to TP13 and TP33. Set $E_o = +10.00V$. Adjust pot A1DR5 so A1D Trips. MM reads $< 1 \text{ ohm}$ _____. Reduce E_o to 9.0V and reset. Increase E_o slowly. When relay A1DK1 energizes, $E_o =$ _____. If E_o

WANL-TME-1422

(meas.) = $+10.00V \pm 50mv$, set point of A1D is established _____. If not, reduce E_o and repeat.

With A1DK1 energized, reduce E_o to zero.

MM continues to read $< 1 \text{ ohm}$ _____.

Relay A1DK1 is sealed in. Press "reset"

switch on the TP Panel. MM reads $\approx \infty$

_____.

5.4.4.3 Connect DVM to A1DTP1 and TP33. Set E_o
= $+9.90V$. DVM reads $> -14.0V$ _____.

Set $E_o = +10.10V$. DVM reads $< -0.10V$ _____.

5.4.4.4 Connect DVM to TP13 and TP33. Set $E_o =$
 $+6.00V$. Adjust pot A1DR5 so A1D trips.

MM reads $< 1 \text{ ohm}$ _____. Reduce E_o to

$5.0V$ and reset. Increase E_o slowly. When

A1DK1 energizes, $E_o =$ _____. If E_o (meas.)

= $+6.00V \pm 50mv$, set point of A1D is established

_____. If not, reduce E_o and repeat. With

A1DK1 energized, reduce E_o to zero. MM

continues to read $< 1 \text{ ohm}$. _____ Relay

A1DK1 is sealed in. Press "reset" switch.

MM reads $\approx \infty$ _____.

5.4.4.5 Connect DVM to A1DTP1 and TP33. Set E_o

= $+5.90V$. DVM reads $> -14.0V$

_____. Set $E_o = +6.10V$. DVM

reads $< -0.10V$ _____.

- 5.4.4.6 Set $E_o = +6.10V$. Connect DVM to J2-P and TP33. DVM reads $+6.10V$ _____.
- 5.4.4.7 Set $E_o = 0.0V$. Connect J2-P to E_{inA} of Figure 9. Connect β_1 to $+16V$; β_o to TP33; MM to β_2 and β_3 ; and open and close switch S1. MM reads $\approx \infty$ _____. Connect oscilloscope to TP13 and TP33. Increase E_o until MM reads $< 1 \text{ ohm}$ _____. During interval of increasing E_o and trip of test circuit (Figure 9), no appreciable transient in E_o , exempting signal step, is observed _____.

5.4.5 Neutronics AC Scram Checks (See Figure 7)

- 5.4.5.1 Connect J1-L to $+16V$; J1-M to $-16V$; and J1-F to the Power Supply return. Allow equipment to warm up for 30 minutes unless this requirement has been previously met. Connect X_1 and X_o of power stat PS1 to 117V, 60 CY AC line; Y_o of PS1 to TP4; Y_1 of PS1 to TP1; Y_2 of PS1 to TP2; Y_3 of PS1 to TP3; Z_1 to $+16V$; Z_2 to trigger input of oscilloscope; and TP29 to vertical input of scope and TP33 to return of scope. Set E_{ac} to 117V _____. Close S1 and open S2 and S3.

TP31 and TP33. DVM reads $+16V \pm 0.010V$

_____. Connect DVM to TP29 and TP33.

DVM reads zero _____.

5.4.5.2 Open S1 and measure on scope time interval

Δt_1 between opening of S1 and dropout of

A4K1. All Δt 's $> 100\text{msec.}$ _____.

This test to be run 3 times. Complete

Table V below:

TABLE V

<u>Run No.</u>	<u>Δt_1 (msec)</u>	<u>Δt_1 (Ave)</u>
1		
2		
3		

5.4.5.3 Open S1 and S3 and close S2. Open S2 and

measure on scope time interval Δt_2 between

opening of S2 and dropout of A4K2. All Δt_2 's

$> 100\text{msec.}$ _____. This test to be run

3 times. Complete Table VI below:

TABLE VI

<u>Run No.</u>	<u>Δt_2 (msec)</u>	<u>Δt_2 (Ave)</u>
1		
2		
3		

- 5.4.5.4 Open S1 and S2 and close S3. Open S3 and measure on scope time interval Δt_3 , between opening of S3 and dropout of A4K3. All Δt_3 's $> 100\text{msec}$ _____. This test to be run 3 times. Complete Table VII below:

TABLE VII

<u>Run No.</u>	<u>Δt_3 (msec)</u>	<u>Δt_3 (Ave)</u>
1		
2		
3		

- 5.4.5.5 Averages of Δt_1 , Δt_2 , and Δt_3 are all within the limits $100\text{msec} \leq \Delta t \leq 125\text{msec}$ _____. Close S1, open S2 and S3. Connect DVM to TP29 and TP33. Vary E_{AC} from 106 to 129 Volt AC. E_o remains at zero _____.
- 5.4.5.6 Close S2, open S1 and S3. Connect DVM to TP29 and TP33. Vary E_{AC} from 106 to 129 Volts AC. E_o remains at zero _____.
- 5.4.5.7 Close S3, open S1 and S2. Connect DVM to TP29 and TP33. Vary E_{AC} from 106 to 129 Volts AC. E_o remains at zero _____.

5.4.5.8 Connect MM to J2-Y and J2-B. Remove P/C cards A4 and A7 from sockets. Connect :
 α_{11} of P_3 to +16V; α_{12} of P_3 to TP33;
 and α_{13} of P_3 to TP29.

5.4.5.9 Connect DVM to TP29 and TP33. Set E_o
 = +10.00V. Adjust pot A1ER5 so A1E trips.
 MM reads $< 1 \text{ ohm}$ _____. Reduce E_o
 to 9.0V and reset. Increase E_o slowly.
 When relay A1EK1 energizes, $E_o =$ _____.
 If E_o (meas.) = +10.00V + 50mv, set point of
 A1E is established _____. If not, reduce
 E_o and repeat. With A1EK1 energized,
 reduce E_o to zero. MM continues to read
 $< 1 \text{ ohm}$ _____. Relay A1EK1 is sealed
 in. Press "reset" switch on TP Panel. MM
 reads $\approx \infty$ _____.

5.4.5.10 Connect DVM to A1ETP1 and TP33. Set E_o
 = +9.90V. DVM reads $\geq 14.0V$ _____. Set
 $E_o = +10.10V$. DVM reads $\leq 0.10V$ _____.

5.4.5.11 Connect DVM to TP29 and TP33. Set E_o
 = +6.00V. Adjust pot A1ER5 so A1E trips.
 MM reads $< 1 \text{ ohm}$ _____. Reduce E_o to 5.0V
 and reset. Increase E_o slowly. When A1EK1

energizes, $E_o = \underline{\hspace{2cm}}$. If E_o (meas.) = $+6.00V \pm 50mv$, set point of A1E is established $\underline{\hspace{2cm}}$. If not, reduce E_o and repeat.

With A1EK1 energized, reduce E_o to zero.

MM continues to read $< 1 \text{ ohm } \underline{\hspace{2cm}}$.

Relay A1EK1 is sealed in. Press "reset" switch. MM reads $\approx \infty \underline{\hspace{2cm}}$.

5.4.5.12 Connect DVM to A1ETP1 and TP33. Set $E_o = +5.90V$. DVM reads $> 14.0V \underline{\hspace{2cm}}$. Set $E_o = +6.10V$. DVM reads $< -0.10V \underline{\hspace{2cm}}$.

5.4.5.13 Set $E_o = +6.10V$. Connect DVM to J2-BB and TP33. DVM reads $+6.10V \underline{\hspace{2cm}}$.

5.4.5.14 Set $E_o = 0.0V$. Connect J2-BB to E_{inA} of Figure 9. Connect β_1 to $+16V$; β_o to TP33; MM to β_2 and β_3 , B_4 to $-16V$ and open and close switch S1. MM reads $\approx \infty \underline{\hspace{2cm}}$. Connect oscilloscope to TP29 and TP33. Increase E_o until MM reads $< 1 \text{ ohm } \underline{\hspace{2cm}}$. During interval of increasing E_o and trip of test circuit (Figure 9), no appreciable transient in E_o , exempting signal step is observed $\underline{\hspace{2cm}}$.

WANL-TME-1422

5.4.5.15 Insert P/C cards A4 and A7.

5.4.6 Actuator +24 Volt Power Supply Scram Checks (See Figure 8)

5.4.6.1 Connect J1-L to +16V; J1-M to -16V; and J1-F to the Power Supply return. Allow equipment to warm up for 30 minutes unless this requirement has been previously met.

Connect: α_8 of P_2 to +28V; α_9 of P_2 to TP33; α_{10} of P_2 TP11; return of +28V P. S. to TP33; α_{11} of P_3 to -28V; α_{12} of P_3 to TP33; α_{13} of P_3 to TP12; and MM to J2-S and J2-L

5.4.6.2 Connect DVM to TP12 and TP33. Set P_2 and P_3 fully CW. Adjust A2R23 so that MM goes to $< 1 \Omega$ when $E_2 = -24.0V \pm 50mv$ ____.

Set $E_2 = -24.5V \pm 50mv$ and reset. MM reads $\approx \infty$ ____.

5.4.6.3 Connect DVM to TP11 and TP33. Set P_3 fully CW. Adjust A2R10 so that MM goes to $< 1 \Omega$ when $E_1 = 24.0V \pm 50mv$ ____.

Connect DVM to A2TP2 and TP33. DVM reads $< +2.00V$ ____.

Connect DVM to TP30 and TP33. DVM reads $> +14.0V$. Set $E_1 = +28.0V$. MM still reads $< 1 \Omega$. Relay A2K1 is sealed in. Set $E_2 = -23.5V \pm 50mv$. Connect DVM to A2TP4 and TP33. DVM reads $< +2.00V$

MM reads $< 1 \Omega$ ____.

5.4.6.4 Connect DVM to TP12 and TP33. P_2 fully CW. Set $E_2 = -24.5V \pm 50mv$ and reset. MM reads $\approx \infty$ _____. Adjust A2R10 so that MM goes to $< 1 \Omega$ when $E_1 = +16V \pm 50mv$ _____. Connect DVM to A2TP2 and TP33. DVM reads $< +2.00V$ _____. Connect DVM to TP30 and TP33. DVM reads $> +14.00V$. Set $E_2 = -23.5V \pm 50mv$. MM still reads $< 1 \Omega$ _____.

5.4.6.5 Set $E_1 = +16.5V \pm 50mv$ with A2R10 set as in 5.4.6.4 _____. Set $E_2 = -24.5V \pm 50mv$ with A2R23 set as in 5.4.6.2 _____ and reset. MM reads $\approx \infty$ _____. Reduce E_2 to $-24V \pm 50mv$.

MM goes to $\sim 1 \Omega$ _____. Set $E_1 = +15.5V \pm 50mv$. MM still reads $< 1 \Omega$ _____. Connect DVM to TP30 and TP33. DVM reads $> +14.00V$ _____.

5.4.6.6 Set $E_1 = +16.5V \pm 50mv$ with A2R10 set as in 5.4.6.4 _____ and reset. Adjust A2R23 so that MM goes to $< 1 \Omega$ when $E_2 = -16.0V \pm 50mv$ _____. Connect DVM to TP30 and TP33. DVM reads $> +8.0V$. Set $E_1 = +15.5V \pm 50mv$. DVM

reads $> +14.0V$; MM reads $\sim 1 \Omega$ _____.

Connect DVM to J2-HH and TP33. DVM

reads $> +14.0V$ _____.

5.4.6.7

Set $E_1 = +16.5V \pm 50mv$ and $E_2 = -16.5V \pm 50mv$

with A2R10 and A2R23 Set as in 5.4.6.6. and reset.

MM reads $\sim \infty$ _____. Connect J2-HH to

EinA of Figure 9; β_1 to $+16V$; β_0 to TP33; and

MM to β_2 and β_3 , β_4 to $-16V$. Open and close S1 (Figure

9). MM reads $\sim \infty$ _____. Set $E_1 = +16.0$

$V \pm 50mv$. Connect DVM to TP30 and TP33.

MM reads $< 1 \Omega$ _____. DVM reads $>$

$+8.0V$ _____. Open and close S1 (Figure 9).

MM reads $\sim 1 \Omega$ _____. Set $E_1 = +16.5$

$V \pm 50mv$ and $E_2 = -16.5V \pm 50mv$, press reset and open

and close S1. MM reads $\sim \infty$ _____. Connect

oscilloscope to TP30 and TP33. Decrease E_1

until MM reads $< 1 \Omega$ _____. During interval

of decreasing E_1 and trip of test circuit (Figure 9),

no appreciable transient in E_0 , exempting signal

step, is observed _____.

5.4.7 Reactor Period Limit Scram Checks (Figure 10)

- 5.4.7.1 Connect J1-L to +16V; J1-M to -16V; J1-F to PowerSupply return; +28V as shown in 5.4.1.9; S1 to DC supply variable from 0 to +2.00 Volts and setable to $\pm 1\text{mv}$; S2 to TP22; and MM to J2-X and J2-Z. Allow equipment to warm up for 30 minutes unless this requirement has been previously met. Close S1. Set $E_T \approx 0$. Remove P/C card A17. Connect: α_8 of P_2 to +16V; α_9 of P_2 to TP33; and α_{10} of P_2 to TP28. Set P_2 fully CCW, press "reset" button. MM reads $\approx \infty$ _____.
- 5.4.7.2 Connect DVM to TP28 and TP33. Adjust A1CR5 so that MM goes to $< 1 \Omega$ when $E_o = +10.0V \pm 50\text{mv}$ _____. Connect DVM to A1CTP1 and TP33. Reset. Set $E_o = +9.90V$, DVM reads $> -14.0V$ _____. Set $E_o = +10.10V$, DVM reads $< -0.10V$ _____.
- 5.4.7.3 Connect DVM to TP28 and TP33. Set P_2 fully CCW. Reset. Adjust A1CR5 so that MM goes to $< 1 \Omega$ when $E_o = +6.0V \pm 50\text{mv}$ _____. Connect DVM to A1CTP1 and TP33. Reset. Set $E_o = +5.90V$, DVM reads $> -14.0V$ _____.

WANL-TME-1422

Set $E_o = +6.10V$, DVM reads $\leq 0.10V$

- 5.4.7.4 Connect DVM to TP28 and TP33. Set P_2 fully CCW, and reset. Adjust A1CR5 so that MM goes to $< 1\Omega$ when $E_o = 8.0V \pm 50mv$

- 5.4.7.5 Remove $\propto 10$ of P_2 from TP28. Insert A17. Allow 15 minutes for warm-up.

- 5.4.7.6 Connect oscilloscope to TP27 and TP33. A12 is free-running _____.

- 5.4.7.7 Zero balance amplifiers A17 and A18 using standard test _____.

- 5.4.7.8 Remove P/C card A16 and calibrate per

Figure 11 by following Table VIII.

TABLE VIII

<u>Connect TP36 To</u>	<u>Connect B10 To</u>	<u>Connect B11 To</u>	<u>Set RD To</u>	<u>Adjust Pot</u>	<u>Until E_B Measures</u>	<u>Calib Complete</u>
J19-32	J19-35	TP33	150K $\pm$ 1%	A16R7	4.347V $\pm$ 10mv	
"	J19-26	"	243K $\pm$ 1%	A16R5	4.379V $\pm$ 10mv	
"	J19-18	"	402K $\pm$ 1%	A16R3	4.124V $\pm$ 10mv	
"	J19-7	"	750K $\pm$ 1%	A16R1	3.934V $\pm$ 10mv	

TABLE IX

<u>Test</u>	<u>Period Trip Select</u>	<u>Interval Select</u>	<u>E₁ For "No Go Ramp"</u>	<u>E_o Reads < 8V peak</u>	<u>E₁ For "Go Ramp"</u>	<u>E_o Reads > 8V peak</u>	<u>Trimmer Pot</u>	<u>Relays Energized</u>
1	1.0 sec.	25%	0.154V		0.162V		A10R3	A10K1, A10K2, A16K1
2	"	50%	"		"		A10R1	" " A16K2
3	"	100%	"		"		A10R7	" " A16K3
4	"	200%	"		"		A10R5	" " A16K4
5	0.5 sec.	25%	0.309V		0.325V		A10R11	A10K3, A10K4, A16K1
6	"	50%	"		"		A10R9	" " A16K2
7	"	100%	"		"		A10R15	" " A16K3
8	"	200%	"		"		A10R13	" " A16K4
9	0.25 sec.	25%	0.618V		0.650V		A13R3	A13K1, A13K2, A16K1
10	"	50%	"		"		A13R1	" " A16K2
11	"	100%	"		"		A13R7	" " A16K3
12	"	200%	"		"		A13R5	" " A16K4
13	0.10 sec.	25%	1.542V		1.624V		A13R11	A13K3, A13K4, A16K1
14	"	50%	"		"		A13R9	" " A16K2
15	"	100%	"		"		A13R15	" " A16K3
16	"	200%	"		"		A13R13	" " A16K4

- 5.4.7.9 Insert A16. Connect oscilloscope to A12TP2 and TP33. Adjust A12R5 so that the smaller of the observed pulse widths (ΔT_2) is 8msec. $\pm 1/2$ msec. _____.
- 5.4.7.10 Connect J2-G to E_{inA} of Figure 9. Connect: β_1 to +16V, β_o to TP33, β_4 to -16V (Figure 9), MM to J2-X and J2-Z (Figure 10), and open S1 (Figure 9). S1 (Figure 10) is closed. MM reads $\approx \infty$ _____. Set up for Tests No. 1 to 16 per Table IX _____. Connect oscilloscope to TP28 and TP33 _____. If the constraints of the "go" and "no go" ramps are not met, the pots in column 8 of Table IX are to be adjusted.
- 5.4.7.11 Close S1 (Figure 10). Set up per Test No. 1, Table IX using "go" ramp. Connect MM to β_2 and β_3 of Figure 9. Open and close S1 (Figure 9). Press "reset" button. Open S1 (Figure 10). MM goes to < 1 μ _____. During test interval, no appreciable transient in E_o , exempting signal step, is observed _____.
- 5.4.7.12 Close S1 (Figure 10). Set up per Test No. 1, Table IX except $E_1 = +0.75V$. Press "reset" button. Open S1 (Figure 10). E_o (max) $< +11.3$ Volts _____.
- 5.4.7.13 Close S1 (Figure 10). Set up per Test No. 16 Table IX except $E_1 = +0.75V$. Press "reset" button. Open S1 (Figure 10). E_o (negative max) < -1.0 Volts _____.

5.4.8 Power Check

- 5.4.8.1 Connect J1-L to +16V, J1-M to -16V, J1-A to +28V, J1-B to +28V return, and J1-F to +16V return.
- 5.4.8.2 All fuse lights are "off" with fuses in place _____. Remove all fuses and reinsert fuse assembly. All fuse lights "on" _____.
- 5.4.8.3 Connect DVM to TP31 and TP33. DVM reads +16V±10mv _____. Connect DVM to TP32 and TP33. DVM reads -16V±10mv _____. Connect DVM to TP34 and TP35. DVM reads +28V±10mv _____.

5.4.9 Safety Ground

- 5.4.9.1 Connect MM (on lowest ohmic scale) to J1-E and Bare Chassis. MM reads ≈ 0.0 ohms _____.

5.4.10 Continuity Check

Connect MM between the points listed on Table X.
MM should read ≤ 1 ohm.

TABLE X

<u>FROM</u>	<u>TO</u>	<u>CONDITION</u>
TP35	J1-B	
J3-E	J2- <u>p</u>	S11B IN OPERATE
J3-F	TP-36	
J3-P	E6	S.5 25% CLOSED
J3-S	J6-4	S11C OPERATE
J3-T	J9-7	S11D OPERATE
J3-U	J23-6	S11D OPERATE
J3-V	J23-16	S11B OPERATE
J3-X	J6-6	S11C OPERATE
J3-Y	J9-5	S11C OPERATE
J3-Z	E3	S1.10 CLOSED
J3- <u>p</u>	TP33	
J3- <u>s</u>	E6	S8 200% CLOSED
J3-GG	E3	S3 - .50 CLOSED
J3- <u>u</u>	J3- <u>t</u>	S11D CHECKOUT
J3- <u>y</u>	E6	S6 50% CLOSED
J3-HH	E6	S7 100% CLOSED
J3-A	J7-11	S11A OPERATE
J3-CC	E3	S2 .25 CLOSED
J3- <u>k</u>	TP34	S11F OPERATE
J3- <u>m</u>	E4, E5, E7 or E8	S11F OPERATE
J3-W	J3- <u>t</u>	S11D OPERATE
J3-B	J7-30	S11A OPERATE
J3-D	J7-32	S11A OPERATE

TABLE X (CONTINUED)

<u>FROM</u>	<u>TO</u>	<u>CONDITION</u>
J3-w	TP-10	S9 CLOSED
J3-f	J22-15	
J3-C	J10-11	S11B OPERATE
J3-i	E3	S4 1.0 CLOSED
TP26	J20-15	
TP15	J3-b	
TP16	J2-b	
TP17	J2-k	
TP18	J2-P	
TP19	J3-q	
TP20	J3-R	
TP5	J3-c	
TP6	J2-h	
TP7	J2-v	
TP8	J2-A	
TP9	J2-V	
TP28	J2-g	
TP30	J2-HH	
J2-E	J18-6	
J2-s	J18-10	
J2-FF	J18-2	
J2-i	J18-7	
J2-x	J18-14	
J2-N	J18-16	
J2-a	J18-15	
J2-DD	J18-9

$\alpha_0 \equiv \frac{1}{\equiv} \equiv \text{IAC GND MODULE}$

NOTE: WHEN $\alpha_4 \rightarrow +28V$; $\alpha_2 \equiv .3-C$
 $.3-f \rightarrow 28V$ RETURN.
PRESS "RESET" SWITCH ON TP PANEL -
WILL RESET RELAY

SYMBOL ($\rightarrow$) IS USED TO MEAN
"CONNECTED TO"

FIG. 1

FIG. 2

FIG. 3

FIG. 4

Fig. 5

7. 6. 9

Fig. 10

FIG. 11