



ALTRONIC RESEARCH, INC.

P.O. BOX 249, YELLVILLE, ARKANSAS, U.S.A. 72687-0249

PHONE 870-449-4093 FAX 870-449-6000

1-800-482-LOAD (5623) in US

altronic.com

**POWER TEST
LOAD SYSTEM**



POWER TEST LOAD SYSTEM

FIG. 1.1

LIMITED WARRANTY

We take pride in manufacturing products of the highest quality and we warrant them to the original purchaser to be free from defects in material and workmanship for the period of one year from date of invoice. Additionally, products of our manufacture repaired by us are warranted against defects in material and workmanship for a period of 90 days from date of invoice, with the provisions described herein.

Should a product, or a portion of a product of our manufacture prove faulty, in material or workmanship, during the life of this warranty, we hereby obligate ourselves, at our own discretion, to repair or replace such portions of the product as required to remedy such defect. If, in our judgment, such repair or replacement fails to be a satisfactory solution, our limit of obligation shall be no more than full refund of the purchase price.

This warranty is limited to products of our own manufacture. Equipment and components originating from other manufacturers are warranted only to the limits of that manufacturer's warranty to us. Furthermore, we shall not be liable for any injury, loss or damage, direct or consequential, arising out of the use, or misuse (by operation above rated capacities, repairs not made by us, or any misapplication) of the equipment. Before using, the user shall determine the suitability of the product for the intended use; and the user assumes all risk and liability whatsoever in connection therewith.

The foregoing is the only warranty of Altronic Research Incorporated and is in lieu of all other warranties expressed or implied.

Warranty returns shall first be authorized by the Customer Service Department and shall be shipped prepaid. **Warranty does not cover freight charges.**

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PRECAUTIONS

WARNING!

Follow these steps before applying any RF power to equipment:

1. Connect interlock circuit to transmitter.
2. Connect appropriate coolant supply.
3. Start coolant flow and observe correct flow volume.

Failure to follow instructions may cause damage to equipment and/or injury to personnel.

⚡WARNING⚡

Do not attempt any service or parts replacement without first disconnecting all AC power and RF power. Failure to do so may result in serious or *fatal electrical shock or burns.*

CAUTION

Do not connect this equipment to any source of RF power without first ensuring that connection has been made to the appropriate AC line voltage. The interlock circuit is designed to indicate a "fault" and prevent operation when line voltage is not present.

CAUTION

Do not apply more than rated power to unit. Damage will occur before operator can intervene.

CAUTION

Do not attempt to install or operate this equipment until you have read this manual and the appropriate instruction manual for your coaxial load.

INTRODUCTION

This handbook was prepared for technical personnel as an aid in understanding and performing installation, routine operation and maintenance procedures for the Power Test Load System. We do not recommend the operation of this system by personnel who have not been trained to operate the transmitter to which the system is connected. High voltages and hot water or steam may be present in the event of failure of some components of the system.

SECTION I

DESCRIPTION AND LEADING PARTICULARS

1-1. Purpose and Application of Equipment. The Power Test Load System is designed to provide the user a simple and reliable calorimeter for transmitter power measurement and a time-delay interlock to ensure that adequate coolant flow is delivered to the coaxial load resistor before power is applied. Each system consists of a coaxial load resistor, a flow switch, a suitable flow meter for the expected coolant flow range, two thermowells, two laboratory-grade thermometers and a CB-1 Control Box Assembly.

1-2. Equipment Supplied. The Power Test Load System is supplied with a wide variety of coaxial load resistors. The standard power supply voltages available are:

110-130VAC, single phase, 50/60 Hz

220-250VAC, single phase, 50/60 Hz

The standard power supply cord for North American 110-130 volt use is a NEMA 5-15P. All other cords have 50mm stripped and tinned ends.

Two laboratory-grade precision thermometers are supplied with each Power Test Load System.

1-3. Equipment Required But Not Supplied. The Power Test Load System is complete as supplied, but the user must supply appropriate means for attaching the system to AC power, plus appropriate RF input and interlock control cables. In cases where the coaxial load resistor is not mounted on the panel, suitable high temperature and pressure hoses and clamps must be available for the installation.

1-4. General Description. The Power Test Load System is designed to function as a simple and reliable calorimeter and to function as an interface between the transmitter and the coaxial load. When properly installed, it will prevent operation of the transmitter when insufficient coolant is flowing through the load, thereby preventing damage to the load and possible damage to the transmitter and the transmission line.

The system consists of a flow meter, two thermowells, a flow switch, associated piping and a Control Box. These components are mounted on a painted aluminum panel ready to mount on the wall of the transmitter room. The piping, flow meter and flow switch are all matched to a coaxial load resistor of a specified power rating.

1-5. General Principle of Operation. After installation, adjustments and verification in accordance with Section III, operation is very straight-forward.

- a. Ascertain that the equipment is attached to the correct AC power supply and transmitter interlock circuit is connected. Start coolant flow and verify that flow is within normal range for the load connected to the system.
- b. Turn Control Box power *ON* and observe that both indicator lamps light.
- c. When the time delay selected (normally 7 seconds) is complete, the *INTERLOCK* lamp will extinguish, *assuming* that the flow switch is closed and the interlock relay has operated.
- d. At this time, you may energize the transmitter in accordance with the manufacturer's instructions.
- e. After a short period of time (usually 2 to 3 minutes) record the indicated flow on the flow meter, then the temperature of the entering and leaving coolant.
- f. When testing is complete, shutdown is accomplished in the reverse of startup. *Always turn the transmitter off first!*
- g. Reduction of the flow and temperature readings to output power values is covered in subsequent sections of this manual and in the instruction manual for your coaxial load.

1-6. Operating and Adjustment Controls. There is one operating control provided for the Power Test Load System: the Control Box power switch.

There are two adjustment controls on the Power Test Load System:

- (1) Time Delay Control - This control is inside the Control Box. It is factory-set to 7 seconds. We recommend that users keep this control set to a value greater than 7 seconds. Adjustment is by a series of DIN switches on the Time Delay Control.

(2) Flow Switch Adjustment - *This is a very sensitive adjustment. We recommend that users do not disturb it unless a certainty exists that it is not set correctly.* This adjustment is made with a small screwdriver placed in the slot on the lower left quadrant of the flow switch. Settings should be made to insure that the trip point is set on a decreasing flow. (These switches typically exhibit 2-3GPM hysteresis, therefore settings made on an increasing flow may be inaccurate.)

1-7. Operator Training. The operator of this equipment must have the following skills/knowledge:

- An understanding of the purpose of the equipment;
- An understanding of the principles of operation of the equipment;
- An understanding of the normal operating procedures for the equipment;
- An understanding of the normal and abnormal indications which may be presented at the control point;
- The proper procedures for starting, using and stopping the equipment under normal conditions;
- The proper procedure for stopping the equipment under abnormal or emergency conditions;
- The proper procedure to lock out and mark controls prior to allowing or commencing maintenance on the equipment;
- The proper procedure to obtain clearance to remove lockouts and out-of-service marks and return the equipment to normal service.

SECTION II

TEST EQUIPMENT AND SPECIAL TOOLS

- 2-1. Test Equipment Required. An ohmmeter is required to adjust the set point of the flow switch. An accurate hydrometer is required to determine the specific gravity of coolant liquid used in systems which contain anything but pure water. No other test equipment is required.
- 2-2. Special Tools Required. No special tools are required to install, adjust or service this system.

SECTION III

PREPARATION FOR USE AND RESHIPMENT

- 3-1. Unpacking Equipment. The system will be received in one or two boxes, depending upon the configuration ordered. When unpacking, take care not to drop the small cylinders which contain the thermometers. Remove all fasteners on the face side of the crate while it is laying flat. Remove packing material and locate the thermometers and if ordered, the hydrometer and hydrometer jar. Set them aside in a secure place, then remove the system panel from the crate.
- 3-2. Inspection. *Inspect the panel and container for damage at this time, as your ability to recover damages from the transportation company is dependent upon prompt reporting of hidden damages.* You should have the system panel, the load, hoses and clamps (if ordered from us), two thermometers and two instruction manuals. Now is a good time to inspect the thermometers and hydrometer and repack them for storage in a safe place until they are needed. Be careful when you unpack them!
- 3-3. Installation. The Power Test Load System must be installed vertically on a wall or solid partition or cabinet. It should be mounted to provide good visibility of the thermometers. NOTE: Be certain to allow 6 inches (152mm) of unobstructed space immediately above the panel to allow the thermometers to be removed and reinserted. If the coaxial load is not mounted on the system panel, it may be mounted in any position necessary to mate to the RF line.

Hoses from the load to the system panel must be high quality and designed for high temperature and high-pressure service. Never use garden hose or automotive heater hose for this service. We use and recommend Aeroquip FC332-12 Special Application Textile Braid Hose. It is rated to +150°C at 250psi/1.725Mpa and should give many years of satisfactory service.

Hose runs up to 50 feet/15 meters will yield accurate measurements provided that the hose is not subjected to extreme temperatures. All hose runs should be supported mechanically. If they pass near critical electrical equipment or service panels, it is prudent to cover hoses with metal spray shields to contain the liquid in case of a rupture.

The thermowells are "wet" type and must have water added to them to conduct heat to the thermometer bulbs. There is a small hole at the base of the column. When water flows from this hole, the thermometers are immersed correctly. Check the thermowells for water prior to each use of the system.

3-4. Connections. Connections to the system are required for AC power, RF power and coolant.

- a. AC power connection is by a NEMA 5-15P plug for North American 110-130 volt equipment. All other voltages have 50mm stripped and tinned ends for a user-supplied appropriate plug.
- b. RF power connection is by an industry standard or customer specified connector to the coaxial load resistor.
- c. Coolant connections are generally to a 3/4" male NPT which is installed at the factory. These connectors may vary when specified by the user.

3-5. Adjustments. There are two adjustments in the system:

- (1) The time delay adjustment is inside of the Control Box and sets the time delay between flow switch actuation and interlock relay actuation. This adjustment is located on top of the time delay relay. This is set to 7 seconds at the factory. It should never be set to a value less than 7 seconds.
- (2) The flow switch actuation point adjustment is located on the flow switch in the lower left quadrant. It is a small screwdriver slot in the bypass valve portion of the switch and controls the amount of coolant which bypasses the main switch shuttle assembly. *This is a very sensitive adjustment and you should not disturb the factory setting unless you are certain that the switch actuation point is incorrect.* To set this adjustment, you must have a valve in the coolant inlet line and an ohmmeter to detect switch actuation. Use the following procedure:
 - a. Disconnect flow switch at terminals inside of Control Box.
 - b. Attach ohmmeter to switch leads. Reading should be greater than 1 megohms.
 - c. Turn on coolant flow and ensure that flow is greater than desired actuation point of switch. Consult the Flow Meter Calibration Table for correct "gauge" reading for the desired actual flow. Ohmmeter should read less than 2 ohms.
 - d. Gradually decrease coolant flow with valve and observe ohmmeter for indication of switch opening.
 - e. Note flow meter reading.
 - f. If needed, make a small change in the flow switch adjustment screw. This control rotates 360°, allowing you to start in either direction.
 - g. Repeat steps c. through f. as needed, to reach desired actuation point.

SECTION IV

THEORY OF OPERATION

- 4-1. General. Physicists have long known that it takes a definite amount of energy in the form of heat to raise the temperature of a certain mass of liquid and conversely, if you know the temperature rise and the mass of the liquid, you can determine the amount of heat and therefore, the amount of energy applied to the liquid. There are many variables in this equation. Among them are: specific heat of the fluid, specific gravity of the fluid, density of the fluid, thermometer accuracy and flow meter accuracy. These factors must be determined or minimized to yield accurate power measurements. The Power Test Load System is designed to provide the user with data which can be reduced to an accurate transmitted power measurement.
- 4-2. Calorimetry Theory. Since we know from physics that we can determine energy put into a system by measuring temperature and flow rate, we have only to adjust our readings to account for variance from classic values in order to accurately determine transmitter power. The theory of RF calorimetry requires a liquid-cooled coaxial load of low VSWR, accurate thermometry and accurate flow measurement. Data from the thermometers is used to obtain the specific heat, specific gravity and density of the fluid. This information is used to obtain coolant and flow meter factors for use in calculating power values.

Some of the terms we use:

- **Specific heat (C_p):** The number of calories required to raise one gram of a substance one °K.
 - **Specific gravity (G):** A ratio of the mass per unit volume at a known temperature to the mass per unit volume of pure water at the same temperature.
 - **Density:** The mass per unit volume of a substance at a certain temperature.
- 4-3. Practical Calorimetry. Practical calorimetry with the Power Test Load System can be reduced to a systematic process requiring no technical skills beyond the ability to read instruments, use graphs and tables and calculate final values (a handheld calculator helps with the multiplication).

First, a warning! If you don't know what the fluid is, you'll never get a correct answer!

If your system uses "pure" water, i.e. tap water, distilled water, deionized water, etc., you know what the fluid is accurately enough for calorimetry. If your coolant is a mixture of water and ethylene glycol, you cannot be certain what your fluid is until you obtain the specific gravity of your fluid (corrected for temperature) with a laboratory grade hydrometer. Water evaporates from your coolant system, but ethylene glycol doesn't. Therefore, glycol concentrations vary almost daily in an operating system. In systems where fluid loss is made up with water/glycol mixtures, the concentration of glycol gradually increases. Be sure that you know what the specific gravity of your coolant is before you start! Use this value and Figure 1.4 to determine the percentage of ethylene glycol in your system. The percentage value is used in the calorimetry process.

To accurately determine the transmitted power going to the load:

1. Add clean water to each thermowell until water flows out of the small hole near the base of the column.
2. Turn on coolant flow and ensure that it is above the minimum value for your system.
3. Turn on Control Box power and observe Interlock lamp. When it goes out, you may energize transmitter.
4. After 2 to 3 minutes of transmitter operation, you may begin reading instruments.
5. Read flow meter and record observed ("gauge") value.
6. Read inlet fluid temperature and record this value.
7. Read outlet fluid temperature and record this value. Take this reading immediately after reading inlet water temperature.
8. Find the average value of the temperature readings recorded.
(Temp . in + Temp . out / 2)
9. Use the average temperature from (8.) to determine K_t from the K_t Graph, Figure 1.2.
10. Use the outlet fluid temperature determined in (7.) to determine flow meter correction factor from the Coolant Density/Flow Meter Correction nomograph, Figure 1.3.

11. The equation used to solve the power problem:

$$P = K_t \times (T_{\text{outlet}} - T_{\text{inlet}}) \times Q \times F$$

Where: P = Power in kilowatts

K_t = Coolant correction factor

T_{outlet} is expressed in °C.

T_{inlet} is expressed in °C>

Q = Coolant flow in gallons per minute

F = Flow Meter Correction Factor

With the data obtained from earlier steps, you should be able to determine the transmitted power within $\pm 3\%$.

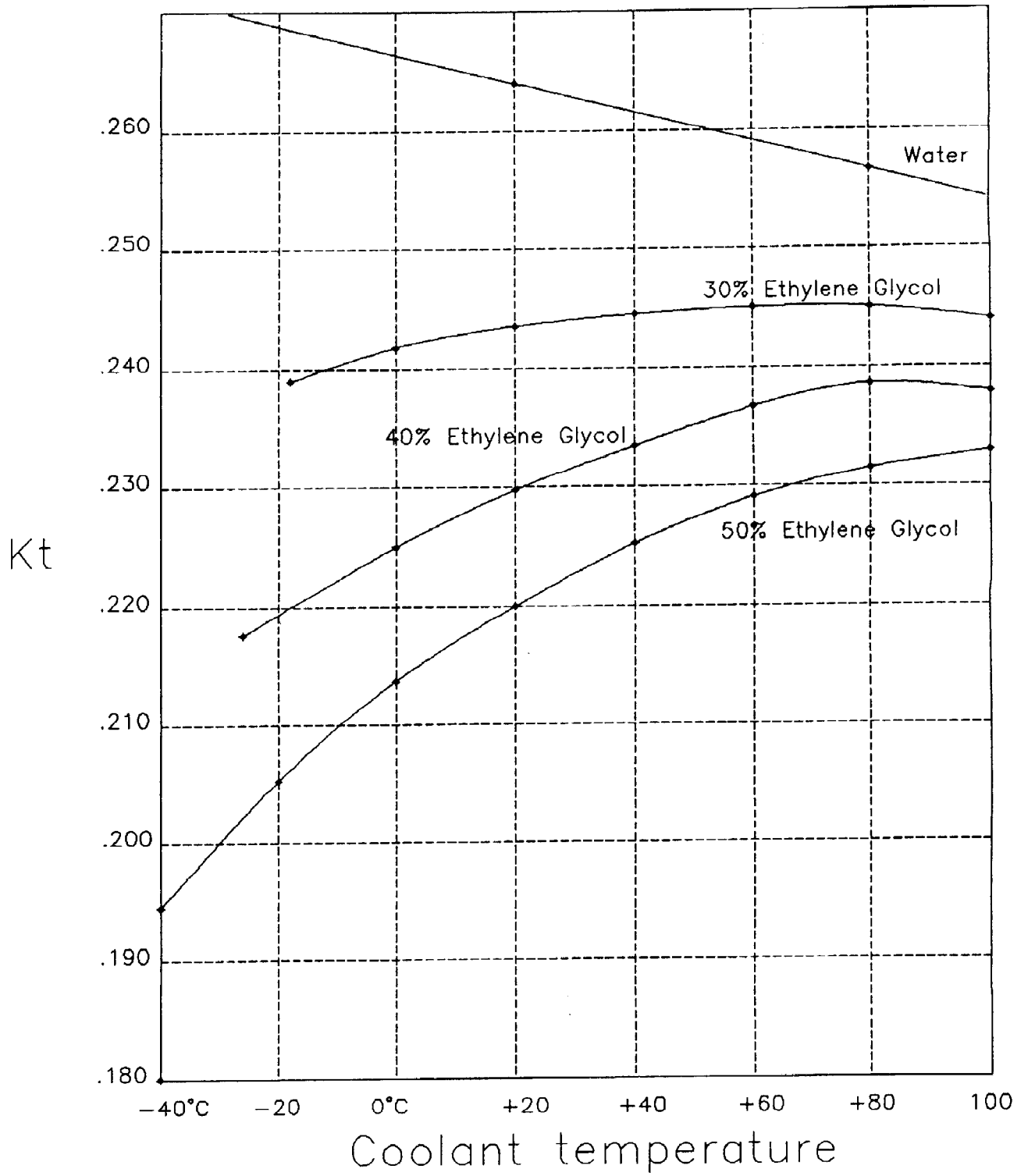
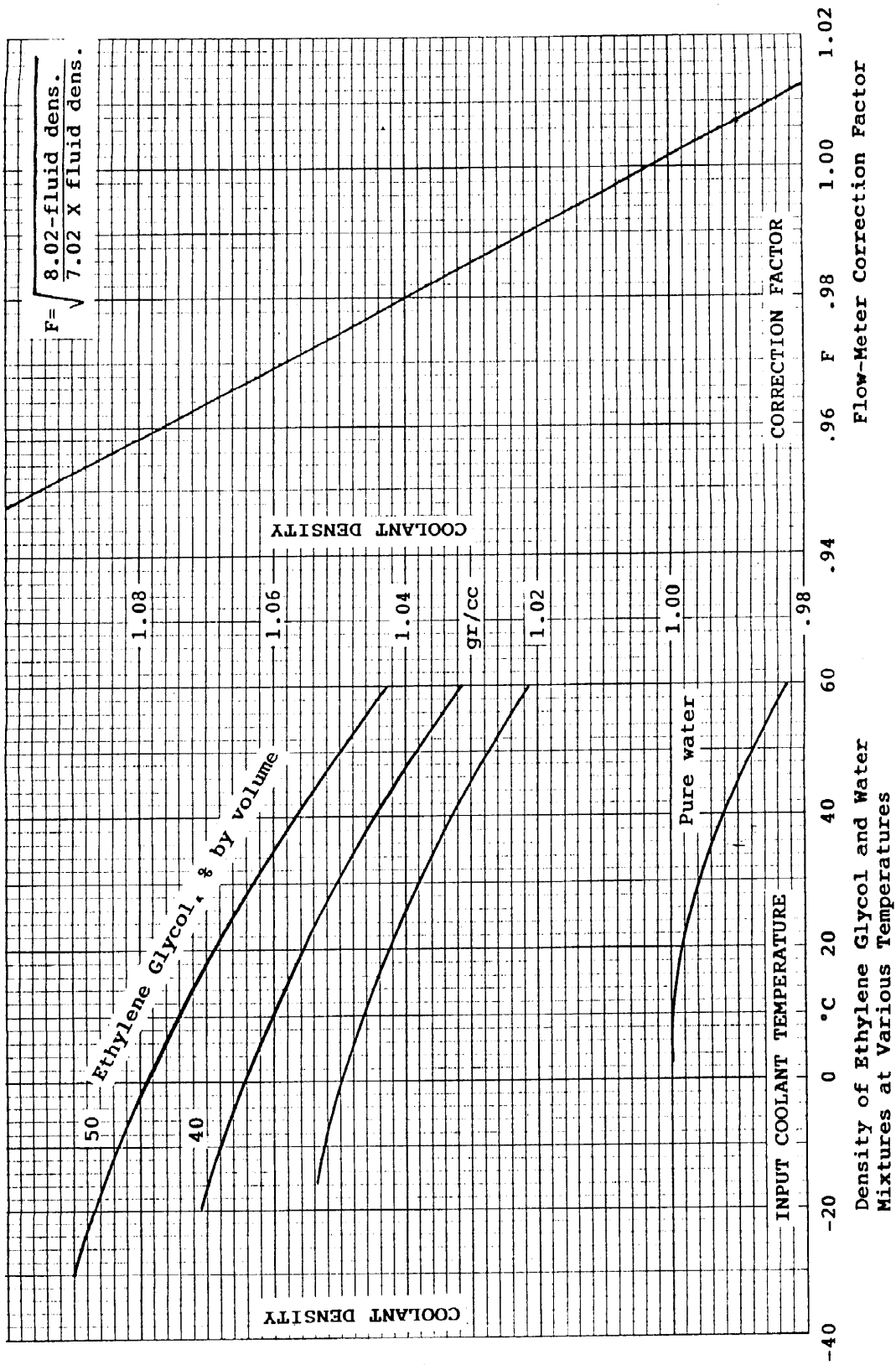


FIG. 1.2



(The above graphs may be used together as a nomograph)

FIG. 1.3

— Densities of Aqueous Ethylene Glycol Solutions
(percent by weight)

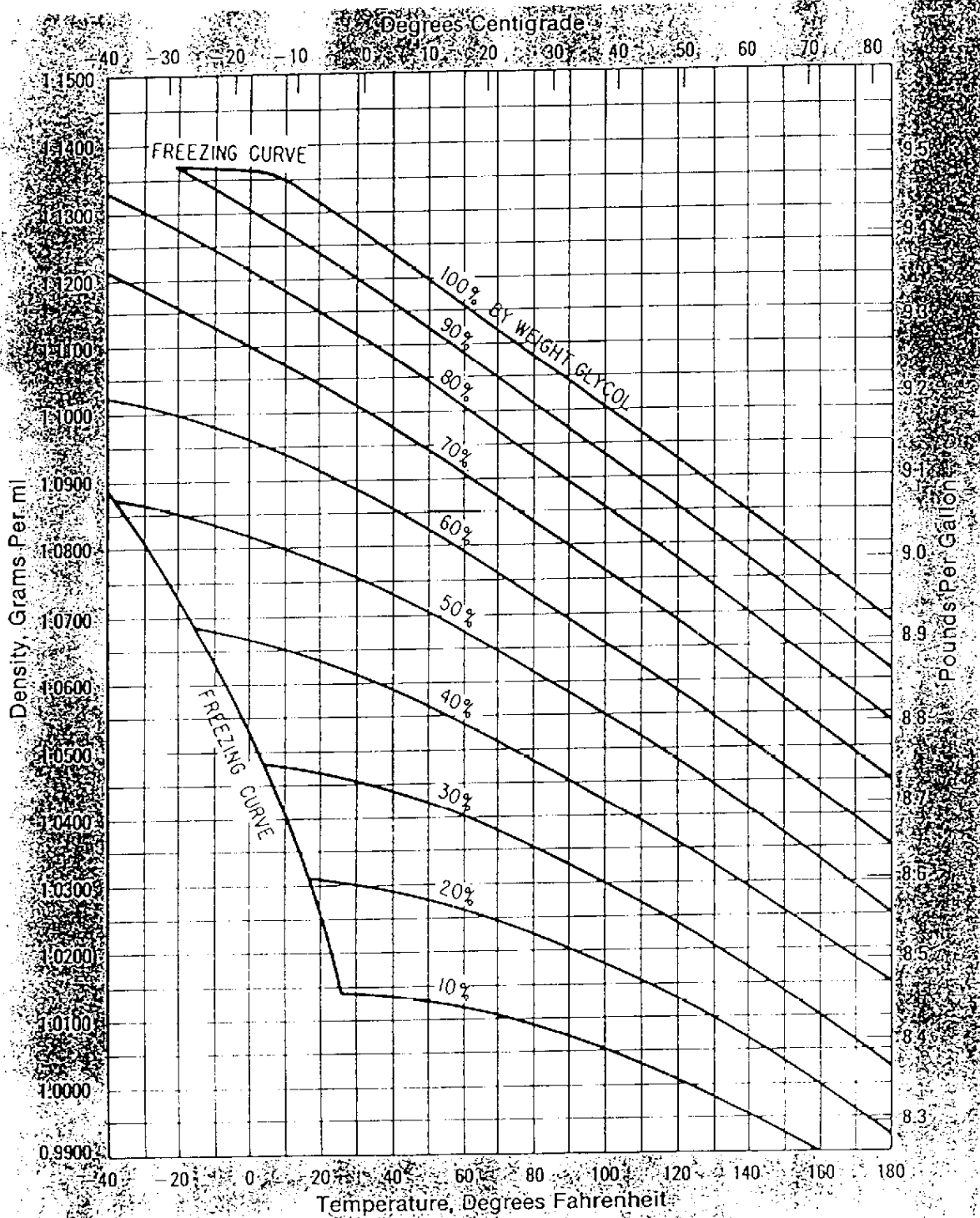


FIG. 1.4

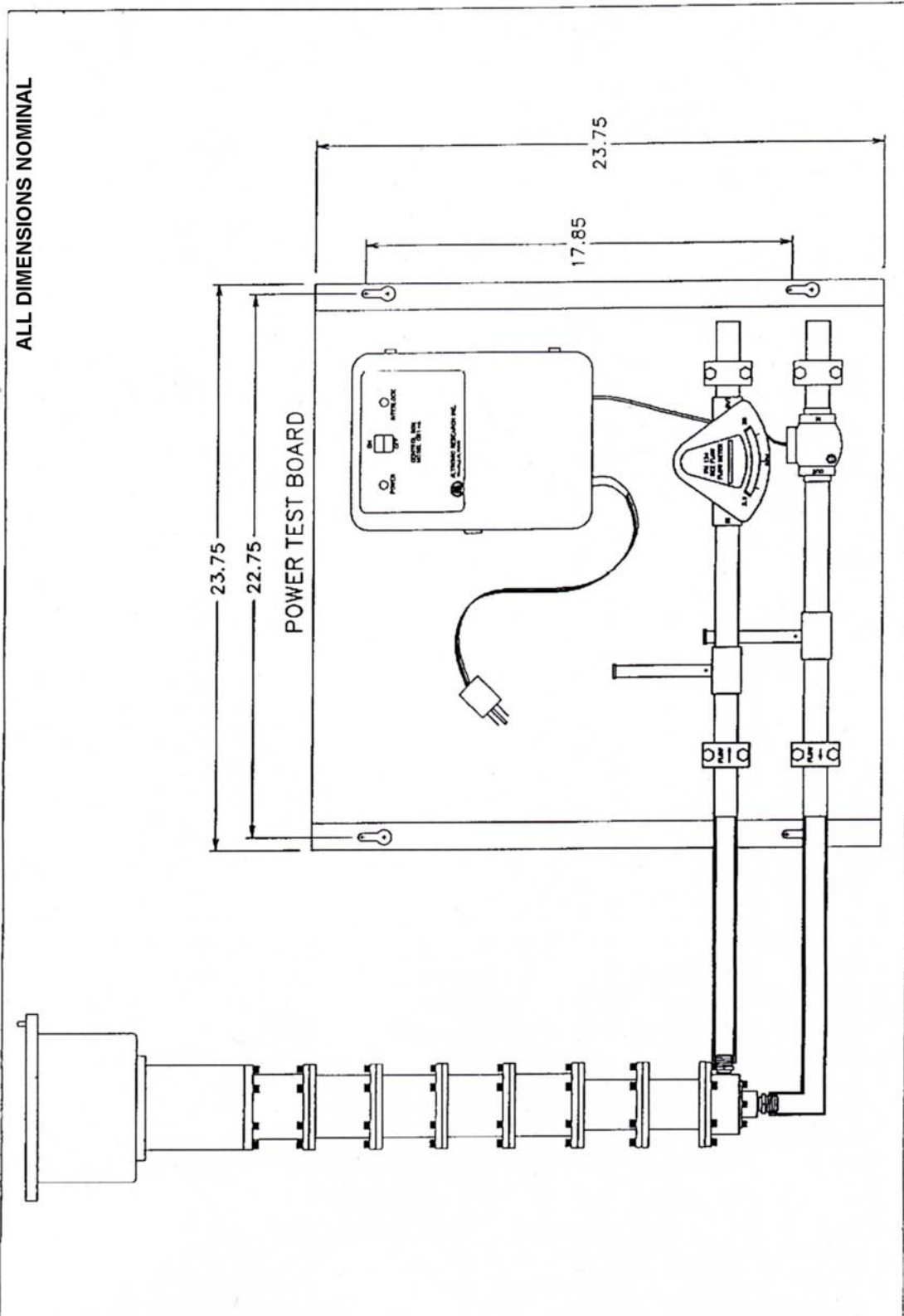
SECTION V

MAINTENANCE

- 5-1. Cleaning. The exterior of the Power Test Load System is plated or painted with a durable acrylic finish. Cleaning is limited to surface cleaning with a neutral glass and plastic cleaner such as Windex or Miller-Stephenson MS-260. Solvent cleaners may damage the finish, legends or labels and should not be used. No internal cleaning should ever be required. In cases where contaminants have been introduced into the system, they should be removed by flushing.
- 5-2. Lubrication. No lubrication is required.
- 5-3. Corrective Maintenance. The only corrective maintenance contemplated is the replacement as an assembly of the flow switch or flow meter. In the event of failure of the CB-1A Control Box Assembly, it may be repaired by any technician with general electronic skills.

SECTION VI

6.1 OUTLINE AND DIMENSIONS



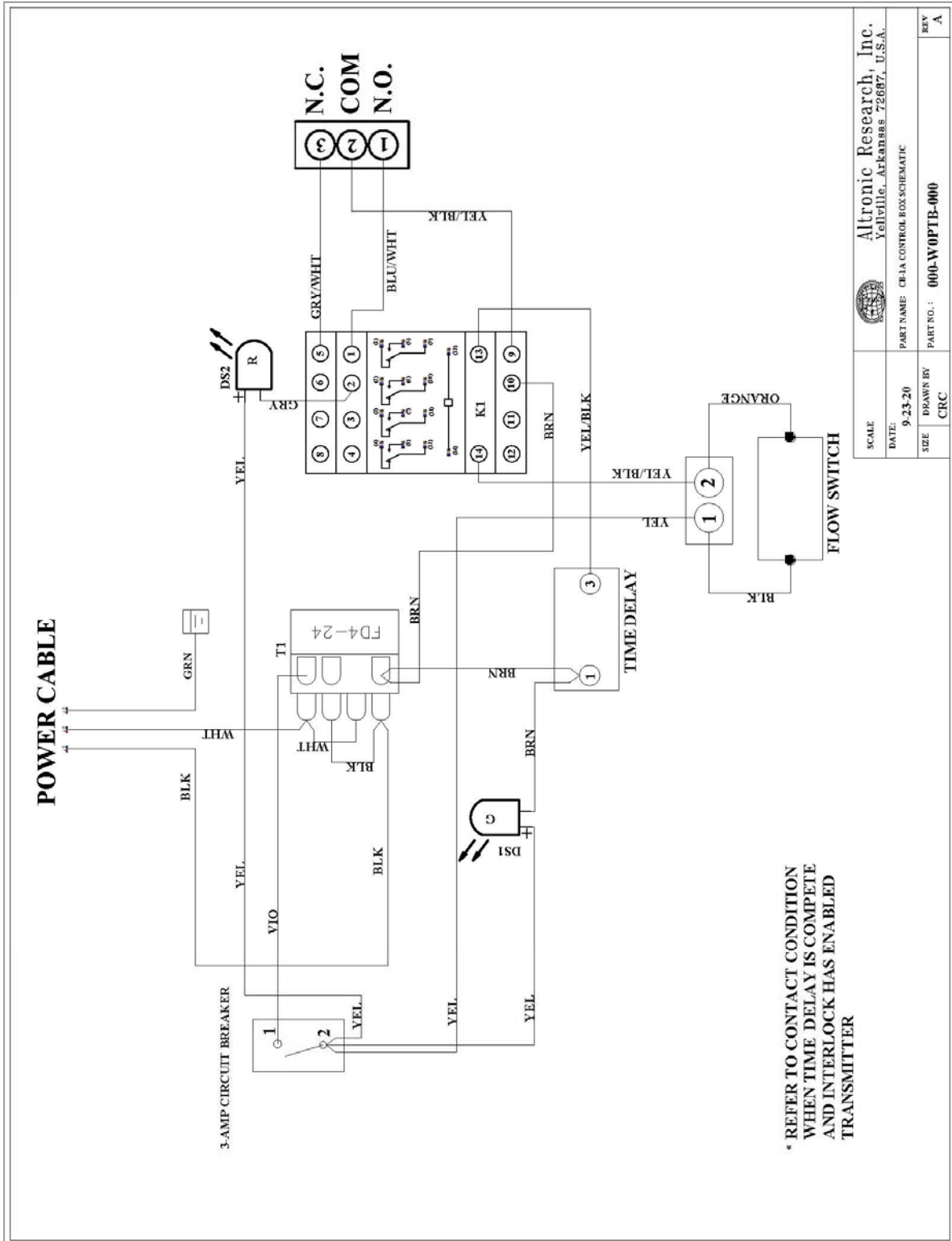
6.2 REPLACEMENT PARTS LIST

The following parts are unique to this system and may be ordered from Altronic Research, Inc. Common hardware components and common electronic components are usually more economically procured locally and are not listed.

<u>Qty. Required</u>	<u>Description</u>	<u>Part Number</u>
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(CONSULT FACTORY)

6.3 SCHEMATIC



* REFER TO CONTACT CONDITION
WHEN TIME DELAY IS COMPLETE
AND INTERLOCK HAS ENABLED
TRANSMITTER

SCALE	Altronic Research, Inc. YELVILLE, ALABAMA 36877, U.S.A.		
DATE	9-23-20	PART NAME	CE-1A CONTROL BOX SCHEMATIC
SIZE	DRAWN BY CRC	PART NO.	000-W0PTB-000
REV	A		

VII. SPECIFICATIONS

Power Test Load System

The Power Test Load System is mounted on an aluminum panel which is 28.25 inches (718mm) wide x 24.25 inches (616mm) high x 1.25 inches (32mm) deep. The components mounted on the panel extend approximately 7 inches (178mm) from the panel.

This system is designed to operate on single phase, 50 or 60 Hertz power supplies. Standard supply voltages are 110-130 or 200-240. Voltage selection is not readily field changeable.

Consult the appropriate RF Coaxial Load Resistor Manual for the ratings and specifications of the load furnished with your system.

Because of variations in load size and mounting provisions, no weight is specified for a complete system.

The time delay relay in the control box is adjustable for 1-895 seconds delay and should never be set to a value less than 7 seconds.

The flow meter provided with this unit is calibrated by us and is rated by the manufacturer to be accurate within $\pm 2\%$. See the calibration table included in this manual.