TECHNICAL MANUAL

INTERMEDIATE MAINTENANCE INSTRUCTIONS

GUIDANCE SECTION
COOLER TEST REPAIR SET

PART NO. 25-33383-173
A/E47T-23

Basic and all changes have been merged to make this a complete publication.

BOEING
F42600-82-G-7501
F42600-90-D-0457
F42610-98-C-0001

Published under authority of the Secretary of the Air Force

22 FEBRUARY 2005 **CHANGE 3 2 APRIL 2008**

LIST OF EFFECTIVE PAGES

INSERT LATEST CHANGED PAGES. DESTROY SUPERSEDED PAGES.

NOTE The portion of the text affected by the changes is indicated by a vertical line in the outer margin of the page. Changes to illustrations are indicated by shaded or screened areas, or by miniature pointing hands.

Dates of issue for original and changed pages are:

Original . . . . . 0 . . . . . 22 February 2005 Change . . . . . 2 . . . . . 5 July 2006
Change . . . . . 1 . . . . . 29 June 2006 Change . . . . . 3 . . . . . 2 April 2008

TOTAL NUMBER OF PAGES IN THIS PUBLICATION IS 96 CONSISTING OF THE FOLLOWING:

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SAFETY SUMMARY

GENERAL SAFETY INSTRUCTIONS.

This manual describes physical and chemical processes, which could cause injury or death to personnel, or damage to equipment if not properly followed. This safety summary includes general safety precautions and instructions that must be understood and applied during operation and maintenance to ensure personnel safety and protection of equipment. Prior to performing any task, the WARNINGs, CAUTIONs, and NOTEs included in that task shall be reviewed and understood.

WARNINGS, CAUTIONS, AND NOTES.

WARNINGs and CAUTIONs are used in the manual to highlight operating or maintenance procedures, practices, conditions, or statements, which are considered essential to protection of personnel (WARNING) or equipment (CAUTION). WARNINGs and CAUTIONs precede the step or procedures to which they apply. WARNINGs and CAUTIONs consist of four parts: Heading (WARNING and CAUTION), a statement of the hazard, minimum precautions, and possible result if disregarded. NOTEs are used in this manual to highlight operating or maintenance procedures, practices, conditions, or statements that are not essential to protection of personnel or equipment. NOTEs may precede or follow the step or procedure, depending upon the information to be highlighted. The headings used and their definitions are as follows:

WARNING

Highlights an essential operating or maintenance procedure, practice, condition, statement, etc., which, if not strictly observed, could result in injury to, or death of, personnel or long term health hazards.

CAUTION

Highlights an essential operating or maintenance procedure, practice, condition, statement, etc., which, if not strictly observed, could result in damage to, or destruction of, equipment or loss of mission effectiveness.

NOTE

Highlights an essential operating or maintenance procedure, practice, condition or statement.

HAZARDOUS MATERIALS WARNINGS.

Hazardous material WARNINGs in this manual are used to warn personnel of Personal Protective Equipment (PPE), ventilation, fire and other hazards. If the PPE for the hazardous material has changed (ref. product MSDS) consult with Base Bioenvironmental Engineering to determine if the current T.O. PPE is adequate. If the PPE is not adequate, notify 20AF/LGM.

Hazardous Materials Description.

The following hazardous materials are used in this manual:

HFC (R134A) is an asphyxiant and contains chlorofluorocarbon (CFC). Use in a well-ventilated area. Respiratory protection is not normally required in well-ventilated area, but dense vapors in confined spaces displaces breathing air causing asphyxiation. Protective clothing should minimize exposed skin. Wear cloth-lined rubber gloves and goggles plus faceshield. Liquid coming in contact with the skin could cause frostbite. Treat frostbite by applying warm water to the affected area.

Dry lubricant is toxic and hazardous. Wear neoprene or mylar gloves and chemical goggles. Use in a well-ventilated area.

High vacuum sealant is toxic and hazardous. Wear impervious gloves and safety glasses. Use in a well-ventilated area.

Refrigerant compressor oil is a skin and eye irritant. Wear rubber or nitrile gloves and chemical workers goggles to prevent eye/hand contact. Use in a well-ventilated area. If contact with skin occurs, wash affected area with soap and water. If contact with eyes occurs, do not rub. Flush eyes with water for at least 15 minutes while holding upper and lower eyelids open to ensure complete cleansing. Wash hands with soap and water after handling oil. Keep away from excessive heat, sparks, and open flames.

Armstrong 520 adhesive is flammable and toxic. Use in a well-ventilated area. Excessive skin contact could cause drying and cracking of skin and dermatitis. Wear chemical-resistant gloves and chemical workers goggles/faceshield to prevent eye/hand contact. Wash hands with soap and water after handling. Keep away from excessive heat, sparks and open flames.

Sodium chromate is caustic, corrosive, and toxic. Respiratory protection is not required where adequate ventilation exists. Wear neoprene gloves and safety goggles/faceshield, cotton coveralls with sleeves extended into gloves, and an apron shall be worn over the coveralls. Check to see that all parts of the body are covered. Use in a well-ventilated area. If dusty situations prevail, work in ventilation hood or wear NIOSH-approved dust respirator or mask. If inhaled, remove to fresh air immediately. If contact with skin occurs, wash affected area with water immediately. If contact with eyes occurs, do not rub. Flush eyes with water for at least 15 minutes while holding upper and lower eyelids open to ensure complete cleansing; then get medical aid immediately. Wash after handling and before eating, drinking, or smoking.

A health hazard exists to personnel whenever mercury is spilled and comes in contact with the body. Should a mercury spill occur, the following health safety actions are required: wear rubber gloves during cleanup, package and dispose through local DPDO office, and contact Bioenvironmental Engineering Organization.

Ultrasonic cleaning detergent is hazardous. Detergent is a skin, eye, and inhalation irritant. Use in a well-ventilated area. Wear rubber gloves and chemical splash goggles. If contact with eyes occurs, do not rub. Flush eyes with water for at least 15 minutes while holding upper and lower eyelids open to ensure complete cleansing; if irritation persists, consult a physician. If contact with skin occurs, flush area with water for 15 minutes. Wash hands thoroughly after handling.

SAFETY PRECAUTIONS.

The following safety precautions shall be observed while performing procedures in this manual. (WARNINGs, CAUTIONs, and/or NOTEs will be repeated within this manual.)

Electrical Safety Requirements.

Rubber goods designed for protection of the technician (electrical rubber gloves with leather protective shells and rubber mats) shall be used when working on energized electrical circuits of 50 volts or more. Electrical rubber gloves with leather protective shells, rubber mats, and rubber blankets shall be used while testing energized electrical circuits of 600 volts or more. When working adjacent to electrically energized circuits in excess of 600 volts, electrical rubber blankets shall be used to cover energized equipment. Testing of energized electrical circuits shall only be done while standing on and in contact with dry surfaces. Normal troubleshooting activity involving the operation of switches, the insertion and/or removal of fuses, or testing of exposed conductors on circuits below 600 volts do not require rubber protective goods. When working adjacent to energized electrical circuits, the technician shall wear applicable safety equipment or use a rubber blanket when deemed necessary. Detailed information on rubber matting, gloves, and blankets can be found in AFOSH Standard 91-501.

Two people (buddy/buddy) within easy access of each other are required during testing, troubleshooting, or performing maintenance on energized equipment.

Lockout or tagout devices shall be attached when circuit breakers or switches are opened to perform maintenance.

After removing power from a component, verify no voltage is present prior to performing maintenance.

Actual fuse amperage ratings shall be verified prior to installation/reinstallation.

Probing Requirements.

Weapon System Specification requirements prohibit direct probing of “in-line launch critical circuits” by organizational level maintenance. The use of approved T.O. procedures to include breakout connector adapters and approved testing equipment must be strictly followed when fault isolating “in-line launch critical circuits”. Organizational maintenance may use direct probing techniques on nonlaunch critical circuits when approved by specific T.O. procedure. Technical Engineering may use direct probing techniques on nonlaunch critical circuits to perform fault isolation using schematics and normal testing techniques with approved testing equipment (appropriate T.O. and/or T.O. 21M-LGM30F-12 listed equipment). Technical Engineering will contact OO-ALC/LMEI (SELECT) if there is a question on whether or not a circuit is “in-line launch critical”.

Manual Lift Requirements.

Maintenance equipment, tools, and replacement components could be awkward and heavy to handle. Consider team lifting when items are known to weigh more than 25 pounds. All pertinent lifting factors should be considered when determining lifting requirements (i.e. individual’s strength, distance item is carried, and size and weight of the object). Any object too difficult to be lifted/carried by one person should be lifted/carried by two or more personnel or use a mechanical lift. A NOTE identifying the weight of the item to be lifted shall be placed in the procedure just prior to lifting heavy (approximately 60 pounds or more) and/or awkward items.

Summary of Warnings.

120-Vac power is present inside cabinet when power cables are connected. Serious shock hazard exists when panels are off.

Pressure is present in the hose. Faceshield and rubber gloves must be used to prevent personnel injury.

120/208 volts of power is present inside test bench. Serious shock hazard exists when panels are removed.

Do not exceed 250-psig pressure when testing PS-1 and TS-1 and make no adjustments except as specified. PS-1 and TS-1 are safety devices to protect equipment and personnel.

Summary of Cautions.

When closing test bench manual shutoff valves, the use of excessive force can damage valve seats.

S3 must be set correctly before S2 is operated to prevent damage to control valve motor.

Facility ground wire, electrical cables, and air shall be connected before operating.

Do not leave MEASURING TUBE HEATER switch on when measuring tube is empty.

Initial coolant flow shall not exceed 1.5 pounds per minute until air is forced out of coolant lines. Excessive air flow rate can damage test bench.

COMPRESSOR AIR RETURN FLOW meter shall not be allowed to exceed 2.5 cfm. Failure to comply could result in damage to flow transducer MT4.

Use two wrenches when loosening or tightening fittings to avoid stressing plumbing system.

Failure to set REFRIGERANT MEASURING TUBE HEATER switch to OFF when measuring tube is not in filled condition will overheat and damage measuring tube assembly.

CONTROL VALVE switch S3 must be set correctly before connecting control valve and operating OPEN/CLOSE switch S2.

GENERAL SAFETY PRECAUTIONS.

The following general safety precautions shall be complied with throughout this manual. (These precautions will **NOT** be repeated within the manual.)

Soldering iron is hot and solder could pop/splash. Avoid contact with tip and wear approved eye protection.

Blow drying items may be hazardous to eyes and skin. Wear goggles and ensure pressure is less than 30 psi.

Cleaning with compressed air can create an eye and/or skin hazard. Wear goggles; ensure air is regulated to less than 30 psi and do not direct the air against skin.

Do not wear metal-type jewelry when working around electronic/electrical equipment.

Shop technicians may work on low voltage circuits (electrical systems of less than 50 volts excluding the MAF and LF batteries and other high amperage systems), while energized for the purpose of testing, calibrating, troubleshooting, minor repairs, and replacement of fuses/circuit breakers. Lockout/tagout power sources whenever possible. Comply with applicable AFOSH requirements.

Sodium chromate solution is a hazardous waste. Contact Bioenvironmental Engineering Office for disposal procedures.

Minuteman Base Coding.

Code symbols are used in this manual to show which information is applicable to a particular base or group of bases. When code symbols appear in paragraph titles, illustration titles, illustration or procedural steps, the information applies only to the base(s) represented by the code symbol. Where no coding appears, the information is applicable to all base(s) covered by this manual. The following code symbols are used:

[1] Wing 1, Squadrons 1 through 3.

[1X] Wing 1, Squadron 4.

< End of coded information where not otherwise obvious

List of Related Publications

Number	Title
T.O. 00-20-3	Maintenance Processing of Reparable Property and Repair Cycle Asset Control Systems
T.O. 21M-LGM30F-01	List of Applicable Publications, LGM30 Weapon System
T.O. 21M-LGM30F-4-(Series)	LGM30F Weapon System Illustrated Parts Breakdown
T.O. 21M-LGM30F-6	Scheduled Inspection and Maintenance Requirements
T.O. 21M-LGM30F-12	Special Maintenance Safety and Electromagnetic Interference Provisions Safety Manual
T.O. 21M-LGM30F-101	Corrosion Control and Treatment
T.O. 21M-LGM30G-2-31	Weapon System Hardness Preservation and Installation Hardware

CHAPTER 1
INTRODUCTION AND GENERAL INFORMATION

1.1 INTRODUCTION.

This manual includes instructions for operation and intermediate level maintenance of the guidance section cooler test repair set A/E47T-23, Part No. 25-33383-173, hereinafter referred to as the test bench. See Figure 1-1. Operation instructions, Chapter 4, briefly describes theory of operation and includes procedures for startup, checkout, and shutdown; however, detailed use of the test bench is described in T.O. 35E9-35-22, Guidance Section Liquid Cooler Maintenance. Maintenance instructions, Chapter 5, consists of test bench checkout, troubleshooting, and repair procedures. Special tools and test equipment required for maintenance of the test bench, Chapter 2, are identified by nomenclature, number, and application. Chapter 3 describes preparation of the test bench for use and preparation for shipment.

1.2 GENERAL INFORMATION.

At all Minuteman wings, the test bench is used at the MSB as the checkout and repair facility for the guidance control section liquid cooler. The following parts can be individually connected to and operated on the test bench:

a. Coolant Chiller Unit, FRK-2/F37U-9

b. Compressor, part of FRK-2/F37U-9

c. Coolant Pump, PMK-48/F37U-9

d. Control Valve Assembly, VAK-31/F37U-9 (400 Hz)

e. Control Valve Assembly, VAK-36/F37U-22 (DC)

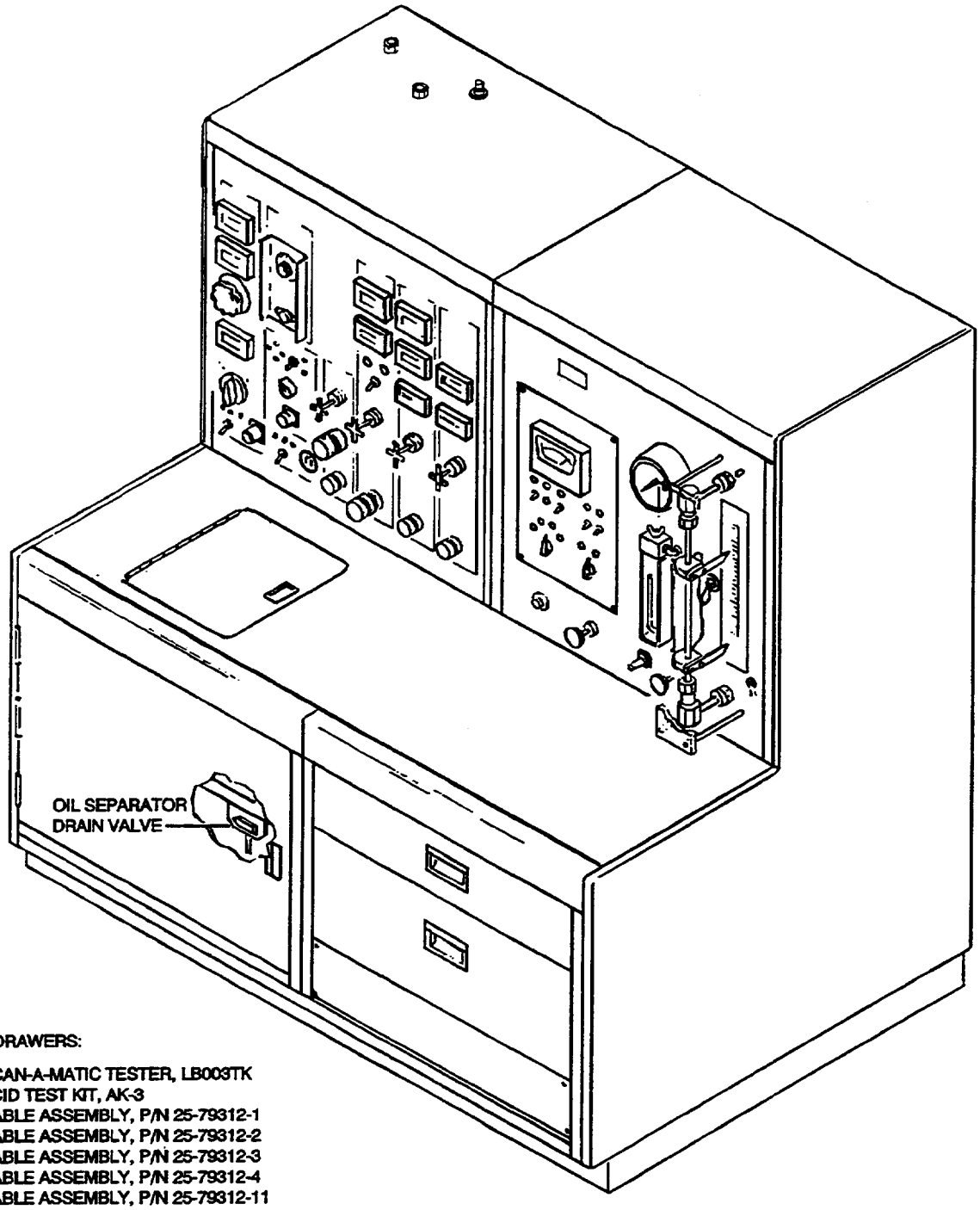
CAUTION

When closing test bench manual shutoff valves, the use of excessive force can damage valve seats.

NOTE

Before removing/replacing components, check for faulty wiring, control air leaks, and other abnormal conditions using standard maintenance practice.

1.2.1 Test Bench. The test bench features do not include provisions for maintaining the electronic control amplifier, which is tested and repaired according to T.O. 35E9-35-22. The test bench contains a supply of coolant, and it connects to compressed air which is used for purging coolant from components after test. A vacuum pump and controls are built into the test bench for evacuation of the chiller. A refrigerant supply cylinder with heater is contained in the rear of the test bench. Driving signals for the control valve assemblies' motors are electronically generated within the test bench.



IN DRAWERS:

SCAN-A-MATIC TESTER, LB003TK
ACID TEST KIT, AK-3
CABLE ASSEMBLY, P/N 25-79312-1
CABLE ASSEMBLY, P/N 25-79312-2
CABLE ASSEMBLY, P/N 25-79312-3
CABLE ASSEMBLY, P/N 25-79312-4
CABLE ASSEMBLY, P/N 25-79312-11
HOSE ASSEMBLY, P/N 25-79314-1 (2)
HOSE ASSEMBLY, P/N 25-79314-2
HOSE ASSEMBLY, P/N 25-79314-3
HOSE ASSEMBLY, P/N 25-79314-4

G0001498

Figure 1-1. Guidance Section Cooler Test Repair Set A/E47T-23

Table 1-1. Table of Leading Particulars

Guidance Section Cooler Test Repair Set	
Width	66.125 inches
Height	69.875 inches
Depth	44.0 inches
Weight	1000 pounds approximately
Input electrical service	a. 208/120 Vac 60 Hz 3Ø 20 amps
	b. 208/120 Vac 400 Hz 3Ø 10 amps
Input compressed air	100 psi

Table 1-2. List of Consumable Materials

Item	Identification	Application
Refrigerant	HFC134a	To refill 125-pound test bench cylinder.
High vacuum sealant	3M Weatherban 606-NF White Acrylic Sealant or equivalent	To seal refrigerant and vacuum connections.
Pipe joint sealing tape	3M Teflon Tape Type B or equivalent	For assembly of pipe thread tubing fittings.
Dry lubricant	Miller Stephenson MS122N/CO2, NSN 9150-01-390-1408, or MS-122B (replacement)	For assembly of straight thread tubing fittings.
Adhesive	Armstrong type 520 or equivalent	For installation of refrigerant measuring tube heating elements.
Vacuum pump oil	Super X/Flushing High Vacuum Pump Oil 5000 or equivalent	For refilling vacuum pump.
Ultrasonic cleaning concentrate detergent	MICRO-10 7930-01-300-3536 or equivalent	Used in ultrasonic cleaner.

CHAPTER 2
SPECIAL TOOLS AND TEST EQUIPMENT

2.1 GENERAL INFORMATION.

This chapter lists the test equipment and special tools for performing checkout, troubleshooting, adjustment, and repair procedures of the cooler test repair set.

2.2 ALTERNATE EQUIPMENT.

If the primary electrically-powered tool, test equipment, or item is not available, an approved alternate may be used. Alternate Air Force standard test equipment and tools may be used as follows:

NOTE

Only government furnished equipment used for official government business will be evaluated for approval as exempt power devices (refer to T.O. 21M-LGM30F-12).

a. Except when specifically designed test equipment is called for or when nuclear certified test equipment is required per the Master Nuclear Certification List (MNCL) and alternate items are not listed therein, or when the table for support equipment does not authorize the use of an alternate or equivalent item/substitute.

NOTE

Electromagnetic Interference (EMI) and Electromagnetic Compatibility (EMC) may have adverse effects on weapons system equipment or ordnance items. Weapon System Specifications and MIL-STD-461 requirements must be complied with during the selection process for identifying alternate electrically-powered tools, items, and test equipment.

b. Any substitute identified by the Test Measurement and Diagnostic Equipment (TMDE) branch, Technical Engineering (TE), or items identified by the USAF Interchangeability and Substitution (I&S) group stock list shall be forwarded to 20AF/LGM for approval. 20AF shall forward the request to OO-ALC/LME for final evaluation and approval.

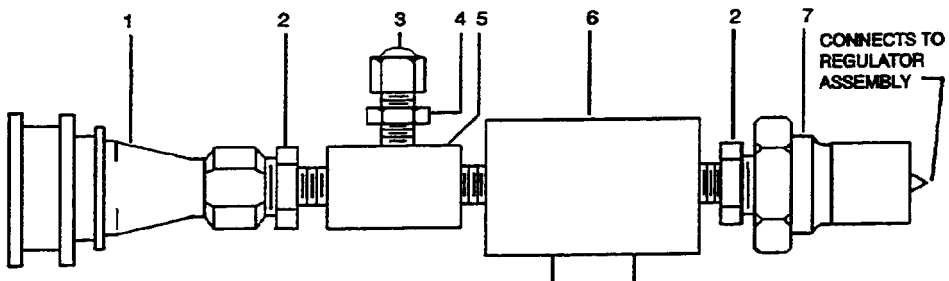
c. The same authority may be exercised by TE for all other equipment and special tools. Extreme care shall be used in selection and use of substitute (alternate) equipment to ensure weapon system or equipment degradation does not result from the use of the substitute.

2.3 TOOLS AND TEST EQUIPMENT.

The tools and test equipment used in this technical manual are listed in Table 2-1. Common hand tools required for the job are not listed.

Table 2-1. Special Tools and Test Equipment

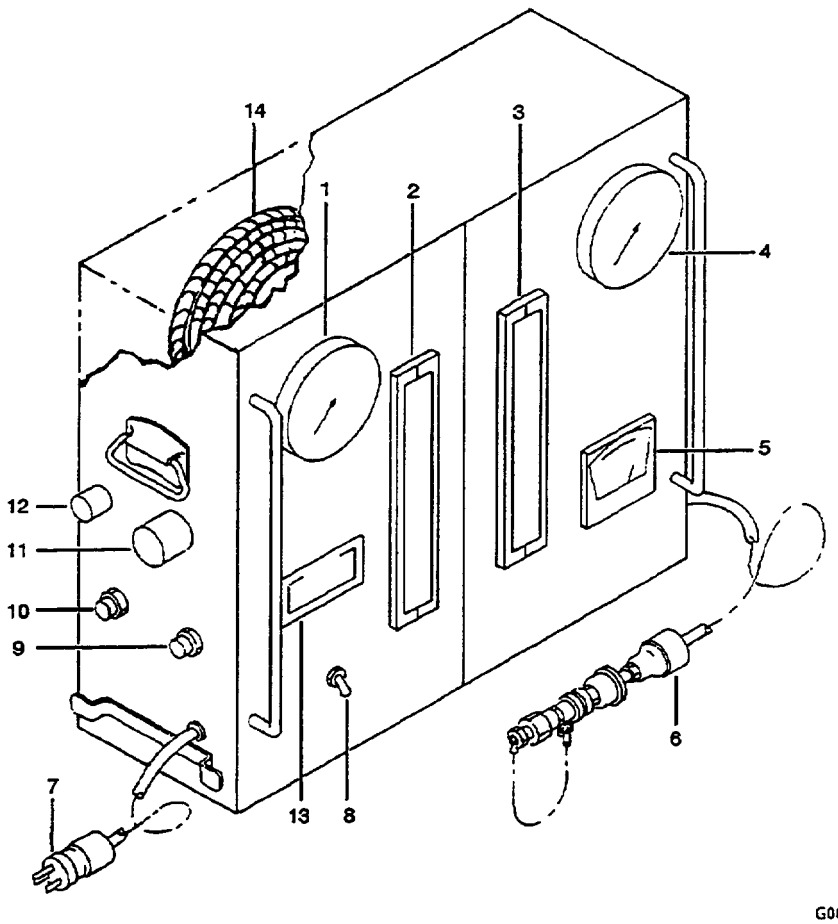
Nomenclature	Designation	Purpose
Multimeter, Digital	6625-00-005-1233 or equivalent	Voltage, resistance, and continuity measuring.
Oscilloscope with HP181A dual channel amplifier	6625-00-477-3616 or equivalent	Modulating control valve motor driving waveform measuring.
Ammeter, clamp-on type	6625-00-649-0411 or equivalent	Checkout of 400 Hz POWER AMPERAGE meter.
Frequency Counter, SAMME120	6625-00-165-2129 or equivalent	Checkout of 400 Hz POWER FREQUENCY meter.
Nitrogen Bottle, charged with 250 psig or greater dry nitrogen	--	Various pressure and flow tests.
Regulator Assembly-Compressed Gas	4820-01-018-9604 or equivalent	Nitrogen pressure control.
Nitrogen Adapter Assembly	Locally manufactured See Figure 2-1	Connects regulator to test bench.
Test Stand used with A/E47T-23	Part No. 25-79824-1	Calibration standard for checkout and adjustment of test bench meters.
Pressure Vessel, one cubic foot capacity, with shutoff valve and 10-inch length of 1/4-inch OD tubing attached	Use empty commercial 15-pound disposable freon cylinder or equivalent	Checkout of test bench charging controls.
Phase Meter	Phase Sequence Indicator, Avtron T470 6625-00-914-1022 or equivalent	Check for proper connection of 400 Hz power cable.
Halogen Leak Detector	4940-00-856-9690 or equivalent	Test for refrigerant leaks.
Printed Circuit Board Puller	MX-3626	Removal and installation of circuit board in electronic enclosure.
Connector Adapter Set	AN/GSM-94(V)	Checkout of 400 Hz power.
Shorting Plug Assembly	TRW Cinch-Jones P-304-AB with jumper wire between pins 1 and 2	Checkout of refrigerant pressure switch PS-2.
Tee, tube to swivel, swivel on run	4730-00-719-2600 or equivalent	Air regulator checkout.
Ultrasonic Cleaner	4940-01-084-4196	Used for cleaning stainless steel filter element.



LEGEND

1. QUICK DISCONNECT, B3-H21 HANSEN MFG CO. (CAGE 73992)
2. REDUCER NIPPLE, 216P-6-4 PARKER HANNIFIN BRASS DIV (CAGE 93061)
3. CAP, 64F-4 PARKER HANNIFIN BRASS DIV (CAGE 93061)
4. MALE CONNECTOR, 48F-4-4 PARKER HANNIFIN BRASS DIV (CAGE 93061)
5. STREET TEE, 2225P-4 PARKER HANNIFIN BRASS DIV (CAGE 93061)
6. NEEDLE VALVE, 1712F4Y HOKE, INC. (CAGE 28968)
7. QUICK DISCONNECT, B3-K21 HANSEN MFG CO. (CAGE 73992)

Figure 2-1. Nitrogen Adapter Assembly



LEGEND

1. COOLANT PRESSURE
2. COOLANT FLOW
3. AIR FLOW
4. AIR PRESSURE
5. VACUUM
6. VACUUM TRANSDUCER
7. POWER CORD
8. POWER SWITCH
9. AIR OUT
10. AIR IN
11. COOLANT OUT
12. COOLANT IN
13. TEMPERATURE
14. HOSE (TWO)

Figure 2-2. Test Stand Used with A/E47T-23

CHAPTER 3
PREPARATION FOR USE AND SHIPMENT

3.1 SHIPPING AND STORAGE REQUIREMENTS.

The test bench motions, such as those encountered during shipping or warehouse handling, require the following items to be removed and packaged separately:

a. Refrigerant cylinder (Figure 5-1, 76).

b. Cylinder band heater, including pressure switch PS-1 (74) and temperature switch TS-1 (75).

c. Photoelectric controller PEC-1 (56).

d. Photoelectric controller PEC-3 (55).

e. All cable, hose, adapter, and test assemblies that are part of the test bench and normally stored in the test bench drawers. See Figure 1-1.

f. The test stand assembly, Figure 2-2.

3.1.1 Vacuum Manometer Gauge. In addition, the tube sealing mechanism shall be installed in the vacuum manometer gauge, Figure 3-1, and all water shall be drained from test bench and test stand. Side panels, front door, and drawers shall be secured in place.

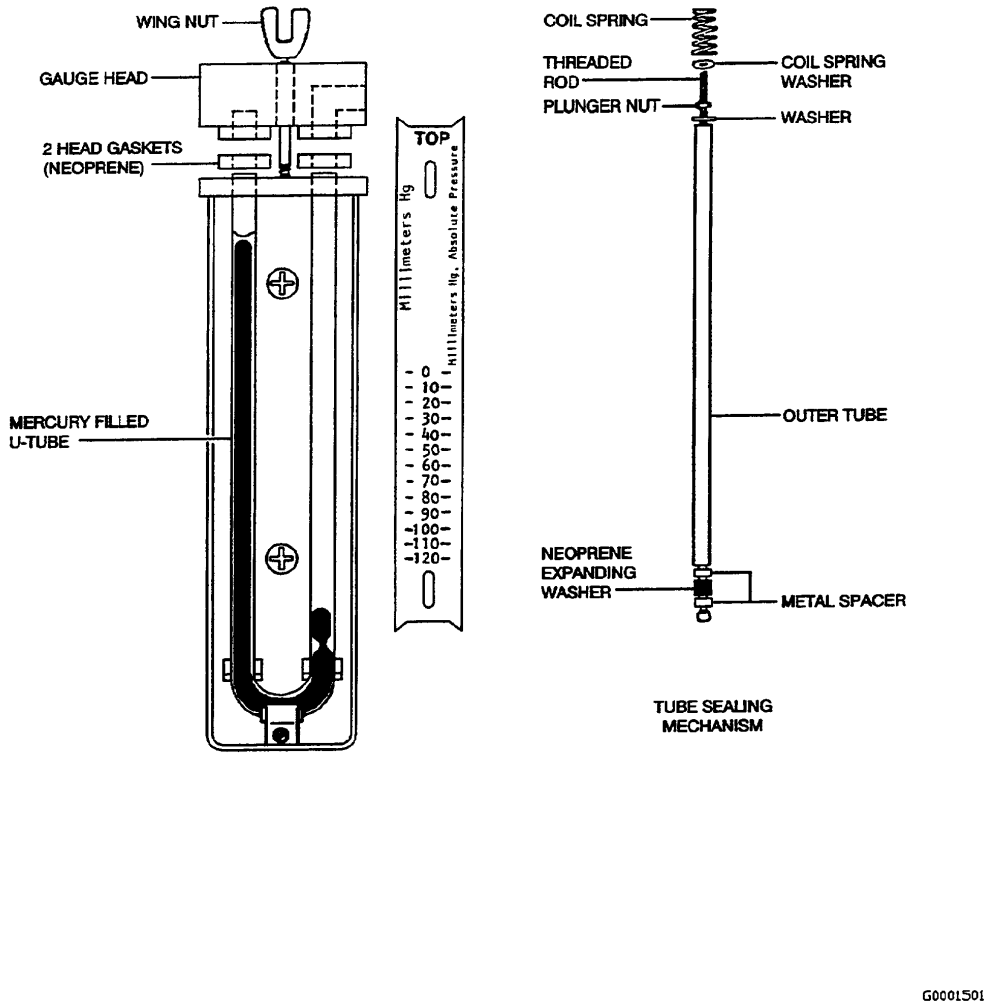


Figure 3-1. Manometer and Sealing Mechanism

3.2 PREPARATION FOR USE.

If test bench has been transported, verify receipt of all packages. Remove packaging, inspect for damage, and check items against shipping list. Verify that items listed in Paragraph 3.1 are included, and place items in Paragraph 3.1, step e, into the test bench drawers.

3.2.1 Refrigerant Cylinder Installation.

a. Install the band heater assembly onto the cylinder. Position the heater just above the cylinder base with the pressure switch aligned to the approximate direction of the refrigerant valve outlet. Snap the band clamp closed.

b. Put the blanket in place on the cylinder.

c. Put the cylinder in the test bench and align the refrigerant valve outlet approximately toward the rear cabinet centerpost.

d. Install refrigerant pressure indicator assembly onto refrigerant valve outlet with indicator and liquid eye toward the rear.

e. Install one red hose to shutoff valve V7 (Figure 5-1, 78) and to end connector of refrigerant pressure indicator assembly.

f. Install the other red hose to side connector of refrigerant pressure indicator and to pressure switch (74).

g. Connect the cable, part of (74), to J108 (58).

3.2.2 Photoelectric Controller Installation.

NOTE

The two photoelectric controllers are identical.

a. Insert one photoelectric controller (PEC-3) into J101 (Figure 5-1, 55).

b. Insert the other photoelectric controller (PEC-1) into J102 (56).

c. Verify that cables are connected to J103 through J113. If a cable is disconnected and its connector marking is not legible, refer to FO-4 for identity.

3.2.3 Manometer Gauge Preparation. The manometer U-tube is fitted with a tube sealing mechanism, Figure 3-1, which prevents mercury spillage during shipping or handling. The mechanism must be removed before the gauge can function:

a. At rear of panel, disconnect vacuum line at top of manometer and remove mounting nuts. Front scale must be removed to access bolt heads.

b. Remove wingnut, gauge head, and two neoprene gauge head gaskets from manometer.

c. Remove coil spring and washer from tube sealing mechanism. Grip end of threaded rod and back off plunger nut about 1/4 inch to reduce expanding washer at bottom end of rod.

WARNING

Potential mercury hazard exists. Be careful not to break the manometer U-tube. Failure to comply may result in personnel injury.

d. Carefully remove the sealing mechanism from the U-tube, avoiding entrainment of mercury.

e. Reassemble and reinstall manometer.

f. Store tube sealing mechanism in test bench drawer for future use.

3.2.4 Ground Connections. The test bench has two ground studs, either of which may be used. Connect facility ground to external ground stud on top or the one on the back, whichever is most convenient.

3.2.5 Electrical Power and Compressed Air.

a. Set the following circuit breakers on test bench to OFF:

400 Hz POWER CB2

60 Hz POWER CB1

60 Hz POWER CB4

b. Connect test bench cables to facility electrical power.

c. Close AIR PURGE valve and connect facility air to test bench.

3.2.6 Checkout. Proceed to Chapter 5.

3.3 PREPARATION FOR SHIPMENT.

The following procedure will prepare the test bench for transportation.

a. Disconnect the power cables, ground wire, and air hose.

b. Remove the right-rear panel.

c. Disconnect both hoses from the refrigerant pressure indicator assembly. Remove the pressure indicator assembly and both hoses from the test bench.

d. Disconnect pressure switch cable (Figure 5-1, 74) from J108 (58), and remove cylinder from test bench.

e. Remove blanket and band heater assembly from the cylinder.

f. Remove photoelectric controllers (55 and 56) from test bench.

3.3.1 Manometer Tube Sealing.

a. Locate tube sealing mechanism (Figure 3-1), normally stored in test bench drawer, and verify plunger nut is backed off enough so expanding washer is not compressed.

WARNING

Potential mercury hazard exists. Be careful not to break the manometer U-tube. Failure to comply may result in personnel injury.

b. Remove manometer by disconnecting vacuum line and two mounting nuts at rear of panel. Front scale must be removed to access bolt heads.

c. Remove wingnut, gauge head, and two neoprene head gaskets from manometer.

d. Very slowly insert sealing mechanism into right-hand leg of U-tube until it barely contacts mercury.

e. Grip end of threaded rod and tighten plunger nut until expanding washer very snugly seals U-tube.

f. Install coil spring washer, coil spring, two head gaskets, gauge head, and wingnut. Reinstall manometer.

3.3.2 Packing. Remove assemblies from test bench drawers. All items in Figure 1-1 should be accounted for. These items, special tools in Table 2-1, and items removed in Paragraph 3.3, steps c through f, are ready for packaging. Reinstall rear panel of test bench, secure drawers, door, and side panels, and bench is ready for packaging. Package and transport in accordance with applicable procedures.

CHAPTER 4
OPERATION INSTRUCTIONS

4.1 THEORY OF OPERATION.

The test bench connects to facility electrical power and compressed air within the repair shop, and operation requires the test equipment listed in Chapter 2. The test bench is otherwise self-contained since it has water and refrigerant storage tanks, and it includes all necessary cables. Refer to schematics FO-1 and FO-2 and to control panel, Figure 4-1, for the following paragraphs.

4.1.1 Electrical Power. See FO-1. Two electrical cables enter the top of the cabinet and connect to terminal blocks. Facility ground connects to a terminal atop the cabinet. One cable carries 60 Hz, 3-phase power which is routed through line filter FL1 and CB1 to the following:

a. COOLANT PUMP switch S1, which controls power to the pump motor and to the heater control panel A1. A1 receives 208 volts from phases A and B, and it controls the coolant temperature in the tank.

b. Circuit breaker CB3 in left side of cabinet, which controls input power to two dc power supply modules PS1 and PS2. These power supplies provide the necessary dc voltages to the electronic enclosure located above PS2.

c. Coolant and compressed airflow transducer interface assemblies A2 and A3.

d. All electronic digital meters M1 through M10.

e. 60 Hz POWER indicators and ac POWER outlet.

4.1.1.1 Phase Motor. The other cable carries 400 Hz, 3-phase power which is routed through line filter FL2 and CB2; the 400 Hz POWER indicators come on when CB2 is set to ON. The 400 Hz power passes through the variable transformer T1, which controls voltage amplitude, and then through the PHASE MONITOR switch S4 to J1. Connector J1 supplies power to the chiller, refrigerant compressor or coolant pump under test. The PHASE MONITOR switch selects each phase of 400 Hz power for frequency, voltage, and current readout on meters M8, M9, and M10. Meter M10 requires a current transformer T2 (electronic transducer) to match the line to the ammeter circuit.

4.1.2 Coolant System. See FO-1 and FO-2. The coolant system includes:

a. A tank fitted with a drain cock and a 240V 2000W immersion-type heater.

b. Temperature sensor RT1, which is monitored by an adjustable thermostat in the heater control panel A1, which in turn controls the heater.

c. Centrifugal pump, driven by a 120V 60 Hz motor.

d. COOLANT PUMP switch that controls power to pump motor and heater control panel.

e. Coolant filter and a manual supply valve V3, to adjust flow to chiller or control valve under test.

f. Two coolant supply line transducers RT3, MT3, which sense temperature and pressure for display on meters M6 and M7, respectively, when a control valve or entire chiller is being tested.

g. Three return line transducers RT2, MT2, and MT5 and meters M3, M4, and M5 which, respectively, sense and display temperature, pressure, and flow of coolant from unit under test. The flowmeter M5 requires linearizer A2 to match it to transducer MT5.

4.1.2.1 Coolant Supply. The chiller unit is tested by connecting it to 400 Hz power at J1 and to the coolant supply and return lines. Coolant supply temperature and flow rate are adjusted as specified, and return temperature is compared with specification. A coolant pump to be tested is mounted on top of the coolant tank connected to COOLANT IN and connected to 400 Hz power at J1. The coolant return flow is adjusted as specified and the return pressure is compared with specification. ac and dc modulating control valves to be tested are connected to COOLANT OUT, COOLANT IN, and electrical connector J2. Coolant return flow is compared to specifications when control valve is operated to fully open and to fully closed states.

4.1.3 Purge Air. See FO-1 and FO-2. Facility air from the inlet on top of the cabinet is reduced in pressure by a 20 psig regulator and routed through shutoff valve V4 to the PURGE SUPPLY connector on the control panel. The air is used to purge coolant from a chiller unit or a modulating control valve after test. When testing is completed on a chiller or control valve, the hoses are disconnected at the panel from COOLANT IN and COOLANT OUT fittings, and they are connected to PURGE SUPPLY and PURGE RETURN. Then AIR PURGE manual valve V4 is opened to force residual coolant to return to the tank.

4.1.4 Compressor Air. See FO-1 and FO-2. The compressor air originates from the compressor under test and enters the control panel at the COMPRESSOR AIR RETURN fitting. The system includes a drain valve, relief valve, and an oil separator which removes compressor oil from air being discharged inside the cabinet. Flow transducer MT4, range extender amplifier A3, and FLOWmeter M2 provide monitoring of compressor discharge. COMPRESSOR AIR RETURN manual valve V1 is used to restrict flow so compressor discharge pressure can be monitored by transducer MT1 and PRESSURE meter M1.

4.1.5 Control Valve Testing System. Coolant is connected and controlled as described above, and coolant return flow is monitored by transducer MT5, linearizer A2, and FLOWmeter M5 during control valve operation. Driving signals for ac and dc modulating control valves, Figure 4-2, FO-1 and FO-5, are generated by independent signal generators within the electronic enclosure. Power supply modules PS1/PS2 provide input power to the circuits, and CONTROL VALVE switch S3 enables the selected signal generator. Switch S3 also selects the desired signal generator output. CONTROL VALVE OPEN/OFF/CLOSE switch S3 controls the sequence of pulses generated by the dc signal generator, and it controls the inputs to both control valve types. Capacitor C20 shifts current phase for ac valve motor operation. Testing a control valve requires prior setting of S3 to prevent damaging the control valve motor. Connector J2 is the electrical input to both control valve types. When driving signals are applied to a dc valve, indicators DS5, DS6, DS7, and DS8 flicker in sequence, indicating driving signals are present and in correct order. When driving signals are issued to a 400 Hz valve, indicator DS3 or DS4 flickers to indicate that the driving signals are present and are switched to the correct motor winding.

4.1.6 Evacuation and Refrigerant Charging System. See FO-2, FO-3, and Figure 4-3. A chiller unit is charged by first evacuating it to a sufficiently low pressure and then allowing it to draw in a measured volume of refrigerant. Controls and gauges for testing, evacuating, and charging the chiller unit are on the right-hand panel. Inside the test bench are the wiring, plumbing, valves, vacuum pump, and refrigerant cylinder. A circuit breaker, 60 Hz POWER CB4, controls power to the entire evacuation and refrigerant charging system. The PANEL POWER switch, TGS-2, switches the 60 Hz, phase C to all system components except the vacuum pump; thus the pump can run when only CB4 and VACUUM PUMP switch TGS-1 are turned on. The vacuum pump evacuates the chiller, and when the pump is turned off, the vacuum break, solenoid valve SOL-B, opens to vent the pump suction preventing oil from being drawn into the chamber.

4.1.6.1 Evacuation. With VACUUM PUMP switch ON and function switch RSS-2 set to EVACUATE, solenoid valves SOL-V/V8 and SOL-P/V9 energize/open to evacuate chiller in preparation for either pressure testing or charging. Vacuum pressure can initially be monitored on the mercury manometer in both barometric and absolute. Higher vacuum pressure in millimeters of mercury, absolute (mm Hg, abs.), is monitored on the panel gauge. Since 1 inch = 25.4 mm and 1 mm = 1000 microns, a refrigerant charging vacuum of 100 microns Hg absolute is a relatively low pressure (high vacuum).

4.1.6.2 Charging. Prior to charging the refrigerant unit with refrigerant, the correct volume of refrigerant is filled into the measuring tube, and since volume is affected by temperature, the refrigerant temperature in the cylinder and measuring tube is controlled. The CYLINDER HEATER switch TGS-3 and MEASURING TUBE HEATER switch TGS-4 are turned on, and the TUBE HEATER indicator comes on until the correct pressure is attained. The CYLINDER HEATER indicator comes on but will cycle after pressure is attained. At operating pressure, PRESSURE switch PS-2 closes, energizing relay CR-H to turn off the tube heater and to enable the charging circuits. Now, when the REFRIGERANT MEASURING TUBE switch RSS-1 is momentarily set to FILL, relay CR-F closes to energize/open solenoid valve SOL-F/V11, allowing refrigerant to flow into the measuring tube. When the tube is nearly full, the upper photoelectric detector/controller valve, PD-1/PEC-1, opens CR-F to close SOL-F/SOL-E to stop the flow. With RSS-2 set to CHARGE, RSS-1 can be momentarily set to CHARGE to close relay CR-C, to energize/open solenoid valve SOL-C/V10, transferring refrigerant from measuring tube to chiller unit by vacuum pressure. The lower photoelectric detector/controller, PD-3/PEC-3, opens CR-C to close SOL-C/V10 to stop the flow after the measured volume has been transferred.

4.1.6.3 Gas Ballast and Purge. The GAS BALLAST valve V17 slightly vents the vacuum pump ahead of the discharge valves to reduce the exhaust pressure change; therefore, reducing or eliminating water condensation within the pump. Water in the vacuum pump causes oil emulsification, reduced efficiency, and discharge valve noise. However, since the ballast gas (air), at atmospheric pressure, is entering the pump chamber too much gas ballast can make it impossible to attain a very low pressure such as 100 microns Hg, abs.

4.2 OPERATION.

Operational procedures for the test bench, during the testing and maintenance of the G&C chiller unit or its components, are described in T.O. 35E9-35-22.

CAUTION

Facility ground wire, electrical cables, and air shall be connected before operating. Failure to comply may result in equipment damage.

4.2.1 Preoperational Checkout. Ensure facility ground wire, electrical cables, and air are connected. Check the drawer for the cable and hydraulic hose assemblies needed for OGE testing. Perform the preoperational checkout procedures, Table 4-1 or Table 4-2, as required, to be sure bench is operational. If any steps of the preoperational checkout fail, proceed to maintenance instructions in Chapter 5.

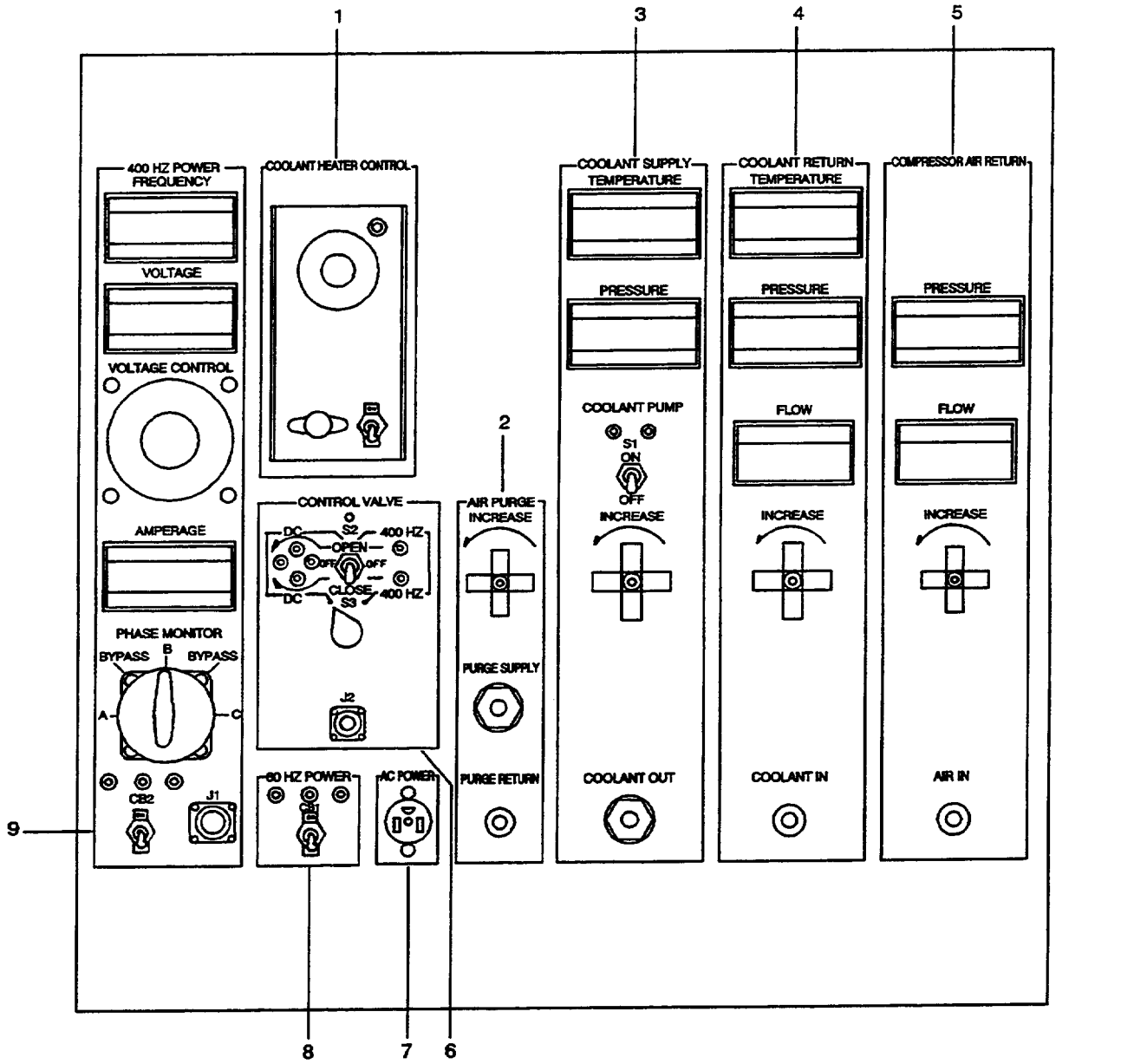


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Figure 4-1. Left Control Panel (Sheet 1 of 3)

No.	Control/Indicator	Function
1.	COOLANT HEATER CONTROL (A1)	
	Potentiometer	Adjusts temperature of water in coolant tank.
	Indicator	On during heater-on cycle.
	Switch	Controls power to heater controls when CB1 and S1 are on.
	Fuse - 15 amp	Protects circuitry in heater control panel (A1).
2.	AIR PURGE	
	Valve (V4)	Controls air to PURGE SUPPLY fitting.
	PURGE SUPPLY fitting	Connects to chiller unit or control valve to be purged of coolant.
	PURGE RETURN fitting	Returns purged coolant to tank.
3.	COOLANT SUPPLY	
	TEMPERATURE meter (M6)	Displays temperature of coolant to chiller unit or control valve under test.
	PRESSURE meter (M7)	Displays coolant pressure at input of unit under test.
	COOLANT PUMP S1 switch and indicators	Switch controls 120 volts to pump and 208 volts to heater control. Indicators are on the two phases of 208 volts.
	Valve (V3)	Controls coolant supply flow when pump is running.
	COOLANT OUT fitting	Input to chiller unit or control valve under test.
4.	COOLANT RETURN	
	TEMPERATURE meter (M3)	Displays temperature of coolant from chiller unit or control valve under test.
	PRESSURE meter (M4)	Displays coolant pressure at output of unit under test.
	FLOW meter (M5)	Indicates coolant flow rate through unit under test.
	Valve (V2)	Used to control or restrict coolant return flow.
	COOLANT IN fitting	Output from unit under test.
5.	COMPRESSOR AIR RETURN	
	PRESSURE meter (M1)	Indicates discharge pressure from compressor under test.
	FLOW meter (M2)	Indicates discharge flow from compressor under test.
	Valve (V1)	Used to control or restrict discharge of compressor under test.
	AIR IN fitting	Output from unit under test.

Figure 4-1. Left Control Panel (Sheet 2)

No.	Control/Indicator	Function
6.	CONTROL VALVE	
	Switch S2	Selects driving signals to open or close either type control valve. Normally set to OFF.
	400 Hz indicators (DS3, DS4)	OPEN or CLOSE flickers to indicate driving signals when 400 Hz control valve is operated.
	DC indicators (DS5 - DS8)	All four flicker in sequence to indicate driving signals when dc control valve is operated.
	CAUTION S3 must be set correctly before S2 is operated to prevent damage to control valve motor.	
	Switch S3	Selects type of control valve to be tested - dc or 400 HZ.
	Connector J2	Connects control valve to be tested.
7.	AC POWER outlet (J3)	120 Vac 60 Hz available when CB1 is on.
8.	60 Hz POWER	
	Indicators (DS9-DS11)	Indicate presence of each phase.
	Circuit breaker CB1	Controls all 60 Hz power to left side of test bench.
9.	400 Hz POWER	
	FREQUENCY meter (M8)	Displays frequency of selected phase.
	VOLTAGE meter (M9)	Displays RMS voltage of selected phase.
	VOLTAGE CONTROL (T1)	Adjusts voltage across load from zero to 120.
	AMPERAGE meter (M10)	Displays current through load of selected phase.
	PHASE MONITOR switch (S4)	Selects phase for display of frequency, voltage and current. BYPASS settings bypass the displays and provides isolation between phases during switching.
	Indicators (DS12 - DS14)	Indicate presence of each phase at input of voltage control.
	Circuit breaker CB2 Connector J1	Controls all 400 Hz power to test bench. Supplies power to the chiller, refrigerant compressor, or coolant pump under test.

Figure 4-1. Left Control Panel (Sheet 3)

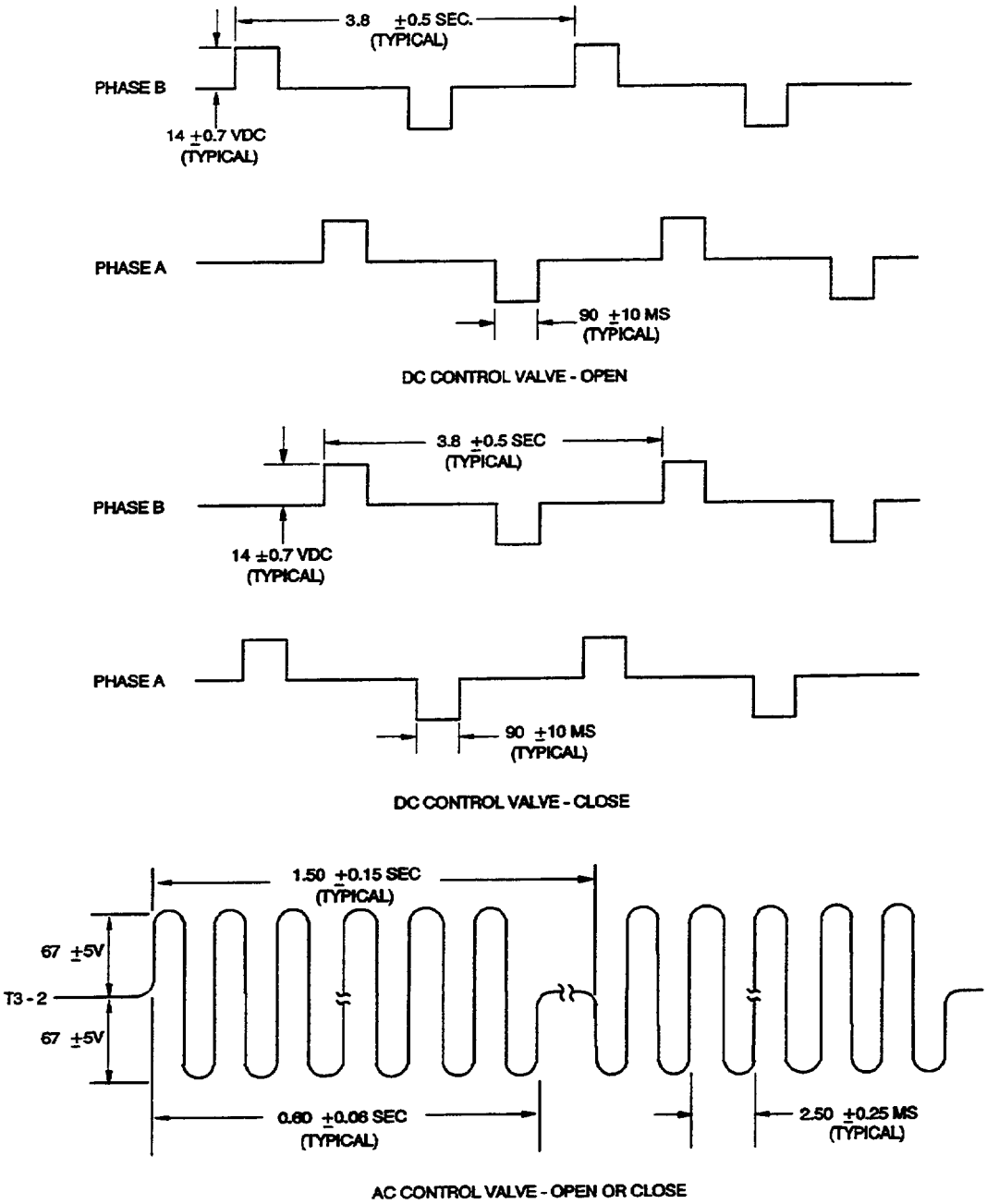

Figure 4-2. Control Valve Driving Signals

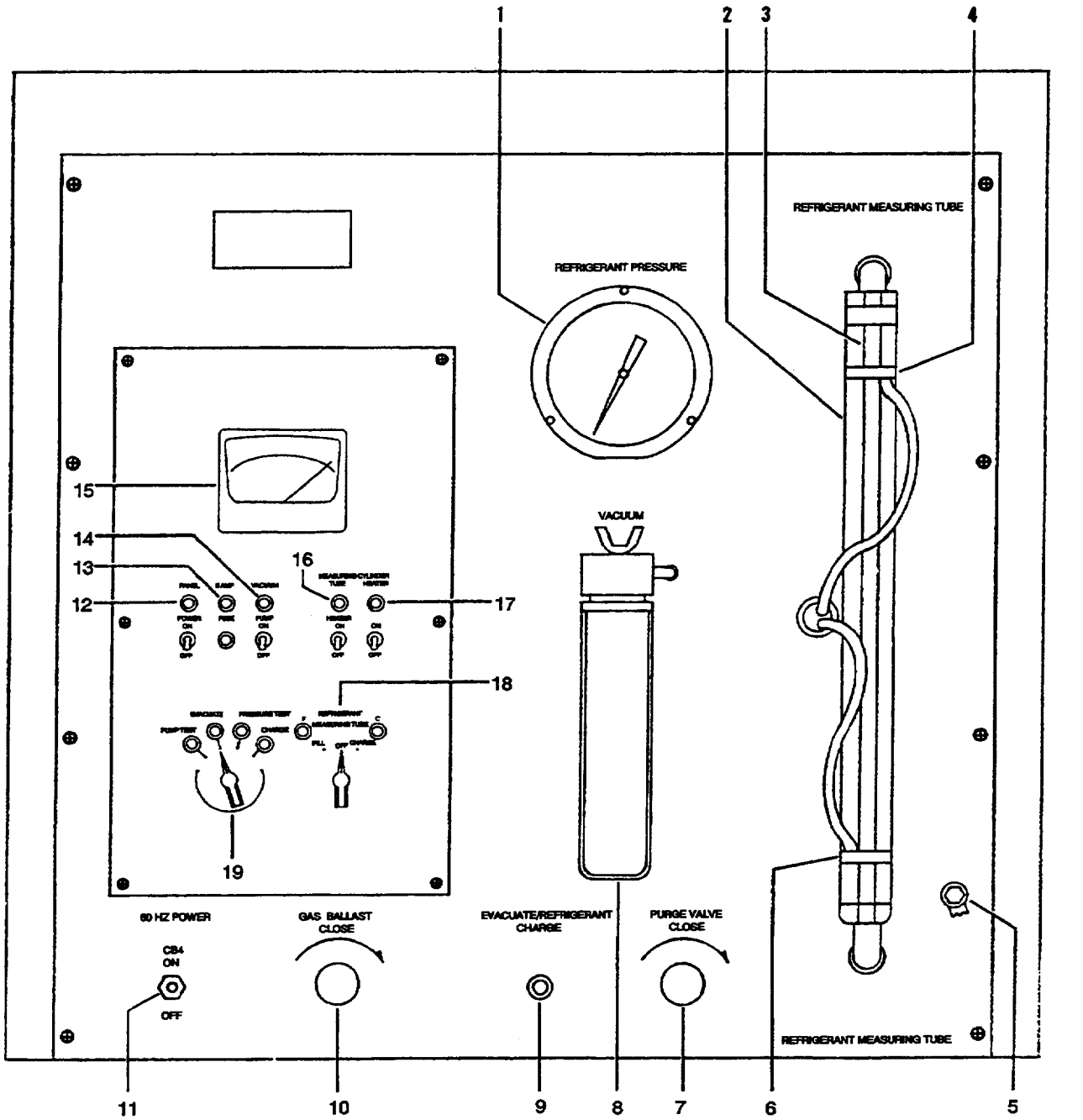

Figure 4-3. Right Control Panel (Sheet 1 of 3)

No.	Control/Indicator	Function
1.	REFRIGERANT PRESSURE gauge	Displays pressure in refrigerant measuring tube.
2.	Scale	Provides reference for adjusting the sight-gauge light beams.
3.	Sight-gauge	Displays level of refrigerant in refrigerant measuring tube.
4.	Upper sight-gauge light beam assembly (PEC-1)	Causes solenoid valves SOL-F/V11 and SOL-E/V13 to close by de-energizing relay CR-F when measuring tube is filled.
5.	Ground stud and cable	Provides grounding for equipment under test.
6.	Lower sight-gauge light beam assembly (PEC-3)	Causes solenoid valve SOL-C/V10 to close by de-energizing relay CR-C when measured volume of refrigerant has been transferred from test bench.
7.	PURGE VALVE (V5)	Provides for release of refrigerant from chiller unit and from test bench.
8.	REFRIGERANT VACUUM manometer gauge	Displays vacuum in millimeters of mercury (Hg), absolute pressure.
9.	EVACUATION/ REFRIGERANT CHARGE fitting	Connects to chiller unit for evacuation or charging.
10.	GAS BALLAST valve (V17)	Provides for ballasting the vacuum pump exhaust chamber with small amount of air to eliminate condensation.
11.	60 Hz POWER CB4 circuit breaker	Controls 120 Vac, 60 Hz power to right side of test bench - independent of CB1 on left side.
12.	PANEL POWER switch with indicator (TGS-2/NLT-2)	Switch controls 120 Vac, 60 Hz power to all controls on service station panel except VACUUM PUMP switch. Indicator comes on with power.
13.	5 AMP fuse with indicator (FU-5/NLT-5)	Provides protection of low-current circuits controlled by service station panel (not of motor or heater circuits). Indicator comes on if fuse fails.
14.	VACUUM PUMP switch with indicator (TGS-1/NLT-1)	Switch controls 120 Vac, 60 Hz power to pump motor and vacuum break solenoid valve. When motor is turned off, vacuum break valve opens to relieve vacuum in pump. Indicator comes on with pump.
15.	Vacuum gauge (M-4)	Displays vacuum at lower pressures - down to about 20 microns Hg, abs.; one micron equals 0.001 millimeter.
16.	MEASURING TUBE HEATER switch with indicator (TGS-4/NLT-4)	Switch controls power to heater control circuits. Indicator goes out when refrigerant is ready for charging, indicating charging circuits are enabled.
17.	CYLINDER HEATER switch with indicator (TGS-3/NLT-3)	Switch controls power to heater control circuits. Indicator and heater cycle OFF and ON as refrigerant temperature is maintained.

Figure 4-3. Right Control Panel (Sheet 2)

No.	Control/Indicator	Function
18.	REFRIGERANT MEASURING TUBE switch with indicators RSS-1/NLT-6, NLT-7):	Switch is spring-loaded to OFF and requires only momentary actuation. Indicators F and C come on during respective operation.
	FILL position	FILL causes solenoid valves SOL-F/V11 and SOL-E/V13 to open, filling measuring tube.
	CHARGE position	When refrigerant in measuring tube is ready, CHARGE causes solenoid valve SOL-C/V10 to open, transferring refrigerant from measuring tube to chiller unit.
19.	Function selector switch with indicators (RSS-2/NLT-8, NLT-11):	Indicator comes on for each switch position.
	PUMP TEST position	Solenoid valve SOL-V/V8 opens to connect vacuum pump suction to manometer and vacuum gauge.
	EVACUATE position	Solenoid valves SOL-V/V8 and SOL-P/V9 open to connect vacuum pump suction to gauges and to chiller unit.
	PRESSURE TEST position	Solenoid valve SOL-P/V9 opens, and SOL-V/V8 closes, so vacuum in chiller can be monitored after evacuation. Test bench can also be tested for leaks if chiller unit is not connected.
	CHARGE position	When refrigerant in measuring tube is ready, CHARGE causes solenoid valve SOL-C/V10 to open, transferring refrigerant from measuring tube to chiller unit.

Figure 4-3. Right Control Panel (Sheet 3)

Table 4-1. Preoperational Checkout - Left Panel

	Procedure	Observation
	NOTE Shop ambient temperature is required to be between 60 and 80 °F.	
1.	Set switches S1 and S2 and circuit breakers CB1 and CB2 to OFF.	
2.	Verify that coolant tank is filled two to four inches from its top with distilled water. If tank was previously drained and left empty, be sure drain valve on tank is closed.	Water should be clear and free of contamination.
	NOTE Allow test equipment to warm up for 10 minutes prior to testing.	
3.	Turn on 60 Hz POWER CB1.	Three 60 Hz POWER indicators come on. Verify all 10 digital panel meters illuminate; type of illumination is not significant.
4.	Set PHASE MONITOR switch to BYPASS.	
5.	**[1] [1X]** Set master power circuit breaker to motor generator to ON.	
6.	**[1] [1X]** Prior to power up of the motor generator, set variable power transformer to HIGH position.	
7.	**[1] [1X]** Set start switch on motor generator control box to START.	
8.	Turn on 400 Hz POWER CB2.	Three 400 Hz POWER indicators come on. VOLTAGE, FREQUENCY, and AMPERAGE meters indicate approximately zero.
	NOTE **[1] [1X]** If frequency is out of tolerance, adjust variable transformer for correct frequency. Transformer is located by 400 Hz generator.	
9.	Set PHASE MONITOR switch to A and rotate VOLTAGE CONTROL.	VOLTAGE meter indicates voltage is adjustable through range of 0 to more than 120 VOLTS AC, FREQUENCY meter indicates 400 (±10) Hz, and AMPERAGE meter indicates approximately zero.
10.	Repeat step 9 with PHASE MONITOR switch set to B and to C.	
11.	Set PHASE MONITOR switch to A.	
12.	Set VOLTAGE CONTROL to 0.	

Table 4-1. Preoperational Checkout - Left Panel - Continued

	Procedure	Observation
13.	Set PHASE MONITOR switch to BYPASS.	
14.	Set 400 Hz POWER CB2 to OFF.	
15.	**[1] [1X]** Set start-stop switch on 400 Hz motor generator control panel to STOP.	
16.	Observe meters for COOLANT SUPPLY, COOLANT RETURN, and COMPRESSOR AIR RETURN.	Flowmeters indicate approximately zero, temperature indications depend on ambient temperature, and pressure indications are not significant.
	CAUTION When closing manual shutoff valves, use of excessive force can damage valve seats.	
17.	Check the following valves for free operation and close them by turning fully clockwise: AIR PURGE COOLANT SUPPLY COOLANT RETURN COMPRESSOR AIR RETURN	
18.	Set COOLANT PUMP switch to ON.	Two COOLANT PUMP indicators come on and coolant pump can be heard or felt to be running
19.	On COOLANT HEATER CONTROL panel, set toggle switch to ON.	Indicator on COOLANT HEATER CONTROL panel may come on depending on temperature of water in tank and setting of thermostat control on panel. If necessary, increase thermostat setting to check out indicator.
20.	Turn off COOLANT PUMP and COOLANT HEATER CONTROL switches.	
21.	Set CONTROL VALVE selector switch S3 to DC; set CONTROL VALVE OPEN-OFF-CLOSE switch S2 to OPEN and to CLOSE.	Four dc indicators go on and off in correct sequence to indicate selected operation.
	NOTE If OPEN and CLOSE indicators do not come on, remove left-rear panel and verify that circuit breaker CB3 (Figure 5-1, 24) is pushed in.	
22.	Set 60 Hz POWER CB1 to OFF.	

Table 4-2. Preoperational Checkout - Right Panel

Procedure	Observation
CAUTION • Do not leave MEASURING TUBE HEATER switch on when measuring tube is empty. Equipment damage will occur. • When closing manual shutoff valves, use of excessive force can damage valve seats.	
1. Set right-hand panel controls as follows:	
60 HZ POWER CB4 - ON	Indicator on
PANEL POWER switch - ON	Indicator on
CYLINDER HEATER switch - ON	Indicator on
MEASURING TUBE HEATER switch - ON	Indicator on
MEASURING TUBE HEATER switch - OFF	Indicator off
VACUUM PUMP switch - OFF	Indicator off
PURGE valve - closed	
GAS BALLAST valve - closed	
2. Remove right-rear panels.	
3. Open LIQUID valve on freon cylinder two turns from fully closed.	
4. Open valves V6 (Figure 5-1, 82) and V7 (78) 1-1/2 turns from fully closed.	REFRIGERANT PRESSURE gauge on cylinder indicates pressure (pressure varies with temperature). Liquid eye displays liquid in line.
5. Check sight glass on vacuum pump.	Oil level must be 1/4 inch minimum above bottom of sight glass.
6. Set function selector switch to PUMP TEST.	PUMP TEST indicator comes on.
7. Turn on VACUUM PUMP switch.	VACUUM PUMP indicator comes on and vacuum pump starts. REFRIGERANT VACUUM manometer and vacuum meter indicate a vacuum pressure.

Table 4-2. Preoperational Checkout - Right Panel - Continued

Procedure		Observation
	NOTE Gas ballast should be open to prevent moisture condensation inside pump. However, if 100 microns or less cannot be attained, slowly close GAS BALLAST valve until knocking can be heard in vacuum pump. Open GAS BALLAST valve until knocking is not heard.	
8.	Open GAS BALLAST valve about two turns.	VACUUM gauge should indicate 100 microns or less within 5 minutes.
9.	Turn off VACUUM PUMP switch.	
10.	Close GAS BALLAST valve.	
11.	Set function selector switch to EVACUATE.	EVACUATE indicator comes on.
12.	Set function selector switch to PRESSURE TEST.	PRESSURE TEST indicator comes on.
13.	Set function selector switch to CHARGE.	CHARGE indicator comes on.
14.	Set CYLINDER HEATER switch to OFF.	
15.	Set PANEL POWER switch to OFF.	
16.	Set 60 Hz POWER CB4 to OFF.	VACUUM gauge pointer settles on center of three dots at right. Manometer indicates about 120 mm.
17.	Close LIQUID valve on freon cylinder.	
18.	Replace rear panels.	
19.	Check valve V13.	Valve V13 should be fully closed. Opening of V13 during charging will allow refrigerant vapor to be vented to the atmosphere.

CHAPTER 5
MAINTENANCE INSTRUCTIONS

5.1 SCOPE.

This chapter contains procedures to checkout, troubleshoot, and repair the test bench. Ordinary hand tools and the equipment listed in Table 2-1 are required. Table 5-1 through Table 5-5 include checkout of the functional test bench subsystems. If a checkout step fails, refer to a related troubleshooting step in one of Table 5-6 through Table 5-10. Troubleshooting tables are also arranged by functional subsystems, and the steps suggest faulty or out-of-adjustment part that would cause the failure. After making an adjustment, repeat the checkout step that failed. After a repair, repeat the procedure.

5.1.1 Component Location.

Refer to Figure 4-1 and Figure 4-3 for location and function of front panel components. For location of components within the test bench, refer to Figure 5-1.

5.2 REPAIR.

The Remedy column in the troubleshooting tables usually includes the procedures to make the repair, since there are no requirements beyond common shop practice.

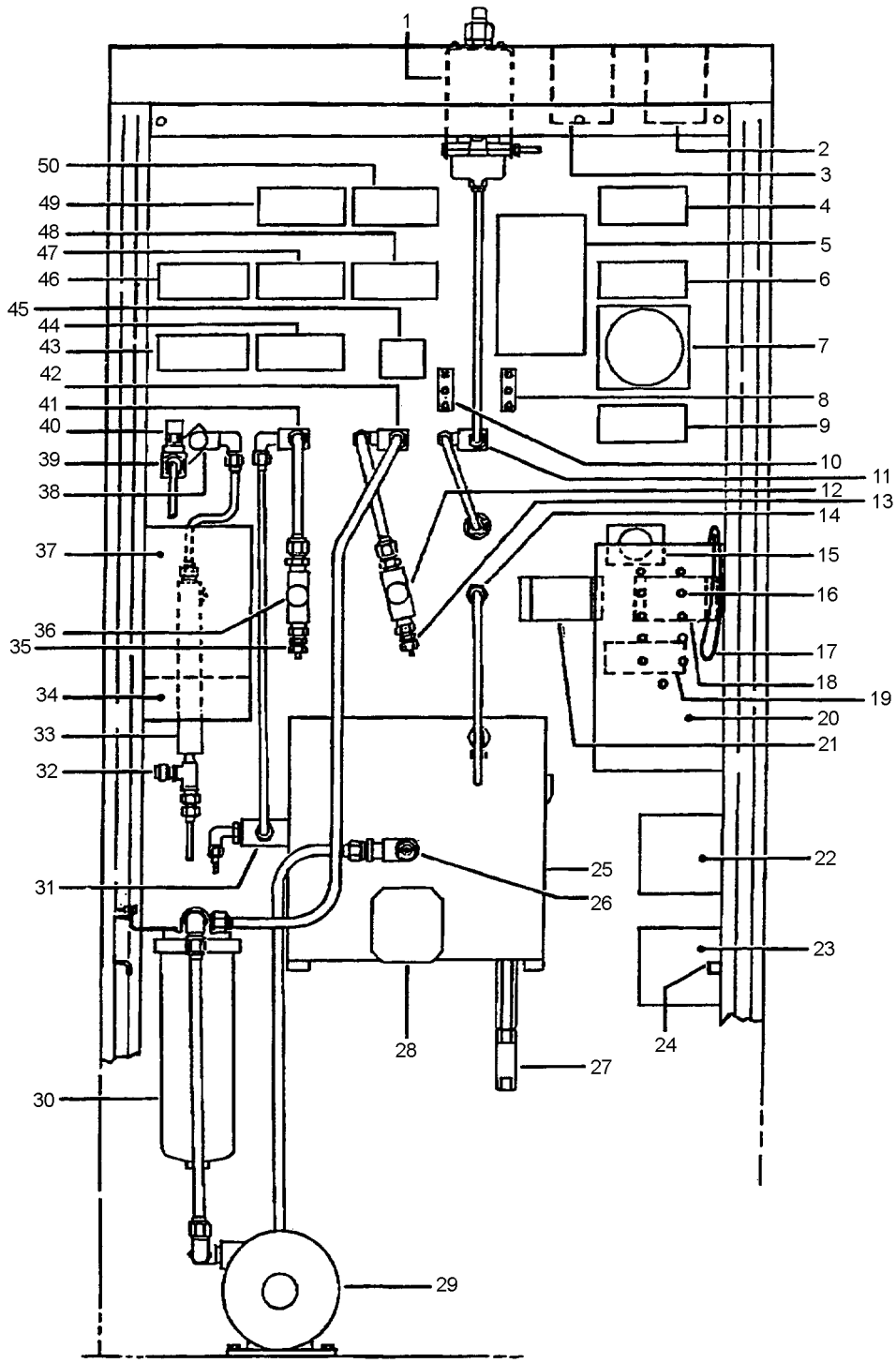

Figure 5-1. Test Repair Set Component Locations (Sheet 1 of 5)

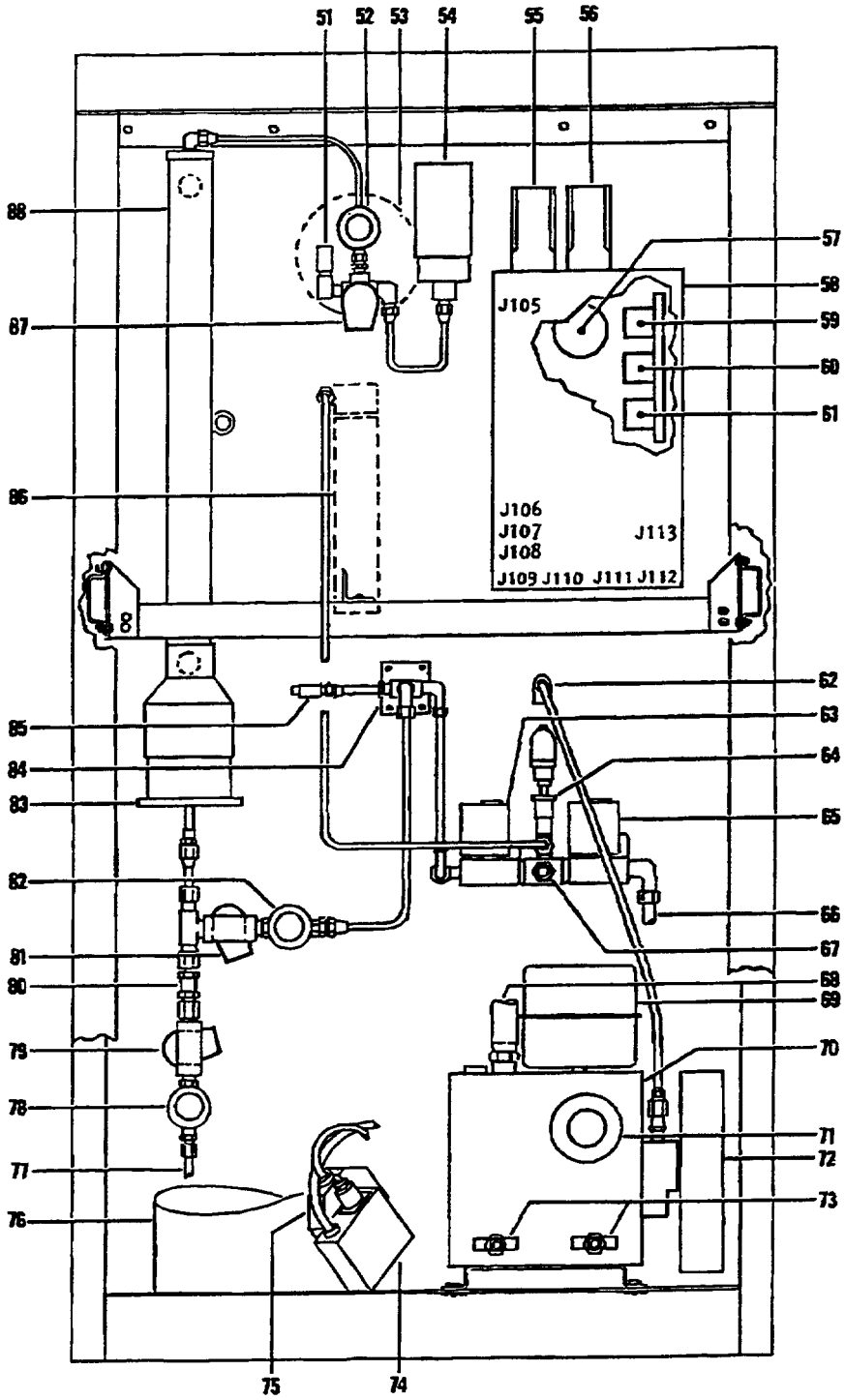

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Figure 5-1. Test Repair Set Component Locations (Sheet 2)

Number	Component
1.	V16, air pressure regulator
2.	FL1, 208 Vac 3-phase 60 Hz filter
3.	FL2, 208 Vac 3-phase 400 Hz filter
4.	M8, 400 Hz POWER-FREQUENCY meter
5.	A1, COOLANT HEATER CONTROL panel
6.	M9, 400 Hz POWER-VOLTAGE meter
7.	T1, 400 Hz POWER-VOLTAGE CONTROL transformer
8.	TB1, terminal strip - 60 Hz neutral
9.	M10, 400 Hz POWER-AMPERAGE meter
10.	TB2, terminal strip - 60 Hz phase C
11.	V4, air purge shutoff valve
12.	MT3, coolant supply pressure sensor
13.	RT3, coolant supply temperature sensor
14.	Air purge return assembly
15.	S4, 400 HZ POWER - PHASE MONITOR switch
16.	J4 through J14, test jacks for PS1, PS2, and electronic enclosure circuits
17.	Wire loop, test point for testing 400 Hz current with clamp on ammeter
18.	CB2, 400 Hz POWER circuit breaker
19.	T2, 400 Hz current transducer
20.	Electronic enclosure
21.	CB1, 60 Hz POWER circuit breaker
22.	PS2, dc power supply
23.	PS1, dc power supply
24.	CB3, circuit breaker at input of PS1 and PS2
25.	Coolant tank
26.	RT1, coolant temperature sensor
27.	Coolant tank drain valve
28.	HR1, coolant heater assembly
29.	Coolant pump and motor assembly
30.	Coolant filter

Figure 5-1. Test Repair Set Component Locations (Sheet 3)

Number	Component
31.	MT5, coolant return flow transducer
32.	V18, compressor air return relief valve - 250 psi
33.	Oil separator, compressor air return
34.	A3, range extending amplifier
35.	RT2, coolant return temperature sensor
36.	MT2, coolant return pressure sensor
37.	A2, linearizer
38.	V1, compressor air return flow transducer
39.	MT4, compressor air return transducer
40.	MT1, compressor air return pressure sensor
41.	V2, coolant return shutoff valve
42.	V3, coolant supply shutoff valve
43.	M2, COMPRESSOR AIR RETURN FLOW meter
44.	M5, COOLANT RETURN FLOW meter
45.	S1, COOLANT PUMP switch
46.	M1, COMPRESSOR AIR RETURN PRESSURE meter
47.	M4, COOLANT RETURN PRESSURE meter
48.	M7, COOLANT SUPPLY PRESSURE meter
49.	M3, COOLANT RETURN TEMPERATURE meter
50.	M6, COOLANT SUPPLY TEMPERATURE meter
51.	V14, refrigerant pressure relief valve - 235 psi
52.	V13, shutoff valve
53.	REFRIGERANT PRESSURE gauge
54.	PS-2, pressure switch
55.	PEC-3 (J101), photoelectric controller-charge (J103 top front)
56.	PEC-1 (J102), photoelectric controller-fill (J104 top front)
57.	M4, vacuum meter-adjustment screw on top
58.	PC2BA, program control center
59.	CR-H, tube heater relay
60.	CR-C, charge relay
61.	CR-F, fill relay

Figure 5-1. Test Repair Set Component Locations (Sheet 4)

Number	Component
62.	V17, GAS BALLAST valve
63.	SOL-P/V9, evacuate and pressure test solenoid valve
64.	PT-4, vacuum transducer
65.	SOL-V/V8, vacuum solenoid valve
66.	Suction line from vacuum pump
67.	Cap-test stand transducer connection
68.	Suction line to oil dropout tank and vacuum breaker solenoid valve, SOL-B
69.	Oil mist, eliminator
70.	Vacuum pump
71.	Oil level sight glass
72.	Drive belt pulley guard
73.	Oil drain valves
74.	PS-1, refrigerant cylinder pressure switch
75.	TS-1, refrigerant cylinder temperature switch
76.	Refrigerant cylinder
77.	Hose from refrigerant cylinder
78.	V7, shutoff valve
79.	SOL-F/V11, fill solenoid valve
80.	V15, check valve
81.	SOL-C/V10, charge solenoid valve
82.	V6, shutoff valve
83.	Measuring tube heater base plate
84.	EVACUATE/REFRIGERANT CHARGE fittings
85.	V5, PURGE VALVE
86.	VACUUM manometer gauge
87.	SOL-E/V12, measuring tube vent solenoid valve
88.	Measuring tube assembly

Figure 5-1. Test Repair Set Component Locations (Sheet 5)

Table 5-1. Power Checkout

Step	Operation	Normal Indication	Trouble Ref. (Table 5-6)
1.	Set 60 Hz POWER CB1 ON.	60 Hz POWER indicators come on.	1.
2.	Set START-STOP switch on 400 Hz generator control box to START.		
3.	Set 400 Hz POWER CB2 ON.	400 Hz POWER indicators come on.	1.
4.	Set PHASE MONITOR switch to A and set VOLTAGE CONTROL to acquire 120-volt indication on 400 Hz POWER VOLTAGE meter.	400 Hz POWER VOLTAGE meter M9 indicates 120 (±2.5) volts.	3.
5.	Set 400 Hz POWER CB2 OFF.		
	NOTE Allow 10-minute warm-up for digital meters in test bench.		
6.	Set PHASE MONITOR switch to BYPASS.		
7.	Connect cable 25-79312-2 to 400 Hz POWER J1.		
	NOTE Ensure that connector adapter is clocked to keyway position 2.		
8.	Connect connector adapter BACC45HR12-01P to cable end.		
9.	Connect phase meter to connector adapter pins 1, 2, 3 (phase A, B, C, respectively).		
10.	Set 400 Hz POWER CB2 ON.	Indicated phase sequence is A-B-C.	Miswiring during repair. Reverse any two of phase wires at input side of FL2.
11.	Set 400 Hz POWER CB2 OFF and disconnect phase meter from connector adapter.		
12.	Set PHASE MONITOR switch to PHASE A and connect multimeter to connector adapter pin 1 and to ground stud (Figure 4-3, 5).		

Table 5-1. Power Checkout - Continued

Step	Operation	Normal Indication	Trouble Ref. (Table 5-6)
13.	(Deleted)		
14.	Set 400 Hz POWER CB2 ON and vary VOLTAGE CONTROL knob.	Voltage varies smoothly from about zero to at least 120 Vac.	2.
	NOTE If using a multimeter capable of reading frequency, steps 19 and 20, may be performed in conjunction with the performance of steps 15 and 16. If completed this way, disregard performing steps 17 and 18, and proceed to step 21 after correct indications are obtained for both voltage and frequency readings.		
15.	Set VOLTAGE CONTROL to acquire 120 volt indication on multimeter.	400 Hz POWER VOLTAGE meter M9 indicates 120 (±2.5) volts.	3.
16.	Repeat steps 14 and 15 for phases B and C at connector adapter pins 2 and 3, respectively.		3.
17.	Set 400 Hz POWER CB2 OFF and disconnect multimeter from connector adapter.		
18.	Set PHASE MONITOR switch to PHASE A and connect frequency counter to connector adapter pin 1 and to ground cable.		
19.	Set 400 Hz POWER CB2 ON and Set VOLTAGE CONTROL knob to 120 Vac.	Indications on frequency counter and 400 Hz POWER FREQUENCY meter M8 are within 3 Hz.	3.
20.	Repeat steps 18 and 19 for phases B and C at connector adapter pins 2 and 3, respectively.		
21.	Set VOLTAGE CONTROL fully counterclockwise.		
22.	Set 400 Hz POWER CB2 OFF and disconnect frequency counter, connector adapter.		
23.	Connect chiller unit for load at end of cable 25-79312-2. Connect ground cable (Figure 4-3, 5) to chiller unit.		
24.	Connect clamp-on ammeter onto wire loop (Figure 5-1, 17) in rear of test bench.		

Table 5-1. Power Checkout - Continued

Step	Operation	Normal Indication	Trouble Ref. (Table 5-6)
25.	Turn on 400 Hz POWER CB2 and slowly adjust VOLTAGE CONTROL to acquire 120 (±2.0) volt indication on 400 Hz POWER VOLTAGE meter.		
26.	Measure all three phases by selecting with PHASE MONITOR switch.	Indications on clamp-on meter and 400 Hz AMPERAGE meter are within 0.5 amp.	3.
27.	Set 400 Hz POWER CB2 OFF. Disconnect and store chiller unit and cable.		

Table 5-1. Power Checkout - Continued

Step	Operation	Normal Indication	Trouble Ref. (Table 5-6)
28.	Set VOLTAGE CONTROL fully counterclockwise.		
29.	Set START-STOP switch on 400 Hz generator control box to STOP.		
30.	Turn off CB1, unless other maintenance is being performed.		
31.	In rear of test bench, ensure CB3 (24) is on.		
32.	Using multimeter, measure dc voltage at test point J4 (16) with reference (- lead) to J14.	+5.3 (±0.02) Vdc.	4.
33.	Measure dc voltage at test point J5 with reference to J14.	+15.0 (±0.1) Vdc.	4.
34.	Measure dc voltage at test point J6 with reference to J14.	-15.0 (±0.1) Vdc.	4.
35.	Measure dc voltage at test point J7 with reference to J14.	+12.0 (±0.1) Vdc.	4.

Table 5-2. Control Valve Driver Circuit Checkout

Step	Operation	Normal Indication	Trouble Reference (Table 5-7)
	CAUTION CONTROL VALVE switch S3 shall be set correctly before connecting control valve and operating OPEN/CLOSE switch S2. Failure to comply could result in damage to valve and test bench.		
	NOTE If directed to this procedure as a result of maintenance, perform power checkout, Table 5-1, before proceeding.		
1.	Set 60 Hz POWER CB1 to ON.		
	NOTE • Allow test equipment to warm up for 10 minutes prior to testing. • Perform steps 2 through 10 if dc type control valve is available.		
2.	Hook up control valve assembly per T.O. 35E9-35-22.		
3.	Set CONTROL VALVE switch S3 to DC.		
4.	Set OPEN-OFF-CLOSE switch S2 to CLOSE.	Control valve stop pin moves toward the closed position until fully closed.	
5.	Set OPEN-OFF-CLOSE switch S2 to OFF.		
6.	Connect oscilloscope channel 1 to J9 and channel 2 to J8 (Figure 5-1, 16). Connect oscilloscope signal ground to J14.		
7.	Connect dc control valve VAK-36/F37U-22 to J2 using cable 25-79312-4.		

Table 5-2. Control Valve Driver Circuit Checkout - Continued

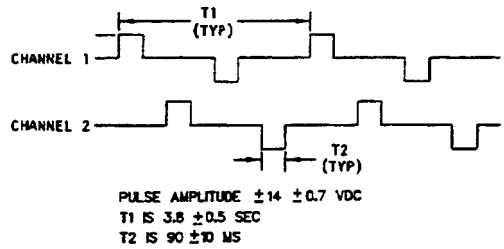
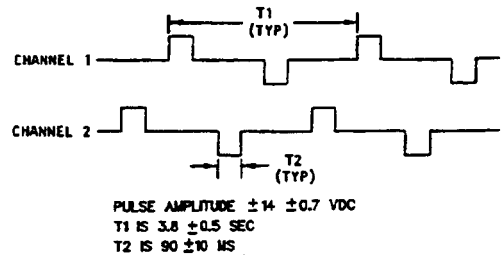
Step	Operation	Normal Indication	Trouble Reference (Table 5-7)
8.	Set OPEN-OFF-CLOSE switch S2 to OPEN.	CONTROL VALVE dc indicators cycle in OPEN sequence. Valve opens. Oscilloscope display as shown below. Disregard distortion, overshoot, and spikes in display. 	1, 2, 3.
9.	Set OPEN/CLOSE switch S2 to CLOSE.	CONTROL VALVE dc indicators cycle in CLOSE sequence. Valve closes. Oscilloscope display as shown below. 	1, 2, 3.
10.	Set OPEN/CLOSE switch S2 to OFF, and disconnect dc control valve and oscilloscope.		

Table 5-3. Coolant System Checkout

Step	Operation	Normal Indication	Trouble Ref (Table 5-8)
	NOTE Prior to making any hose connections with hose assemblies, inspect quick-disconnect fittings and hoses for ease of operation and visible defects, including debris.		
1.	Connect test stand to test bench with two 25-79314-1 hoses; test stand COOLANT IN to COOLANT OUT and test stand COOLANT OUT to COOLANT IN.		
2.	Plug test stand power cable into ac POWER receptacle (Figure 4-1, 7) on test bench, and set test stand power switch to on.		
3.	Close COOLANT RETURN valve by turning fully clockwise.		
4.	Set COOLANT HEATER CONTROL switch OFF, turn CB1 ON, and set COOLANT PUMP switch S1 ON.	COOLANT PUMP indicators come on.	1.
	NOTE Allow test equipment to warm up for 10 minutes prior to testing.		
5.	Open COOLANT SUPPLY valve about one turn.		

Table 5-3. Coolant System Checkout - Continued

Step	Operation	Normal Indication	Trouble Ref (Table 5-8)
	CAUTION Flow meters are normally not damaged by reasonable excess in fluid velocity or hydraulic shock, provided it is full of fluid. Excessive overspeed of a dry transducer may cause damage to test bench flow meter. **NOTE** • Momentary fluctuation of indicator meter is normal, provided above caution is observed. • On test stand coolant flow rotameter gauge, read scale opposite bottom of flare on moving indicator.		
6.	Very slowly turn COOLANT RETURN valve counterclockwise to attain flow rate of about 1 pound per minute. Wait 1 minute to be sure all air is forced from coolant lines.	COOLANT RETURN FLOW indication increases to 1 pound per minute and pump can be heard running.	1.
7.	Open COOLANT SUPPLY valve.		

Table 5-3. Coolant System Checkout - Continued

Step	Operation	Normal Indication	Trouble Ref (Table 5-8)
8.	Adjust COOLANT RETURN valve for a minimum of 5 pounds per minute flow and a minimum of 14 (±3) psig on COOLANT SUPPLY PRESSURE meter on test bench.	A minimum of 5 pounds per minute flow and a minimum of 14 (±3) psig indicated on test stand meters.	2.
	NOTE If MR1000 type flow meter is installed in test bench, meter will display reading to the thousandths place (three decimal places). Reading shall be rounded to the hundredths place (two decimal places).		
9.	Adjust test bench valves for test stand indications of 1.0 (±0.2), 3.0 (±0.2), and 5.0 (±0.2) pounds per minute coolant flow.	Test bench COOLANT RETURN FLOW meter indicates within 0.45 pound per minute of each test stand indication.	5.
	NOTE COOLANT RETURN valve may require slight opening to attain required pressure, but do not exceed 0.5 pound per minute on test stand flow gauge.		
10.	Close COOLANT RETURN valve and adjust COOLANT SUPPLY valve for test stand pressure indications of 5 (±0.5), 10 (±0.5), and 15 (±0.5) psig.	Test bench COOLANT SUPPLY PRESSURE meter M7 indicates within 0.5 psig of each test stand indication.	4.
		Test bench COOLANT RETURN PRESSURE meter M4 indicates within 0.5 psig of each test stand indication.	3.
11.	Adjust test bench coolant control valves for four to 5 pounds per minute flow at not less than 10 psig as indicated by test stand. After two-minute wait for stabilization, read test stand temperature.	COOLANT SUPPLY TEMPERATURE meter M6 indicates within 0.4 °F of test stand temperature.	7.
		COOLANT RETURN TEMPERATURE meter M3 indicates within 0.4 °F of test stand temperature.	6.

Table 5-3. Coolant System Checkout - Continued

Step	Operation	Normal Indication	Trouble Ref (Table 5-8)
11. - Cont	**NOTE** Prior to next step, COOLANT SUPPLY TEMPERATURE must indicate less than 80 °F. If necessary, turn off COOLANT PUMP switch S1. Drain and refill coolant tank with cool distilled water to within two to four inches from top. Turn on S1.		
12.	Adjust flow for 2 to 3 pounds per minute at not less than 10 psig as indicated on test stand. Note that COOLANT SUPPLY TEMPERATURE indicates less than 80 °F. Record the temperature.		
13.	Turn on COOLANT HEATER CONTROL switch and adjust dial to a setting 10 °F above temperature recorded in step 12.	COOLANT SUPPLY TEMPERATURE indicates the dial setting (±3) degrees within 25 minutes.	8.
14.	After 25 minutes, turn off COOLANT HEATER CONTROL and COOLANT PUMP switches.		
15.	Close COOLANT SUPPLY and COOLANT RETURN valves.		
16.	Close AIR PURGE valve fully clockwise.		
17.	Verify facility air is connected to test bench.		
18.	Disconnect hose 25-79314-1 from test bench COOLANT SUPPLY and connect it to AIR PURGE SUPPLY.		
19.	Disconnect other hose 25-79314-1 from test bench COOLANT RETURN and connect it to PURGE RETURN.		
20.	Slowly open AIR PURGE valve to purge coolant from test stand. With valve fully open, purge for 5 minutes or until test stand rotameter appears dry.	Air bubbles in test stand flow gauge indicate coolant has been returned to test bench tank.	
21.	Disconnect and store hose assemblies.		

Table 5-4. Air Regulation Checkout

Step	Operation	Normal Indication	Trouble Ref (Table 5-9)
1.	Verify facility air is connected to test bench.		
2.	Set 60 Hz POWER CB1 on.		
	NOTE • Allow test equipment to warm up for 10 minutes prior to testing. • Prior to making any hose connections with hose assemblies, inspect quick-disconnect fittings and hoses for ease of operation and visible defects, including debris.		
3.	Connect hose assembly 25-79314-1 from AIR PURGE SUPPLY to test stand COOLANT IN.		
4.	Connect hose assembly 25-79314-1 to test stand COOLANT OUT, and leave other end disconnected.		
5.	Slowly open AIR PURGE valve.	Test stand COOLANT PRESSURE gauge indicates 20 (±2) psig.	1.
6.	Close AIR PURGE valve.		
7.	Connect free end of hose assembly 25-79314-1 to test bench PURGE RETURN to relieve pressure.		
8.	Remove and store hoses.		
9.	Verify the following valves are closed: COMPRESSOR AIR RETURN, nitrogen cylinder LIQUID, nitrogen regulator.		
10.	Connect nitrogen regulator through nitrogen adapter assembly (Figure 2-1) and hose assembly 25-79840-1 to test stand AIR IN.		
11.	Connect hose assembly 25-79314-2 to test stand AIR OUT and to test bench COMPRESSOR AIR RETURN AIR IN.		

Table 5-4. Air Regulation Checkout - Continued

Step	Operation	Normal Indication	Trouble Ref (Table 5-9)
	CAUTION COMPRESSOR AIR RETURN FLOW meter shall not be allowed to exceed 2.5 CFM. Failure to comply could result in damage to flow transducer MT4.		
	NOTE • Test stand or test bench should not exceed 225 psig. Pressure relief valve may open. • When reading airflow rotameter on test stand, scale opposite center of ball in indicator should be used.		
12.	Verify test stand PRESSURE gauge indicates 0.0 (±2.0) psig. Slowly open nitrogen valve and adjust regulator for test stand PRESSURE gauge indications of 50 (±3) and 100 (±4) psig. COMPRESSOR AIR RETURN valve may be opened slightly for fine adjustment.	COMPRESSOR AIR PRESSURE meter M1 indicates within 5 psig of test stand at each pressure setting.	2.
13.	Close nitrogen cylinder valve and bleed pressure from COMPRESSOR AIR RETURN VALVE.		
14.	Connect nitrogen source through a hose to a tee fitting and then to test stand COOLANT IN.		
15.	Connect open end of tee (step 14) through a shut off valve to the test stand AIR IN. Close the shut off valve.		
16.	On test bench, fully open COMPRESSOR AIR RETURN valve.		
17.	Adjust nitrogen source pressure to 10 to 15 psig indication on test stand COOLANT pressure gauge. NOTE: It may be necessary in the following step to maintain 10 to 15 psig on test stand COOLANT pressure gauge in steps 18 and 20.		
18.	Slowly open valve (step 15) for 0.5 (±0.2) ACFM indication on test bench COMPRESSOR AIR RETURN FLOW meter.		

Table 5-4. Air Regulation Checkout - Continued

Step	Operation	Normal Indication	Trouble Ref (Table 5-9)
19.	(Deleted)		
20.	Slowly open valve (step 15) for 1.5 (±0.2) ACFM indication on test bench COMPRESSOR AIR RETURN FLOW meter.		
21.	Record the following readings: Test STAND Airflow Test BENCH compressor air return flow Test STAND coolant pressure		
22.	Reduce nitrogen source pressure to 0 psig.		
23.	Compute readings taken in step 21 as follows:		

$$\frac{\text{Actual indication on test stand airflow meter, corrected with calibration chart attached to test stand} \quad (.97)\ (\text{Local barometric pressure in Hg})}{29.92} = \text{Test stand (Corrected)}$$

$$\text{Actual test bench reading} \sqrt{\quad} .97 \left(\frac{\text{Local barometric pressure} + \left(\text{test stand coolant pressure} \right) \left(2.04 \right)}{29.92} \right) = \text{Test bench (Corrected)}$$

Table 5-4. Air Regulation Checkout - Continued

Step	Operation	Normal Indication	Trouble Ref (Table 5-9)
24.	Compute sea level flow rate for the test STAND and test BENCH flow meters as follows:		
	$\text{Test bench (Corrected)} \times \frac{\text{Local barometric pressure in Hg}}{29.92} = \text{Test bench (Sea level)}$		
	$\text{Test stand (Corrected)} + \sqrt{\frac{\text{Local barometric pressure in Hg}}{29.92}} = \text{Test stand (Sea level)}$		
25.	Test Bench (Sea level) and Test Stand (Sea level) shall agree within (± 0.2).	Within tolerance	2.
26.	Close COMPRESSOR AIR RETURN valve.		
27.	Disconnect all hoses connection nitrogen source; test bench and test stand.		
28.	Turn off nitrogen regulator, close nitrogen valve and close COMPRESSOR AIR RETURN VALVE.		
29.	Disconnect all hoses. Remove tee from hose assembly 25-79314-1 and reinstall nipple removed in step 14. Store hose assemblies and tee.		

Table 5-5. Refrigeration Controls Checkout

Step	Operation	Normal Indication	Trouble Reference (Table 5-10)
	WARNING • 120-Vac power is present inside cabinet when power cables are connected. Serious shock hazard exists when panels are off. Failure to comply may result in personnel injury. • Do not exceed 235-psig pressure during the following tests. Relief valve may open. Failure to comply may result in personnel injury.		
	NOTE Schematics FO-2 and FO-3 illustrate plumbing and electrical refrigerant controls by nomenclature, function, and number. These identifying numbers are nonstandard but agree with engineering data supplied to depot and are useful here for checkout and troubleshooting.		
1.	Verify CB4 is set to OFF. Disconnect refrigerant cylinder heater cable P108 (Figure 5-1, 58) from J108 in rear of test bench.		
2.	Connect multimeter across cable connector P108 pins X and Y. (Pin Y is crossways, and pin X is next to Y clockwise when viewing P108 pins.)	Multimeter indicates less than one ohm resistance.	1.
3.	Ensure that both refrigerant cylinder valves are closed.		
4.	Remove cap (Figure 2-1, 3) from nitrogen adapter assembly, and connect assembly to nitrogen regulator.		
	WARNING Pressure is present in the hose. Faceshield and leather gloves must be used to prevent personnel injury.		
5.	Close valve V7 and close the in-line shutoff valve on the end of supply tank hose (Figure 5-1, 77).		

Table 5-5. Refrigeration Controls Checkout - Continued

Step	Operation	Normal Indication	Trouble Reference (Table 5-10)
	NOTE If using self-sealing hoses, perform step 6, then proceed to step 8. If not using self-sealing hoses, proceed to step 7.		
6.	Disconnect hose (Figure 5-1, 77) from in-line shutoff valve. Connect hose to reclaimer and reclaim per manufacturer's instructions.		
7.	Disconnect the in-line shutoff valve from V7. Connect reclaimer system to in-line shutoff valve with another refrigeration hose. Open in-line shutoff valve and reclaim in accordance with reclaimer manufacturer's instructions. Remove in-line shutoff valve and hose from reclaimer.		
8.	Connect reclaimer system to EVACUATION/CHARGE port on the front of the test bench. Set 60 Hz power CB4 to ON.	60 HZ POWER indicator on.	Table 5-6, step 1.
9.	Turn TGS-2 (PANEL POWER SWITCH) to ON.	PANEL POWER indicator NLT-2 on.	4, 5.
10.	Set RSS-1 (REFRIGERANT MEASURING TUBE SWITCH) selector switch to FILL.	RSS-1 FILL indicator on.	
11.	Reclaim from test bench plumbing and fill tube in accordance with reclaimer manufacturer's instructions.		
12.	Set TGS-2 (PANEL POWER SWITCH) to OFF.	All indicator lights off. Switch RSS-1 repositions to OFF.	
13.	Connect hose (77) to uncapped fitting on nitrogen adapter assembly (Figure 2-1, 3).		
14.	Connect hose assembly, Part No. 25-79840-1, from test stand AIR IN to nitrogen adapter assembly.		
15.	Connect hose assembly, Part No. 25-79840-2, to test stand AIR OUT, and leave quick-disconnect end free.		
16.	Apply nitrogen and vary pressure by releasing pressure at nitrogen source; monitor both multimeter and test stand AIR PRESSURE gauges.	Resistance increases to greater than 1 megohm with pressure increase to 126 to 150 psig and returns to less than one ohm when pressure falls below 126 psig.	2.

Table 5-5. Refrigeration Controls Checkout - Continued

Step	Operation	Normal Indication	Trouble Reference (Table 5-10)
17.	Adjust PS-1, if required, and retest if adjusted.		
18.	Disconnect multimeter and turn off nitrogen source. Reconnect connector P108.		
19.	Disconnect hose (Figure 5-1, 77) slowly to bleed pressure from nitrogen adapter assembly; replace cap (Figure 2-1, 3), and reconnect hose to valve V7. Open in-line shutoff valve fully and valve V7 1-1/2 turns from fully closed position.		
20.	Disconnect P105 from J105 located on program control center (Figure 5-1, 58) in rear of test bench, and connect shorting plug assembly, Part No. P-304-AB (Table 2-1), into J105.		
21.	Connect reclaimer system to EVACUATE/REFRIGERANT CHARGE outlet on front of test bench. Prepare reclaimer to accept freon as per manufacturer's instructions.		
22.	Set PANEL POWER switch TGS-2 to ON.	PANEL POWER indicator NLT-2 on.	4, 5.
23.	Loosen thumbscrews on lower sight-gauge light beam assembly (Figure 4-3, 6) and insert a piece of black paper between sight-gauge and rounded half of light beam assembly.		
24.	Set selector switch RSS-2 (Figure 4-3, 19) to CHARGE.	CHARGE indicator NLT-11 on.	4.
25.	Turn on MEASURING TUBE HEATER switch TGS-4.	MEASURING TUBE HEATER indicator NLT-4 may flash on momentarily when TGS-4 is turned on.	
26.	Momentarily set REFRIGERANT MEASURING TUBE switch RSS-1 to CHARGE, and then turn off MEASURING TUBE HEATER switch TGS-4.	REFRIGERANT MEASURING TUBE C indicator NLT-6 comes on and stays on.	4, 14.
27.	Reclaim in accordance with reclaimer manufacturer's instructions, ensure refrigerant pressure gauge on test bench has registered zero. Remove reclaimer hose from EVACUATE/REFRIGERANT CHARGE outlet.		

Table 5-5. Refrigeration Controls Checkout - Continued

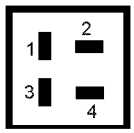
Step	Operation	Normal Indication	Trouble Reference (Table 5-10)
	NOTE Pins are numbered as follows when viewing P105 contacts:  		
28.	Connect multimeter across P105 pins 1 and 2.	Multimeter indicates greater than 1 megohm resistance.	3.
29.	Resistance decreases to less than one ohm when pressure increases to 145 to 160 psig, and returns to greater than 1 megohm when pressure decreases to 145 psig minimum.		
30.	Apply nitrogen and vary pressure to test operation of pressure switch. Observe both test stand pressure gauge and multimeter.	Resistance decreases to less than one ohm when pressure increases to 100 to 122 psig, and returns to greater than 1 megohm when pressure decreases to 100 psig minimum.	3.
31.	Adjust nitrogen pressure for test stand indication of 125 psig.	Test bench REFRIGERANT PRESSURE gauge PI-2 indicates 125 (±5) psig.	9.
32.	Turn off nitrogen source and relieve pressure by opening purge V5 on test bench. Disconnect test stand.		
33.	Turn off PANEL POWER switch TGS-2 and remove shorting plug, Part No. P-304-AB, and reconnect P105 into J105. Remove black paper from between lower sight-gauge light beam assembly.		

Table 5-5. Refrigeration Controls Checkout - Continued

Step	Operation	Normal Indication	Trouble Reference (Table 5-10)
34.	Set refrigerant controls on test bench as follows:		
	NOTE Zero (center dot) both micron gauges on test stand and test bench before proceeding to step 34a.		
	a. PANEL POWER switch TGS-2... on b. PURGE VALVE V5... close c. GAS BALLAST VALVE... close		
	CAUTION Use two wrenches when loosening or tightening fittings to avoid stressing plumbing system. Failure to comply may cause equipment damage.		
35.	Remove cap (Figure 5-1, 67) from fitting between solenoid valves V8 (65) and V9 (63).		
36.	Connect test stand vacuum gauge transducer to fitting, connect test stand electrical power connector, turn on test stand switch, and allow a 10-minute warm-up period.		
37.	Set VACUUM PUMP switch TGS-1 to ON.	VACUUM PUMP indicator NLT-1 on, pump operates.	4, 6.
38.	Set selector switch RSS-2 to PUMP TEST.	PUMP TEST indicator NLT-8 on.	4.
		REFRIGERANT VACUUM manometer indicates a vacuum.	7.
	NOTE • If 100 microns or less cannot be attained, slowly close GAS BALLAST valve and then slightly open GAS BALLAST valve. • GAS BALLAST valve should be open to prevent condensation buildup inside pump. Minimize knocking by partially closing valve.		
39.	Open GAS BALLAST valve V17 about two turns to achieve steady state operation. Minimize knocking by adjusting clockwise or counterclockwise as applicable.	Test stand VACUUM gauge indicates 100 microns or less within 5 minutes.	7, 13.

Table 5-5. Refrigeration Controls Checkout - Continued

Step	Operation	Normal Indication	Trouble Reference (Table 5-10)
40.	Allow time for stabilization.	VACUUM meter M-4 (57) indicates within approximately 25 microns of test stand VACUUM gauge within 30 minutes.	8.
41.	Turn test stand power switch off and disconnect test stand electrical power connector.		
	CAUTION Use two wrenches when loosening or tightening fittings to avoid stressing plumbing system. Failure to comply may cause equipment damage.		
42.	Set TGS-1 VACUUM PUMP switch OFF, remove test stand vacuum gauge transducer from test bench fitting, and reinstall cap (67) on fitting.		
43.	Set VACUUM PUMP switch TGS-1 on.	VACUUM meter M-4 (57) indicates 100 microns or less within 5 minutes.	7, 13.
		Mercury height is about equal in both legs of manometer and are opposite zero on scale.	10.
44.	Set VACUUM PUMP switch to OFF.		
45.	Connect reclaimer system to valve V13 (52) and set cylinder heater switch TGS-3 to ON.		
46.	Position CYLINDER HEATER to ON.		
	NOTE Loosen two thumbscrews on photo detector assembly sight-glass to ensure assembly moves freely.		
47.	Using scale in back of refrigerant sight tube, position photo detector scanners so pointers are 11.25 inches apart. Tighten thumbscrew firmly against rod.		

Table 5-5. Refrigeration Controls Checkout - Continued

Step	Operation	Normal Indication	Trouble Reference (Table 5-10)
	NOTE Perform steps 48 through 60 only if scanner units have been replaced or if faulty scanner is suspected.		
48.	Open valves V6 (82), V7 (78) and V13 (52) 1-1/2 turns from closed position. Open LIQUID valve on refrigerant cylinder. Ensure in-line valve is fully open.		
	NOTE As measuring tube fills, valve V13 will vent freon. Reclaimer must be operated to capture escaping vapor. Periodically, valve V13 must be fully closed to assess refrigerant level in tube. If level no longer rises and has not reached PD-1, reset RSS-1 to fill and reopen valve V13 as required to fill tube.		
49.	Momentarily set REFRIGERANT MEASURING TUBE selector switch RSS-1 to FILL.	Refrigerant rises in sight glass to photo detector. REFRIGERANT F indicator ON while measuring tube is filling.	11, 12.
50.	When refrigerant liquid level reaches upper level sensor PD-1 on measuring tube shut valve V13 and shut down reclaimer system.	RSS-1 FILL light extinguishes and freon level stops rising at PD-1.	
51.	Turn TGS-2 (PANEL POWER SWITCH) to OFF.		
52.	Inside cabinet, disconnect P104 (Figure 5-1, 56) on top of control panel. Push cable through opening to front of cabinet and plug it into SKAN-A-MATIC tester.		
53.	Remove controller PEC-1 (56) from J102 on top of control panel and plug it into SKAN-A-MATIC tester.		
54.	Plug tester into J3 and turn on both tester switch and CB1.		
55.	Slide upper photo detector scanner to location above refrigerant level in sight glass.	SKAN-A-MATIC tester VAPOR indicator comes on.	Faulty controller PEC-1 or detector PD-1; replace faulty component.
56.	Slide scanner to location below refrigerant level.	SKAN-A-MATIC tester LIQUID indicator comes on.	Faulty PEC-1 or PD-1; replace faulty component.

Table 5-5. Refrigeration Controls Checkout - Continued

Step	Operation	Normal Indication	Trouble Reference (Table 5-10)
57.	Turn off SKAN-A-MATIC tester; reinstall PEC-1 and reconnect P104 to top of control panel.		
58.	Repeat steps 50 through 54 with lower photo detector scanner P103 and controller PEC-3 (55) from J101.		Faulty PEC-3 or PD-3; replace component.
59.	Turn off SKAN-A-MATIC tester; reinstall PEC-3 and reconnect P103 to top of control panel.		
60.	Turn off CB1.		
61.	Turn TGS-2 (PANEL POWER SWITCH) to ON.		
	NOTE If steps 48 through 60 were performed, omit steps 62 through 65.		
62.	Using scale in back of refrigerant sight tube, position photo detector scanners so pointers are 11.25 inches apart. Tighten thumbscrew firmly against rod.	Photo detector assembly should slide freely on sight-gauge.	
63.	Open valve V6 (82), V7 (78), and V13 (52) 1-1/2 turns from closed position. Open LIQUID valve on refrigerant cylinder.	Liquid eye and cylinder pressure gauge indicate refrigerant supply.	
	NOTE As measuring tube fills, valve V13 will vent freon. Reclaimer must be operated to capture escaping vapor. Periodically, valve V13 must be fully closed to assess refrigerant level in tube. If level no longer rises and has not reached PD-1, reset RSS-1 and reopen valve V13, as required, to fill tube.		
64.	When CYLINDER HEATER light goes out, momentarily set REFRIGERANT MEASURING TUBE selector switch RSS-1 to FILL.	Refrigerant rises in sight glass to level of upper photo detector. REFRIGERANT F indicator ON while measuring tube is filling.	11, 12.
65.	When refrigerant liquid level reaches upper level sensor PD-1 on measuring tube, shut valve V13 and shut down reclaimer system.	RSS-1 FILL light extinguishes and freon level stops rising at PD-1.	
66.	Set MEASURE TUBE HEATER switch TGS-4 to ON. Set CYLINDER HEATER to OFF.	MEASURING TUBE HEATER indicator comes on.	14.

Table 5-5. Refrigeration Controls Checkout - Continued

Step	Operation	Normal Indication	Trouble Reference (Table 5-10)
67.	Using vacuum bottle, connect self-sealing refrigerant hose to test bench EVACUATE/REFRIGERANT CHARGE and vacuum bottle liquid valve and open valve.		
68.	Set selector switch RSS-2 to EVACUATE and set vacuum pump switch TGS-1 to ON. Wait until vacuum is less than 300 microns. Adjust GAS BALLAST valve as necessary to obtain vacuum.	EVACUATE indicator NLT-9 comes on. Pressure stabilizes at less than 300 microns.	13.
69.	Verify that pointer of upper photo detector scanner is even with top of refrigerant column in sight tube glass. If required, reposition scanners without changing space between them.		
	NOTE Verify MEASURING TUBE HEATER indicator extinguishes before proceeding.		
70.	Set selector switch RSS-2 to CHARGE.	CHARGE indicator NLT-11 on.	
71.	Set TGS-1 VACUUM PUMP switch to OFF.		
72.	Momentarily set REFRIGERANT MEASURING TUBE switch to CHARGE.	REFRIGERANT MEASURING TUBE C indicator comes on during charge. Refrigerant level in sight glass drops to lower photo detector scanner within 45 to 60 seconds and stops.	4, 13, 15.
73.	When refrigerant level in measuring tube drops to lower photo detector PD-3 on measuring tube and RSS-1 C indicator extinguishes, close LIQUID valve on vacuum bottle.		
	CAUTION Failure to set REFRIGERANT MEASURING TUBE HEATER switch to OFF when measuring tube is not in filled condition will overheat and damage measuring tube assembly.		
74.	Set REFRIGERANT MEASURING TUBE HEATER switch to OFF.		

Table 5-5. Refrigeration Controls Checkout - Continued

Step	Operation	Normal Indication	Trouble Reference (Table 5-10)
75.	Set CYLINDER HEATER, PANEL POWER, 60 HZ POWER switches CB1 and CB4 to OFF and close LIQUID valve on refrigerant cylinder.		
76.	Close valve V13, remove reclaimer system, and recap valve V13.		

Table 5-6. Power Troubleshooting

Trouble	Probable Cause	Remedy
WARNING 120/208 volts of power is present inside test bench. Serious shock hazard exists when panels are removed. Failure to comply could cause personnel injury.		
1. Indicators DS1, DS2, DS9 through DS15 fail to come on.	1. Internal failure of indicator assembly, unless multiple failure.	a. Turn off power and disconnect both power cables. b. Unsolder indicator leads, loosen nut behind panel, and remove front knurled nut and indicator. c. Install new indicator.
	2. Wiring or switch failure.	a. Check continuity per FO-4 with power disconnected. Replace switch or repair wiring as required.
	3. Input power filter failure.	a. With power disconnected, remove protective cover from filter (Figure 5-1, 2 and 3). b. Apply power and check for 120 Vac between neutral and each phase. c. Disconnect power and replace filter if required. d. Repeat step b if filter was replaced. e. Disconnect power and reinstall cover.
2. Missing or erratic phase A, B or C as measured on J1 or indicated on 400 Hz meters.	1. PHASE MONITOR switch S4 or related wiring.	a. Check continuity per FO-4 with power connected. Replace S4 or repair wiring as required.

Table 5-6. Power Troubleshooting - Continued

Trouble		Probable Cause		Remedy	
2. - Cont		2.	VOLTAGE CONTROL variable transformer T1.	a.	With power disconnected, test each transformer (7) section for control using multimeter across terminals 3, 4, and 3, 5.
				b.	If a transformer section continuity is open or erratic because of wear, replace transformer.
				c.	If S4 and T1 are good, isolate wiring fault to J1 or panel meter and repair as required.
3.	400 Hz POWER meters faulty or out of adjustment.	1.	VOLTAGE M9 or FREQUENCY M8 meter.	a.	Remove window from front of meter by raising edge with small screwdriver and sliding out. Adjust screw in upper right-hand corner. Slide window back in place.
				b.	If adjustment is not effective, replace meter. See Paragraph 5.4.3.
		2.	AMPERAGE meter/transducer M10/T2.	a.	Adjust screw on current transformer T2 transducer (19).
				b.	If adjustment is not effective, replace meter M10 and transducer T2.
4.	Power supply module PS1 or PS2 out of tolerance.	1.	Complete absence of output voltage on both PS1 and PS2 indicates wiring or CB3 fault.	a.	Disconnect power and check continuity. Repair wiring or replace CB3 as required.
		2.	Output voltage of PS1 or PS2 present but out of adjustment.	a.	With power applied, adjust the appropriate pod on PS2 for its proper voltage. Adjust pod A for +5.3 (±0.02) Vdc, pod B for +15.0 (±0.1) Vdc, and for pod C for -15.0 (±0.1). Adjust the pod on the bottom of PS1 for +12.0 (±0.1) Vdc.
				b.	If adjustment is not effective, turn off all power and replace power supply module.

Table 5-7. Control Valve Driver Circuit Troubleshooting

Trouble	Probable Cause	Remedy
WARNING 120/208 volts of power is present inside test bench. Serious shock hazard exists when panels are removed. Failure to comply could result in personnel injury. **CAUTION** CONTROL VALVE switch S3 must be set correctly before connecting control valve and operating OPEN/CLOSE switch S2. Damage to valve and test bench will occur.		
1. LED indicators not coming on when driving circuits operate.	1. Individual LED failure indicates faulty LED, wiring or driving signal	a. Turn off all power and replace printed circuit board in electronic enclosure (Figure 5-1, 20). Fault isolate LEDs, wiring, and switches S2 and S3 meter. Repair as required. b. If LED replacement is required, tag wires and unsolder. Remove nut and lockwasher from rear and pull LED from front. Install new LED using care to solder wires to correct pins.
2. Waveforms incorrect during checkout.	1. Driving circuits on printed circuit board failed.	a. With power applied, adjust the appropriate pod on PS2 for its proper voltage. Adjust pod A for 5 Vdc reading, pod B for +15 Vdc reading, and pod C for -15 Vdc reading; adjust the pod on the bottom of PS1 for the proper 12 Vdc reading.
3. LEDs and waveforms okay but control valve not operating.	1. Faulty control valve or wiring.	a. Try different control valve and fault isolate wiring as applicable.

Table 5-8. Coolant System Troubleshooting

Trouble	Probable Cause	Remedy
NOTE Refer to component replacement procedures for tubing fittings and for digital panel meters.		
1. COOLANT PUMP indicators fail to come on or coolant pump fails to run.	1. Indicator assembly failure unless both are out.	a. Turn off CB1 and replace indicator per power troubleshooting table.
		b. Fault isolate wiring and COOLANT PUMP switch S1 per FO-4.
	2. COOLANT PUMP switch if both indicators are out and pump is not running.	a. Fault isolate wiring and S1.
	3. Coolant pump if indicators are on but pump is not running.	a. Turn off CB1, drain coolant tank, and replace coolant pump and motor assembly (Figure 5-1, 29).
2. Coolant flow and pressure checkout failure.	1. Coolant filter element clogged.	a. Turn off pump, drain tank, disconnect ringnut, and lower part of filter housing (30), and remove filter element.
		b. Examine element and housing. Clean out filter housing, and install new element if required.
	2. Valves V2 (41), V3 (42) or transducers MT5 (31), RT2 (35) clogged.	a. Disconnect and examine for obstruction.
	3. Coolant pump dogged or worn.	a. Remove pump, and replace or clean as required.

Table 5-8. Coolant System Troubleshooting - Continued

Trouble	Probable Cause	Remedy
3. COOLANT RETURN PRESSURE meter M4 checkout fails.	1. Meter M4 out of adjustment.	a. Remove window from front of meter by raising end with small screwdriver and sliding out.
		b. If meter does not indicate within 0.0 (±0.5) psig, adjust lower screw in right end of meter.
		c. If meter does not indicate within 15.0 (±0.5) psig, adjust upper screw in right end of meter.
		d. Reinstall window.
	2. Meter M4 or transducer MT2 faulty.	a. Turn off CB1, and replace M4 or MT2 (36) as required.
4. COOLANT SUPPLY PRESSURE meter M7 checkout fails.	1. Meter M7 out of adjustment.	a. Same as remedy for COOLANT RETURN PRESSURE meter M4.
	2. Meter M7 or transducer MT3 faulty.	a. Turn off CB1, and replace M7 or MT3 (12) as required.
NOTE For PRI-3 type meter use steps 5 (1a thru d) and for MR1000 type meter use steps 5 (1e thru h).		
5. COOLANT RETURN FLOW meter M5 checkout fails.	1. Meter M5, linearizer A2 or transducer MT5 faulty or out of calibration.	a. Turn off CB1, and remove M5, A2 (37) and MT5 (31). Do not adjust units or remove tags. Install replacement M5, A2, and MT5 as a calibrated set having matching tag numbers. Leave tags attached.
		b. Remove window from front of meter by raising end with small screwdriver and sliding out.
		c. Set internal right-hand switches No. 7, 8, 9, 10 to up, down, up, down positions, respectively. Do not disturb left-hand switches, right-hand switches No. 1 through 6, or adjustment screws.
		d. Reinstall window.
		e. Turn off CB1, and remove M5, A2(37) and MT5(31). Do not adjust units or remove tags. Install replacement M5, A2, and MT5 as a calibrated set having matching tag numbers. Leave tags attached.

Table 5-8. Coolant System Troubleshooting - Continued

Trouble	Probable Cause	Remedy
5. - Cont		f. Refer to FO-4 during wiring connections. Connected wire marked M5(5) to pin 5 on meter. Connected wire marked M5(-) to pin 8 on meter.
		g. Remove two wires marked M5(15) from connector plug and install on pin 11 of meter.
		h. Remove two wires marked M5(5) from connector plug and install on pin 12 of meter.
6. COOLANT RETURN TEMPERATURE meter M3 checkout fails.	1. Meter M3 or sensor RT2 faulty or out of calibration.	a. Turn off CB1, and remove M3 and RT2. (35). Install replacement M3 and RT2 as a calibrated set having matching serial numbers.
7. COOLANT SUPPLY TEMPERATURE meter M6 checkout fails.	1. Meter M6 or transducer RT3 faulty or out of calibration.	a. Turn off CB1, and remove M6 and RT3. (13). Install replacement M6 and RT3 as a calibrated set having matching serial numbers.
8. COOLANT HEATER CONTROL panel A1 checkout fails.	1. Panel A1, immersion heater HR1, temperature sensor RT1 faulty.	a. Turn off COOLANT PUMP switch S1 and 60 Hz POWER CB1.
		b. Remove screws from rear cover of A1 (5) and carefully move cover to one side.
		c. Using wiring diagram FO-4, identify and isolate wires to HR1 (28) and RT1 (26), and check continuity.
		d. Replace HR1 or RT1 if open-circuited.
		e. Replace A1 if HR1 and RT1 are both good.

Table 5-9. Air Regulation Troubleshooting

Trouble	Probable Cause	Remedy
NOTE Refer to component replacement procedures for tubing fittings and for digital panel meters.		
1. Pressure regulator V16 checkout failure.	1. Regulator V16 faulty.	a. If indicated pressure is out of tolerance, remove and replace (Figure 5-1, 1) V16. b. If indicated pressure is zero or if regulator replacement does not correct problem, replace valve V4 (11).
2. COMPRESSOR AIR RETURN PRESSURE meter M1 checkout failure.	1. Meter M1 out of adjustment.	a. Remove window from front of meter by raising end with small screwdriver and sliding out. b. If meter does not indicate within 0.0 (±2.0) psig, adjust lower screw in right end of meter. c. If meter does not indicate within 100 (±5) psig, adjust upper screw in right end of meter. d. Reinstall window.
	2. Meter M1 or sensor MT1 faulty.	a. Turn off CB1 and replace M1 or MT1 (40) as required.
3. COMPRESSOR AIR RETURN FLOW meter M2 checkout failure.	1. Meter M2, amplifier A3 or transducer MT4 faulty.	a. Turn off CB1, and remove M2, A3 (34), and MT4 (39). Do not adjust units or remove tags. Install replacement M2, A3, and MT4 as a calibrated set having matching tag numbers. Leave tags attached.

Table 5-10. Refrigeration Controls Troubleshooting

Trouble	Probable Cause	Remedy
WARNING • 120-Vac power is present inside test bench. Serious shock hazard exists when panels are removed. Failure to comply could result in personnel injury. • Do not exceed 250-psig pressure when testing PS-1 and TS-1 and make no adjustments except as specified. PS-1 and TS-1 are safety devices to protect equipment and personnel. Failure to comply may result in personnel injury.		
NOTE Refer to component replacement procedures for tubing fittings.		
1. Refrigerant cylinder pressure switch PS-1 or temperature switch TS-1 open before cylinder is heated and before pressure is applied during checkout.	1. PS-1, TS-1 or wiring faulty.	a. Turn off CB4 and remove cover from PS-1 (Figure 5-1, 74). Loosen cover screws of electrical box and open to expose TS-1 (75) on band heater. Using multimeter, isolate open circuit. b. If TS-1 or PS-1 is open circuited, replace it. c. If neither TS-1 nor PS-1 is open, fault isolate wiring per FO-4 and repair as required.
2. Pressure switch PS-1 out of adjustment or faulty.	1. PS-1 out of adjustment.	a. Attempt to adjust PS-1 to open within range of 126 to 150 psig, using adjustment screws on PS-1 and pressure gauge on nitrogen cylinder.
	2. If adjustment attempt is not successful, PS-1 is faulty.	a. Remove and replace entire PS-1 assembly.
3. Pressure switch PS-2 out of adjustment or faulty.	1. PS-2 out of adjustment.	a. Turn off CB4 and remove cover from PS-2 (54). Using 1/4 wrench, turn adjusting nut on top of switch assembly until signal indicator on switch is fully up. Nut will turn easily until it reaches stop; do not force. b. Apply nitrogen pressure, and adjust regulator for 160 psig indication on test stand.

Table 5-10. Refrigeration Controls Troubleshooting - Continued

Trouble	Probable Cause	Remedy
3. - Cont		c. Connect multimeter across terminals of PS-2.
		d. Back off signal adjusting nut until switch closes, as indicated on multimeter.
		e. Change nitrogen pressure and check that switch closes with increasing pressure at 160 psig maximum and switch opens with decreasing pressure at 145 psig minimum.
	2. PS-2 faulty.	a. Replace PS-2.
4. Fault neon panel indicators NLT-1 thru NLT-11, faulty switch or faulty wiring.	1. Internal resistor failed.	a. Replace neon indicator assembly.
	2. Damaged wire, loose terminals or switch failure.	a. Fault isolate per FO-4 and repair as required.
5. 5 AMP FUSE indicator on.	1. Fuse failed.	a. Replace fuse.
	2. Short to ground in refrigerant fill and charge control circuits.	a. With power disconnected, use schematic FO-4 and multimeter to isolate fault. Repair as required.
6. Vacuum pump does not run.	1. Loss of electrical power if VACUUM PUMP indicator not on.	a. Disconnect power and fault isolate wiring and VACUUM PUMP switch TGS-1 at J112 (58) pins 2 and 3.
	2. Vacuum pump motor failure.	a. Remove vacuum pump motor (70).
		b. Install replacement pump motor and adjust belt to flex the thickness of the belt with normal thumb pressure midway between pulleys.
7. Vacuum failure during vacuum pump test.	1. Solenoid valve SOL-V/V8 not open or SOL-P/V9 not closed or pump is not functioning properly if no vacuum is indicated.	a. Disconnect power and fault isolate wiring and selector switch RSS-2 at J111 (58) pins 3 and 4.
		b. Check continuity of SOL-V coil at P111 pins 3 and 4. Repair wiring or replace SOL-V/V8 (65) as required.
		c. Remove vacuum pump drive belt pulley guard (72) and replace belt if broken or slipping.

Table 5-10. Refrigeration Controls Troubleshooting - Continued

Trouble	Probable Cause	Remedy
7. - Cont		d. Remove and replace SOL-P/V9 (63).
	2. Required vacuum pressure cannot be attained.	a. Ensure tubing fittings are tight.
		b. If vacuum pump oil contamination is suspected, drain oil. Unscrew discharge mist eliminator tank from pump and pour one pint super X/Flushing High Vacuum oil into discharge opening of pump casting. Reinstall tank and run pump about 2 minutes. Remove tank, add 1/3 pint oil and reinstall tank.
		c. Replace vacuum pump.
8. VACUUM meter M-4 (57) not within 25 microns of test stand.	1. VACUUM meter out of adjustment.	a. Turn off CB4.
		b. Remove rear cover of program control center (58) and remove meter retaining nuts (do not remove wires). Slide meter out front of panel.
		c. Turn on CB4.
		d. Turn adjustment screw on top of meter until indication is within 25 microns of test stand indication.
		e. Turn off CB4.
		f. Reinstall meter and cover.
		g. Turn on CB4.
	2. VACUUM meter faulty.	a. Turn off CB4 and replace meter.
9. REFRIGERANT PRESSURE gauge out of calibration.		a. Remove and replace gauge.
10. Manometer gauge (86) mercury columns not about equal height at 100 microns vacuum.	1. Manometer faulty.	a. Remove scale from front of manometer, and have tube sealing mechanism ready to install. (See Chapter 3).
		b. One person hold manometer and a second person disconnect tube fitting and two mounting nuts in rear. Remove manometer from panel, keeping U-tube upright.

Table 5-10. Refrigeration Controls Troubleshooting - Continued

Trouble	Probable Cause	Remedy
10. - Cont		c. Remove wingnut, gauge head, and two neoprene gaskets from manometer. d. Slowly insert plunger end of sealing mechanism into right-hand leg of U-tube until it barely contacts mercury. e. Grip threaded end of mechanism and turn down nut until expansion washer at plunger end makes very snug fit in tube. f. Carefully install washer, coil spring, gauge head, and wingnut on manometer. g. On replacement manometer, reverse the removal procedure, again being careful when removing sealing mechanism and in keeping U-tube upright. h. Store tube sealing mechanism in top drawer of test bench.
11. Refrigerant measuring tube will not fill.	1. If REFRIGERANT F indicator does not come on, failure is electrical.	a. Fault isolate by replacing the following plug-in parts: 1. PEC-1 (56) at J102 on top of control panel assembly (58). Refer to checkout with SKAN-A-MATIC tester. 2. Relay CR-F (61) within control panel assembly. b. With power off, fault isolate REFRIGERANT MEASURING TUBE switch RSS-1 and related wiring.
	2. If REFRIGERANT F indicator comes on, failure is in refrigerant line.	a. Verify refrigerant is indicated in liquid eye on cylinder and that valves V6 (82), V7 (78), and V13 (52) are open.

Table 5-10. Refrigeration Controls Troubleshooting - Continued

Trouble	Probable Cause	Remedy
11. - Cont		b. If measuring tube partially fills and REFRIGERANT PRESSURE gauge indicates operating pressure of about 125 psig, failure is in solenoid valve SOL-E/V12 (87). Check continuity of solenoid at P105 (58) pins 3 and 4. Repair wiring, if required, or remove and replace solenoid valve.
		c. If no refrigerant transfers to measuring tube and no pressure increase registers on gauge, failure is in solenoid valve SOL-F/V11 (79). Check continuity at P109 (58) pins 1 and 4. Repair wiring, if required, or remove and replace solenoid valve.
12. Refrigerant measuring tube overfills.	1. Photoelectric device failure.	a. If upper photo detector scanner PD-1 (Figure 4-3, 4) light beam is visible, photoelectric controller PEC-1 (Figure 5-1, 56) at J102.
		b. If PD-1 light beam is not visible or if PEC-1 did not correct problem, replace PD-1 at J104 (56) and on sight glass.
		c. Refer to checkout with SKAN-A-MATIC tester.
		d. Fault isolate and repair wiring.
13. Evacuation of pressure vessel fails.	1. System leaks if unable to attain required vacuum.	a. Check hose connections and tighten fittings if required.
	2. SOL-P/V9 not open if vacuum occurs too quickly.	a. Check continuity of SOL-P/V9 (63) at P110 (58) pins 1 and 2. Repair wiring, if required, or remove and replace solenoid valve.
14. Refrigerant does not transfer from measuring tube when charge cycle is attempted.	1. If REFRIGERANT C indicator does not come on, failure is electrical.	a. Verify MEASURING TUBE HEATER indicator cycled from ON to OFF before charge attempt and that function selector switch is set to CHARGE.
		b. Fault isolate by replacing the following plug-in parts: 1. PEC-3 at J101 (55). 2. Relay CR-C (60). 3. Relay CR-H (59).

Table 5-10. Refrigeration Controls Troubleshooting - Continued

Trouble	Probable Cause	Remedy
14. - Cont		c. With power off, fault isolate REFRIGERANT MEASURING TUBE switch RSS-1, function switch RSS-2, and related wiring.
		d. Disconnect a wire from each measuring tube heater element and check continuity through it. Replace element if open circuited. See Paragraph 5.4.2.
	2. If REFRIGERANT C indicator does come on, failure is in solenoid valve SOL-C/V10.	a. With power off, check continuity of SOL-C at P109 (58) pins 1 and 3.
		b. Repair wiring, if required, or remove and replace solenoid valve (81).
15. Refrigerant transfer does not stop at lower photo detector during charge cycle.	1. Photoelectric device failure.	a. If lower photo detector PD-3 light beam is visible, replace photoelectric controller PEC-3 at J101 (55).
		b. If light beam is not visible or if PEC-3 did not correct problem, replace PD-3 at J103 (55) and on sight glass.
		c. Refer to checkout with SKAN-A-MATIC tester.
		d. Fault isolate and repair wiring.
16. Pressure vessel weight incorrect after charge test.		a. Contact technical engineering.
17. No evidence of refrigerant cylinder heating. Blanket should feel warm and REFRIGERANT PRESSURE gauge indication should rise to about 125 psig.	1. Cylinder heater faulty.	a. Turn off CB4, and check continuity across plug P108 (58) pins Y and Z. (Pin Y is crossways, and pin X is next to Y counterclockwise when viewing P108 pins).
		b. If open circuited, open electrical box on heater assembly, disconnect wires in box, unsnap, and remove band heater.
		c. Install and assemble replacement heater.
	2. CYLINDER HEATER switch TGS-3 or wiring faulty.	a. Fault isolate TGS-3 and wiring. Repair as required.

Table 5-10. Refrigeration Controls Troubleshooting - Continued

Trouble	Probable Cause	Remedy
18. CYLINDER HEATER indicator does not cycle off during periods when refrigerant valve is closed and heater switch is on. Cylinder is hot.	1. Thermostat temperature switch TS-1 not opening.	a. Turn off CB4. b. Loosen cover screws and remove cover of box to access TS-1 (75). c. Replace TS-1.

5.3 SERVICE.

Routine and periodic servicing is required of the coolant supply, coolant filter, refrigerant supply, and vacuum pump.

5.3.1 Coolant Supply and Filter Servicing. It is required to replenish the coolant in the storage tank to 3 (±1) inches from the top and to periodically remove and clean/replace the filter element. Place a suitable container under the coolant tank petcock and drain water. Access the filter element by removing the ringnut and lower filter housing (Figure 5-1, 30). Examine the filter element. If damaged, discard and replace with a new filter element. If undamaged, clean the filter element with an ultrasonic cleaner (Table 2-1) as follows:

WARNING

Ultrasonic cleaning detergent is toxic and hazardous. Wear approved eye and hand protection. Failure to comply could result in personnel injury.

a. In a clean container, mix four liters of distilled water with 100 milliliters of Micro 10 ultrasonic cleaning concentrate detergent or equivalent. Stir to thoroughly dissolve concentrate.

WARNING

Filter element and/or ultrasonic cleaner may be contaminated with sodium chromate solution. Wear approved eye and hand protection. Failure to comply may result in personnel injury.

b. Wipe inside of ultrasonic cleaner with a clean, dry cloth to remove dust or impurities before use.

c. Place filter element into ultrasonic cleaner.

d. Pour cleaning solution into the ultrasonic cleaner until filter element is covered. Place lid on cleaner.

e. Plug ultrasonic cleaner into a 110-volt outlet and set selector switch to ON.

f. Allow ultrasonic cleaner to operate a minimum of 15 minutes.

g. Set selector switch to OFF and unplug unit.

NOTE

When cleaning extremely dirty filter elements, additional cleaning may be required. Discard filter element if not clean after second additional cleaning.

h. If additional cleaning is required, proceed to step a.

i. Remove filter element from ultrasonic cleaner.

j. Add 100 milliliters of ultrasonic cleaning concentrate to original solution and stir to thoroughly dissolve concentrate.

k. Place filter element into ultrasonic cleaner.

l. Repeat step d, step e, and step f.

m. Remove filter element from ultrasonic cleaner and rinse with distilled water.

WARNING

Solution in ultrasonic cleaner may be contaminated with sodium chromate solution. Wear approved eye and hand protection. Failure to comply may result in personnel injury.

NOTE

Residual stains on the filter element do not affect the operational capability as long as the element passes the flow checkout procedure.

n. Empty solution from ultrasonic cleaner into a container suitable for disposal of hazardous waste.

o. Rinse ultrasonic cleaner with distilled water empty into container suitable for disposal of hazardous waste. Dry with a clean cloth.

5.3.2 Refrigerant Supply Service. The refrigerant supply must be replenished if refrigerant is not visible in the liquid eye on the cylinder when the LIQUID valve is open.

NOTE

The supply tank should be connected with a low-loss refrigerant hose which contains an integral shutoff valve at the end connected to the tank.

a. Close both the liquid and vapor valves on the tank.

b. If the tank is connected with a low-loss refrigerant hose with a shutoff valve, go to step d. If the tank is not equipped with such a hose, close valve V7.

NOTE

Venting of the refrigerant vapor contained in the hose connecting the tank to the test bench is allowable under section 608 of the Clean Air Act. However, any nonshutoff-type refrigerant hoses should be changed to low-loss type hoses to minimize refrigerant venting during future tank replacements.

c. Slowly loosen the hose connection on the tank. Allow the pressure to bleed off before disconnecting the hose.

d. Close the shutoff valve at the end of the hose connecting the tank to the test bench.

e. Remove and replace refrigerant supply tank.

5.3.3 Vacuum Pump Service. Contaminated oil is the most common cause of poor performance, and the contamination is controlled to a great extent by gas ballast operation. Avoid extended operation with the GAS BALLAST valve closed. Oil can be visually checked by draining a small quantity into a clean container and inspecting for solid or liquid contaminants. Periodically, and when found to be contaminated, the oil must be changed. When servicing the vacuum pump, also make the following inspections:

a. Remove the guard (Figure 5-1, 72) and inspect the belt for wear and adjustment. Belt should flex about the thickness of belt with normal thumb pressure midway between pulleys.

b. Turn the pump clockwise by hand. Observe no mechanical interference, but an increase in required force at angle where discharge occurs. If required force indicates cylinder is flooded, causing a hydraulic lock, rock the pump pulley by hand to force the oil out. The pump will flood if the vacuum break valve (SOL-B, 68) fails to open.

c. When pump is operating, observe that oil is about midway in sight glass (71) when inlet pressure is low and that oil level changes with large changes in vacuum indications. If there are no discernible oil level changes, oil passages within the pump may be obstructed.

5.3.3.1 Changing the Oil. Open both drain valves (73), remove the filler plug and oil mist eliminator (69), and remove the drive belt guard. After the oil drains, turn the pump pulley clockwise a few turns by hand to clear all oil from cylinder. Close the drain valves. The oil capacity of the pump is 1-1/3 pints or 21-1/3 ounces. Pour about seven ounces through filler plug hole and the remainder through the hole from which the oil mist eliminator was removed. Check that filler plug and gasket are clean and in good condition, and reinstall plug with gasket and the oil mist eliminator. If oil was badly contaminated, it may be necessary to flush the pump by changing the oil one or more additional times with a short operating period between changes.

5.3.3.2 Oil Mist Eliminator. Pump back-pressure of 4 to 6 psig, as measured at the mist eliminator inlet or pump filler plug, is an indication of clogged filter element. Pump motor heating is another indication. If mist is being discharged from mist eliminator, the filter element or gasket may be ruptured. However, periodic replacement of the filter element greatly reduces the probability of these failures occurring. When required, remove the top half of the mist eliminator, clean and inspect housing, replace filter element with a new one, and reassemble using a new gasket.

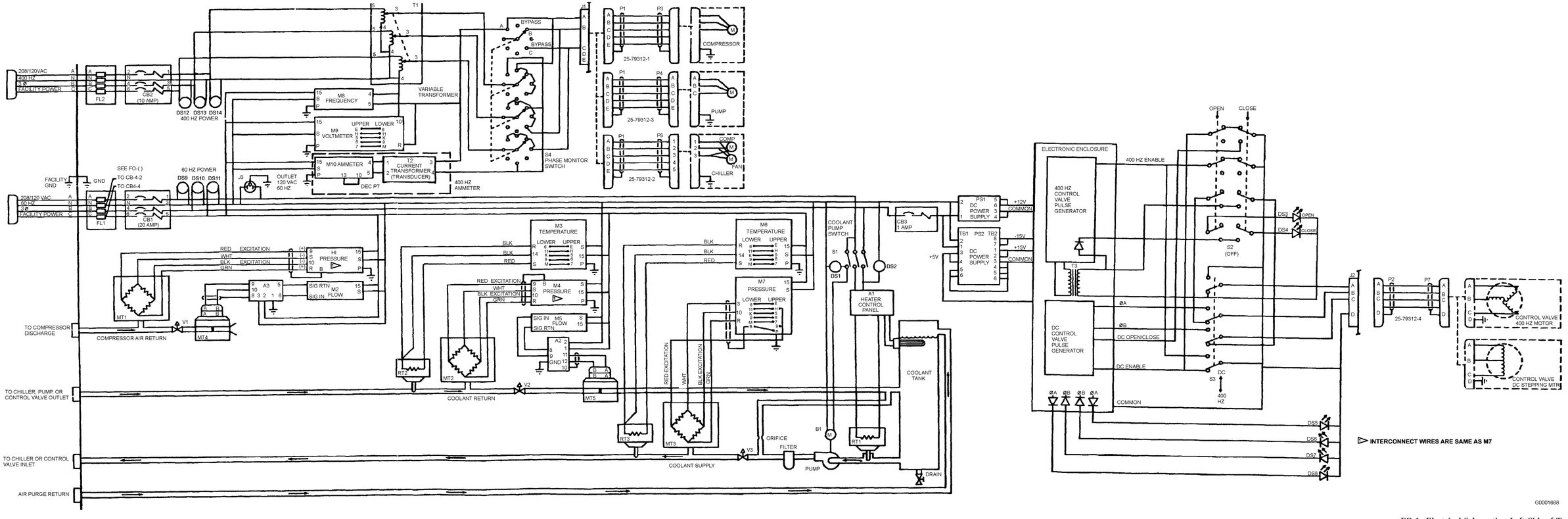
5.4 COMPONENT REPLACEMENT.

The removal and installation of test bench components requires use of common hand tools and common shop skills. Special procedures in this section apply to components with hidden fasteners and to components requiring sealing.

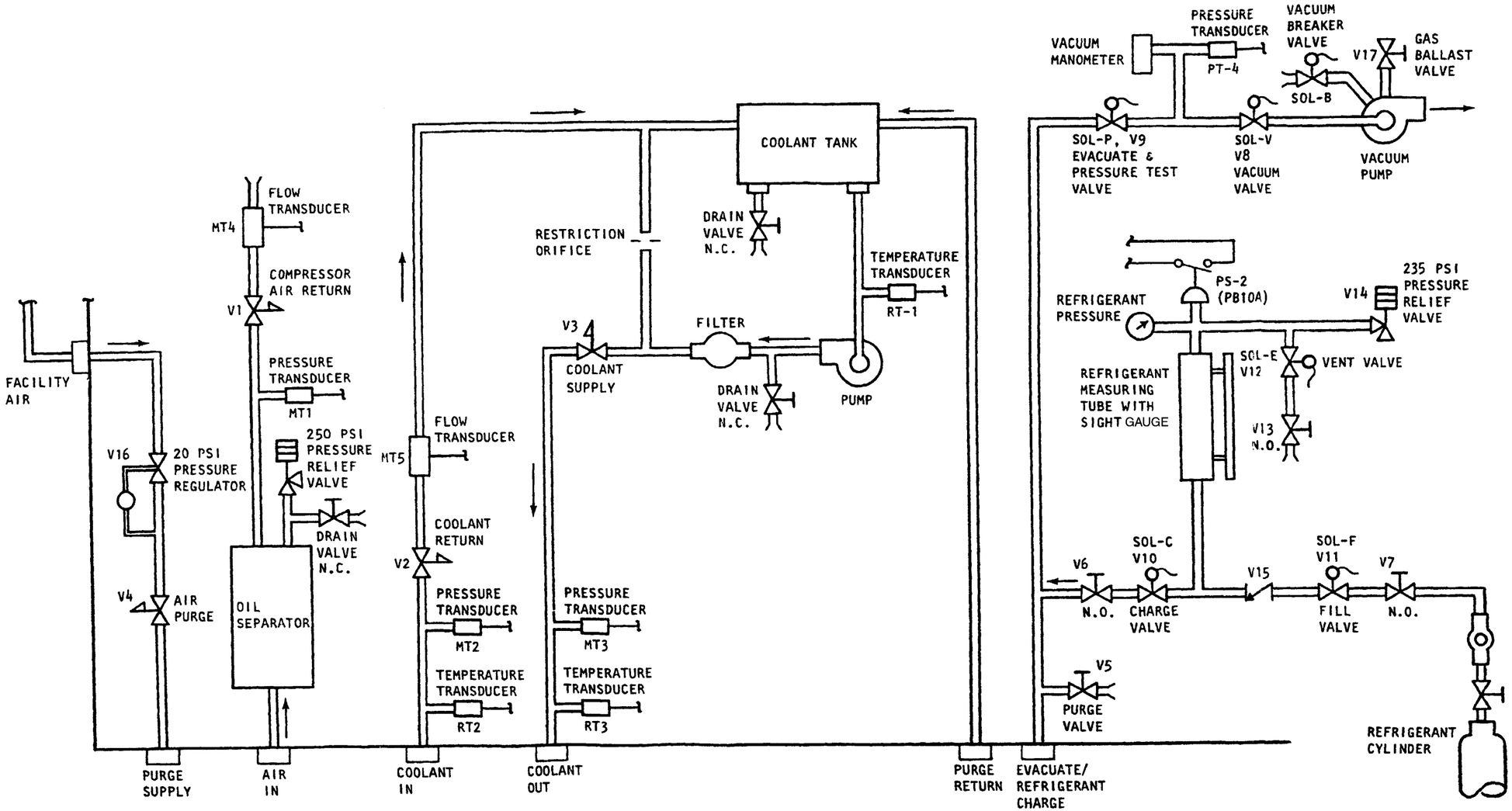
5.4.1 Tubing Fittings. Before assembling tubing components, inspect all parts for damage, wear, thread condition, and cleanliness. Reject unsatisfactory parts. Wrap male pipe threads of coolant and air fittings with Teflon tape. On refrigerant and vacuum pipe threads, first apply high vacuum sealant, then wrap with two layers of Teflon tape, and apply sealant over the tape. Assemble all straight thread fittings using dry lubricant or water.

5.4.2 Measuring Tube Heater Replacement. Before installing immersion heater elements into the refrigerant measuring tube baseplate (83), apply adhesive to the heater element threads.

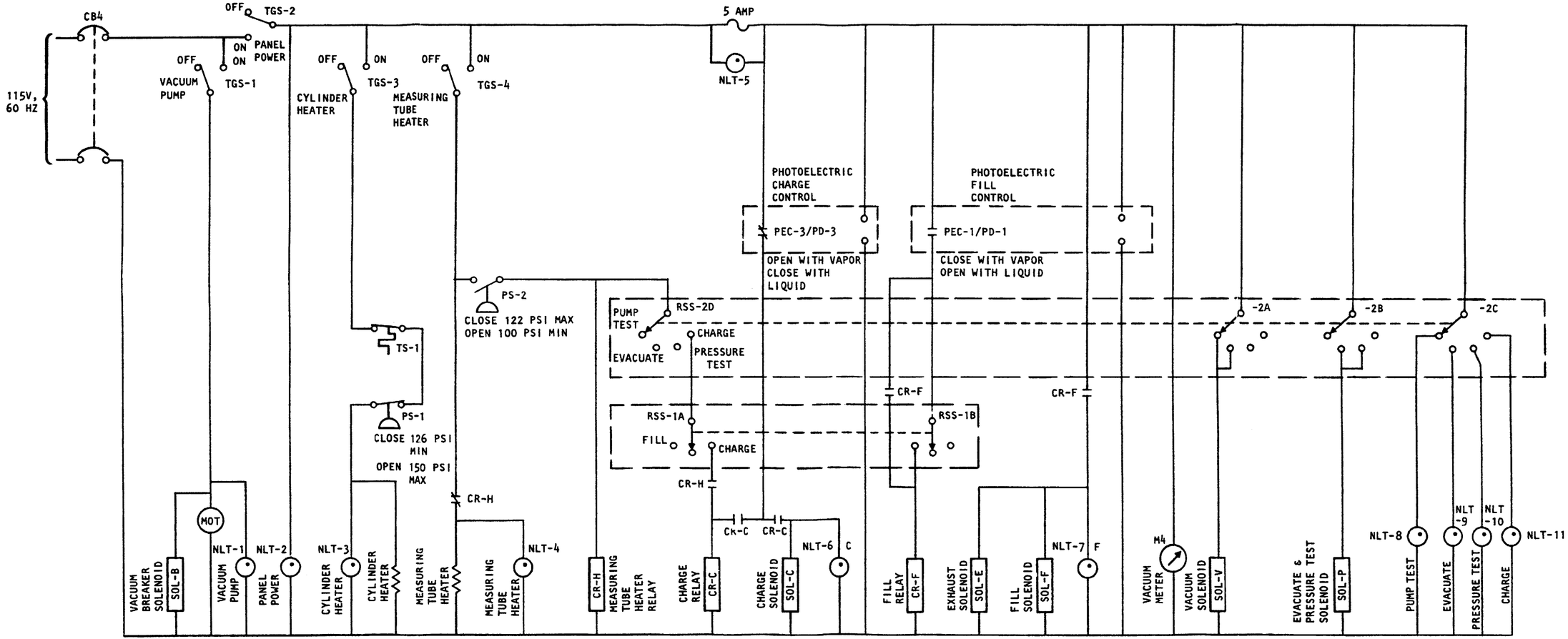
5.4.3 Digital Panel Meters. The digital type meters contain either one or two printed circuit boards which protrude out the rear for cable connection. The two flowmeters have screw terminals and all other meters use cable connectors. All except the flowmeters fasten to the panel by a screw-clamp arrangement accessible behind the front window. The flowmeters fasten to the panel with mounting brackets and screws at the rear. To remove a flowmeter, first electrically disconnect it at the rear. Then remove the bracket screw and the bracket at each end. To remove any other meter, pull the cable connector(s) off the rear, and then on the front slide the window out by first carefully lifting one end with a small screwdriver. Loosen the mounting screw at each end and remove the meter from the panel. Reverse the procedure to install a meter.



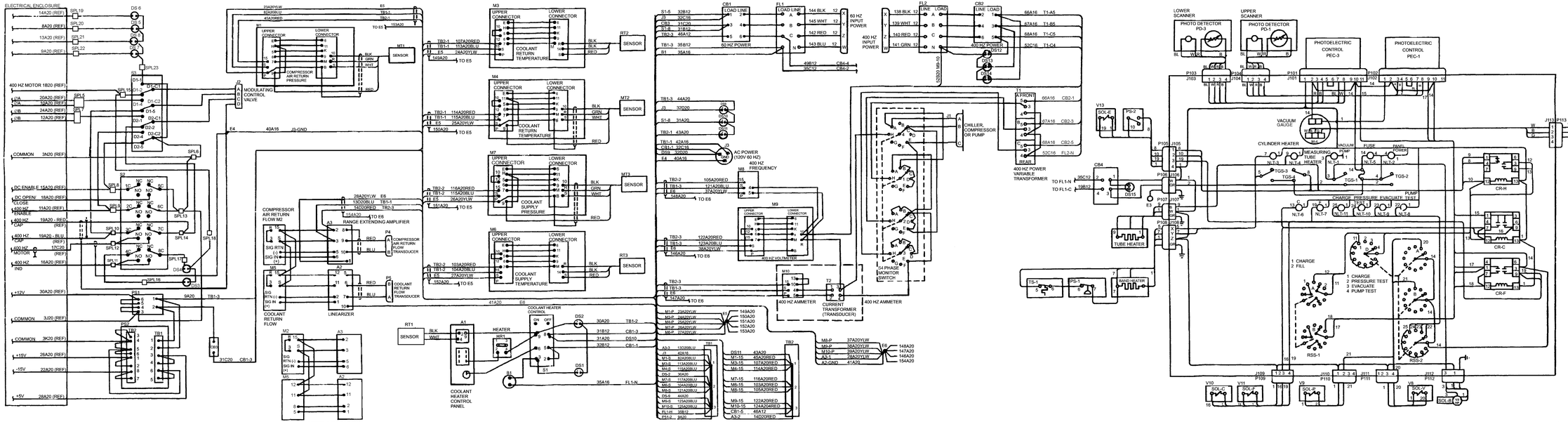
FO-1. Electrical Schematic - Left Side of Test Bench



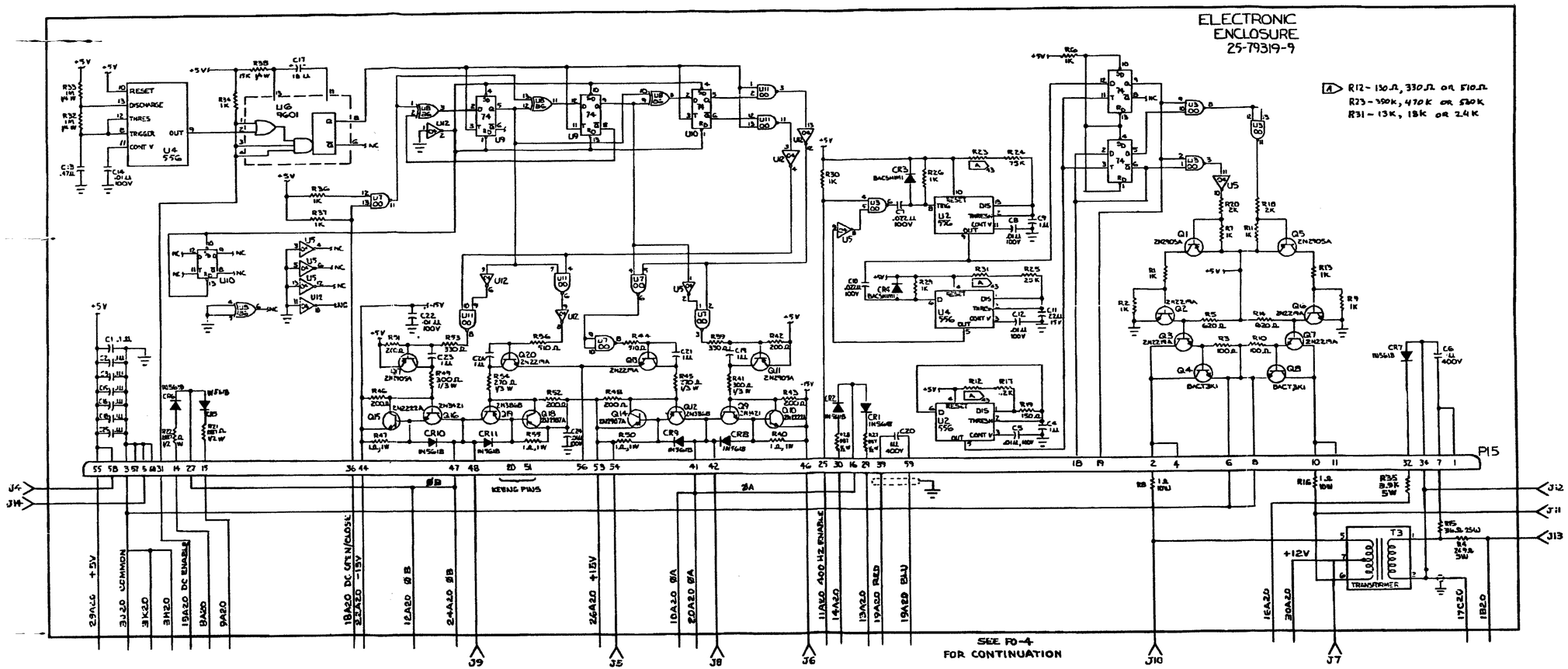
FO-2. Plumbing Schematic



FO-3. Electrical Schematic - Right Side of Test Bench



FO-4. Wiring Diagram



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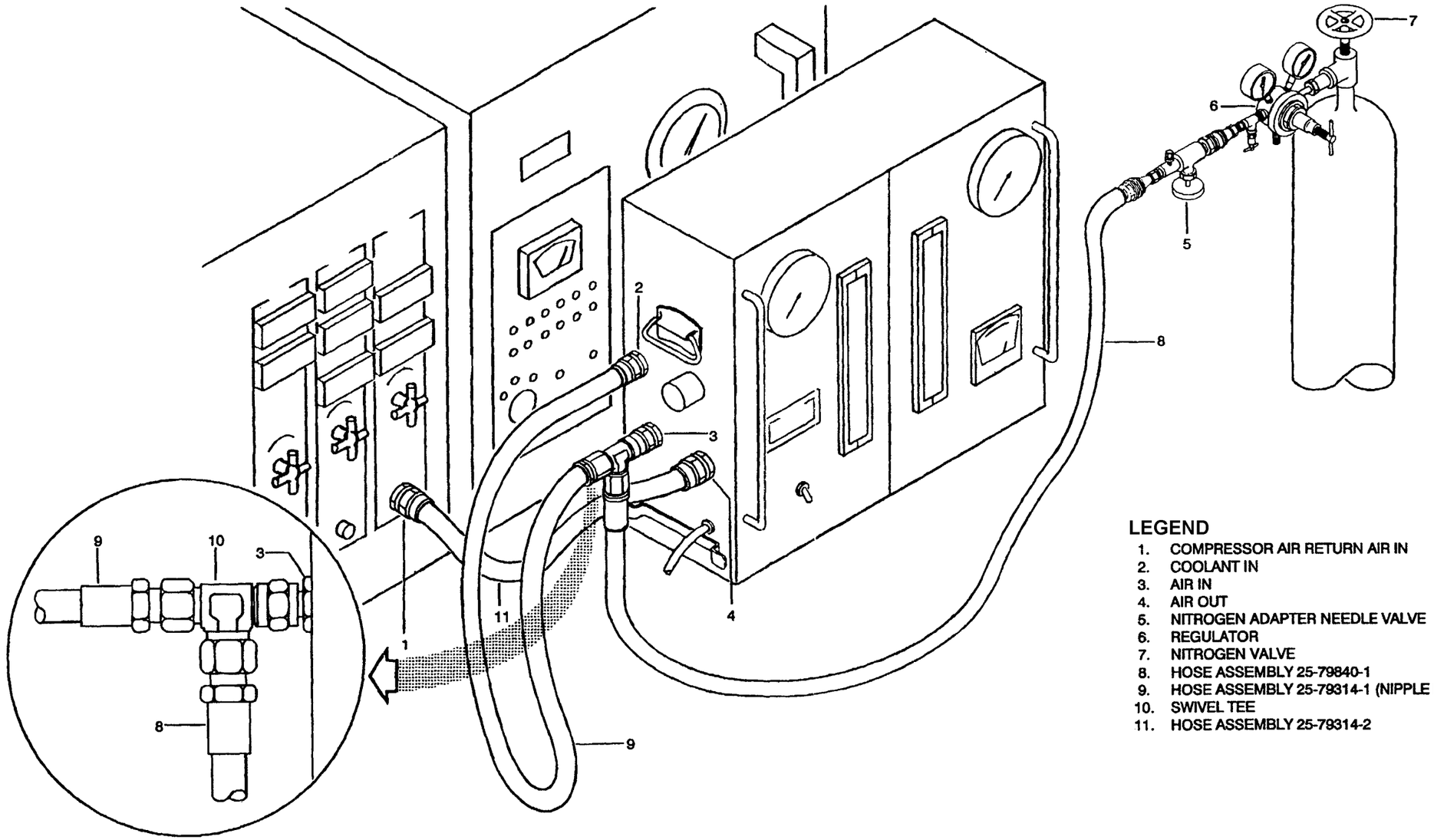
FO-5. Electronic Enclosure Schematic



LEGEND

1. COMPRESSOR AIR RETURN AIR IN
2. COOLANT IN
3. AIR IN
4. AIR OUT
5. NITROGEN ADAPTER NEEDLE VALVE
6. REGULATOR
7. NITROGEN VALVE
8. HOSE ASSEMBLY 25-79840-1
9. HOSE ASSEMBLY 25-79314-1 (NIPPLE REMOVED)
10. SWIVEL TEE
11. HOSE ASSEMBLY 25-79314-2

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FO-6. Airflow Checkout Connections