ALTRONIC RESEARCH, INC.

P.O. BOX 249
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U.S.A.

MODEL 58600
COAXIAL LOAD RESISTOR

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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

!!!DANGER!!!

THIS UNIT MUST BE TOTALLY DISCONNECTED FROM ALL RF POWER BEFORE ANY REPAIRS ARE ATTEMPTED. ANY ATTEMPT AT REPAIR WITHOUT DISCONNECTING THE POWER COULD RESULT IN *FATAL ELECTRICAL SHOCK*!!!

WARNING

COOLING WATER CANNOT BE RUN IN SERIES FROM LOAD TO LOAD. EACH LOAD REQUIRES 33 GPM WITH OUTLET TEMPERATURES NOT TO EXCEED 82°C.

WARNING

DO NOT APPLY POWER WITHOUT THE MINIMUM RATED FLOW OF COOLANT THROUGH THE LOAD. A SAFETY INTERLOCK SWITCH IS RECOMMENDED. EVEN A BRIEF APPLICATION OF POWER TO THE LOAD WITHOUT THE CIRCULATION OF COOLANT WILL CAUSE IMMEDIATE BURN OUT.

WARNING

THE LOAD RESISTOR CONSISTS OF A CERAMIC SUBSTRATE COATED WITH A SPECIAL RESISTIVE FILM. IF ANY DAMAGE OCCURS TO THE RESISTOR, THERE COULD BE SHARDS OR SHARP BROKEN PIECES OF CERAMIC IN THE LOAD. CARE SHOULD BE TAKEN TO AVOID CUTS OR INJURIES.

☠WARNING☠

ETHYLENE GLYCOL IS A TOXIC SUBSTANCE THAT MAY CAUSE PERMANENT DAMAGE TO THE SKIN, KIDNEYS, LIVER AND OTHER ORGANS. AVOID CONTACT WITH SKIN. AVOID BREATHING VAPORS. SEE THE MATERIAL SAFETY DATA SHEET FOR THE SPECIFIC PRECAUTIONS AND FIRST AID MEASURES PRESCRIBED BY THE MANUFACTURER.

PRECAUTIONS

☠CAUTION☠

WHEN USING ANY CLEANING SOLVENTS OR SOLUTIONS, ASSURE THAT THERE IS ADEQUATE VENTILATION TO PROTECT PERSONNEL FROM BREATHING ANY IRRITABLE OR POSSIBLY TOXIC FUMES.

NOTICE

FAILURE OF UNIT DUE TO ACCUMULATION OF SOLIDS IN WATER WILL VOID THE WARRANTY.

CAUTION

USE ONLY CLEAR, COLORLESS, ANALYTIC OR TECHNICAL GRADE ETHYLENE GLYCOL WITH PURE TAP OR POTABLE* WATER AS A SOURCE COOLANT. DO NOT USE ANY STOP LEAK, SEALANTS, AUTOMOTIVE ANTIFREEZE OR UNION CARBIDE UCARTHERM™ IN COOLANT. USE OF THESE SUBSTANCES WILL VOID THE WARRANTY.

IMPORTANT

ADDITION OF ETHYLENE GLYCOL TO THE WATER REDUCES THE HEAT CAPACITY OF THE COOLING SYSTEM. COOLANT FLOW RATE MUST BE INCREASED BY AT LEAST 20% OVER MINIMUM FLOW.

CAUTION

DO NOT APPLY MORE THAN THE MAXIMUM RATED RF POWER TO THE LOAD. THIS WILL CAUSE INTERNAL DAMAGE TO THE LOAD.

* **Potable Water:** The U.S. Health Department has established standards for potable water at a maximum of 500ppm of dissolved solids. Hard water (particularly dissolved salts) can cause damage to resistive film and load. Water condition can be adjusted by mixing distilled water in sufficient quantities with coolant water.

INTRODUCTION

This handbook is for technical personnel as an aid in understanding and performing installation, service and maintenance procedures for the OMEGALINE® Model 58600 Coaxial Load. Personnel are considered to be skilled if they have the necessary knowledge and practical experience of electrical and radio engineering to appreciate the various hazards that can arise from working on radio transmitters, and to take appropriate precautions to ensure the safety of personnel.

SECTION I

DESCRIPTION AND LEADING PARTICULARS

1-1. Purpose and Application of Equipment. The OMEGALINE® Model 58600 is designed to continuously dissipate 600,000 watts of RF power when operated within its specified ambient temperature range.

1-2. Equipment Supplied.
Three Model 157250 dummy loads, enclosure, plumbing and appropriate control circuitry.

1-3. Equipment Required But Not Supplied.
Piping from the Model 58600 to the Dry Cooler and return with drain valve.
Wiring from the Model 58600 to the transmitter interlock and pump start circuitry.

1-4. General Description. The Model 58600 consists of an outer painted aluminum housing with doors that rests on a powder-coated base frame. RF enters the housing at the top through a standard 9 3/16 EIA flange. The 58600 is cooled by liquid that is pumped from a user-supplied source, circulated through the loads, and then returned to the source. Interlock and pump circuitry terminals are located on a terminal strip inside the housing. Ground terminals are provided on the back lower center side of the housing. The unit is designed for indoor and sheltered installations. It must not be subjected to freezing temperatures. The 58600 load elements are basically three 250 kW 150-ohm water loads operated in parallel to give a combined rating of 600 kW at 50 ohms. They are termination-type units having their characteristic impedance at the input end and tapered to zero impedance (short circuit) at the other end. The center conductors are tubular resistors whose DC resistance is equal to three times the characteristic impedance of the line. The outer conductor of the coaxial line is the load enclosure. The RF dielectric medium consists of three distinct materials: the liquid coolant, the plastic

water jacket, and the air space. Coolant enters the cabinet through the flanged connection labeled inlet, and proceeds through a manifold to each of the water loads. It flows axially up the center of the resistor tube, mushrooms over into the annular channel under the water jacket, and makes a second pass over the resistor in direct physical contact with the resistive film. Thus the coolant makes intimate contact with both the inside and outside cylindrical surfaces of the resistor, providing optimum heat transfer with a minimal flow rate. The coolant moves out of the water loads and into the return manifold, and back to the flanged connection on the cabinet labeled outlet.

1-5. Electrical Description. The Model 58600 contains a 50-ohm non-reactive resistor assembly capable of dissipating 600,000 watts of applied electrical energy at frequencies between DC and 2 MHz with a maximum VSWR of 1.15 to 1. No provisions are made for tuning the resistor assembly. The transmitter interlock circuit consists of 3 flow switches, 3 door switches and one level switch wired in series to the interlock terminal connections. This terminal provides a closed pair when the doors are closed, the flow switches sense a minimal flow required for operation, and the level switch senses no water has leaked from the loads. An additional switch is wired to a terminal pair on the terminal strip. When wired in series to the pump run circuitry, this switch will stop pump operation if a coolant leak occurs.

1-6. Performance Characteristics. When properly serviced, this device is very reliable and capable of continuous operation at 600kW RMS input. The Unit requires protection from freezing unless prepared for storage. The maximum design temperature for continuous operation is 60°C inlet temperature.

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

GENERAL THEORY OF OPERATION

2-1. The Omegaline® Model 58600 is an energy conversion and transfer device. RF energy is conducted to the load cabinet by the RF duct, where it enters the load cabinet at the top and is divided between three loads. Each load is nominally rated at 250kW and, in this application, is rated at 200kW. The RF energy is converted to heat by the resistive elements in the loads.

CARE SHOULD BE TAKEN TO OPERATE UNIT BELOW STATED MAXIMUM AMBIENT OPERATING TEMPERATURE.

OPERATION ABOVE RATED AMBIENT TEMPERATURE MAY CAUSE AN OVERHEAT AND DAMAGE TO THE WATER LOADS.

PROVISIONS ARE MADE TO TRIP THE INTERLOCK IN THE EVENT OF OVERHEAT, BUT THE INTERLOCK MUST BE PROPERLY CONNECTED TO THE RF SOURCE FOR THIS FUNCTION TO OPERATE.

NEVER OPERATE WITH INTERLOCK DISCONNECTED OR MALFUNCTIONING.
TO DO SO WILL VOID THE WARRANTY.

2-2. The loads are made with a single resistor and are water-cooled. Cooling water enters the load at the bottom (opposite the RF end) and flows through the center of the resistor to the RF end where it turns and enters the space between the outside of the resistor and the inside of the water jacket. This water is in direct contact with the resistive film and absorbs the heat produced by the resistor as it flows to the bottom of the load. The water then enters an annular chamber and is discharged from the side of the water housing cap.

2-3. The control circuitry is also designed to provide an interlock signal to the RF source to prevent the application of power to the load when it is not ready to dissipate heat. The logic of the system is simple and depends on the closure of a series of switches in order to enable the transmitter. An additional switch has been provided to be used in series with the pump switch. When liquid is found to have leaked into the load cabinet, the interlock will open, stopping RF transmission, then the pump circuitry will open, stopping pump operation.

SECTION III

TEST EQUIPMENT AND SPECIAL TOOLS

3-1. Test Equipment Required. No test equipment is required for routine maintenance, however it may be necessary to verify DC resistance of the coaxial resistor and/or verify coolant temperature, in which case you will need an accurate digital ohm-meter and precision thermometer.

3-2. Special Tools Required. This device is easily maintained with common hand tools and general electronic servicing tools. Many faults can be corrected in less than one hour. Common hand tools will be adequate for most maintenance. In addition, pipe wrenches in 24 inch and 12 inch sizes should be available.

SECTION IV

MAINTENANCE

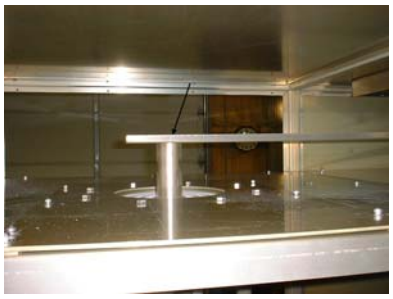
The OMEGALINE® RF loads will require little in the way of maintenance. In the event of mechanical damage to the unit, operational difficulty, or information concerning a desired unusual application of the load, contact the factory.

4-1. <u>Water Load Removal.</u> The three Omegaline® Model 157250 loads incorporated in this unit are contained in the cabinet. Maintenance of the loads is covered in the Model 157250 technical manual which is attached as Appendix A of this manual. Access to the loads is through the three doors.

<u>WARNING</u>!
DO NOT OPEN CABINET WITHOUT LOCKING OUT ALL RF ENERGY SOURCES AND NOTIFYING YOUR SUPERVISOR AND ALL TRANSMITTER PERSONNEL THAT YOU ARE DOING SO. FAILURE TO FOLLOW THIS INSTRUCTION COULD RESULT IN FATAL ELECTRICAL SHOCK OR SEVERE BURN.

Following are steps to remove a 157250 from the enclosure:

A. Remove the support bracket from the top and bottom load bracket by removing the ¼ - 20 socket head screws that hold them in place.



B. Remove the 3/8 – 16 hex bolt that secures the conductor to the RF input.

C. Remove the ¼ - 20 socket head bolts fasten the top and bottom load bracket to the enclosure housing.

D. Remove the 3/8 – 16 nut that holds the RF ground strap to the base of the 157250 and set the strap out of the way.

E. Separate the unions that connect to the water inlet and water outlet manifolds.

F. Support and remove the load as needed.

SPECIAL NOTE: After maintenance has been performed on the cooling circuit or when there is reason to suspect that the coolant is contaminated, the cooling circuit should be thoroughly flushed with clean water. This should be done by filling the system with clean water and running a short time, then draining and cleaning filter screen. This should be done several times until water is completely clear and filter remains clear of particles. Then refill the system with required amount of potable water or approved ethylene glycol mixture.

WARNING!

USE OF ANYTHING OTHER THAN PURE POTABLE WATER OR A MIXTURE OF TECHNICAL ETHYLENE GLYCOL AND POTABLE WATER, OR USE OF A MIXTURE MORE CONCENTRATED THAN 35% ETHYLENE GLYCOL WILL VOID THE WARRANTY!!!

4-2. Cleaning. Cleaning the Omegaline® Model 58600 is limited to washing and rinsing painted surfaces. A mild glass and plastic cleaner suitable for use on polycarbonate surfaces should be used as necessary to remove soil.

SECTION V

CALORIMETRY

5-1. 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 OMEGALINE® Power Test Load System is designed to provide the user with data which can be reduced to an accurate transmitted power measurement.

5-2. 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.

5-3. Practical Calorimetry. Practical calorimetry with the OMEGALINE® 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 the Ethylene Glycol Solution Densities chart 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. After 2 to 3 minutes of transmitter operation, you may begin reading instruments.

4. Read flow meter and record observed ("gauge") value.

5. Read inlet fluid temperature and record this value.

6. Read outlet fluid temperature and record this value. Take this reading immediately after reading inlet water temperature.

7. Find the average value of the temperature readings recorded.
(Temp . $_{in}$ + Temp . $_{out}$ / 2)

8. Use the average temperature from (7.) to determine K_t from the K_t Graph.

9. Use the outlet fluid temperature determined in (6.) to determine flow meter correction factor from the Coolant Density/Flow Meter Correction nomograph.

10. The equation used to solve the power problem:

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

Where: P = Power in kilowatts

K_t = Coolant correction factor

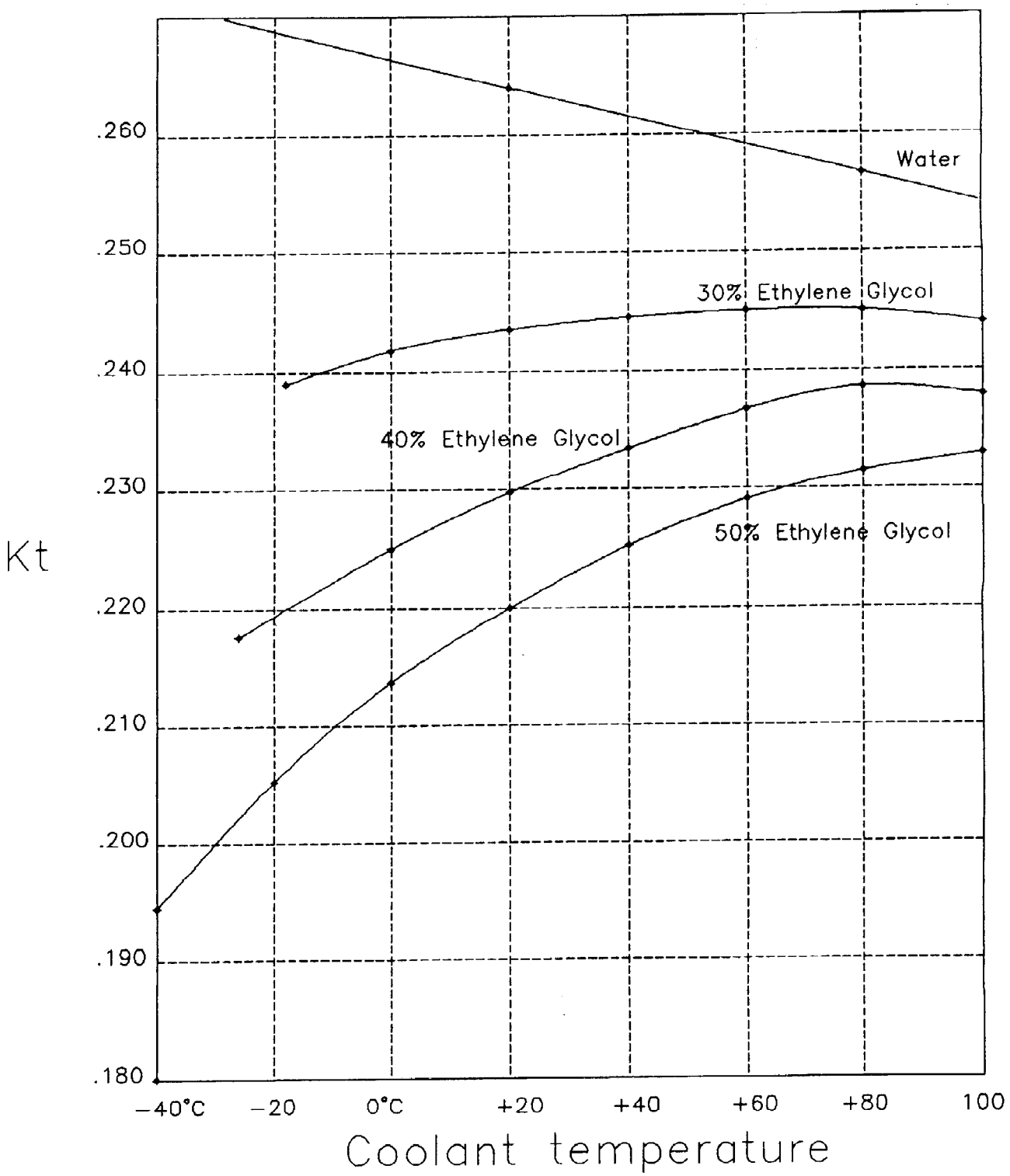
T_{outlet} is expressed in °C.

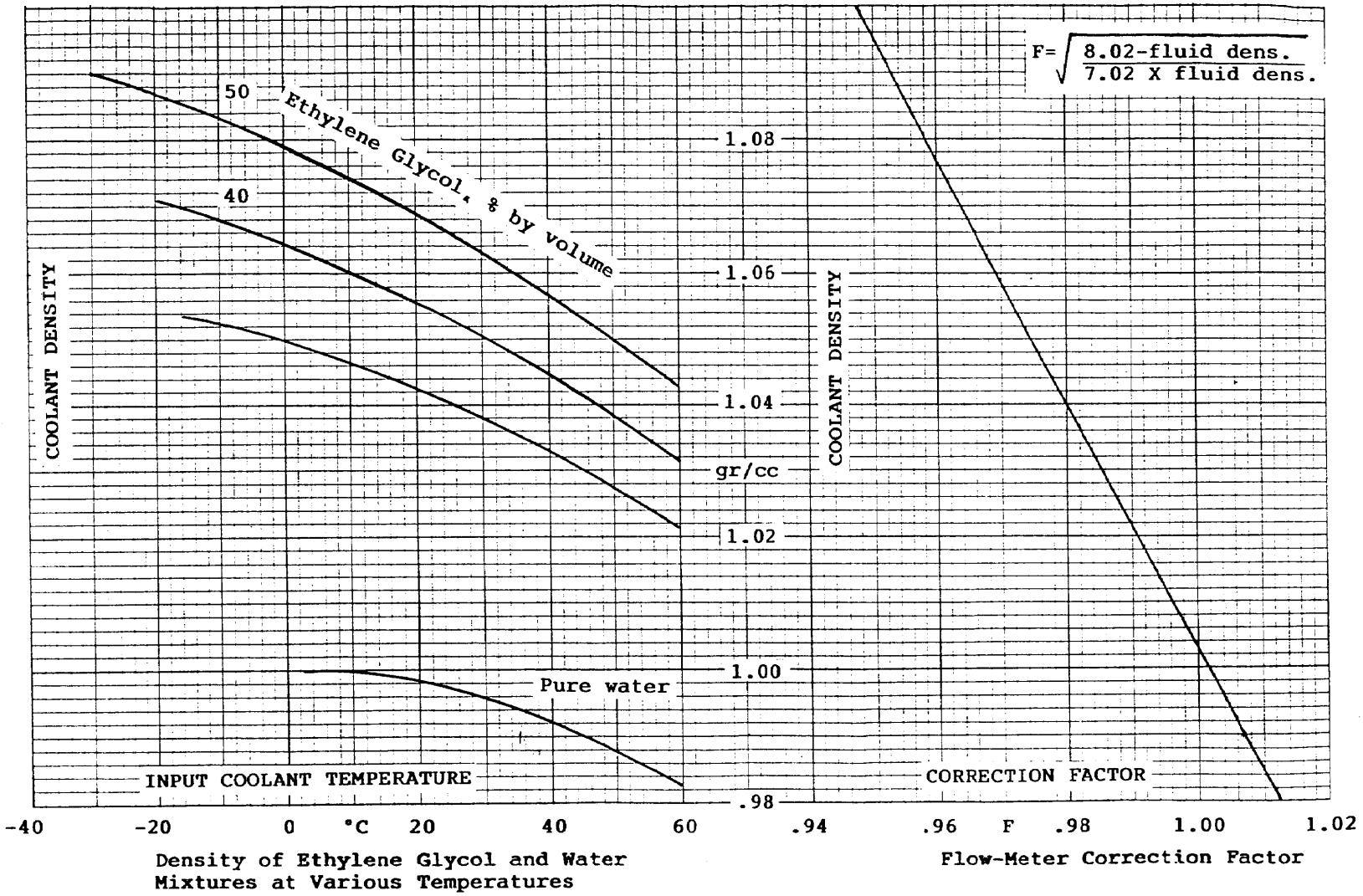
T_{inlet} is expressed in °C>

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 ± 3%.


Kt
.260
.250
.240
.230
.220
.210
.200
.190
.180
Water
30% Ethylene Glycol
40% Ethylene Glycol
50% Ethylene Glycol
−40°C
−20
0°C
+20
+40
+60
+80
100
Coolant temperature

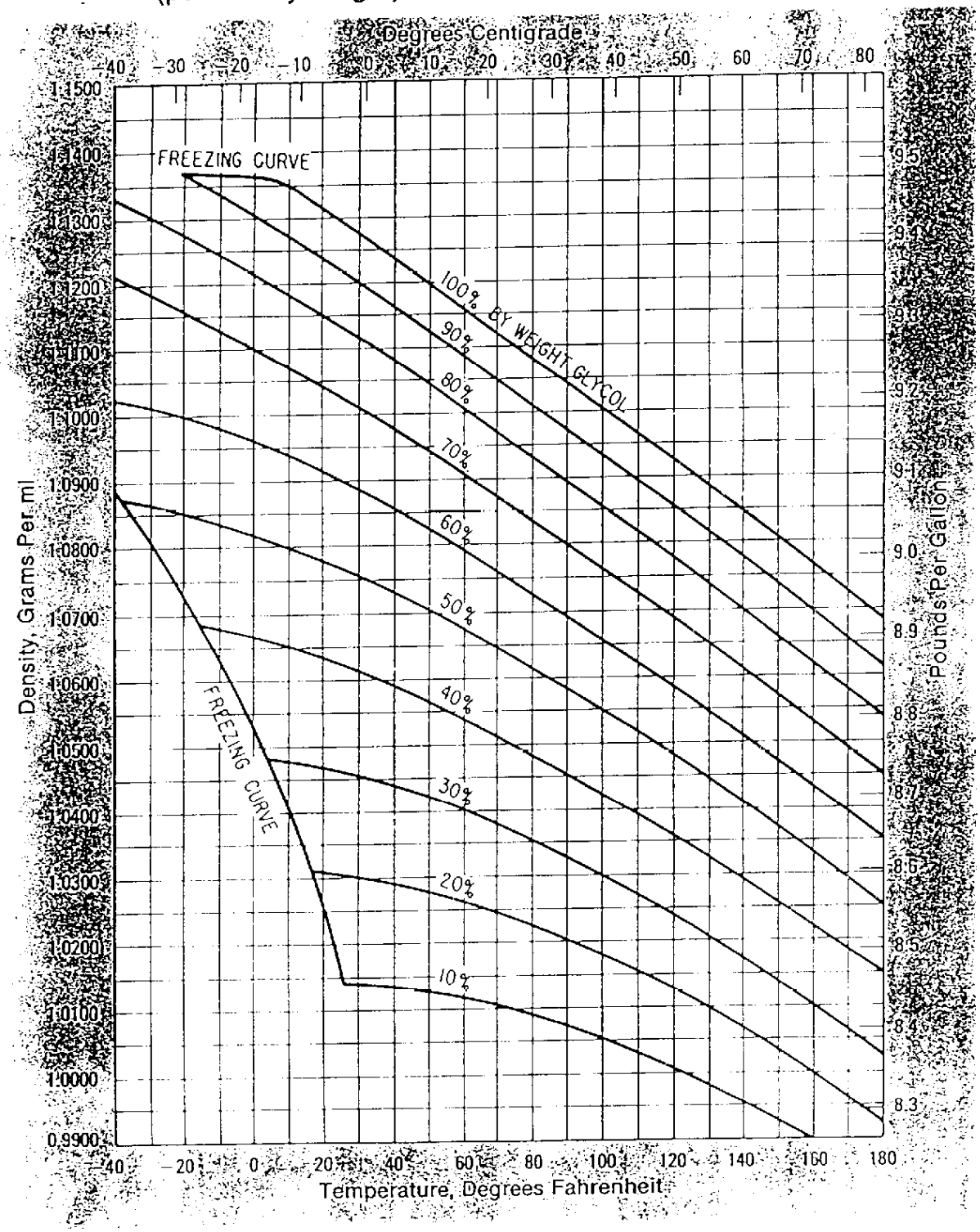


Density of Ethylene Glycol and Water Mixtures at Various Temperatures

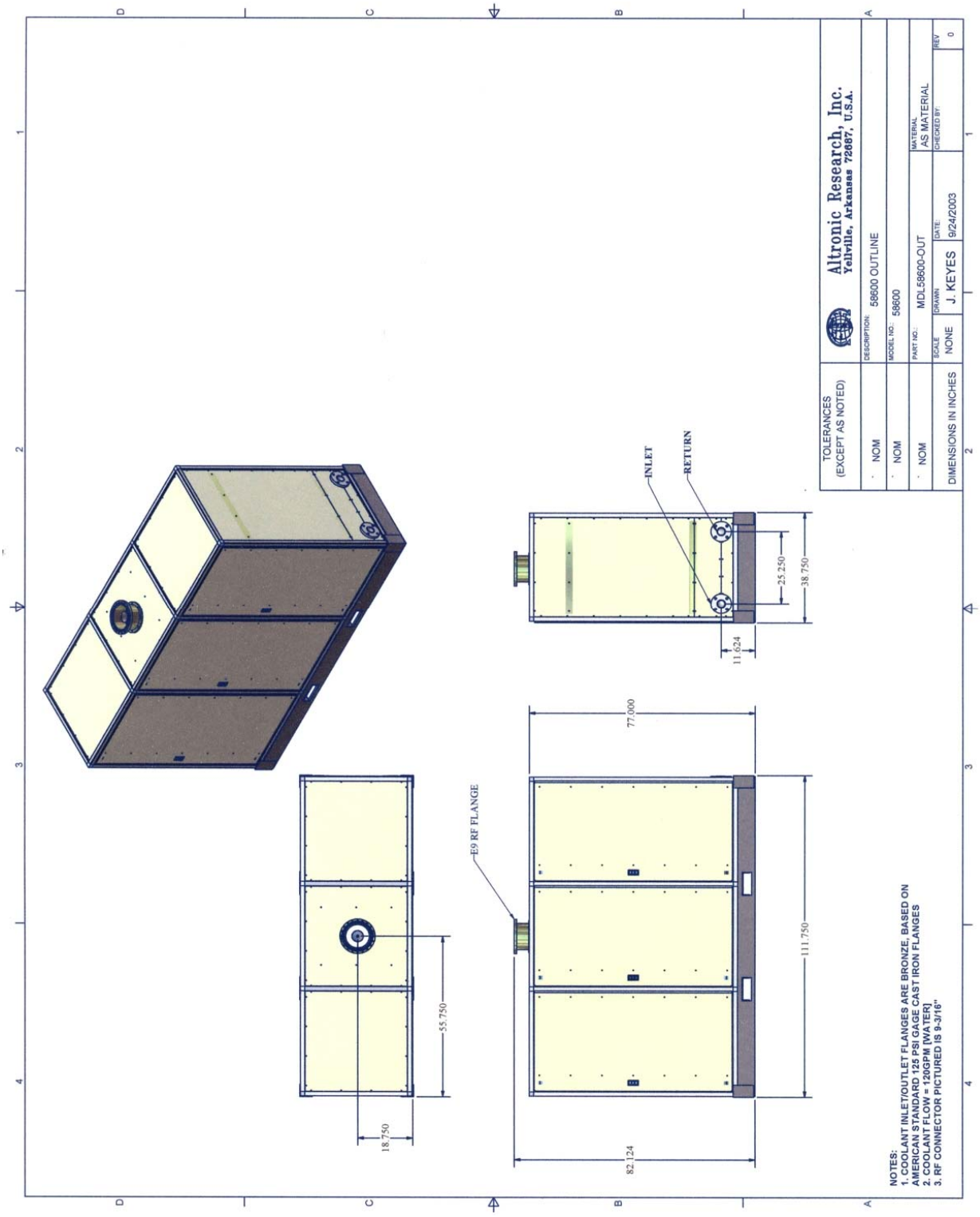
Flow-Meter Correction Factor

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

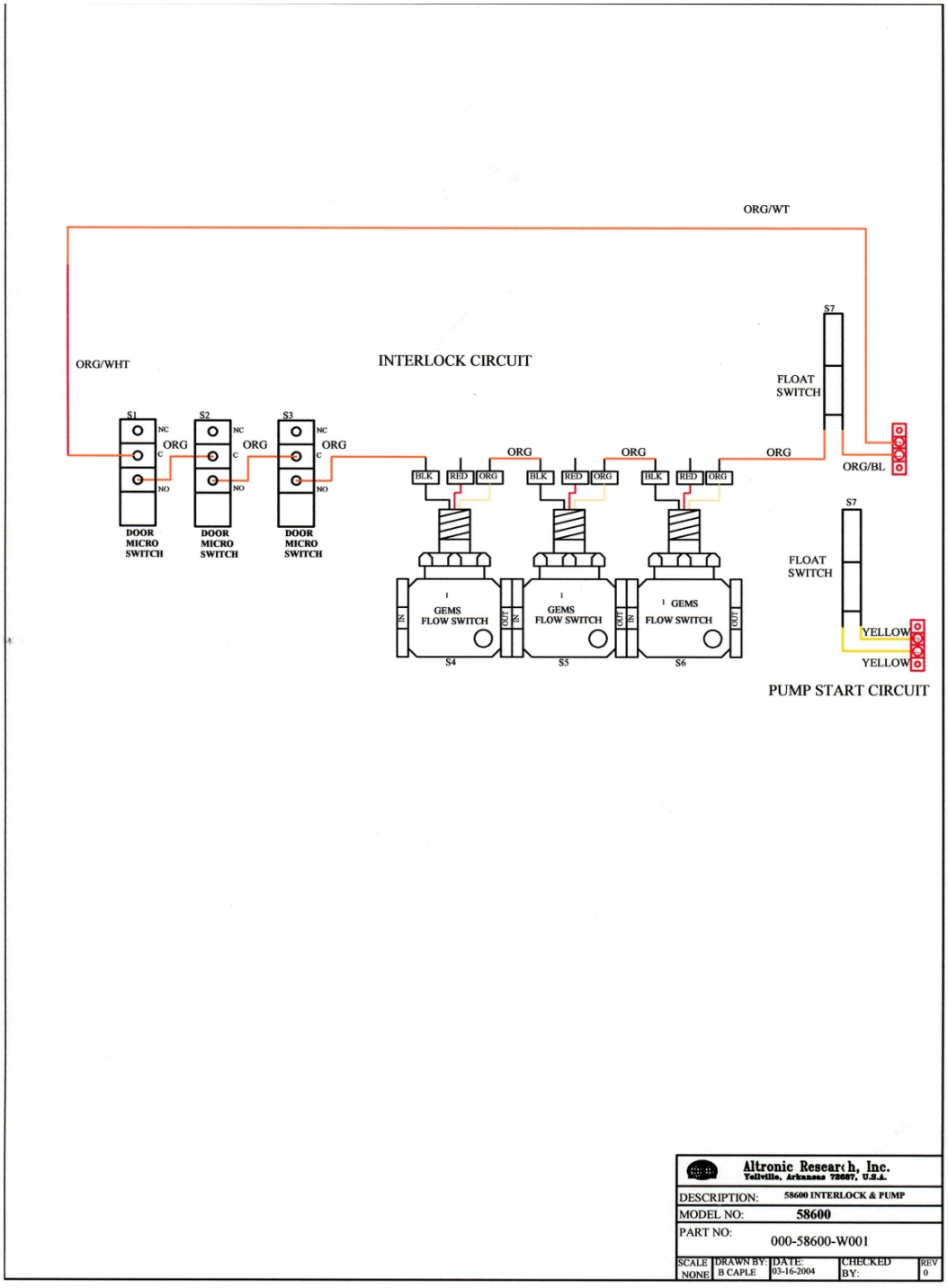
— Densities of Aqueous Ethylene Glycol Solutions (percent by weight)



OUTLINE DRAWING



SCHEMATIC DIAGRAM



REPLACEMENT PARTS LIST
Model 58600

(CONSULT FACTORY)

SPECIFICATIONS: Model 58600

Impedance ----------> 50 ohms

Frequency Range ----------> DC to 2 MHz

VSWR ----------> 1:15 to 1

<u>Connectors</u>:

Model 58600E9 ----------> 9 3/16 Fixed Flange

Minimum Flow ----------> 100 GPM / 120 GPM w/glycol

Coolant Type ----------> Potable water or 35% ethylene glycol mixture

Power Rating ----------> 600 KW Cont.

Ambient Temperature vs. Power Ratings:

<u>600KW continuous</u>:

Potable water only ----------> 4°C to 60°C

35% Ethylene Glycol ----------> -20°C to +60°C

Finish----------> Beige Splatter

Serial No._____Frequency_____Resistance_____

Model_____Inspected by_____Date_____

☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆

CRAFTED WITH PRIDE IN ARKANSAS, U.S.A.

APPENDIX A