WANL-EOM-001
NOVEMBER 15, 1963

TECHNICAL MANUAL

CONTROL DRUM ACTUATOR CHECKER

MASTER

Astronuclear Laboratory
Westinghouse Electric Corporation

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INFORMATION CATEGORY

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TABLE OF CONTENTS

<u>Chapter</u>		<u>Page</u>
1	INTRODUCTION	1
	GENERAL INFORMATION	3
	General	3
	Leading Particulars	16
	Equipment Supplied	20
2	INSTALLATION	23
	Installation Planning	23
	Logistics	24
	Receiving Data	24
	Material Handling	24
	Installation Procedures	24
	Preparation for Reshipment	28
3	PRINCIPLES OF OPERATION	31
	Functional System Operation	31
	Functional Operation of Electronic Circuits	31
	Functional Operation of Mechanical Assemblies	33
4	OPERATION	35
	Controls and Indicators	35
	Operating Instructions	35
	Emergency Operation	37
5	MAINTENANCE	38
	Field Maintenance	38
	General	38
	Maintenance Test Equipment	38
	Performance Tests	39
	Alignment	41
	Shop Maintenance	43
	General	43
	Performance Test Tables	43
	Cleaning	43
	Major Repairs	43
	Reassembly and Testing of Subassemblies and Assemblies	45
	Instructions for Testing	45
6	DRAWINGS	46

WANL-EOM-001

LIST OF ILLUSTRATIONS

<u>Figure</u>	<u>Title</u>	<u>Page</u>
1-1	Control Drum Actuator Checker System 1402, Westinghouse Astronuclear Laboratory No. 909E463	Frontispiece
1-2	Block Diagram Control Drums Actuator Checker System 1402 WANL Dwg. No. 945C410	1
1-3	Functional Schematic Diagram Control Drum Actuator System 1402, Westinghouse Astronuclear Laboratory Dwg. No. 977D694	2
1-4	Actuator Support Cart WANL P/N NT 700157	4
1-5	Hydraulic-Pneumatic Power Supplies Cart WANL P/N NT 650041 (Four views showing major components)	5
1-6	Outline Drawing Hydraulic-Pneumatic Power Supplies Cart WANL P/N NT 650041	6
1-7	Block Diagram Hydraulic-Pneumatic Power Supplies Cart WANL P/N NT 650041	6
1-8	Front View - Electronics Console WANL P/N 977D714	7
1-9	Rear View - Electronics Console WANL P/N 977D714	7
1-10	Wiring Diagram - Electronics Console WANL P/N 977D714 WANL Dwg. No. 928F663	8
1-11	Panel Layout - Power Control Panel WANL P/N 977D697	9
1-12	Photograph - Meter Panel WANL P/N 977D472	9
1-13	Photograph - Function Generator Panel WANL P/N 977D714	9
1-14	Photograph and Panel Layout - Control Panel WANL P/N 936J118	10
1-15	Photograph - Internal Views Control Panel Drawer, Top and Bottom Sides of Chassis, WANL P/N 936J118	12
1-16	Photograph - Recorder Panel Components	14
1-17	Photographs - Power Supplies Chassis, Top and Bottom Sides of Chassis	15
1-18	Output Curve for Variable Volume Vane Hydraulic Pump	17
1-19	Control Drum Actuator Checker - Interconnection Diagram	22
3-1	Modified Functional Schematic - Control Drum Actuator Checker System	30
3-2	Cutaway showing Movable Cam Principle for Automatically Adjusting Hydraulic Pump Volume to Demand in a Variable - Volume Pump	32
5-1	Test Setup - Actuator Position Indicator	42

WANL-EOM-001

LIST OF TABLES

<u>Table</u>	<u>Title</u>	<u>Page</u>
1-1	Primary Power Requirements	16
1-2	Variable Volume Vane Hydraulic Pump Data	17
1-3	Equipment Dimensions and Weight	17
1-4	Equipment Dimensions and Weight (for packaging and shipment)	18
1-5	Cable Data	19
1-6	Equipment Supplied	20
4-1	Controls and Indicators	34
5-1	Maintenance Test Equipment	38
5-2	Performance Tests (Troubleshooting Chart)	39
5-3	Angular Degrees Versus Volts Input	43
5-4	Solvent Type Cleaners	44

WANL-EOM-001

Figure 1-1 - Control Drum Actuator Checker System 1402, Westinghouse
Astronuclear Laboratory No. 909E463

INTRODUCTION

The Control Drum Actuator Checker, Aerojet-General Part No. 1402, Westinghouse Astronuclear Laboratory, NERVA project, WANL Part No. 909E463 is described herein. It is used to verify the operation of the hydraulic control drum actuators before they are installed on the reactor. It provides for local checkout after installation. It also provides for pre-installation hydraulic leak and pneumatic seal test on individual actuator assemblies.

Figure 1-2 - Block Diagram Control Drums Actuator Checker System 1402
WANL Dwg. No. 945C410

WANTL-EOM-001

Figure 1-3 - Functional Schematic Diagram Control Drum Actuator System 1402,
Westinghouse Astronuclear Laboratory Dwg. No. 977D694

CHAPTER 1

GENERAL INFORMATION

1-1 GENERAL DESCRIPTION

1-2 The Control Drum Actuator Checker, NERVA Support Equipment No. 1402, (Figure 1-1) verifies the performance of the hydraulic control drum actuators prior to their installation on the reactor. The checker also provides for local checkout of the actuators following their installation. The checker has provisions for performing pneumatic seal and hydraulic leak testing on individual actuator assemblies prior to their installation.

1-3 The Control Drum Actuator Checker supplies hydraulic pressure, pneumatic pressure, and electrical inputs to checkout and calibrate the torque transducers, thermocouples, feed-back potentiometers, limit switches, and hydraulic motors of the actuators (and feed-back assemblies) before they are installed on the reactor. The Control Drum Actuator Checker System consists of three mobile and separate units of equipment. These are:

- a. Actuator Support cart WANL P/N NT 700157 (Figure 1-4)
- b. Hydraulic-Pneumatic Power Supplies Cart WANL P/N NT 650041 (Figure 1-5)
- c. Electronics Console WANL P/N 9770714 (Figure 1-8)

1-4 Actuator Support Cart - The actuator support cart (Figure 1-4) is a test stand which also provides support for the actuator during its movement from storage racks to the proximity of the electronics console and the hydraulic-pneumatic power supplies cart and throughout its testing. The cart is equipped with quick fastening and disconnect devices to reduce installation and setup time to a minimum. The cart is designed to support the actuator during test and to permit full viewing by the test operator. The cart is fitted with casters to facilitate ease of movement. Foot operated levers are provided to lock the cart in position to permit torquing of the actuator shaft (using the calibrated torque wrenches provided) for calibrating and checking the strain gage torque transducers.

1-5 Hydraulic-Pneumatic Power Supplies Cart - The hydraulic-pneumatic power supplies cart (Figure 1-5) houses an electric-motor-driven hydraulic power supply (700-1000 psi) allowing hydraulic leak testing and operating the actuator motor upon command. An electric-motor-driven air compressor supplies 70 psi air for operating the pneumatic locking pin. Space is provided on the cart for a gas bottle along with its associated valves and regulators used to leak test the various seals at pressures up to 1000 psi. The cart is provided with quick disconnect hose couplings to reduce setup time. Hydraulic pressures are controlled by a Moog 21-142 magnetic amplifier controlled servo-valve. A three-way electrically operated solenoid valve is provided to control the compressed air.

1-6 Electronics Console - The electronics console (Figure 1-8) contains the following control panels and panel drawers:

Figure 1-4 - Actuator Support Cart WANL P/N NT 700157

WANL-EOM-001

Figure 1-5 - Hydraulic-Pneumatic Power Supplies Cart WANL P/N NT 650041
(Four views showing major components)

Figure 1-6 - Outline Drawing Hydraulic-Pneumatic Power Supplies Cart WANL
PN/NT 650041

Figure 1-7 - Block Diagram Hydraulic-Pneumatic Power Supplies Cart WANL
P/N NT 650041

Figures 1-8 and 1-9 - Front and Rear View - Electronics Console WANL P/N 977D714

Figure 1-10 - Wiring Diagram - Electronics Console WANL P/N 977D714
WANL Dwg. No. 928F663

WANL-EOM-001

Figure 1-11 - Panel Layout - Power Control Panel WANL P/N 977D697

Figure 1-12 - Meter Panel WANL P/N 977D472

Figure 1-13 - Function Generator Panel WANL P/N 977D714

WANL-EOM-001

Figure 1-14 - Photograph and Panel Layout - Control Panel WANL P/N 936J118

- a. Power control panel (Figure 1-11)
- b. Meter panel (Figure 1-12)
- c. Function generator panel (Figure 1-13)
- d. Control panel drawer (Figure 1-14 and 1-15)
- e. Recorder driver panel drawer (Figure 1-8)
- f. Recorder panel drawer (Figure 1-16)
- g. Power supply panel drawer (Figure 1-17)
- h. Storage drawer (Figure 1-8)
- i. Writing surface drawer (Figure 1-8)

1-7 Power Control Panel - The power control panel (Figure 1-11) is the top panel on the electronics console. The panel is equipped with a red POWER-ON indicator, a torque balance nullmeter and a circuit breaker.

1-8 Meter Panel - The meter panel (Figure 1-12) acts as a housing for the 400 cycle power supply and the Vacuum Tube Voltmeter. A set of test leads are provided for use with the Vacuum Tube Voltmeter. The Vacuum Tube Voltmeter and the 400 cycle power supply are covered by the panel front door which is normally closed except when performing tests on the unit.

1-9 Function Generator Panel - The function generator (Figure 1-13) is a commercially available item supplied by Exact Electronics Inc. It generates square, sine, triangle and ramp waves over a continuously variable frequency ramp of 0.001 cps to 10 KC. The waveforms are available simultaneously from the designated jacks on the right hand side of the panel and they may be selected singly using the main output jack. The waveforms may be continuously triggered externally or by the push button on the panel face.

1-10 Control Panel Drawer - The control panel drawer, WANL P/N 936J118, (Figure 1-14) contains the necessary controls and indicators for completely checking out the torque transducers, thermocouples, feed-back potentiometers, limit switches and hydraulic motor of the actuator. The control panel is provided with a digital position indicator which is capable of displaying angular positions from 0 to 199.8 degrees in 0.2 degree increments with an accuracy of 0.1% of full scale.

1-11 Recorder Driver Panel Drawer - The recorder driver panel drawer (Figure 1-8) contains the necessary galvanometer driver amplifiers and power supplies for the operation of the recorder. The galvanometer driver amplifiers are etched circuit plug-in cards. The case and power supply provides input and output connections and the necessary d-c power for operation of up to seven amplifier cards. Individual input and output connectors are located on the rear of the drawer. The 1-162A amplifier is a low-gain, wideband, d-c amplifier, capable of driving high-frequency light beam galvanometers as well as standard CEC galvanometers. Terminal lugs are provided on the amplifier card for installation of output-matching and current-limiting resistors (as required for use with other galvanometers).

1-12 Recorder Panel Drawer - The Type 5-124 Recorder Oscillograph (Figure 1-16) is a multi-channel, portable, direct-recording, photographic type instrument. It uses 7-inch wide print-out recording paper, and provides up to six individual channels of data. Dynamic measurements from d-c to 5000 cps are possible using standard CEC Type 7-300 Galvanometers. An external timer assembly is also included.

Figure 1-15 - Internal Views Control Panel Drawer, Top and Bottom Sides of Chassis, WANL P/N 936J118

1-13 The Type 5-124 is composed of four basic modules or assemblies. By simply removing the cover assembly, all parts and assemblies of the oscillograph are exposed.

- a. Front housing assembly
- b. Power supply assembly
- c. Instrument base assembly
- d. Rear housing assembly

1-14 The front housing includes the following major parts:

- a. The control panel, which includes the following controls:

- POWER ON-OFF switch
 - LAMP start switch
 - INTENSITY control
 - Drive motor ON-OFF switch
 - Speed selector pushbuttons 0.25 to 64 inches per second

- b. The remaining footage indicator.
- c. The paper transport assembly, which contains the metering roller and necessary gears to transmit power from the transmission to the metering roller for transporting paper.
- d. The transmission which provides the five pushbutton-selected speeds to the paper transport assembly.
- e. The pinch roller.
- f. The final mirror of the optical system, which reflects the galvanometer beams through the collimating lens onto the recording paper.
- g. The collimating lens, which focuses the galvanometer beams on the recording paper.

1-15 The power supply provides regulated power to all functions of the oscillograph. It also contains the lamp housing assembly which is the optical source of oscillograph. The power supply is built as an entity and may be installed easily or removed. All the electronic components of the oscillograph are contained in the power supply. The lamp housing contains the ultra-violet light source, concentrating lens and aperture control for concentrating light from the recording lamp on the galvanometers.

1-16 The remaining major parts of the oscillograph are mounted directly to the instrument base and include:

- a. The drive motor providing power to the transmission.
- b. The galvanometer block and its supports, including the galvanometer extracting and inserting tool holders.
- c. The blower motor, which cools the power supply.
- d. The paper brake, which restrains the roll of paper and actuates the remaining footage indicator.

1-17 The rear housing includes the following major parts:

- a. The receptacles for inputs to the galvanometers.

RECORDING OSCILLOGRAPH

FRONT VIEW

REAR VIEW

EXTERNAL TIMER ASSEMBLY

Figure 1-16 - Recorder Panel Components

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Figure 1-17 - Power Supplies Chassis, Top and Bottom Sides of Chassis

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- b. The fuseholders and fuses for the galvanometer lamp and drive motor.
- c. The remote control receptacle, for remote operation of the drive motor.
- d. The input leads to the galvanometers.

1-18 Power Supply Panel Drawer - The power supply panel drawer (Figure 1-17) contains the following power supplies:

- 22.5 volts DC power supply (actuator torque transducers)
- 24 volts DC power supply (SCRAM power supply)
- 25 volts DC power supply (feedback potentiometers)
- 26 volts DC power supply (controls supply)
- 28 volts DC power supply (indicators supply)
- 110 volts DC power supply (command supply)

The above power supplies provide d-c power for all of the components and functions of the complete electronics console.

1-19 Storage Drawer - A storage drawer is provided in the console for storage of small parts, Technical Manuals, tools, etc.

1-20 Writing Surface - A pull-out writing surface is provided on the electronics console. This surface is at a convenient height to allow the operator to use it as a desk.

LEADING PARTICULARS

Table 1-1 - Primary Power Requirements

Power requirements in operation

- 1200 va, 115 volts AC, 60 cps, 10 amps
- 2400 va, 220 volts AC, 60 cps, 3 phase

Starting power requirements

- 1500 va, 115 volts AC, 60 cps, 15 amps
- 3000 va, 220 volts AC, 60 cps, 3 phase

Table 1-2 - Variable Volume Vane Hydraulic Pump PVR7M-ML10

Maximum recommended operating pressure	1000 psi
Pressure compensating range	500-1000 psi
Maximum drive rpm	1800
Minimum drive rpm	500
Maximum pump delivery	6.5 gpm
Weight	18 lb

WANL-EOM-001

Table 1-2 (Cont)

Mounting	Manifold
Pressure psi	500-1000
Input HP at maximum gpm setting	1.4 4.2
Deadhead HP	0.4 0.9

VARIABLE VOLUME HYDRAULIC PUMP
MODEL PVR7M-ML10

A FLAT OUTPUT CURVE IS CHARACTERISTIC OF THE ABOVE PUMP IN THE 500 TO 1,000 PSI RANGE. A PUMP WITH OPTIMUM PRESSURE-VOLUME CHARACTERISTICS FOR ANY SINGLE PRESSURE SETTING BETWEEN 200 AND 1,000 PSI CAN BE SUPPLIED ON SPECIAL ORDER.

Figure 1-18 - Output Curve for Variable Volume Vane Hydraulic Pump

Table 1-3 - Equipment Dimensions and Weight

Item	Fig. No.	Length	Width	Height	Weight (lbs)
Actuator Support Cart WANL P/N NT 700157	1-2	3	3	3	300
Hydraulic-Pneumatic Power Supplies Cart WANL P/N NT 650041	1-3	5	3	4 1/2	1000
Electronics Console WANL P/N 977D714	1-4				775
Associated Cabling (See Table 1-5)		2	2	2	50
Data Package including WANL-EOM-001 WANL drawings Commercial instruction books		2	2	2	50

Transportability

The Control Drum Actuator Checker System, Aerojet P/N 1402, is readily transportable. It is shipped in 14 separate packages. Only three of the packages require heavy duty loading facilities similar to those used for 1 ton palletized items. A listing of the packages, their dimensions and shipping weights is set forth in the table below.

Table 1-4 - Equipment Dimensions and Weight (for Packaging and Shipment)

<u>Box No.</u>	<u>(Length) (Width) (Height)</u>	<u>Weight (lbs)</u>
1	24 in. x 20 in. x 20 in. a. 40 cycle power supply b. Vacuum Tube Voltmeter	50
2	24 in. x 20 in. x 20 in. a. Function generator b. Recorder drivers	50
3	24 in. x 20 in. x 20 in. Recorder	50
4	24 in. x 20 in. x 20 in. Power supply drawer (amplifiers)	75
5	24 in. x 20 in. x 20 in. a. Writing table surface b. Pullout drawer c. Top door d. Meter panel	50
6	24 in. x 20 in. x 20 in. Connecting cables	50
7	Spare Parts Fuses, hardware mirror, spare magnetic amplifier Galvanometers	50
8	Miscellaneous a. Torque wrenches b. Pressure cap c. Torque adapters d. Hoses and cables e. Gas regulator and gages	50
9	Recording paper supply	50
10	30 in. x 32 in. x 6 ft Cabinet rack	300

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Table 1-4 (Cont)

<u>Box No.</u>	<u>(Length)(Width)(Height)</u>	<u>Weight (lbs)</u>
11	5 ft x 3 ft x 4 1/2 ft Hydraulic-pneumatic power supplies cart	1000
12	12 in. x 12 in. x 3 ft Gas bottle	50
13	3 ft x 3 ft x 3 ft Actuator stand	300
14	Manuals and drawings	50
Total		2175

Cabling Requirements

Cable drawings to be supplied are listed below, together with reference designations. Cable fabrication data for the respective interconnecting cable is supplied on the pages that follow.

Table 1-5 - Cable Data

<u>Cable Assembly</u>	<u>Reference Designation</u>	<u>Westinghouse Astronuclear WANL P/N</u>
Power	W1	945C951
Interconnection	W2	977D745G01
Interconnection	W3	977D745G02
Interconnection	W4	977D745G03
Interconnection	W5	977D745G04
Interconnection	W6	977D745G05
Interconnection	W7	945C939
Interconnection	W8	945C937
Interconnection	W9	945C930

Storage Conditions

The storage conditions for the units without packaging are those normally used for laboratory equipment - remove oil, gas bottle.

The storage conditions for the units repackaged and palletized are those of the normal warehouse environment - a clean, dry covered area.

Capabilities and LimitationsCapabilities

The equipment under normal laboratory operating conditions should not age, wear, or have its operation impaired. The following units require calibration or adjustment. They should be submitted to the metrology department in accordance with the local schedule.

Vacuum Tube Voltmeter,
Function Generator,
Digital Indicator,
400 cps Generator,
Recorder Operational Amplifier,
Power Supplies.

After 100 hours perform checks. Refer to elapsed time indicator located on lower right rear of the electronics console for cumulative hours of operation of the electronics console.

Limitations

Unintended exposure to sand, dust, salt spray, fungus, etc., will adversely affect operation. Cleaning and related checks should be made after such exposure. Refer to the procedures set forth in Chapter 5 - Maintenance.

EQUIPMENT SUPPLIED

The highest assemblies supplied as separate units of the Control Drum Actuator Checker System are tabulated below.

Table 1-6

<u>WANL Part No.</u>	<u>Official Nomenclature</u>	<u>Common Name</u>
NT 700157	Actuator Support Cart	Test Stand
NT 650041	Hydraulic-Pneumatic Power Supplies Cart	Same
977D714	Electronics Console	Console
NT 650039	Function Generator Panel	Same
936J118	Control Panel Drawer	Control Panel
909E465	Power Supply Panel Drawer	Power Supply
977D697	Power Control Panel	Power Control

WANL-EOM-001

Table 1-6 (Cont)

<u>WANL Part No.</u>	<u>Official Nomenclature</u>	<u>Common Name</u>
977D472	Meter Panel	Vacuum Tube Voltmeter and 400 cps power supply
	Recorder Panel Drawer	Recorder
	Recorder Driver Panel Drawer	Driver Amplifier
	Storage Drawer	Drawer
	Writing Surface Drawer	Desk Table
	Associated Cabling	
	(See table of leading particulars on previous pages for detailed cable data.)	
	Power Extension Cord	
	Additional Hydraulic Hoses	
	(Two 20 ft lengths)

Figure 1-19 - Control Drum Actuator Checker - Interconnection Diagram 22

CHAPTER 2

INSTALLATION

This chapter provides data relative to the installation of the equipment. It includes information relative to installation planning, logistics, installation procedures, and preparation for reshipment.

SECTION I

INSTALLATION PLANNING

2-1 General

2-2 The control drum servo system checker consists of three units of equipment:

- a. Actuator Support Cart (Figure 1-4)
- b. Hydraulic-Pneumatic Power Supplies Cart (Figure 1-5)
- c. Electronics Console (Figure 1-8)

2-3 The actuator support cart and the hydraulic-pneumatic power supplies cart will be shipped assembled. The electronics console will be disassembled for shipment. The electronics console will be shipped in packages and crates. Electronics technicians will be required for the assembly of the electronics console.

2-4 Power Requirements - External power available at the site should be sufficient to include the added requirements set forth in the table of leading particulars in Chapter 1 of this manual.

2-5 Safety Requirements - Place approved rubber mats in front of panel board installations. Fasten all compressed gas cylinders when in use, transit, or on standby by a chain or a rigid retaining bar or structure. Do not move cylinders without the valve cap securely in place. Always use a regulator gage and valve when using compressed gas. Do not use grease or oil to lubricate the valves or joints of compressed gas bottles. Do not subject containers of compressed gas to dropping, bumping, rough handling or temperature in excess of normal atmosphere. Avoid inhaling helium gas that has been exposed to oil or oil covered surfaces.

2-6 Receipt and Unpacking of the Equipment

2-7 The equipment will arrive at its destination in 14 packages and containers. It will be packed as shown in Table 1-4.

2-8 Housing the Equipment

2-9 Upon arrival at its destination the equipment should be examined to determine that there has been no shipping damage. The equipment should be stored in a warehouse or similar environment.

SECTION II

LOGISTICS

2-10 Receiving Data

2-11 All units are packaged and labeled in accordance with standard commercial requirements. A list of the packages is set forth in the table of leading particulars in Table 1-4. Crated dimensions are shown on this list. Uncrated dimensions and weights are shown on the respective outline drawings. Verify that the required number of undamaged packages have been received before unpackaging and installation. Unpackaging should be done at the test location.

A packing list of the shipping containers is set forth in the table of leading particulars section in Chapter 1 of this manual.

2-12 Material Handling

2-13 Ordinary material handling and rigging equipment is required to transport and handle the major items of equipment, auxiliary items, and structures which constitute the equipment. Fork lift trucks with a one ton capacity for palletized loads will be adequate for the larger size packages.

SECTION III

INSTALLATION PROCEDURES

2-14 General

2-15 Follow the procedures below to assemble the Control Drum Actuator Checker after receipt of the equipment. A test procedure to determine whether the equipment is functioning properly is also included in the installation procedures.

- a. Assemble the electronics console by inserting roller drawers into locations shown in the photograph (Figure 1-8) in Chapter 1 of this manual.
- b. Check the Actuator Support Cart for the following:
 1. Four casters attached to cart.
 2. Handle inserted in place.
 3. Mirror attached to bottom cross bars.
 4. Three fastening blocks attached.
 5. Three fastening blocks move freely.
 6. Casters roll and turn freely.
 7. Foot locking levers lock cart.
 8. Handle removes and replaces.
 9. Cart accepts actuator.
 10. Fastening blocks hold actuator.
 11. Mirror allows visibility of bottom of actuator.
- c. Check the Hydraulic-Pneumatic Power Supplies Cart for the following:

WANL-EOM-001

1. Four wheels (2 fixed and 2 swivel) attached to cart.
2. Foot lock attached and operating.
3. Handle attached to cart.
4. Air compressor, 1/3 HP motor, and 3 gallon air tank installed on cart.
5. Hydraulic Power Unit, 5 HP motor, and oil tank installed on cart.
6. Gas bottle, gages and reducing valve installed on cart.
7. The 5 HP motor starter installed on cart panel.
8. The 1/3 HP motor switch installed on cart panel.
9. The 0-2000 psi oil pressure gage installed on panel.
10. The 0-150 psi air pressure gage installed on panel.
11. Servo-valve installed on panel.
12. Pneumatic solenoid valve installed on panel.
13. Quick-disconnect accessory air hose installed on solenoid valve.
14. Two quick-disconnect, accessory hydraulic hoses installed on servo-valve.
15. Oil filter cartridge installed in oil filter.
16. The AC power cord installed on cart.
17. Pressure reducing valves and pressure gages supplied for gas bottle.
18. Accessory hose supplied for gas.
19. Reservoir does not leak when filled with Mil H 5606A oil.
20. Gas bottle supplies 1000 psi.
21. Air compressor supplies 56 psi.
22. Pneumatic system does not leak.
23. Hydraulic system supplies 1000 psi.
24. Hydraulic system does not leak.

d. Following the assembly of the electronics console check as follows:

1. Power Control Panel installed.
2. Meter Panel and AC and DC test leads installed (behind cover door).
3. Function Generator Panel installed.
4. Control Panel installed.
5. Recorder Driver Amplifier chassis installed.
6. Seven Recorder Driver Amplifier Cards installed.
7. Writing surface installed.
8. Oscillograph Recorder installed.
9. Pull-out spare parts drawer installed.
10. Power Supply chassis and panel installed.
11. The 1 3/4 inch blank panel, installed.
12. Back Panel door installed.
13. All Chassis-interconnecting cables properly connected. (See Figure 1-10 for connector panel wiring details, cabling requirements and interconnection data in Table of Leading Particulars in Chapter 1 of this manual.)
14. All fuses, pilot and indicator lamps installed.
15. All front panel switches in the OFF position.
16. No indicators light when power cord is plugged into 110 volt, 60 cps AC line.
17. Pilot Lamp on Power Control Panel lights when Breaker-Power Switch is placed ON.
18. Elapsed Time Indicator operates. (Located at bottom right in rear of electronics console.)
19. The 60 cps Indicator lights on Control Panel.
20. POWER ON Switch lights when POWER ON Switch is pressed.

WANL-EOM-001

21. The 400 cps Indicator lights. (When power switch of 400 cps supply is placed in ON position.)
22. The 22.5 volt DC Indicator lights.
23. The 25 volt DC Indicator lights.
24. The 26 volt DC Indicator lights.
25. The 110 volt DC Indicator lights.
26. PIN INSERT Switch lights green. (If PIN REMOVE lights red, press Pin Insert once.)
27. OPERATE Switch lights blue. (If SCRAM lights white, press OPERATE Switch once.)
28. SCRAM NORMAL Switch lights blue. (If SCRAM REVERSE lights white, press SCRAM NORMAL once.)
29. DITHER OFF Switch lights white. (If DITHER ON lights blue, press DITHER OFF once.)
30. TORQUE BALANCE lights green. (If TORQUE RECORD lights red, press TORQUE BALANCE once.)
31. FUNCTION GENERATOR OUT Switch lights white. (If FUNCTION GENERATOR IN lights blue, press FUNCTION GENERATOR IN once.)
32. MAGAMP OUT Switch lights white. (If MAGAMP IN lights blue, press MAGAMP OUT once.)
33. Set position COMMAND on zero.
34. Actuator Position Indicator reads 00.0 to 05.0 degrees. (When Indicator Toggle Switch is in ON position.)
35. Place Test Meter (behind cover door) ON-OFF Switch to ON position, Function Switch to +DC volts, and voltage RANGE as needed.
36. Pull out power supply chassis. Measure 25.0 ± 3 volt DC at test points location on power supply chassis.
37. Measure 25.0 ± 3 volt DC at test points location on Power Supply Chassis.
38. Measure 26.0 ± 3 volt DC at test points location on Power Supply Chassis.
39. Measure 110.0 ± 5 volt DC at test points location on Power Supply Chassis.
40. Measure 26.5 ± 3 volt DC at SCRAM test points location on Power Supply Chassis.
41. Measure 110.0 ± 5 volt AC 60 cps at test points location on Power Supply Chassis (switch to AC volts).
42. Slide Power Supply Chassis back into cabinet. Pull out Control Panel Chassis. Measure 22.5 ± 3 volt DC at test points location in Control Panel Drawer.
43. Measure 25.0 ± 3 volt DC at test points location in Control Panel Drawer.
44. Measure 26.0 ± 3 volt DC at test points location in Control Panel Drawer.
45. Measure 110.0 ± 5 volt DC at test points location in Control Panel Drawer.
46. Measure 110.0 ± 5 volt AC 60 cps at test points location in Control Panel Drawer. (Function switch on test meter panel turned to AC.)
47. Measure 110.0 ± 5 volt AC at the output terminals of the 400 cps supply (beside test meter). If not 110.0 volt AC, adjust frequency control knob to 400 cps and output voltage (screwdriver adjust) control for 110.0 ± 5 volt AC.
48. Measure 110.0 ± 5 volt AC, 400 cps at test points location in Control Panel Drawer on the control chassis.
49. Slide the Control Panel back into the cabinet.

2-16 Additional post-installation tests.

CAUTION

Do not conduct the following tests unless the detailed installation procedures previously set forth in this Chapter at Section III have been completed.

2-17 Listed below are operational checks of the equipment with the actuator connected which can be performed immediately after completion of the installation procedures previously set forth in this chapter and all other requirements specified in this manual and in the WANL drawings.

2-18 Operational Precautions

CAUTION

The feedback pot can be damaged by checking resistance with an ohmmeter.

CAUTION

Pneumatic and hydraulic fittings must be clean prior to making connections.

CAUTION

Observe adequate safety precautions while using high pressure gas.

CAUTION

The checker hydraulic system shall be cycled through an electronic filter system, ELECTRO-MECHANICAL OIL FILTER - WESTON HYDRAULICS DIVISION OF BORG-WARNER, No. 110 or 200 or equivalent, prior to using on actuator.

2-19 Operational Check

- a. Place actuator in test stand provided with actuator checker.
- b. Connect pneumatic lines to actuator and set regulator to zero.
- c. Energize pneumatic solenoid valve from checker.
- d. Switch on 25 volt DC supply to feedback potentiometer.

WANL-EOM-001

- e. Check feedback pot voltage output using the Vacuum Tube Voltmeter. With actuator at 0°, feedback voltage shall be 0.05 ± 0.01 volts.
- f. Start hydraulic system on checker and set at 700 ± 100 psi.
- g. Switch on 400 cycles and 25 volt DC power.
- h. Open and close actuator by-pass valve and cycle actuator alternately to remove air from hydraulic lines and actuator.
- i. Command 30° actuator position and check voltage at the servo valve. The servo valve voltage shall be positive 0.3 ± 0.05 volts.
- j. Open circuit the servo with the mag amplifier OUT switch and the actuator shall return to 0° position. No specific time is required.
- k. By means of zero and range adjustments, obtain a negative 0.5 volts on the servo with actuator at 0° position and positive 0.5 volts with actuator at 180° position.

SECTION IV

PREPARATION FOR RESHIPMENT

2-20 If the equipment is operational at the conclusion of the tests and the tests are to continue at another site, it is desirable that the individual units be moved without disassembly. This procedure is preferable to complete breakdown and recreating which may be done if local conditions dictate.

If the equipment is not operational at the conclusion of the tests (or at any time prior thereto), it is strongly recommended that the individual items of equipment be kept intact. This will aid in troubleshooting and debugging at the shop level and eventually at the manufacturer's plant.

The Actuator Support Cart should be repackaged and shipped in the same manner as it was originally shipped.

CAUTION

The mirror should be separately packaged to prevent damage to its surface.

The hydraulic-pneumatic power supplies cart should be shipped only after removal of the gas bottle proper. The gages, etc. attached to the gas bottle should be shipped with the cart in normal commercial packaging. The gas bottle should be shipped in accordance with the appropriate ICC regulations.

CAUTION

All oil should be drained from the unit prior to shipment.

WANL-EOM-001

All pneumatic and hydraulic fittings should be cleaned, plugged and covered for continued cleanliness prior to shipment.

Personnel should avoid breathing residual helium and other gases that have been exposed to oil surfaces. An instant pneumonia-like ailment follows such exposure.

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Figure 3-1 - Modified Functional Schematic - Control Drum Actuator Checker System

CHAPTER 3

PRINCIPLES OF OPERATION

SECTION I

FUNCTIONAL SYSTEM OPERATION

3-1 GENERAL

3-2 The Control Drum Actuator Checker is effectively a closed loop servo-system used as test equipment to verify the reciprocal angular positioning of the actuator when mounted on a test stand (simulating similar mounting on a reactor of novel design). It utilizes a specially designed hydraulic-pneumatic power unit to provide the angular motion normal to actuators used on the aforementioned reactor. The actuator's motion of 0° to 180° produced by this system is readout on a counter on the electronics console panel face. The variations in output are readily observed on a six channel recorder. Comparisons of the output with the input cranked into the system can then be made. See the modified functional schematic (Figure 1-3) and other data in this chapter for further information.

3-3 The hydraulic system positions the actuator, and the pneumatic system inserts or withdraws a locking pin (plunger of pneumatic pin protrudes on actuator when at the REMOVE PIN position). Mechanically the position of the actuator may be monitored by looking into a mirror at the base of the actuator test stand. Electrically the monitoring of the remote positioning is done by conventional circuits feeding the data to a legend type display on the front of the electronics console.

SECTION II

FUNCTIONAL OPERATION OF ELECTRONIC CIRCUITS

3-4 The purpose of the SCRAM override circuitry is to check for proper high speed shutdown (in less than 1/2 second) of the reactor by the actuators.

3-5 The feedback assembly (external to the Control Drum Actuator Checker System transmits an electrical signal corresponding to the angular position of the actuator) to the control panel where it is amplified and converted to mechanical motion on a 189.8° counter with a display readout on the front of the panel and also to the feedback input of the magnetic amplifier. The counter was designed to readout from 0° to 180°. The additional readouts will help to detect angular excursions and eliminate a driving into the stops type of situation.

3-6 The six channel oscillograph records data taken in order from the feedback signal (extra-sensitive), the torque transducer on the actuator, the servo-valve command, the feedback signal (normal), the error signal, and the function generator.

3-7 The "ZERO" adjust control on the control panel allows the proper initial offset voltage to be inserted into the system.

Figure 3-2 - Cutaway showing Movable Cam Principle for Automatically Adjusting Hydraulic Pump Volume to Demand in a Variable-Volume Pump

3-8 A command signal manually inserted into the potentiometer on the face of the control panel is fed to a variable resistor and transformer network together with a dither (oscillating) signal. The output signal is then fed through the variable resistance of the manually inserted range input. When desired the latter signal is varied by a waveform and amplitude inputs manually inserted and provided by a function generator before being fed into a magnetic amplifier and then through relay circuitry to a servo valve on the hydraulic-pneumatic power supplies cart. Before transmission to the cart it is possible to change the input to the relay circuitry from the magnetic amplifier by triggering a manually operated SCRAM switch and the a SCRAM reverse switch just to the right of the SCRAM operate switch (which effectively causes a phase reversal if the red SCRAM reverse button is pressed).

SECTION III

FUNCTIONAL OPERATION OF MECHANICAL ASSEMBLIES

3-9 The mechanical assemblies of the Control Drum Actuator Checker System operate in a conventional manner.

3-10 The Hydraulic-Pneumatic Power Supplies Cart houses the hydraulic pump powered by a 5 HP 220 volt, 3 phase-electric motor. The pump is a vane type with variable volume. It is pressure compensated for 7 gallons per minute maximum flow and 1000 psi maximum pressure. The subplate is mounted to a 20 gallon reservoir. It has a 125 micron intake filter and a 10 micron discharge filter. The pump discharge is fitted with a 0-2000 psi pressure gage and adjustable relief valve and piped to a 31-01 A servo valve. The servo valve is piped to the return and valve actuator ports fitted with 10 feet of hydraulic hose. The hose has quick disconnect fittings on the free ends of the hoses.

3-11 The Hydraulic-Pneumatic Power Supplies Cart also houses the air compressor for 70 psi maximum pressure and for 2 to 3 CFM. It is driven by a 1/3 HP 220 volt, three phase electric motor. The air compressor is automatically controlled between 55-70 psi and is equipped with a pressure gage and a three-way solenoid valve. A half size oil-pumped gas bottle is fitted with a regulator, shut off valves and six feet of hose with a quick disconnect on the free end. Both motors are fitted with manual starters.

The above units are completely assembled, wired and piped on a four-wheeled cart with two locking wheels and guide handle and 25 feet of cable with a four pronged twist plug for connection to a 220 volt, three phase, 60 cycle AC supply.

Table 4-1				
Location	Name of Meter, Switch, Control, Etc.	Reference Designation	Function	Action Required
Actuator Support Cart	Mirror	None	Visual indicator of mechanical position of actuator	None
Hydraulic-Pneumatic Power Supplies Cart		None		WANT-EOM-001
	Gages			
	Bottle Pressure		Gage nearest bottle indicates bottle pressure	
	Regulator		Gage above reducing valve indicates 0-1000 psi	
	Reducing Valve		Regulate gas pressure out	
	Valve Cap (gas cylinder)			
	5 HP motor starter		Energizes 5 HP motor	
	1/3 HP motor		Energizes 1/3 HP motor	
	Oil pressure gage (0-2000 psi)		Indicates oil pressure	
	Air pressure gage (10-150 psi)		Indicates oil pressure	
	Limit switch		Starts and stops compressor	
	Servo valve		Controls hydraulic oil on command	
Electronics Console Power Control Panel	Oil level gages			
	Low level gage		Low oil level	Secure operation if no oil shown
	High level gage		Normal operating level	Fill to this level
	Red power ON indicator (lamp)	1A1-DS1	Lights when system is energized	Reset circuit breaker if not lit
	Torque balance nullmeter	1A1-M1	Output of strain gage	Reads only when TORQUE BAL lamp is ON
	Circuit breaker	1A1-CB1	Energy shutdown	Reset when emergency condition is remedied
Meter Panel	Vacuum Tube Volt-meter			
	ON-OFF toggle switch	1A2-M1	Energizes meter movement	Switch to ON for power
	Function switch	1A2-S1	Selects AC or DC volts	Select
	Voltage range selector	1A2-S2	Selects range required	Select
Power Supply (400 cps)	AC-OFF toggle switch	1A3	Power switch	Switch to AC for 400 cps power
	Output voltage control (screwdriver adjustment)	1A3-S1	Regulates output voltage	None
	Frequency control knob		Selects output frequency	None
Function Generator Panel		1A4		
	ON-OFF toggle switch	1A4-S1	Power switch	Switch to ON for power
	Trigger	1A4	Selects internal versus external	Use as required
	Timing	1A4	Fine frequency control	Regulate
	Multiplier	1A4	Coarse frequency control	Regulate
Control Panel Drawer			Output control	Regulate
	POWER ON	1A5-DS1	Power switch	Set to ON for power
	TORQUE BALANCE - TORQUE RECORD	1A5-DS2	Inserts torque record channel	Select
	INSERT PIN - REMOVE PIN	1A5-DS3	Removes pin or actuator	Select
	OPERATE SCRAM	1A5-DS4	Energize SCRAM circuit	Select
	SCRAM NORMAL - SCRAM REVERSE	1A5-DS5	Allows phase reversal of SCRAM circuit	Select
	DITHER ON - DITHER OFF	1A5-DS6	Energizes dither circuit	Select
	FUNCTION GENERATOR IN - FUNCTION GENERATOR OUT	1A5-DS7	Energizes function generator	Select
	MAGNETIC AMPLIFIER IN - MAGNETIC AMPLIFIER OUT	1A5-DS8	Inserts magnetic amplifier in loop	Select
	TORQUE BALANCE	1A5-R23	Allows balancing of torque transducer	Adjustment
	DITHER	1A5-R2	Sets amplitude of dither	Adjustment
	ZERO	1A5-R3	Sets initial offset (-0.5 volts)	Adjustment
	RANGE	1A5-R4	Sets final offset (+0.5 volts at 180°)	Adjustment
	FB OFFSET	1A5-R25	An offset feedback control potentiometer	Fine adjustment of the feedback channel
	BAL/REC	1A5-S10	Allows nulling of torque balance nullmeter (1A1-M1) on Power Control Panel	Select
	Indicators (left hand)			
	1. 0°	1A5-DS9	Actuator is at 0° position	Observe
	2. 180°	1A5-DS10	Actuator is at 180° position	Observe
	3. PIN IN	1A5-DS11	Plunger of pneumatic pin on actuators does not protrude	Observe
	4. PIN OUT	1A5-DS12	Plunger of pneumatic pin on actuator does protrude	Observe
	5. LOCKED	1A5-DS13	Interlocked with PIN IN-OUT movement above (for safety)	Observe
	6. OPERATE	1A5-DS14		
	Indicators (right hand)			
	7. 60 cps	1A5-DS15	60 cps preset	Observe
	8. 400 cps	1A5-DS16	400 cps preset	Observe
	9. 22.5 volts DC	1A5-DS17	22.5 cps preset	Observe
	10. 25 volts DC	1A5-DS18	25 volts DC	Observe
	11. 28 volts DC	1A5-DS19	28 volts DC	Observe
	12. 110 volts DC	1A5-DS20	110 volts DC	Observe
Galvanometer Driver Amplifier		1A6-		
Recorder Panel Drawer	Control Panel			
	POWER ON-OFF switch	1A7-S101	Energize recorder	Switch to ON for power
	LAMP start switch	DS101	Push button to light galvanometer	Press several times to strike the illuminator lamp
	INTENSITY control	S102	Regulates continuously variable galvanometer lamp intensity.	Adjust after previous 3 steps plus 30 minutes
	Drive motor ON-OFF switch	S103	Push button to start drive motor	Push to start
	Speed selector pushbuttons 0.25 to 64	None	Selects the desired speed in inches per second	Select
	The remaining footage indicator.	None	Indicates remaining paper supply	None
Extend Timer Assembly (to the left of the recording oscillograph)	Timing Mode Selector (slide switch printed circuit)	1A8-S101b	To select timing mode (1, 10, 100 pulses per second)	If timing mode operation is desired, turn to 1, 10, or 100 pulse per second

CHAPTER 4

OPERATION

4-1 This chapter provides data relative to Controls and Indicators, Operating Instructions, and Emergency Operation.

SECTION I

CONTROLS AND INDICATORS

(Table 4-1)

4-2 There are no interlock circuits as such in the system proper.

SECTION II

OPERATING INSTRUCTIONS

4-3 Starting, Operating and Stopping Procedures

4-4 The step-by-step operating procedures describing the starting procedures, pertinent operating procedures, and normal stopping procedures are set forth below.

- a. Place all Power Switches in OFF position.
- b. Fill hydraulic reservoir of Hydraulic-Pneumatic Supplied Cart with 20 gallons of MIL-H-5000A hydraulic fluid (level should be visible in both low and high level gages).
- c. Install two hydraulic and one pneumatic lines.
- d. Install all electrical cables (Hydraulic-Pneumatic Supplies Cart into 220 volt three phase 60 cps).
- e. Install pressure cap and leakage flowmeter for leak test of actuator seals.
- f. Pressurize to 1000 psi from gas bottle and regulator.
- g. Read and record gas leakage (according to WANL Procedure NRX-A1-P7).
- h. Remove hydraulic discharge line and install hydraulic leakage flowmeter.
- i. Momentarily press START and STOP buttons of hydraulic pump and observe rotation of motor shaft. (If rotation is not in the direction of the arrow, interchange two leads in the 220 volt male power plug.)
- j. Press hydraulic pump START button. Hydraulic pressure indicates 800 ± 100 psi. (If not see instructions on hydraulic pump.)
- k. Read and record hydraulic leakage rate. (If greater than 100 cc/min press hydraulic pump STOP button according to WANL Procedure NRX-A1-P7.)
- l. Press hydraulic pump STOP button.
- m. Remove hydraulic leakage flowmeter.
- n. Reconnect hydraulic discharge line.
- o. Place Breaker-Power switch (top panel of Electronics Console) in ON position. Elapsed Time Indicator (lower panel at rear of console) operates, 60 cps legend lights blue.
- p. Press POWER ON Switch (Control Panel). POWER ON lights white. 22.5 volt DC, 25 volt DC, 28 volt DC, 110 volt DC light blue. Torque Balance lights

white, PIN INSERT lights green. OPERATE lights red, SCRAM NORMAL lights blue. DITHER OFF lights white, FUNCT GEN (function generator) lights white, MAGAMP (magnetic amplifier) OUT lights white. 0° lights blue, PIN IN and LOCKED light green.

- q. Push button on galvanometer-driver amplifier to open panel. Then place DRIVER POWER SWITCH in ON position. (Indicator Lights)
- r. Place RECORDER POWER Switch in ON position.
- s. Press and hold momentarily the LAMP Starter button in Recorder. (Lamp lights inside recorder unit.)
- t. Place TIMING SELECTOR Switch in desired timing pulse rate position.
- u. Rotate TORQUE BALANCE control until BALANCE METER (top panel) indicates center null position.
- v. Press TORQUE RECORD. (TORQUE RECORD lights blue)
- w. Adjust TORQUE TRANS (2nd channel) on Driver for Mid-position.
- x. Apply Torque Wrench and Adapter to Actuator shaft to produce desired torques. (Adjust Gain Control for desired Galvanometer deflection.)
- y. Start Recorder paper drive motor for desired paper speed and apply positive and negative torques of desired calibrated values. After a few minutes the paper record will show timing lines and torque deflections.
- z. Remove Torque Wrench and Adapter.
- aa. Place 400 cps Power Supply Power Switch in ON position (behind 2nd Panel door). (Pilot lamp lights, and 400 cps Indicator lights on Control Panel.)
- bb. Place Pneumatic START (bottom) Switch in ON position. (Air compressor gage indicates 70 ± 10 psi and motor stops.)
- cc. Press Hydraulic Compressor (top) START button. (Hydraulic pressure gage indicates 800 ± 100 psi.)
- dd. Insert locking key (not a part of the Control Drum Actuator Checker) into Actuator and turn clockwise.
- ee. Move manual Locking Pin on Actuator (not a part of the Control Drum Actuator Checker) to unlocked position.
- ff. Press REMOVE PIN. (REMOVE PIN lights red, PIN OUT and OPERATE light red.) (Plunger of pneumatic pin protrudes on actuator.)
- gg. Press DITHER ON to ON and the MAGAMP IN to IN. (DITHER ON and MAGAMP IN lights blue.)
- hh. Turn Actuator Position Switch ON. (Actuator position indicates 0.0 to 5.0 degrees.)
- ii. Operate COMMAND control to position ACTUATOR to desired position. (ACTUATOR POSITION follows mechanical position of actuator as seen on mirror at bottom of actuator (test stand) Support Cart. 180° lights blue when at 180°.)
- jj. Operate SCRAM, and SCRAM MANUAL and SCRAM REVERSE Switch. (ACTUATOR POSITION read out follows.)
- kk. Press OPERATE button (OPERATE lights red). Return command to 0.
- ll. Place FUNCTION GENERATOR Power Switch in ON position. (Pilot lamp lights.)
- mm. Set OUTPUT ATTENUATOR on Function Generator Panel to 0.
- nn. Select desired waveform and amplitudes.
- oo. Command the Actuator by setting the command potentiometer on the control panel to its desired initial position.
- pp. Press FUNCT GEN (function generator) Switch.

WANL-EOM-001

- qq. Operate Recorder for desired record of actions and responses. (Adjacent channel gives for desired signal levels on galvanometers.)
- rr. Place Vacuum Tube Voltmeter (behind 2nd panel door) POWER Switch in ON position (pilot lamp lights.)
- ss. Using a Vacuum Tube Voltmeter place test leads into DC or AC jacks and measure signals at the test jacks.
- tt. With Actuator commanded to 180.0 position, measure signal at AMP (amplifier) signal test point (Control Console front panel) with a Vacuum Tube Voltmeter. Make zero adjust for minus 0.5 volt DC.
- uu. With Actuator commanded to 180.0 position, measure signal at AMP (amplifier) signal test point with a Vacuum Tube Voltmeter. RANGE adjust for plus 0.5 volt DC.
- vv. System is ready for actuator checkout in accordance with WANL procedure NRX-A1-P7.

SECTION III

EMERGENCY OPERATION

4-5 There is no emergency operation of the system contemplated. There is one emergency shut down procedure. The circuit breaker switch at the top center of the panel on the Electronics Controls turns all power OFF in an emergency.

CHAPTER 5MAINTENANCESECTION IFIELD MAINTENANCE5-1 General

5-2 Day to day maintenance of the equipment by operating personnel is routine in nature. It consists of standard field practices, standard cleaning and inspection methods and procedures, etc. Follow the routine set forth in Chapter 2, Section III.

5-3 Maintenance Test Equipment

5-4 Tools and test equipment required for maintenance are listed in Table 5-1.

Table 5-1

<u>Tools and Test Equipment</u>	<u>Manufacturer</u>	<u>Type No.</u>	<u>Quantity</u>	<u>Requires Calibration</u>
Vacuum Tube Voltmeter	Simpson		1	Monthly
Torque Wrench 0-100 in./lbs	Richmont Products CLECO Division, Reed Roller Bit Co.	4SDR750F	1	--
Adapter - Spline to Torque Wrench		2SDR750F	1	--
Master Potentiometer	Leeds & Northrup	Model K-2	1	Monthly
Connector, galvanometer plug	CEC	97918	18	No
Connector, remote control plug	CEC	158332-1	1	No
Socket Contact Assembly	CEC	97519-2	6	No
Pin Contact Assembly	CEC	97520-2	6	No
Wrench, galvanometer	CEC	47857		
Tool, galvanometer lifting	CEC	31333	1	No

5-5 Performance Tests

5-6 Performance tests in the field consist of repetition of the tests and checks in the installation procedures set forth in Chapter 2, Section III of this manual. In addition, the troubleshooting procedures set forth in the table below can be followed when applicable.

Table 5-2

<u>Malfunction</u>	<u>Probable Trouble</u>	<u>Remedy</u>
No 65 psi	Gas Supply Expended	Check pressure regulator motor Check compressor operation Check piping for rupture Check pneumatic valve
No 800 psi	Gas Supply Expended	Replace Gas Bottle
No 800 psi	Gas Supply Expended	Check starter Check motor Check compressor Check piping Check servo valve Check hoses and connection Check low level cut-out switch
Pilot lamp does not light	Burned out lamp	Check circuit breaker switch
	Circuit breaker switch OFF	Check pilot lamp (burned out lamp)
Pilot lamp does not light	Defective or ruptured supply cord	Check Supply Cord
	No supply power	Check supply power
Elapsed time indicator inoperative	No input power	Check for broken lead or loose wiring
60 cps indicator does not light	Burned out lamp	Check indicator lamps (2# 327 lamps)
	Burned out resistors	Check resistors (R10, R20) on control chassis

WANL-EOM-001

Table 5-2 (Cont)

Malfunction	Probable Trouble	Remedy
POWER ON lamp does not light	Power not ON Lamp burned out Broken lead	Turn POWER ON switch ON Replace with #327 lamps Repair
400 cps indicator lamp does not light	Lamp burned out Broken lead Defective 400 cps supply	Replace with #327 lamp Repair Follow procedure in NJE manual
22.5 volts DC Indicator lamp does not light	Resistor(s) R9, R22 on control chassis Lamp(s) burned out Broken lead	Replace Replace with #327 lamp(s) Repair
	Blown fuse (F1) (on back of power supply)	Check test points on control chassis and power supplies Replace with WANL P/N 313002
	22.5 volts DC Power Supply	Follow procedure in Mid-Eastern Manual
Indicator does not respond to changing input signal	Defective component in power supply Defective component in bridge power supply Defective chopper Defective component in servo amplifier	Locate defective component and replace Locate defective component and replace Replace Locate defective component and replace
Indicator does not respond to changing input signal and indicator drives to one end of scale	Defective component in bridge circuit Defective chopper	Locate defective component and replace Replace
Indicator oscillates at one or more position indications	Defective tape and spool base assembly	Clean slidewire tape or replace TA'POT assembly

WANL-EOM-001

Table 5-2 (Cont)

<u>Malfunction</u>	<u>Probable Trouble</u>	<u>Remedy</u>
Counter oscillates throughout its range	Defective tape and spool base assembly	Clean slidewire tape or replace TA'POT assembly
	Defective wiper contact	Clean or replace
	Defective component in bridge circuit	Locate defective component and replace
	Defective chopper	Replace
	Defective component in servo amplifier	Locate defective component and replace
Indicator operates but cannot be calibrated	Defective component in bridge circuit	Locate defective component and replace
Indicator operates but responds sluggishly or has a wide dead band	Defective component in servo amplifier	Locate defective component and replace
Indicator operates but responds sluggishly or has a wide dead band	Defective servo motor	Replace
	Defective component in power supply	Locate defective component
	Defective tape drive mechanism	Locate mechanical fault and repair
	Defective counter drive mechanism	Locate mechanical fault and repair

5-7 Alignment

5-8 With one exception, there are no alignment and adjustment procedures for the equipment under field maintenance conditions. The single exception is for the Actuator Position (degrees) Indicator (Millivoltmeter WANL P/N NT 650044). At sixty day intervals, follow instructions recited below under calibration procedures.

Power supplies are factory calibrated prior to shipment and inspected in accordance with rigid requirements to completely eliminate interface problems including the requirement for further adjustments in the field.

5-9 Calibration Procedures

5-10 After installation, the Actuator Position Indicator (degrees) - Millivoltmeter WANL P/N NT 650044 - should be calibrated at 60-day intervals. The following procedure is used during final inspection to calibrate the indicator. The master potentiometer must be a Leeds and Northrup Model K-2 or equivalent.

Set up test equipment and indicator as shown in Figure 5-1.

R1 AND R2 MUST BE EXACT 100 TO 1 DIVIDER.
 R1 AND R2 MUST HAVE ACCURACY OF ± 0.02 PERCENT, AND
 HAVE TEMPERATURE COEFFICIENT OF ± 5 PPM.
 SUGGESTED VALUE OF R1 IS 9900 OHMS AND R2 IS 100 OHMS

Figure 5-1 - Test Setup - Actuator Position Indicator

- Connect 115 volts AC, 60 cps, a-c power to pins 1 and 2 of connector J1. Allow a ten-minute warmup period.
- Adjust R3 and R4 so that master potentiometer reads 0.01 volt, and apply a 1 volt, d-c signal from the voltage divider to terminals E1 (+) and E2 (-) on the back of the indicator.
- The meter should read 18 ± 0.2 degrees. If the instrument is not within tolerance, remove the dust cap from the trimming potentiometer on the rear of the indicator and adjust the L0 potentiometer until the instrument is within tolerance.
- Adjust R3 and R4 so that the master potentiometer reads 0.1 volt and apply a 10 volt d-c signal from the voltage divider to the indicator.
- The Milli-V-Meter should read 180 ± 0.2 degrees. If the instrument is not within tolerance, adjust the HI potentiometer on the rear of the meter until the instrument is within tolerance.
- Since the trimming potentiometers may interact slightly, repeat steps c through e until the proper readings are reached.
- After the indicator has been calibrated at the low and high points, it may be checked through its complete range (see table 5-3).

Table 5-3 - Angular Degrees Versus Volts Input

<u>Angular Degrees</u>	<u>Voltage Divider (Volts)</u>	<u>Master Potentiometer Reading</u>
18	1	0.01
36	2	0.02
54	3	0.03
72	4	0.04
90	5	0.05
108	6	0.06
126	7	0.07
144	8	0.08
162	9	0.09
180	10	0.10

SECTION IISHOP MAINTENANCE5-11 GENERAL

5-12 Maintenance not normally accomplished by operating personnel consists of removal and overhaul of major components in accordance with the instructions contained in the respective commercial operation and maintenance manuals. For example, see Figure 5-124 in the CEC manual on the recording oscillograph for the optical adjustment diagram.

5-13 Performance Test Tables

5-14 Performance test tables for all components, sub-assemblies, and sub-subassemblies that must be removed for special testing and repair are set forth in Table 5-2 and in the respective commercial operation and maintenance manuals for such items.

5-15 Cleaning

5-16 There are no special instructions and procedures for cleaning. A chart indicating preferred solvents and cleaning materials is set forth below.

5-17 Major Repairs

5-18 No major repairs by non-operating personnel are contemplated. Major repairs of divisible units will be made by either the original vendor or the Westinghouse Astro-nuclear Laboratory, Pittsburgh, Pennsylvania. Disassembly shall be done in accordance with standard shop practice. The defective unit should be tagged, dated and signed by the person removing the unit. Note the total operating time for the unit as recorded on the Elapsed Time Indicator (located on the rear right bottom of the electronic console).

Table 5-3 - Solvent Type Cleaners

Specification	Characteristics	Applications	Standard Navy Stock No. and Container Size		Substitutes
51C65 (Ships) Solvent-Emul- sion Grease Cleaning Com- pound	An emulsion type solvent capable of being cut back with water kerosene or Stoddard solvent.	Used as an emulsion spray or emulsion soak cleaner depending upon the applica- tion.	51-C-1586-25	5 Gal	P-C-576 Type I
			51-C-1586-55	55 Gal	51-C-1569-40 1 Gal
VV-K-211 Kerosene	A colorless petrole- um fraction which boils in a range of 200°F to 300°F. It has a flash point of 115°F (min) and a fire point of 130°F (min).	For use in softening and removing congealed lubri- cants prior to relubrica- tion under cold weather conditions. Also used for the removing of oils and greases prior to preserva- tion.	7-K-505	5 Gal	P-S-661 First choice
			7-K-525	50 Gal	51-C-1326-67 5 Gal
					51-C-1326-75 55 Gal
					7-0-2 Second choice
					7-0-145 Bulk
					7-0-145-5 5 Gal
					7-0-145-55 55 Gal
P-S-661 Dry-Cleaning Solvent	A colorless inflam- mable petroleum fraction having a f flash point of 100°F (min) and fire point of 110°F (min).	A general cleaning agent for exposed metallic sur- faces of test equipments and certain of their com- ponent parts. Attacks rubber and electrical insulation.	51-C-1326-67	5 Gal	7-0-2
			51-C-1326-75	55 Gal	7-0-145 Bulk
					7-0-145-5 5 Gal
					7-0-145-55 55 Gal
JAN-A-463 Ethyl Alcohol	An organic water soluble solvent sup- plied in 2 grades. <u>Grade I</u> -95% ethyl alcohol with no dena- turant added. <u>Grade II</u> -94.9% ethyl alcohol with 0.75% benzene added as a denaturant.	For cleaning of optics (len- ses and prisms), electrical components (contacts and relays), etc.	51-A-1965	5 Gal	P-S-661
			51-A-1972	50 Gal	51-C-1326-67 5 Gal
					51-C-1326-75 55 Gal
					NOTE: P-S-661 should not be used on optical lenses and prisms.
7-0-2 Diesel Fuel	A clear petroleum distillate with a flash point of 150°F (min), a fire point of 180°F (min) and a pour point of 0°F (max).	Flush cleaning of oil lubri- cated brackets and housings other than hydraulic sys- tems. Used generally where P-S-661 is normally employed, but leaves a slight residue.	7-0-145	Bulk	First choice P-S-661
			7-0-145-5	5 Gal	51-C-1326-67 5 Gal
			7-0-145-55	55 Gal	51-C-1326-75 55 Gal
					Second choice VV-K-211
					7-K-505 5 Gal
					7-K-525 55 Gal
O-S-571 Soda Ash	A white salt (Na) ₂ CO ₃ which is mildly alkaline, mixed with water.	As a water solution for cleaning to remove traces of salts.	51-S-2056-50	50 Lb	One pound of laundry soap added to one gallon of boiling water.
			51-S-2056-100	100 Lb	
Fingerprint Remover	A compound consist- ing of a petroleum derivative, an alco- hol, a wetting agent, and a petrolatum. It has a flash point of approximately 85°F.	Intended as a fingerprint remover and as a tempo- rary preservative. It leaves a slight residual film.	51-R-148-50	5 Gal	None approved.
JAN-A-264 Phosphoric Acid	A mixture of phos- phoric acid and butyl alcohol.	A diluted mixture of the acid and alcohol is used to remove light rust and to condition metal surfaces prior to application of pro- tective coatings.	JAN-A-264		None approved.
			51-A-1303-25	12 to 13 Gal	
AN-O-A-391 Butyl Alcohol			AN-O-A-391		
			R51-A-1857	5 Gal	
Phosphoric Acid Metal Conditioner					

5-19 Reassembly and Testing of Subassemblies and Assemblies

5-20 Reassembly is the reverse of disassembly. The tests necessary after reassembly are the same tests recited earlier in this manual in the sections on installation and operation, Chapter 2, Section III, Chapter 3, Section II, and Chapter 4, Section II.

5-21 Instructions for Testing

5-22 The only subassembly that lends itself to separate test is the Actuator Position (Counter) Degrees. The test procedure is set forth under the alignment procedures in Chapter 5, Section I.

CHAPTER 6

DRAWINGS

6-1 Design drawings used in the actual construction of the equipment are:

System Block Diagrams

Control Drum Servo System	977D694
Control Drum Actuator Checker 1402 NRX control and instrumentation	945C410
Cable interconnection diagram Control Drum Checker 1402	978D187

Console Assembly, Actuator Checker

Console Power Panel Assy.	977D698
Panel - console power	977D697
Console power panel wiring diagram and schematic	977D717
Multi-range Millivolt Meter Assy. (Mod)	977D743
Function Generator Chassis Assy. (Mod)	977D714
Panel, function generator	977D712
Signal Control Chassis Assy.	909E460
Panel - signal control chassis	909E459
Schematic diagram - signal control chassis	934J974
Chassis, assembly - signal control, control drum checker 1402	936J118
Wiring diagram - signal control chassis	928F679
Power Supply Chassis Assy.	909E465
Panel - power supply chassis	977D710
Chassis - power supply chassis	909E466
Schematic diagram, power supply chassis	977D711
Wiring diagram - power supply chassis	928F677
	(two sheets)
Console Wiring Diagram	928F663
Panel, meter and 400 cps power supply	977D742
Panel, connector	977D718
Cable assy. W1, special purpose electrical	945C951
Cable assy. W2, special purpose electrical	977D745G01
Cable assy. W3, special purpose electrical	977D745G02
Cable assy. W4, special purpose electrical	977D745G03
Cable assy. W5, special purpose electrical	977D745G04
Cable assy. W6, special purpose electrical	977D745G05
Cable assy. W7, special purpose electrical	945C939
Cable assy. W8, special purpose electrical	945C937
Cable assy. W9, special purpose electrical	945C930
Cable assy. W10, special purpose electrical	945C427G01
Cable assy. W11, special purpose electrical	945C427G02
Cable assy. W12, special purpose electrical	945C935
Cable assy. W13, special purpose electrical (branched)	977D748
Cable assy. W14, special purpose electrical	945C938
Cable assy. W15, special purpose electrical	945C924
Cable assy. W16, special purpose electrical	945C931
Cable assy. W17, special purpose electrical (branched)	977D746

Test Stand Assy.

Test stand	NT700157 Sheet 1
Handle, test stand	NT700157 Sheet 2
Clamp, test stand	NT700157 Sheet 3
Gasket, test stand	NT700157 Sheet 4
Pressure cap, test stand	NT700157 Sheet 5
Torque adapter, test stand	NT700157 Sheet 6
	NT700157 Sheet 7