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REPORT NO. R-1676

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DATE 19 December 1940

NRL Report No. R-1676
Test of Radiomarine Type ET-8021
30 watt Radio Telephone Equipments

SUBJECT

FR-1676

Test of Radiomarine Type ET-8021

30 watt Radio Telephone Equipments

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19 December 1940

NRL Report No. R-1676
BuShips Prob. No. T5-35C

NAVY DEPARTMENT [redacted]

Report on [redacted]

Test of Radiomarine Type ET-8021

30 watt Radio Telephone Equipment

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D. C.

Number of Pages: Text - 26 Tables - 14 Plates - 11

Authorization: BuShips let. S67/43 (10-19-DR6) of 23 Oct. 1940.

Date of Test: October 2 - December 16, 1940

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FR-1676

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SECTION I

AUTHORIZATION

1-1. The tests herein reported were authorized by Bureau of Ships letter S67/43 (10-19-DR6) of 23 October 1940. The above letter assigned Bureau of Ships Problem T5-35C, Priority A, to cover the tests of the Radiomarine Type ET-8021, 30 watt radio telephone equipments.

OBJECT OF TEST

1-2. The object of the tests was:

(a) To examine the equipment for the purpose of determining its ability to withstand the rigors of Naval usage.

(b) To determine the performance of the equipment when it was subjected to the various conditions likely to be encountered in the Naval Service.

(c) To ascertain what changes or modifications are necessary or desirable in the equipment to insure satisfactory operation under Naval Service conditions.

ABSTRACT OF TESTS

1-3. The tests herein reported were conducted with a view of determining the potentialities of the equipment under Naval conditions of operation. Briefly, inspection and tests were conducted as follows:

(a) Transmitter

General examination of equipment

(1) Check of vacuum tubes employed and method of mounting.
(2) Inspection of panel controls.
(3) Investigation of tuning methods.
(4) Accessibility, ease of adjustment and protective features.
(5) Wiring.
(6) Insulation.
(7) Weights and dimensions.
(8) Physical construction, ventilation, corrosion resisting measures.
(9) Check of meters, switches, resistors, fuses, capacitors, etc.
(10) Mounting and shockproofing methods.
(11) Handset, controls, and mounting.
(12) Connection facilities.
(13) Power equipment.

[redacted]

Operational data and tests

(1) Power output determination.
(2) Effect of temperature variations.
(3) Effect of humidity.
(4) Effect of vibration.
(5) Locked key operation.
(6) Local and remote control features.
(7) Modulation characteristics.
(8) Break-in method.
(9) Power required for operation.
(10) Instruction book.

(b) Receiver

General examination of equipment

(1) Electrical inspection of circuits, etc.
(2) Mechanical inspection of components, controls, etc.
(3) Instruction book.
(4) Spare parts.

Operational data and tests.

(1) Listening tests on antenna.
(2) Laboratory measurements in shielded room.
    A. Sensitivity and noise output.
    B. Image ratio.
    C. I-F response.
    D. Selectivity.
    E. Resonant overload.
    F. Effect of modulation depth.
    G. Gain control range.
    H. Radiation at oscillator frequency.
(3) Effects of temperature variations.
(4) Effect of humidity variations.
(5) Effects of vibration.

[redacted]

Conclusions

(a) The general appearance and construction of the Model ET-8021 equipment is good. Component parts of good quality are employed, although not all parts would comply with the requirements of Naval specifications. Standard tubes of a minimum number of types are used.

(b) A flexible system of tuning and antenna adjustment for the transmitter has been provided, making it possible to obtain optimum performance without undue difficulty.

(c) A number of minor modifications are indicated to improve operation and maintenance of the transmitter circuits, and improvements in wiring are considered necessary in order to prevent failures due to vibration.

(d) The receiver has moderate sensitivity, good selectivity, and a poor image ratio.

(e) The AVC characteristics are apparently satisfactory for the type of service for which the receiver was designed.

(f) The receiver operated satisfactorily in the presence of high humidity, except when started cold after prolonged exposure to such humidity. Its gain under the latter condition was greatly reduced, and it required about two hours to return to approximately normal.

(g) High temperatures did not greatly affect its gain, but starting at very low temperatures was accompanied by low gain. This effect was reduced as the receiver heated up and when the controls were manipulated.

(h) No appreciable frequency shift occurred during temperature and humidity variations.

(i) The quality of reproduction on voice was satisfactory but not excellent. Response with modulation was linear up to high modulation levels.

(j) The lack of an r-f stage is apparent in the sensitivity and image response obtained with this receiver.

[redacted]

Recommendations

It is recommended:

(a) That taper pins be used to secure the bevel gear in the selector switch mechanism instead of the set screws now used. (See par. 2-2(a).)

(b) That consideration be given to replacing steel hinges and steel parts of Lord mounts with non-corrosive metal. (See par. 2-8(c).)

(c) That non-detachable thumb screws be used on all access doors. (See par. 2-8(d).)

(d) That consideration be given to waiving the requirement of drip-proof construction. (This applies particularly to the power equipment.) (See par. 2-8(f).)

(e) That the handset cradle switch spring have its tension increased to guard against interruption of communication during severe vibration; and that provision be made for servicing the push-to-talk switch in the handset. (See par. 2-11.)

(f) That a cable clamping and grounding device be provided for the cables entering the Transmitter-Receiver unit and that soldering lugs be furnished with the Power and Remote Control units. (See par. 2-12.)

(g) The use of steel as a chassis and cabinet material is generally considered as undesirable. (See par. 3-2(l).)

(h) That consideration be given to providing additional meters for tuning and adjustment purposes and spare meters for replacement purposes; additionally, the use of a test set for monitoring and servicing operations would be desirable. (See par. 2-3(a).)

(i) That the necessary provision be made for supplying replacement meters, since standard Navy meters cannot be used for this purpose. (See par. 2-9(a).)

(j) That, while no interlock protection is provided, the Bureau consider the advisability of not requiring this feature in the interest of simplicity. (See par. 2-4.)

(k) That additional precautions be taken to adequately secure and protect the wiring and that improved soldering practices be required. (See par. 2-5.)

(l) Wiring should be modified to facilitate socket removal and to eliminate long unsupported leads. (See par. 3-2(j), (o), (q).)

(m) Flameproof wire of an approved type, insulated for at least 300 volts continuous operation, should be used for wiring throughout the receiver. (See par. 3-2(cc).)

[redacted]

(n) That, while phenolic insulation is employed in the transmitter in locations normally prohibited by Navy standard practice, that the use of this material be considered acceptable in the equipment in question. (See par. 2-6).)

(o) The crystal socket insulation should be of non-hygroscopic material and should have longer leakage paths. (See par. 3-2(m).)

(p) Air dielectric ceramic insulated trimmers should be used in r-f circuits. (See par. 3-2(w).)

(q) The band switch should utilize ceramic insulation. (See par. 3-2(y).)

(r) Creepage distance on terminal strips should be increased. (See par. 3-2(aa).)

(s) That the necessary steps be taken to insure that vacuum tubes will not be subjected to voltages in excess of their normal rating. (See par. 2-14.)

(t) That the maladjustment of the P.A. circuit, which causes overloads to disrupt the high voltage fuse, be corrected in a suitable manner. (See par. 2-18.)

(u) The crystal holders should be so designed that the crystals can be plugged only in the proper position. (See par. 3-2(t).)

(v) An r-f amplifier stage would be desirable to improve sensitivity and image ratio, although the receiver has considerable merit in its present form. (See par. 3-6(a).)

(w) All r-f coils and terminal strips should be wax impregnated. (See par. 3-2(u), (aa).)

(x) The paper tube electrolytic condensers should be replaced by approved hermetically sealed paper types in the power filter circuits. (See par. 3-2(x).)

(y) Steps should be taken to reduce the radiation voltages appearing at the antenna terminals. (See par. 3-6(f).)

(z) The loss of sensitivity at low temperatures should be investigated and corrected. (See par. 3-7(b).)

(aa) All controls requiring lubrication should use a lubricant which will not have an excessive viscosity change in the temperature range of +50 to -15° C. (See par. 3-7(b).)

(bb) That the necessary modifications and additions be made to the instruction book in order to insure satisfactory maintenance and servicing. (See par. 2-23.)

(cc) That consideration be given to providing sufficient and suitable spare parts with the Model ET-8021 equipment. (See par. 2-24.)

[redacted]

MATERIAL UNDER TEST

1-4. The material under test consisted of the following:

1 - Model ET-8021 Radio Telephone Equipment
Radiomarine Corporation of America
Serial No. 4023
Frequency: 2110 - 2738 kc (from nameplate)
2000 - 3000 kc (from instruction pamphlet)
Power Supply: 110 volts, d.c.

1 - Remote Control Unit, with handset (No Serial number)

1 - Power Supply Unit, 110 volts, d.c., Serial No. 4023.

Type AVA-10, V-cut Crystals, Temp. 35° C, as follows:

Frequency	2059	Serial	4902
	2110		11710
	2215		11755
	2670		11769
	2283		12040
	2738		11625
	2051		12403
	2067		12007
	2113		8085
	2083		11704
	2142		8132
	2126		12020

3 - Interconnecting cables.
1 - Instruction Pamphlet.

Vacuum Tubes as follows:
2 - 6K6-G
2 - 5W4
2 - 6K8
2 - 6SQ7
2 - 6H6
4 - 6SK7
5 - 1624

1 - Model ET-8021 Radio Telephone Equipment
Radiomarine Corporation of America
Serial No. 4038
Frequency: 2110 - 2738 kc (from nameplate)
2000 - 3000 kc (from instruction pamphlet)
Power: 32 volts d.c.

1 - Remote Control Unit, with handset (No Serial number)

1 - Power Supply Unit, 32 volts d.c., Serial No. 4038.

[redacted]

Type AVA-10 V-cut crystals, Temp. 35° C, as follows:

Frequency	2051	Serial	12042
	2118		12427
	2215		11751
	2738		11787
	2083		11705
	2142		8136
	2283		12128
	2067		9317
	2059		12413
	2110		12015
	2670		8279
	2126		11921

3 - Interconnecting Cables
1 - Instruction Pamphlet
Vacuum Tubes as follows:
 2 - 6K6-G
 2 - 5W4
 2 - 6K8
 2 - 6SQ7
 2 - 6H6
 4 - 6SK7
 5 - 1624

1-5. Plates TR-1, TR-2, TR-3, and TR-4 are views showing the construction of the 110-volt, d.c., Model ET-8021 Equipment. The 32-volt d.c. model is practically identical with the 110-volt model, except for minor differences in the power unit and wiring to adapt it to a 32-volt supply.

1-6. The above described equipments were received at the Naval Research Laboratory on September 26, 1940.

METHOD OF TEST

1-7. The equipments, when received, were carefully unpacked and examined. Adequate precautions had been taken in preparing the equipment for shipment and no damage had occurred during transit. With the aid of the instruction pamphlets furnished, the equipments were placed into commission.

Transmitter

1-8. The general construction of the transmitter was examined and the component parts were inspected as completely as possible without resorting to complete disassembly or destruction of the various parts.

1-9. The transmitter was adjusted in accordance with the directions contained in the instruction pamphlet to operate at several of the frequencies governed by the crystals furnished. Measurements of power output (carrier power) were made by means of a lamp load and a photronic cell. Two 15-watt, 32-volt lamps, connected in parallel were used as a load

[redacted]

resistance. A capacitor of 300 micromicrofarads was connected in series with this load. The bases of the lamps were removed to minimize capacity losses. A photronic cell, rigidly anchored at a definite distance from the lamp load, and a microammeter were used to determine the power dissipated. A quick acting, low capacity switch was used to transfer the lamp load from the r-f source to a 60-cycle calibrating source in order that the various parts of the load and measuring circuit might be maintained at temperature equilibrium. A precision type wattmeter (Weston Model 310, Ser.7966) was used to determine the exact power required to produce the same photronic cell deflection which was obtained from the output of the transmitter.

1-10. The complete equipment (110 volt d.c. model) was placed within a test chamber and subjected to variations in ambient temperature and relative humidity. The 32-volt, d.c. model equipment was set up outside the test chamber where it could be operated at a substantially constant temperature and was used as a monitoring device for the equipment which was being subjected to variations in temperature and humidity. The equipment under test was loaded into a dummy antenna consisting of a 300 micromicrofarad capacitor and a 25-ohm low inductance plaque resistor. Provision was made to check the power output of the transmitter under test at stated intervals during the course of the various tests conducted in the test chamber. The ambient temperature was varied between the limits of +50° Centigrade and -15° Centigrade. The relative humidity was varied between the limits of approximately 30% and 95% at a temperature of 40° Centigrade.

1-11. The ability of the equipment to withstand vibration was determined by mounting the 110-volt d.c. model on a vibration platform which was capable of producing vibration of varying degrees of amplitude and frequency. The equipment under test was kept under constant observation and voice signals were transmitted at stated intervals. These signals were monitored and observed by means of the 32-volt model installed nearby, and listening tests were conducted on the reception of voice-modulated signals.

1-12. The 110-volt d.c. equipment was operated into an actual antenna whose fundamental or quarter wave resonance point was approximately 2900 kilocycles. The resistance of this antenna ranged between 5 ohms at 2100 kilocycles and 9 ohms at 2800 kilocycles. The capacity of this antenna fell between the limits of 550 micromicrofarads at 2100 kilocycles and approximately 2,000 micromicrofarads at 2700 kilocycles. When operating into this antenna, a 300-micromicrofarad series condenser was used.

Receiver

1-13. The receiver section of the equipment was examined; first from the electrical viewpoint, with most of the information being derived from the circuit schematic diagram and other parts of the instruction book; second, from the mechanical and structural viewpoint, by direct visual inspection. The results of these examinations are given in paragraphs 3-1 and 3-2.

[redacted]

1-14. The equipment was operated on an antenna (described in paragraph 1-12) for listening tests. A controllable standard signal was provided from an antenna about 1,000 feet away and tests were made at various levels, with and without modulation. The results of these tests are described in paragraph 3-5 and are shown in Tables R-1 and R-2.

1-15. The receiver characteristics were measured in a shielded room, using a standard signal generator (Measurements, Inc. Model 65, Serial 70) and a standard dummy antenna (General Radio Type 418-G). The audio output was measured by means of an output meter (General Radio Type 583A, Serial 64). The sensitivity of the receiver was measured at full gain, since the noise level on loud speaker operation was very low. A value of signal plus noise output of 40 milliwatts was chosen as being far enough below the AVC threshold point at 30% modulation. Noise output was measured with modulation off and with carrier off.

Selectivity was measured by varying the frequency at various input levels to give a 40 milliwatt output on each side of resonance.

Image ratio was determined by measurement of the input at the image frequency necessary to give 40 milliwatts output. This value of input was divided by the input for 40 milliwatts output at the desired frequency.

I-F response was measured as the antenna input at the i-f peak frequency (455 kilocycles) necessary to give 40 milliwatts output. A resonant overload characteristic measurement was made with inputs from 0.4 microvolt to 2 volts. Noise level with modulation off was measured at each point.

The effect of various carrier modulation percentages was determined in terms of a-f output at 400 c-p-s. The attenuation of the gain control was measured at the point of minimum output.

The voltage appearing at the antenna terminals due to the receiver oscillator was measured by substitution. The output caused by this undesired voltage in another receiver, coupled to the antenna terminal of the Radiomarine equipment through a 5,000-ohm resistance was measured. The standard signal generator was then substituted for the Radiomarine receiver, and the input necessary to give the same output from the measuring receiver was determined. This measurement was made at the fundamental, second harmonic, third harmonic, etc., of the oscillator frequency.

The results of the above measurements are described in paragraph 3-6 (a) to (f) and are shown in Plates R-1, R-2, and R-3, and Tables R-3, R-4, R-5, and R-6.

1-16. The equipment was set up in the temperature and humidity chamber as described in paragraphs 1-10, 2-15, and 2-16. Signal generator and output meter connections were made as shown in Plate TR-5. Since the transmitter output load was left connected to the antenna terminal of the equipment throughout the temperature and humidity tests, 1000-ohm

[redacted]

non-inductive resistors were used to isolate the equipments under test from each other, and also to protect the signal generator from the transmitter antenna voltage during operation of each transmitter. Changes in gain and noise level were measured during the course of the tests described in the above-mentioned paragraphs and as given in paragraph 3-7. Results of the tests are shown in Plates R-4, R-5, and R-6, and Tables R-7, R-8, and R-9.

1-17. The equipment was set up for the vibration test as described in paragraph 1-11 and 2-17. The receiver was checked for changes in gain or functioning, with the results given in paragraph 3-8.

1-18. No receiver frequency measurements were made during the temperature, humidity, and vibration tests, other than the signal generator dial settings, due primarily to lack of time and the unavailability of precision frequency measuring equipment during the test period.

DATA RECORDED

1-19. The data recorded during the tests are shown in the appended tables and plates. Tables or plates with the prefix TR refer to the equipment as a whole; the prefix T refers to transmitter, while the prefix R covers receiver data.

[redacted]

SECTION II

TRANSMITTER - MECHANICAL DESIGN AND CONSTRUCTION

2-1. Vacuum Tubes. The Radiomarine ET-8021 transmitter employs four type 1624 vacuum tubes in the following manner:

(a) One crystal controlled master oscillator.
(b) One power amplifier.
(c) Two modulators.

The tube sockets are of isolantite secured to the sub-panel by means of two screws. No shock mounting or tube base clamps are provided, but no damage or trouble due to this was noted during the vibration test to which the equipment was subjected. The tube sockets are of a type which grips the base pins firmly and there appeared to be no tendency for the tubes to work loose. Connection to the tube cap is made by a bakelite insulated clip which provides firm contact and appears to be satisfactory.

2-2. Panel Controls. The following controls, located on the front panel of the equipment, are provided:

(a) Station Selector Switch; 6 position. The fluted plastic knob, 1-5/8" in diameter, is secured to the shaft by means of two set screws. All sections of the switch and gears are pinned to the shaft, except the control knob itself and the bevel gear actuating the vertical (P.A.) part of the switch. This gear is secured by means of two set screws 180° apart. It is recommended that taper pin fastening be substituted to assure dependable operation.

(b) Handset-Loudspeaker switch; 2 position, nickel-plated toggle switch.

(c) Local-Remote Switch; 2 position, nickel-plated toggle switch.

(d) Volume Control and Start-Stop switch combined in one unit. The fluted plastic knob, 1-1/8" in diameter, is secured to the shaft by means of two set screws.

(e) Receiver Pilot Light. 1/2-inch diameter red glass indicator.

(f) Transmitter Pilot Light. 1/2-inch diameter green glass indicator.

The following controls are located on the front panel of the Remote Control Unit:

(g) Handset-Loudspeaker Switch. Nickel-plated toggle type.

[redacted]

(h) Volume Control. A fluted plastic knob, 1-1/8" in diameter, is provided.

Both handsets (transmitter and remote control) are equipped with "push to talk" buttons in the grips. These buttons cannot be locked in the "on" position. The above controls appear adequate in size and ease of manipulation and are so spaced and shaped that they can be operated even when conditions require the operator to wear gloves or mittens.

2-3. Tuning. The tuning adjustments are all accomplished through the access door opening in the top of the transmitter cabinet. The means of adjustment provided are listed below.

(a) Crystal Oscillator Tank Circuit. This circuit is provided with six trimmer condensers, one for each transmitting frequency, which are numbered to correspond to the position of the Station Selector Switch. Adjustment can be made with a screw driver. As described on page 7 of the instruction book, the proper tuning of this circuit requires the use of a 0 - 50 milliampere, d-c milliammeter, which is not supplied with the equipment. Provision has been made in the form of a removable link located just inside the access door for the connection of this meter.

(b) Power Amplifier Tank Circuit. Tuning of this circuit is accomplished by means of five adjustable clip leads, which may be moved to the proper position on the P.A. tank coil. Frequency channels one and two have a common clip, while all other transmitting channels are provided with separate adjustments. The leads to the clips are color coded as described on page 7 of the instruction book and are not otherwise marked. The clips themselves are equipped with a screw clamp and may be fastened securely in place after the proper tuning adjustments have been made.

(c) Antenna Tuning. The antenna circuit is tuned using six adjustable clip leads on a coil in a manner similar to that used in tuning the P.A. tank circuit. A separate adjustment is required for each frequency channel, and the color coded leads may then be secured in place by use of the screw clips provided.

(d) Antenna Coupling. Three adjustable clip leads are used in conjunction with the coupling coil, located at the top front of the unit just inside the access door, to secure the proper coupling. The leads are color coded and have the same type of clip as the P.A. and antenna coil leads. Since only three coupling leads are employed, individual adjustment is not provided on each of the six transmitting frequencies. Positions 1, 2, and 3 of the Station Selector switch have a common clip; position 4 has its own clip; and positions 5 and 6 have a common clip.

2-4. Accessibility and Protection of Personnel. As mentioned in the previous paragraph, tuning adjustments are all accomplished through the access door opening in the top of the transmitter case. This door measures 16" x 10", the opening 15-3/4" x 9-1/2". No interlock protection is provided on either the transmitter access door or the hinged side on the power unit. Tubes may be removed and replaced without dif-

[redacted]

ficulty, using the transmitter access door opening. Wiring and components located beneath the sub-panel can be reached only by unbolting the set from its foundation, after which the bottom cover can be removed by taking out 14 screws. Fuses are mounted in the power unit and are completely accessible.

2-5. Wiring. In general, wiring is fairly well done. Some defects and desirable changes were noted however.

(a) Much of the wiring is done with commercial, color coded, flexible wire, which has been cabled together where possible. These cables are not solidly secured throughout their run, and consequently may shift enough to cause fatigue and breakage of the wires and chafing of the insulation. It is recommended that clamps secured to the sub-panel be used to hold the cables in their proper location.

(b) In connecting leads to lugs, solder is often depended on for mechanical strength.

(c) Where silk-braid-covered bus bar wiring is employed, runs of considerable length are made in a few cases without intermediate support. This allows movement and vibration of the wire, particularly noticeable in the lead running from the plate current milliammeter to the antenna transfer relay.

(d) The flexible plate leads to the modulator tubes in the 110-volt d-c equipment can readily touch the bare antenna wire. Although for short periods the insulation of these wires was found to withstand this condition without breakdown, it is recommended that the wiring be modified to prevent contact between these leads. Examination of the 32-volt model reveals that the plate leads of the modulator tubes are formed in a manner to prevent contact with the antenna lead, by decreasing the length of these leads. This same procedure should be followed in the 110-volt d-c model, or the same result may be attained by moving the antenna post from its present rear location to a position on top of the transmitter case.

(e) Leads to the 1/10 mfd condenser in the remote control unit have been soldered to the terminal nuts, making it impossible to renew the condenser without first unsoldering the leads.

(f) The by-pass condenser from the negative brush of the dynamotor to ground was found to be unsoldered. Apparently no solder had ever been applied.

(g) Wires connecting to the filter condenser in the upper right part of the power unit are so placed as to almost short out one of the filter capacitors.

(h) Soldering to the lug on the plate current milliammeter prevents removal of the terminal nut.

[redacted]

2-6. Insulation. Ceramic material, probably isolantite, has been used in the tube sockets, P.A. and Antenna coil forms, those sections of the Station Selector Switch controlling the P.A. and antenna circuits, the antenna post insulator, and the P.A. plate choke core. Phenolic insulation has been employed in terminal strips, resistor mounting panel, and those sections of the Station Selector Switch controlling the crystal oscillator. A yellow molded material of undetermined type is used for the forms of the antenna coupling coil and oscillator coil. The main terminal strip of the transmitter unit is of molded material, while those of the power and remote control units are phenolic. Crystal holders are isolantite; fixed condensers, in general, are phenolic. As can be observed in the above list, phenolic insulation has been employed in some applications where its use is prohibited in standard Naval equipment. These are its use in the r-f crystal switching circuit and for the tuning condenser terminal strip, and its use in those parts of the circuit where the voltage exceeds 500 volts, such as terminal strips and the resistor mounting panel.

2-7. Weights and Dimensions. The weights and dimensions of the various units are given in Table TR-1.

2-8. General Physical Construction.

(a) Both transmitter and receiver are assembled on a common chassis of plated steel. A steel cabinet equipped with a removable bottom and an access door in the top encloses the entire unit. The front panel and interior shield are aluminum. All exterior surfaces of the cabinet, including the front panel, are finished in gray wrinkle. Interior surfaces of the cabinet, except for the front and bottom panels, are similarly finished. Both front and bottom panels are given a glossy, gray coating on the inner surface. The handset hangs (securely held) on hook at left side of cabinet.

(b) Screws, which may be removed in service are as follows:

Bottom shield: Four nickel-plated brass screws. (Bottom shield must be taken off before cabinet is removed, since several of the screws are equipped with nuts.)

Components: Nickel-plated brass screws and nuts are used in most cases. By-pass condensers have plated steel studs and nuts.

(c) Steel has been employed in many instances where it has been the practice in Navy apparatus to use other materials. However, wherever steel has been used, a protective coating has been applied to prevent corrosion. The hinges for both the access door on the transmitter unit and those on the power unit are of steel. Much of the paint originally applied to these hinges has been scraped away by the normal hinge action, and some rusting has resulted. It is recommended that rustproof hinges be provided. Metal portion of Lord mounts are of plated steel, and formation of rust on these parts has been observed. Additionally, it has been found that this type of mount should have unplated parts of non-corrosive metal if long life is to be attained. Therefore, it is recommended that monel metal be substituted for steel in this application.

[redacted]

(d) The access door of the unit is held in the closed position by means of two knurled, nickel-plated brass thumbscrews. In order to open the door, it is necessary to remove these screws entirely. It has been found that such screws are almost certain to become lost, and it is suggested that non-detachable thumbscrews secured to the cover be employed. Thumbscrews mounted in this manner will also act as knobs by means of which the door may be raised. The omission of means for raising the cover after the screws are removed is a minor but annoying fault in the present design. Non-detachable thumbscrews should also be incorporated in the power unit.

(e) No ventilation has been provided in either the transmitter or power units, but there was no evidence during the test period that overheating resulted because of this. The rotary converter for the receiver and the dynamotor for the transmitter are mounted externally on top of the power unit and are provided with six screened ventilation holes in each end bell.

(f) No attempt has been made in the construction of any unit of the equipment to render it dripproof.

(g) The dynamotor is provided with grease-packed ball bearings. End bells and retainer screws must be removed before grease can be added. Directions as to type of lubricant, frequency of lubrication, and disassembly necessary should be included in the instruction book.

2-9. Component Parts

(a) Meters are provided on the front panel to read plate current and antenna current. Both meters are manufactured by Simpson Electric Company. The plate milliammeter is a Model 125, 200-milliampere instrument with zero adjustment screw and gray plastic case. The antenna ammeter is a Model 135, 2-ampere, r-f, self-contained instrument with zero adjustment screw and gray plastic case. Chief differences between these meters and the Navy specifications are shown below, and it will be noted that replacement with Navy meters is not possible.

		Navy limits (17-I-12)	
	Instruments employed	max.	min.
Diameter of flange	2-3/4	2-9/16	2-1/2
Diameter of body	2-3/16	2-1/16	-
Depth of case	1-3/8	1-3/4	-
Radius of mounting screw circle	1-7/32	1-5/32	1-5/32
Mounting screws	4-40	4-40	

Provision has been made for the connection of additional meters which are necessary for the proper adjustment of the transmitter. However, these meters are not supplied with the equipment.

(b) Switches employed in the transmitter are as follows:

[redacted]

2 DPDT nickel-plated toggle switches (Handset-Loudspeaker and Remote-Local switches).
1 SPST switch incorporated in the volume control (off-on).
1 Push-button switch in the handset.
1 8-section, 6-position Station Selector Switch.

In addition, one DPDT nickel-plated toggle switch is used in the remote control unit. All switches except the Station Selector Switch are rated at 3 amperes at 125 volts.

(c) Various types of resistors are used in the equipment, none of them being equipped with ferrule mountings. Composition resistors of 1/2, 1, and 2-watt sizes are included, all larger resistors being of the wire-wound, coated variety. Except for the composition resistors, leads are not depended upon for mechanical support.

(d) All fuses are mounted on the bakelite connection panel of the power unit. Fuses employed are listed below:

Purpose	Rating (110-volt d-c equipment)	Type
Main line	30 ampere 250 volt	Standard renewable link, cartridge type.
Receiver Converter Input	1/2 ampere 1,000 volt	Littelfuse 3" overall, 3/8" diameter ferrules.
Receiver-Converter Output	1 ampere 250 volt	Littelfuse 1-3/16" overall, 1/4" diam. ferrules.

Fuse positions are marked with a number indicating the amperage, but not the voltage rating, of the fuse required.

(e) Capacitors used in the transmitter section of the equipment include small, molded, bakelite-encased mica condensers (Sangamo and Faradon), pyranol-filled filter condensers (General Electric), and one 25 mfd, 50-volt electrolytic condenser of the cardboard cartridge type (Cornell Dubilier). All condensers are so located as to make their replacement possible without serious disassembly.

(f) The antenna terminal is located on the rear of the transmitter chassis and protrudes through a hole cut in the transmitter cabinet. The terminal stud is 10-24.

2-10. Mounting and Shockproofing.

(a) Transmitter-Receiver Unit. This unit is equipped with two flat horizontal mounting bars fastened to the cabinet base by means of four #35 Lord mounts. A 3/8-inch diameter hole in each end of the mounting bars permits the equipment to be secured to a suitable support.

[redacted]

The shock mounting provided adequate protection during the vibration test. The Lord mounts may be replaced after unbolting the equipment from its support and removing the bottom panel of the transmitter cabinet.

(b) Power Unit. The power unit is provided with mounting bars in a manner similar to that employed in the transmitter unit. However, no shock mounts are incorporated. The mounting bars may be arranged for either deck or bulkhead mounting, suitable holes being provided for securing the bars on either the bottom or back of the power unit cabinet. The rotary converter and dynamotor are flexibly mounted with rubber washers to the top of the power unit case.

(c) Remote Control Unit. Four 1/4-inch holes allow the remote control unit to be mounted on a vertical support. No mounting bars or shock mounts are used.

2-11. Handset. A Western Electric Type F3 handset and hook switch is provided with both transmitter and remote control units. A rubber buffered spring device of satisfactory construction keeps the handset in place and prevents its loss when the equipment is subjected to vibration. It was noted during vibration tests at the Laboratory that the hook switch spring is of insufficient strength, severe vibration of the cradle occurring at some frequencies (handset off hook). Although this vibration did not cause the switch contacts to operate, it is believed that under some conditions this might result. This switch is in the microphone circuit, and its intermittent opening would make transmitted speech unintelligible. It is therefore recommended that a stronger switch spring be employed. The button switch of the handset cannot be removed without special tools; and since this switch is in more constant use than any other in the equipment, it is believed that such construction is undesirable.

2-12. Method of Connection. All three units of the equipment are provided with terminal strips or panels for the connection of supply and control leads. The transmitter is equipped with solderless clamp connection strips manufactured by Burke Electric Company. This strip extends out from the rear of the cabinet, and no provision for clamping the cable or grounding the cable shield is made, thus placing stress on the connections themselves. Both the power unit and remote control unit have cable clamps where the cable enters the cabinet which serve to relieve connections from all stress and ground the cable shield at the same time. Terminals in these units are provided with lock washers, but solder lugs are not supplied. It is suggested that suitable lugs be provided to which wires may be clamped and soldered. Cable for the interconnection of the units is supplied with the equipment. Ten-conductor, rubber covered, shielded cable is used between transmitter and power unit and to the remote control. Approximately nine feet of cable for each purpose was provided. The two-conductor rubber covered cable from power unit to supply was 20-feet long in the 110-volt equipment and nine feet long in the 32-volt equipment. Shielded wire was used in the 32-volt equipment and unshielded in the 110. The handset of the transmitter unit is connected by means of a flexible four-conductor wire to a small terminal strip beneath the chassis. Replacement involves removing the entire unit from its base and taking off the bottom shield. A cable clamp prevents terminals from being stressed.

[redacted]

2-13. Power Unit. The power unit, which has been described to some extent in paragraph 2-8, includes the receiver converter and transmitter dynamotor, which are mounted on top of the unit, a starting relay for each, and radio frequency filters for both input and output. Fuses for both machines and the line are mounted on the terminal panel. One side of the cabinet is hinged to provide access to the enclosed components. This door is held in the closed position by two round head screws and with the door closed, all exposed parts of the power unit are at ground potential. No interlock protection is employed.

OPERATIONAL DATA AND TESTS

2-14. Power Output and Operation into Actual Antenna. Table T-1, appended to this report, shows the power output of the 110-volt, d-c Model ET 8021 transmitter. The outputs were obtained with the equipment tuned up on each of the six channels simultaneously, so that operation on any one could be selected by manipulation of the Station Selector Switch only. The dummy antenna constants are given in the same table, while the method of measurement has been described in paragraph 1-9. The power outputs listed in Table T-1 are the values obtained without modulation; i.e., carrier only. Outputs varied from 26.8 to 32.9 watts, depending on frequency, as compared to the manufacturer's rating of 30 watts. It is pointed out that during the power output tests conducted at the Laboratory, the measured plate voltage was found to be approximately 700 volts, instead of the 630 volts at which the dynamotor is rated, possibly due to the high line voltage existing at the time. The Type 1624 vacuum tube is rated at 600 volts maximum plate voltage for modulator application and 500 volts as a plate-modulated r-f power amplifier. Since, under the conditions stated, this rating is considerably exceeded, satisfactory operation over extended periods cannot be expected. Operation on an actual antenna, described in paragraph 1-12, was also accomplished. Adjustment and performance were found to be satisfactory, and emitted signals of good quality and adequate signal strength were obtained.

2-15. Variation of Ambient Temperature. Table T-2 tabulates information obtained during the course of this test. The temperature was held at 50° C (low humidity) for a period of approximately two hours while readings were taken at about 15-minute intervals. During this period the receiver was operated continuously, whereas the transmitter was on only long enough to enable readings to be made. At the end of the two-hour period, the entire equipment was shut down and allowed to stand idle. The ambient temperature was meanwhile reduced to -15° C and was held between -15 and -17.5° C for the remainder of the test. After an idle period of about 1-3/4 hours at this low temperature, the equipment was re-started without difficulty and readings made. The receiver was then turned on continuously and the test proceeded as described for the first period. An examination of the data reveals no serious change in output or other values as a result of the temperature change. The equipment could be started and all controls operated without difficulty at the lowest ambient temperature attained.

2-16. Variation of Humidity. Two humidity tests were conducted on the 110-volt, d-c Radiomarine equipment. The data obtained in the

[redacted]

first test are shown in Table T-3. The receiver was operated continuously during the entire test, while the transmitter was on only long enough to obtain readings. This humidity test followed the usual pattern of such tests to which standard Navy apparatus is subjected. The humidity was held at a low value for one hour, raised to 97%, where it was maintained for one hour, then dropped to less than 30% for the remaining hour of the test. No difficulties of any kind were encountered during this test, the equipment performing satisfactorily at all times. In the second of the humidity tests, conducted to determine the ability of the equipment to operate after being idle, the humidity was raised to 97% at a temperature of 40° C and maintained in this condition for 2 hours, 43 minutes. The entire equipment was idle during this period. At the end of this time the equipment was started and its performance checked against that observed under the low humidity conditions existing previous to the test. It was found that no serious change had occurred due to the high humidity, and operation was satisfactory in every respect.

2-17. Vibration Test. The transmitter-receiver and power units of the 110-volt, d-c Radiomarine equipment were subjected to a standard vibration test. The transmitter-receiver unit was secured to the vibration table by means of the shock mounting straps provided on the base of the cabinet. The data obtained during this test are listed in Table T-4. The emitted signal was monitored at frequent intervals throughout the test with the 32-volt equipment receiver and was found to be satisfactory and of good quality at all times. No difficulties were encountered or damage observed during the test period due to the effects of vibration and the shock mounting appears to protect the equipment adequately. The trouble noted in Table T-4 relative to the opening of the high voltage fuse was not due to effects of vibration, and is more fully discussed in paragraph 2-18 below. During the vibration test, the transmitter was in operation continuously, except for those periods in which the high voltage fuse was being replaced. The vibration test lasted for approximately one hour. While no damage or faulty operation was noted during the test, this does not constitute definite assurance that failure of parts will not occur if the equipment is subjected to lengthy periods of vibration in actual service. Therefore, the improvements in wiring mentioned in paragraph 2-5 above should be given serious consideration.

2-18. Locked Key. Table T-5 shows the results obtained when an attempt was made to operate under locked key, full power output condition for one hour. It will be noted that frequent interruptions were encountered due to the opening of the high voltage fuse in the power unit. Subsequently, operation at ordinary room temperature (about 21° C) revealed that this trouble was not critically dependent on the ambient temperature, since the same difficulty was found. In each instance, it was noted that the current indicated by the plate milliammeter increased slowly from its normal value to about 108 milliamperes and then increased very suddenly to a point where the 1/2 ampere fuse opened. A Radiomarine representative stated that the same trouble has been encountered recently by them and has been found due to excessive drive of the PA, coupled with the fact that the screen of this tube is working near its maximum rating. Several remedies were suggested, but lack of time prevented a trial of their efficacy. It is recommended that this objectionable feature be thoroughly

[redacted]

investigated and its elimination accomplished before acceptance of the equipment for Naval use. It should be pointed out that the dynamotor is rated on its nameplate for intermittent duty. However, overheating did not occur during the locked key test described above.

2-19. Control. A remote control unit was furnished with the ET-8021 transmitter. This remote control is equipped with loudspeaker and handset, either of which may be selected by a suitable toggle switch located on the remote control panel. The handset is provided with a cradle hook and push-button switch having the same functions as those in the transmitter unit itself. No station selector switch is provided in the remote control and the receiver cannot be turned on and off from the remote position. The remote control is effective only when the control transfer switch mounted on the transmitter panel is in the "remote" position. Local control of the transmitter can be attained irrespective of the position of controls in the remote unit by merely changing the control transfer switch to the "local" position.

2-20. Modulation. Quantitative tests of the modulation capabilities of this transmitter were not conducted. However, listening tests on the companion equipment submitted revealed that transmitted speech was at all times clear and intelligible.

2-21. Break-in. Break-in operation is accomplished by means of a send-receive relay mounted in the upper section of the transmitter unit just inside the access door. The relay is actuated by the push-button on the handset and receives its coil energy from a voltage divider in the receiver power supply through a 5,000-ohm series resistor current limiter. The send-receive relay is a DPDT device, one arm of which transfers the antenna while the other serves to open the plate return circuits of the transmitter tubes when in the receive position.

2-22. Power Input. The power inputsunder the various conditions of supply and operation are given on page 6 of the instruction book and repeated below.

12-volt, d-c Supply:
Receiver (stand-by condition) 10 amperes, 120 watts.
Receiver and Transmitter, 32 amperes, 384 watts.

32-volt, d-c Supply:
Receiver (Stand-by condition) 4 amperes, 128 watts.
Receiver and Transmitter, 12 amperes, 384 watts.

110-volt, d-c Supply:
Receiver (Stand-by condition) 1.2 amperes, 132 watts.
Receiver and Transmitter, 3.6 amperes, 396 watts.

2-23. Instruction Book. The instruction book which was supplied with the Radiomarine equipment has been written from an operating rather than a servicing viewpoint, and hence much information essential for the proper maintenance of the apparatus has been omitted. The schematic diagram is quite unlike those to which Naval operators are accustomed. In addition, symbol numbers are not used and some difficulty is certain to be encountered in tracing circuits. No parts list is supplied, and

[redacted]

many components are incompletely marked with their ratings on the schematic diagram. It is suggested that the instruction book be rewritten with the expanded purpose of providing, not only operating, but also complete servicing information as well and that the schematic diagram be redrawn to conform with the simpler Navy type.

2-24. <u>Spare Parts.</u> No spare parts accompanied the Radiomarine equipment. Since numerous component parts are of such design and manufacture that they are not likely to be available within the Naval organization, it is deemed advisable that some definite provision be made to permit repairs by operating personnel. It may be pointed out that many of the parts used would fail to comply with Navy standards and hence disruptions and failures under the rigors of Naval service will undoubtedly occur. It is suggested that the manufacturer be consulted to determine which parts are most subject to failure, based on service records of the Model ET-8021 equipments, or equipments of similar construction.

2-25. <u>Summary of Defects and Suggested Changes.</u> Such items as appear definitely defective together with suggestions for improvement and modification are listed below. At the end of each of the statements there appears the paragraph number in the body of the report wherein each matter is discussed in detail.

(1) Set screws instead of taper pins are used to secure bevel gear in selector switch mechanism. (2-2(a))

(2) Additional 50-milliampere meter required for tuning; additional 100-milliampere meter required for adjustment of modulator. The following additional meters are recommended:

0 - 2 amperes r-f meter (spare)
0 - 200 milliamperes d-c meter (spare)
Multi-range voltmeter; 10 to 750 volts.

<u>Note</u>: If test set with multi-range volt-milliammeter were provided, three of the above meters could be eliminated and servicing operations would be greatly facilitated. (2-3(a))

(3) No interlock protection is provided. (2-4)

(4) Wires inadequately secured; solder is depended on for mechanical strength; contact between high voltage leads is possible; poor soldering practice has been employed in some instances. (2-5)

(5) Phenolic insulation used in applications where normally prohibited by Naval specifications. (2-6)

(6) Steel has been used in applications where trouble may develop due to corrosion. (2-8(c))

(7) Detachable thumb screws are employed on access doors. (2-8(d))

(8) Drip-proof construction has not been provided. (2-8(f))

[redacted]

(9) Navy standard meters cannot be used as replacements. (2-9(a))

(10) Handset cradle switch spring lacks sufficient tension; special tools required to remove press-to-talk switch in handset. (2-11)

(11) No cable clamping and grounding device provided on transmitter-receiver unit; soldering lugs not supplied on power and remote units. (2-12)

(12) Type 1624 vacuum tubes operated in excess of rating. (2-14)

(13) Maladjustment of PA circuit causes overloads in lock key operation (2-18)

(14) Instruction book incomplete as compared with usual Navy practice. (2-23)

(15) No spares are provided with the Model ET-8021 equipment. (2-24)

[redacted]

SECTION III

RECEIVER SECTION OF EQUIPMENT

3-1. Electrical Inspection. The equipment was given an electrical inspection and the following information obtained, in large part from the schematic diagram and the instruction book:

(a) Type of circuit: Superheterodyne.
(b) Frequency range: 2,000 to 3,000 kilocycles (not continuously variable).
(c) Number of bands: Six fixed crystal frequencies on switch.
(d) Crystals: Crystal oscillator control at each frequency.
(e) Crystal mounting: Each crystal in individual holder with General Radio plug mounting. Crystal must be properly oriented in socket.
(f) Total number of tubes: Eight.
(g) Tube types used: 6K6G, 6SK7, 6K8, 6SQ7, 6H6, 5W4.
(h) Power supply required: 110 V., d.c., 132 watts (Also available for 32 V., d.c., (128 watts) and 12 V., d.c., (120 watts).)
(i) Type of B supply and maximum B voltage at receiver: Dynamotor. Voltages not given in instruction book.
(j) Antenna required: Not given in instruction book.
(k) Antenna input circuit: Single tuned circuit directly connected to transmitter antenna loading coil through 455 kilocycle wave-trap.
(l) Radio frequency amplifier: None
(m) Radio frequency tuning: Fixed condensers on band switch.
(n) Converter: 6K8 (pentode section)
(o) Oscillator: 6K8 (triode section), crystal controlled.
(p) Intermediate frequency amplifier: Frequency 455 kilocycles. 3 transformers, (6 tuned circuits) also 1 transformer in AVC amplifier circuit.
(q) Second detector: Conventional diode. Both plates of 6SQ7 diode section.
(r) AVC system: Separate i-f amplifier stage for AVC. One section of 6H6 for AVC diode converter and both i-f stages on control.
(s) CW oscillator: None.
(t) Noise suppressor: Automatic "noise gate" type; one section of 6H6.
(u) Audio frequency amplifier: Triode section of 6SQ7 (first stage) resistance coupled to 6K6G pentode output stage.
(v) Audio output circuit: Transformer feeding loudspeaker and handset.
(w) Gain control: R-F gain; cathode bias control of converter and first i-f amplifier.
(x) Safety devices: No interlock switches.
(y) Changeover means: Handset push button actuates power and antenna transfer relays.
(z) Remote control: Remote handset and ringer stations obtainable.

[redacted]

(aa) Receiver sensitivity (from instruction book): Not given.

(bb) Miscellaneous: Speaker switch turns handset phone off in speaker position.

3-2. Mechanical Inspection. The equipment was given a mechanical inspection and the following information obtained.

(a) Number of units comprising equipment: Two, not including remote or ringer units.

(b) Size: Shown in Table TR-1.

(c) Weight: Shown in Table TR-1.

(d) General Type of Construction: Single chassis for receiver and transmitter, with external power supply unit. Both units enclosed in metal cabinets with no ventilating holes. All operating controls on front panel, with handset hanging (securely held) on hook at left side of cabinet. Loudspeaker mounted behind grillwork on front panel. (Paragraph 2-8 applies.) In addition, loudspeaker is mounted behind grillwork on front panel.

(e) Number of front panel controls and function: Four; Frequency switch (6 points), Volume control-power switch, handset-speaker switch, local-remote switch. (Paragraph 2-2 applies.)

(f) Other controls: Lifting handset off hook connects handset circuit to transmitter and places power on transmitter in "stand-by" condition. Handset push button switches from receiver to transmitter operation.

(g) General layout and accessibility of controls: Very accessible; symmetrical and neat.

(h) Ease of control and operation: All controls work easily. The use of a single switch for frequency shifting is very convenient.

(i) Accessibility for servicing: Fairly good.

(j) Accessibility for repair: Generally good, but tube sockets in two cases require much disassembly, due to mounting of other components on the socket terminals. Wiring and components located beneath the sub-panel can be reached only by unbolting the set from its foundation, after which the bottom cover can be removed by taking out 14 screws.

(k) Power indicator: Pilot lights on front panel indicate when both transmitter and receiver power supplies are on. Position of indicator dot on receiver volume control would also show if all power were "off" or "on."

(l) Materials and finishes used: The chassis and cabinet are cadmium plated steel. The panel is aluminum. Panel and cabinet have gray crackle finish. The same applies to the power supply and remote units. The band switch shaft and detent plate, by-pass condenser cans, tube socket mounting flanges, and compression trimmer condenser common plates, are all cadmium plated steel. The output transformer case is lacquered aluminum. Corrosion resistance protection is fair.

(m) Moisture resistance: Trimmer condensers and terminal strips seem poorly protected. Coils and terminal strips appear to need wax impregnation and coating. Leakage paths are short (1/16") from high side of crystal socket to ground, through material that may be hygroscopic.

(n) General protection against high temperatures: Appears good.

[redacted]

(o) Ability to withstand vibration and shock: Too many long unsupported solid wire leads. Cabled leads run more than half way around edge of chassis, about 30 inches without anchorage. Lord shock mounts on base appear to be good mounting.

(p) General ruggedness: Good.

(q) Tube mounting, sockets, etc.: Tubes vertically mounted in ceramic sockets. Sockets removable but have many components attached to them; making replacement difficult.

(r) Tube shields: None used. Metal tubes used where shielding is needed.

(s) Transformers, chokes, etc.: Transformers and chokes appear to be well cased (potting unknown). Terminals are satisfactory. All units are readily replaceable.

(t) Crystal mounting: Each crystal in individual holder, with "banana" type plugs. Insulation to chassis questionable in presence of condensation. Crystals switched by front panel control.

(u) R-F transformer structure: Wound on 1-inch bakelite tube. Varnished but not waxed or shielded. Wound with about #20 to #30 wire. Wide terminal spacing and rugged construction.

(v) I-F transformer structures: Appear to be Sickles units. Air dielectric (ceramic insulated) trimmers. Wax dipped coils on paper forms. Good broadcast receiver type.

(w) Variable condensers: None evident, except compression type trimmers. These might be rendered inoperative by condensation. They are mica dielectric, screw compression type. The grounded side is a cadmium plated steel channel, common to all units. Plating growth might affect the adjustment.

(x) Fixed condensers: All molded mica, except for one paper tubular electrolytic, one metal encased electrolytic unit, and three .1 mfd metal encased units. All molded condensers are mounted with screws directly to chassis.

(y) Switch construction: Frequency switch - Bakelite wafer, silver plated "spoon" type contacts. Toggle switches - Bakelite laminated housing for "local-remote" and "handset-speaker."

(z) Resistors: Mostly 1/2 watt, mounted with pigtails. Not objectionable, except from servicing standpoint where several leads come to the same terminal. Haphazard mounting appearance.

(aa) Terminal strips: Creepage path about .1 inch. Five 3-terminal strips and several 1-terminal strips used. Terminal strip on oscillator trimmer - two 6-terminal strips with .065-inch creepage path. The creepage paths all appear to be too short.

(bb) Mounting of components: Screws, nuts, and lockwashers used. Many heavy units mounted on chassis .075" thick, with screws threaded into chassis and no securing nuts. This, however, is probably safe. Many resistors and condensers are mounted on pigtails of considerable length, but mounting is generally sturdy.

(cc) Wiring: Fairly neat; several long leads of solid wire which can move under conditions of vibration. Cabled leads are not well anchored, but insulation of cabled leads appears to be good. Solid wire is insulated with impregnated celanese, which affords some stiffening and also insulation; probably satisfactory as used. If leads were better anchored in several places, they would probably be more reliable. Soldering workmanship fair. Stranded wire, having two fabric wraps, the outer varnished, is used for power leads.

[redacted]

(dd) Miscellaneous: Antenna connection is made to feed-through insulator at back of cabinet.

3-3. Examination of Instruction Book. The comments in paragraph 2-23 apply to the receiver as well as the transmitter portion of the equipment.

3-4. Spare Parts. The comments in paragraph 2-24 apply.

3-5. Listening Tests. The equipment was set up in the Transmitter Building and connected to an outside antenna. A standard signal generator was set up in the Laboratory Annex building about 1,000 feet away, and its output connected to an outside antenna for the purpose of radiating a readily controllable field at the frequency of test. Tests were made with and without 30% modulation at various carrier levels, and voice modulation was also made available by means of a suitable microphone and audio amplifier modulating the signal generator.

The presence of a strong variable noise field in the transmitter building location made it difficult to get consistent results at the lower levels of signal generator input. The results tabulated in Table R-1 were obtained in this test.

The listening test was repeated on the following day in an attempt to obtain more favorable local noise conditions. The results are shown in Table R-2.

As shown in Table R-2, the results obtained in the second test were similar to those of the first, the differences being what might be expected with some difference in local noise level. The automatic "noise gate" was probably of help in obtaining readability on weak signals in a strong noise field, but the receiver did not perform quite as well as another make using an r-f amplifier ahead of the converter and no noise limiter.

3-6. Laboratory Measurements. The receiver section of the equipment was measured in a shielded room, as outlined in paragraph 1-15, with the following results:

(a) Sensitivity, Noise Output, Image Ratio, and I-F Response. These are shown in Table R-3.

(b) Selectivity. The selectivity characteristics of the receiver are shown on Plate R-1. Table R-4 summarizes this characteristic.

(c) Resonant Overload and Carrier Noise. Resonant overload characteristics are shown on graph form on Plate R-2 and in tabular form in Table R-5.

(d) Effect of Modulation Depth on Output. Plate R-3 shows the effect of varying the signal modulation depth on the audio output from the receiver. The curve departs from linearity at about 70% modulation.

(e) Gain Control Range. The maximum attenuation of the sensitivity, or gain, control of the receiver is somewhat more than 80 decibels.

[redacted]

(f) Radiation of Oscillator Frequency. The voltages appearing at the antenna terminals due to the local crystal oscillator of the receiver were measured in terms of the microvolts input from a standard signal generator required to give the same output from a receiver tuned to the oscillator frequency. Both the receiver under test and the standard signal generator were connected in turn to the input terminals of the measuring receiver. The resulting data are shown in Table R-6.

3-7. Temperature and Humidity Tests. The equipment was set up in the large temperature-humidity chamber and was tested under the conditions described in paragraphs 2-15 and 2-16. The circuit arrangement is shown schematically in Plate TR-5.

(a) Effect of Humidity on Gain and Noise Level of Receiver. The receiver noise output level was set to .4 milliwatt by means of the gain control prior to the beginning of the test, with no carrier input. The local noise, however, had greatly decreased by the time the test was actually started, and this lower noise level varied considerably throughout the test.

The change in receiver gain with variation of humidity was measured in terms of the carrier input voltage required to maintain an arbitrary standard output of 10 milliwatts (signal plus noise), with the standard signal generator modulated 30% at 400 c-p-s. Noise outputs with modulation off and with carrier off, were also measured. Readings were taken at approximately 15-minute intervals.

The results of the test are shown on Plate R-4 and tabulated in Table R-7.

(b) Effect of Temperature on Gain, Noise Level, and Control Operation. The change in receiver gain with variation of temperature was measured in a way similar to that in the previous test, except that 90% modulation was used. Due to better local noise conditions (lower electrical interference noise) during this test, the receiver gain was raised to maximum, and the input for a constant output of 50 milliwatts was measured. Noise outputs were also checked, as well as signal generator dial settings.

The receiver was operated continuously for 2 hours at +50° C and then shut off. Power was left off while the temperature was brought down to -17° C, except for a brief reading at +1° C. The receiver was started up again after 1 hour at -17° C. Readings of input and output were taken at +50° C, +1° C, and -17° C.

The controls were checked at -17° C for operation and were found to be somewhat stiff, the band switch being particularly so, but operation was still possible. There was no audible noise with carrier off.

Table R-8 shows the results of these tests. At +50° C after about two hours of operation, the load impedance for maximum receiver output had dropped from 12.5 ohms to 6 ohms. This value returned to normal when the receiver was operated at or below average room temperatures.

[redacted]

(c) Effect of Humidity on Cold Start Gain and Noise Characteristics. The 90% modulated input for 50 milliwatts output, with gain control at maximum, was measured at 40° C and 23% humidity. Noise was also measured, and the signal generator dial reading obtained. The receiver was then turned off, and the humidity increased to 97% at the same temperature, as described in the latter part of paragraph 2-16. The receiver was turned on after 2 hours and 43 minutes, and the input for 50 milliwatts output, and noise, were immediately measured. The same measurements were then made at suitable short intervals to show the variations occurring after starting up.

These results are shown on Plate R-5 and the values shown in Plate R-9 are derived from those on these graphs.

3-8. Effects of Vibration. The equipment was subjected to a vibration test as described in paragraph 2-17. The receiver gain was measured whenever possible, between the intervals of vibration and transmitter operation. Very little usable data were obtained, however, due to the extremely high variable noise level in the Transmitter Building where the tests were conducted. The receiver appeared to function well during the test, with good reception of voice modulated signals being obtained during vibration.

3-9. Summary of Defects. The following defects were found as a result of the examinations and tests listed in paragraphs 3-1 to 3-8.

(a) The crystals can be plugged into their sockets in two possible ways, only one of which is recommended. (Par.3-1([illegible]), 3-2(t).)

(b) The leakage paths in the crystal sockets should be longer, and the sockets should employ higher quality insulating material than that provided, in order to withstand prolonged high humidity. (Par. 3-2(m) and (t).)

(c) No radio frequency amplifier is used. This probably accounts for the relatively poor showing of this receiver on sensitivity and image ratio measurements as compared to those of other manufacture tested at the same time. (Par. 3-1(l), 3-6(a).)

(d) No interlocks are provided to protect operating personnel from high voltages. (Par. 3-1(x).)

(e) Replacement of tube sockets would be facilitated if the socket terminals were not used to support other components. (Par. 3-2(j).)

(f) Use of steel for the chassis and cabinet is undesirable, although the corrosion protection employed may be adequate. (Par. 3-2(l).)

(g) The coils and terminal strips should be wax impregnated. The creepage distances on terminal strips are dangerously short. (Par. 3-2(m).)

[redacted]

(h) Several long unsupported leads are used which might give trouble under prolonged vibration. These should be more securely anchored. (Par. 3-2(o).)

(i) Mica dielectric compression-type trimmer condensers are used in the tuned circuits. (Par. 3-2(w).)

(j) Electrolytic condensers are used (one paper tube and one metal tube type). (Par. 3-2(x).)

(k) The band switch utilizes bakelite wafers in the receiver circuits. (Par. 3-2(y).)

(l) Radiation voltages appearing at the antenna terminals are extremely high, probably due partly to the lack of an r-f stage. (Par. 3-6(f), Table R-6.)

(m) The sensitivity seems to decrease excessively at low temperatures. (Par. 3-7(b), Table R-8.)

(n) The 32-volt high voltage dynamotor had its output terminals reversed when received.

(o) One of the remote control boxes furnished failed after working satisfactorily at first. No attempt was made to locate the trouble due to lack of time. It would appear that proper inspection had not been given to the equipment prior to shipment.

[redacted]

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Table TR-1

Model ET-8021 Radiomarine Radio Telephone

Dimensions and Weights

Remote Control Unit	D –	5-3/8 inches
	H –	8-3/8 inches
	W –	13-3/8 inches (including hand set in position)
	Weight –	10 pounds 6 ounces.
Transmitter-Receiver	D –	17-3/4 inches
	H –	13 inches
	W –	22-1/4 inches (legs overall – 24 inches)
	Weight –	85 pounds 8 ounces (including tubes and crystals)
Power Unit	D –	5-3/8 inches
	H –	13 inches
	W –	20 inches (legs overall – 22 inches)
	Weight –	42 pounds 8 ounces
Cables	Weight –	9 pounds 2 ounces
Total Weight	–	147 pounds 8 ounces

– – –

Table T-1

Model ET-8021 Radiomarine Radio Telephone

Power Output Measurements

Antenna: 300 mfd + two 32-volt, 15-watt lamps in parallel.

	2110 kc	2118 kc	2126 kc	2142 kc	2670 kc	2738 kc
I_p (ma)	96	95	95	96	92	95
Internal I_{RF} (amp)	1.06	1.06	1.07	1.08	1.00	1.02
Line E (volts)	119.5	119.5	120	119	119	119
E_p (volts)	700	702	702	693	702	700
Selector Sw. Position	Boston	Miami	New York	Norfolk	Cst.Gd.	Ship
Watts Output	31.2	31.0	31.3	32.9	26.8	28.8

Note: The plate voltage E_p was measured at terminals 4 and 5 of the power unit.

[redacted]

Table T-2

Model ET-8021 Radiomarine Radio Telephone

Variation of Ambient Temperature – 2738 kilocycles

Time	Ambient Temp °C	Relative Humidity %	Plate Current ma	I_{RF} Internal amp.	I_{RF} External amp.	Emitted Signal	Output Watts
0	50	17	94	1.00	0.96	Satis-	23.0
20	50	16	93	1.08	1.03	factory	26.5
35	49	17	93	1.09	1.03	"	26.5
50	49	17	90	1.01	.97	"	23.5
1:05	49.5	17	93	1.09	1.04	"	27.0
1:27	50	16	92	1.07	1.04	"	27.0
1:37	49.5	16	92	1.08	1.03	"	26.5
1:52	49.5	16	95	1.11	1.05	"	27.6
2:06	50	15	93	1.09	1.04	"	27.0
2:21	46	17.5					
2:36	28	19					
2:51	8.5						
3:06	-0.5	Equipment idle from 2:10 to 6:04					
3:21	-5.0						
3:36	-9.0						
4:00	-12.5						
4:15	-14.5						
4:32	-15.5						
4:50	-17.0						
5:05	-17.5						
5:26	-17.0						
5:44	-16.5						
6:00	-17.0						
6:05	-17.0		106	1.25	1.15	"	33.0
6:20	-16.5	Receiver on continuously after 6:20.					
6:35	-17.5		87	1.10	1.00	"	25.0
7:05	-16.0		86	1.07	.99	"	24.5
7:25	-15.5		87	1.10	1.00	"	25.0

[redacted]

Table T-3

Model ET-8021 Radiomarine Radio Telephone

Variation in Humidity - 2738 kilocycles

Time	Ambient Temp °C	Relative Humidity %	Plate Current ma	I_{RF} Internal amp	I_{RF} External amp	Emitted Signal	Output Watts
0	40	19	94	1.10	1.03	Satis-	26.5
20	39	14.5	92	1.06	1.01	factory	25.5
35	40	13	93	1.08	1.04	"	27.0
50	40	13	90	1.00		"	
80	39	90.5	93	1.08	1.03	"	26.5
107	39	97	94	1.10	1.05	"	27.6
122	39	97	92	1.07	1.02	"	26.0
140	39	97	93	1.06	1.01	"	25.5
155	39	97	92	1.09	1.03	"	26.5
170	39.5	97	93	1.07	1.03	"	26.5
185	39	56.5	93	1.09	1.04	"	27.0
200	40	27	94	1.10	1.04	"	27.0
215	39.5	26.5	94	1.11	1.05	"	27.6
230	40	29	94	1.10	1.04	"	27.0
245	40	29	94	1.10	1.04	"	27.0
260	40	29	93	1.10	1.05	"	27.6

Antenna: 300 micromicrofarads in series with 25-ohm plaque resistors.

Power output at end of first test period - 27 watts

Maximum power decrease noted thereafter - 25.5 watts

Difference - 1.5 watts or 5.55%

[redacted]

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Table T-4 DECLASSIFIED

Model ET-8021 Radiomarine Radio Telephone

Vibration Test - 2738 kilocycles

Time	Plate Current ma	I_{RF} External amps	I_{RF} External amps	Signal	Condition
2:25	83	0.93	0.91	Satis-	Stationary
2:26	83	0.93	0.90	factory	Vibration
2:30	84	0.93	0.90	"	"
2:35	85	0.93	0.92	"	"
2:38	High voltage fuse in power unit opened				Stationary
2:58	82	0.93	0.92	Satis-	"
3:00	82	0.93	0.92	factory	Vibration
3:05	84	0.92	0.92	"	"
3:10	95	0.93	0.92	"	"
3:15	85	0.92	0.91	"	"
3:20	87	0.92	0.91	"	"
3:25	82	0.92	0.90	"	"
3:26	82	0.92	0.90	"	Stationary

At 3:10 a gradual increase in the plate current was observed until a value of 105 milliamperes was reached. At this point the plate meter went violently off-scale and it was necessary to interrupt the supply to prevent blowing the high voltage fuse. This same phenomenon occurred several times before the test was concluded.

- - -

Table T-5

Model ET-8021 Radiomarine Radio Telephone

Locked Key Operation for One Hour - 2738 kilocycles

Time	Ambient temp °C	Relative Humidity %	Plate Current ma	I_{RF} Internal amp	I_{RF} External amp	Emitted Signal	Output Watts
2:10	40	25	87	0.90	0.83	Satisfactory	17.2
3:05	39.5	27.3	96	1.12	1.06	"	28.1
3:15	40	25	97	1.10	1.02	"	26.1
3:45	39	27.5	96	1.10	1.04	"	27.0
3:55	40	25	98	1.09	1.03	"	26.5

During the above test the high voltage fuse opened at 2:20. Set was inoperative until 3:05 when the test was resumed. The fuse again opened at 3:20 and was replaced and the test continued at 3:45. Fuse reopened at 3:55 and the test was concluded.

[redacted]

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Table R-1

Listening Tests on Radiomarine ET-8021

Radio-Telephone - October 4, 1940
Frequency = 2738 kilocycles

(1)	Sig.Gen. Input to Antenna in Lab.Annex	2 volts	100,000 microvolts	10,000 microvolts	5,000 microvolts
(2)	Signal + Noise Output (30% modulation)	90 milliwatts	80 milliwatts	30 milliwatts	19 milliwatts
(3)	Noise: Carrier on	less than .06 mw	.3 mw	10 mw	13 mw
(4)	Noise: Carrier off	30 mw	30 mw	30 mw	-
(5)	Ratio in decibels Signal + Noise to noise $\frac{(2)}{(3)}$	31.7 db	24.75 db	4.77 db	1.67 db
(6)	Comments on Quality and Intelligibility	Good	Good	Under-standable	Inaudible above noise

[redacted]

Table R-2

Listening Tests on Radiomarine ET-8021

Radio Telephone - October 7, 1940

Frequency = 2738 kilocycles

(1)	Sig.Gen. Input to Antenna in Lab. Annex	2 volts	100,000 microvolts	10,000 microvolts	5,000 microvolts
(2)	Signal + Noise Output (30% Modulation)	100 milliwatts	85 milliwatts	40 milliwatts	25 milliwatts
(3)	Noise: Carrier on	.02 mw	.4 mw	15 mw	17 mw
(4)	Noise: Carrier off	8 mw	8 mw	11 mw	11 mw
(5)	Ratio in db: Signal + Noise to Noise: $\frac{(2)}{(3)}$	37db	23.3db	4.3db	1.7 db
(6)	Comments on Quality and Intelligibility	Good, negligible noise	Good, negligible noise	Understandable, but not reliable.	Speech audible but not understandable.

[redacted]

Table R-3

Sensitivity, Noise Output, Image Ratio

and I-F Response of Radio Marine ET-8021

Radio Telephone Receiver

Gain control at maximum; input modulated 30% at 400 c-p-s.
Output impedance 12.5 ohms.

Selector Switch Position	1	2	3	4	5	6
Frequency	2506 kc	2514 kc	2522 kc	2538 kc	2670 kc	2738 kc
Input through standard dummy antenna	10 micro-volts	8.5 micro-volts	7.8 micro-volts	7.8 micro-volts	8.3 micro-volts	8.0 micro-volts
A-F Output in 12.5 ohms	40 milliwatts	40 milliwatts	40 mw	40 mw	40 mw	40 mw
Noise output - Modulation off	1.5 mw	1.6 mw	1.4 mw	1.5 mw	1.3 mw	1.7 mw
Noise output - carrier off	.15 mw	.17 mw	.15 mw	.17 mw	.17 mw	.20 mw
Image frequency	1596 kc	1604 kc	1612 kc	1628 kc	1760 kc	1828 kc
Image ratio	37.8	27.2	27.8	26.3	19.0	18.6
I-F Response from Antenna for 40 mw output, 455 kc	131,000 microvolts	131,000 micro-volts	131,000 micro volts	131,000 micro-volts	131,000 micro-volts	131,000 micro-volts

[redacted]

Table R-4

Selectivity of Radiomarine ET-8021
Radio Telephone Receiver

f_o = 2738 kilocycles

Gain control at maximum; input, 30% modulated at 400c-p-s; constant output = 40 milliwatts.

Ratio: Input off max.response / Input at max. response	Ratio in DB	Band Width: Kc	Band Width: %
1.4	3	3.3	.13
2	6	5.3	.21
10	20	9.8	.39
100	40	16.4	.65
1000	60	24.0	.95
10,000	80	38.0	1.5

[redacted]

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Table R-5

Resonant Overload Characteristics
of Radiomarine ET-8021 Radio Telephone Receiver

Gain control on maximum; input 30% modulated at 400 c-p-s.

(1) Threshold of AVC action:	Input 12 microvolts Output 120 milliwatts
(2) Maximum variation of output for +100 db increase of input	120 to 700 milliwatts (7.6 db)
(3) Input for 6 db change in AVC threshold output	400 microvolts
(4) Range of linear detection below AVC threshold	Input 9 to 12 microvolts Output 65 to 120 milliwatts
(5) Carrier noise output (modulation off);	Max. - 2.4 milliwatts Min. - .02 milliwatt Ratio - 20.8 db
(6) Range of input variation to decrease carrier noise from max. to min. value	20 to 5,000 microvolts (+ 48 db)
(7) Maximum power output of receiver	700 milliwatts

[redacted]

Table R-6

Radiation Voltage Due to Receiver Oscillator
Appearing at Antenna Terminals of Radiomarine ET-8021
Radio Telephone Receiver

Gain Control on Maximum

Frequency Switch Position	1	2	3	4	5	6
Receiver Osc.Freq.	2051 kc	2059 kc	2067 kc	2083 kc	2215 kc	2283 kc
Radiation Voltage - Fundamental	45,000 microvolts	33,000 µv	39,000 µv	47,000 µv	47,000 µv	47,000 µv
Radiation Voltage - 2nd Harmonic	9,210 microvolts	9,000 µv	9,050 µv	6,750 µv	7,150 µv	6,150 µv
Radiation Voltage - 3rd Harmonic	365 microvolts	325 µv	310 µv	290 µv	665 µv	580 µv

[redacted]

Table R-8

Effect of Temperature on Gain and Noise Level
of Radiomarine ET-8021 Radio Telephone Equipment

Gain Control set at maximum

Temperature	50° C start	50° C end	0° C	After 60 min at approx. -17° C	-15° C end
Time	0	120 min.	190 min.	315 min.	410 min.
Input for 50 mw output	76 µv	76 µv	8700 µv	8700 µv	60 µv
Gain Ratio	1.0	1.0	.0087	.0087	1.27
DB Change in Initial Gain	0	0	-41.2 DB	-41.2 DB	+2.08 DB
Carrier Noise Level - Mod.Off	.38 mw	.38 mw	.3 mw	.25 mw	.02 mw
Carrier Noise Ratio	1.0	1.0	.79	.66	.0525
DB Change in carrier noise	0	0	-1.02 DB	-1.8 DB	-12.8 DB
Noise Output - Carrier Off	.06 mw	.05 mw	.04 mw	.07 mw	1.2 mw
Noise Ratio Carrier Off	1	.835	.67	1.17	20
DB Change in Noise Output - Carrier Off	0	-.8 DB	-1.74 DB	+ .7 DB	+13 DB

[redacted]

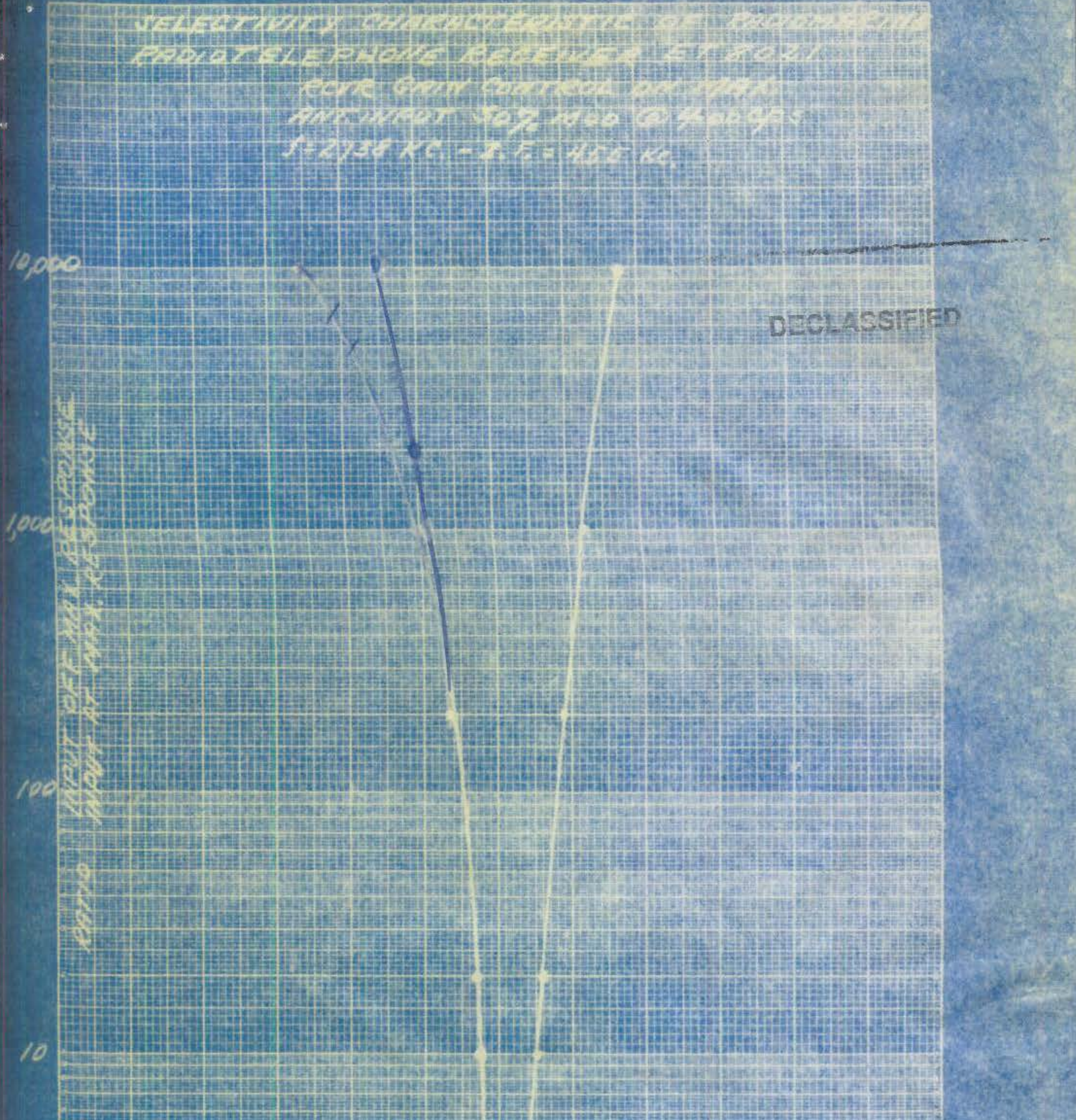
Table R-9

Effect of Humidity on Cold-Start Gain
and Noise Characteristics
of Radiomarine ET-8021 Radio Telephone
Receiver

Gain Control on maximum - Equipment turned off from 0 to 200 minutes.

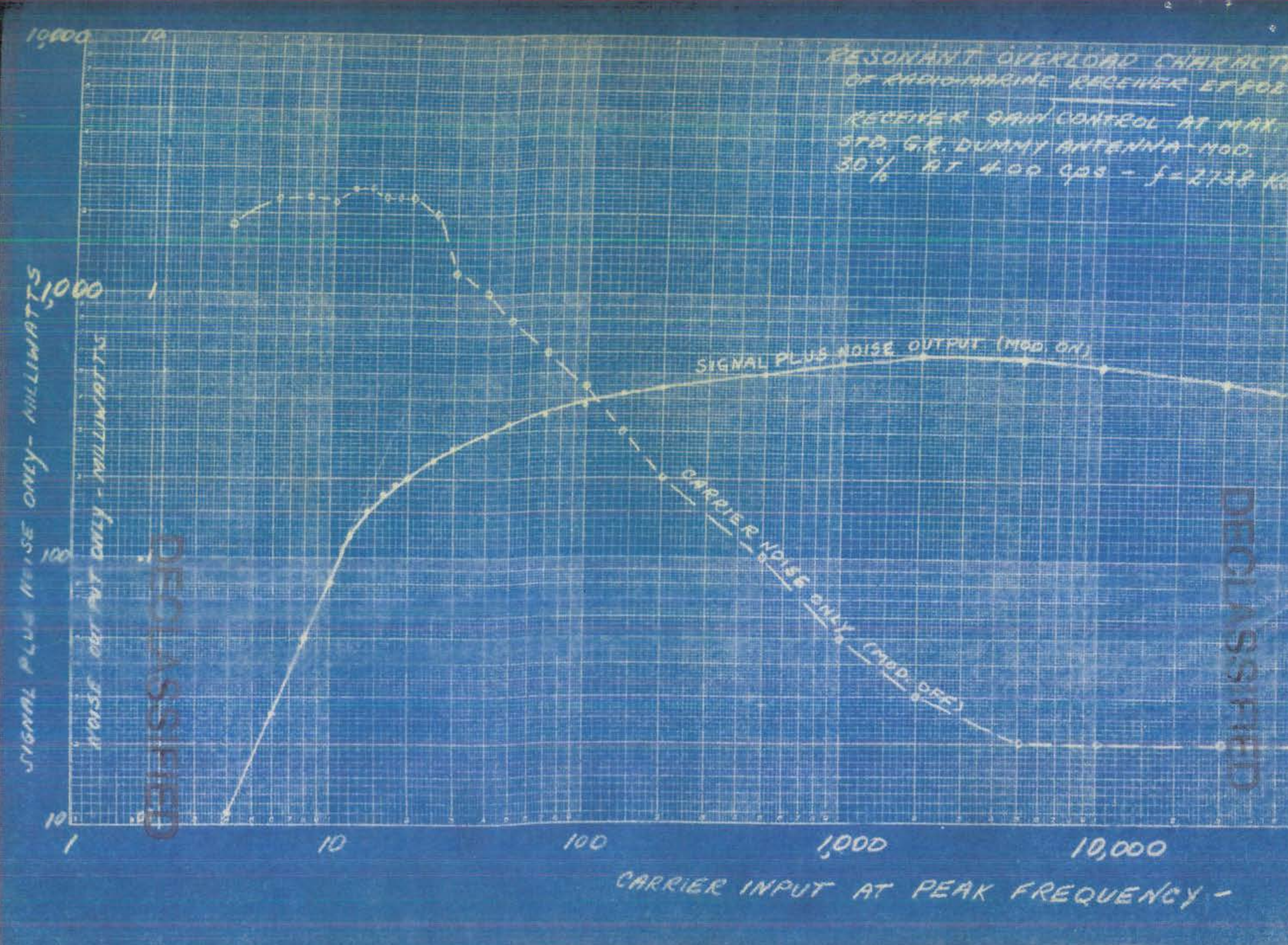
Condition	Initial Check (a)	Equipment turned on (b)	Reading (c)	Reading (d)	Final Reading (e)
Time	0	200 min.	205 min.	240 min.	300 min.
Humidity	23%	97%	97%	97%	26%
Input for 50 mw output	46 microvolts	2900 µv	2500 µv	195 µv	43 µv
Gain Ratio Change	1	.0158	.0184	.236	1.07
DB Change in Gain	0	-36 DB	-34.46 DB	-12.52 DB	+ .8 DB
Carrier Noise Level - Mod.Off	1.3 mw	.02 mw	.02 mw	.17 mw	1.4 mw
Carrier Noise Ratio	1	.0154	.0154	.13	1.08
DB Change in Carrier Noise	0	-18.12 DB	-18.12 DB	-8.84 DB	+ .33 DB
Noise Output - Carrier Off	.16 mw	.02 mw	.02 mw	.04 mw	.17 mw
Noise Ratio - Carrier Off	1	.125	.125	.25	1.06
DB Change in Noise - Carrier Off	± 0	-9.03 DB	-9.03 DB	-6.02 DB	+ .36 DB

[redacted]

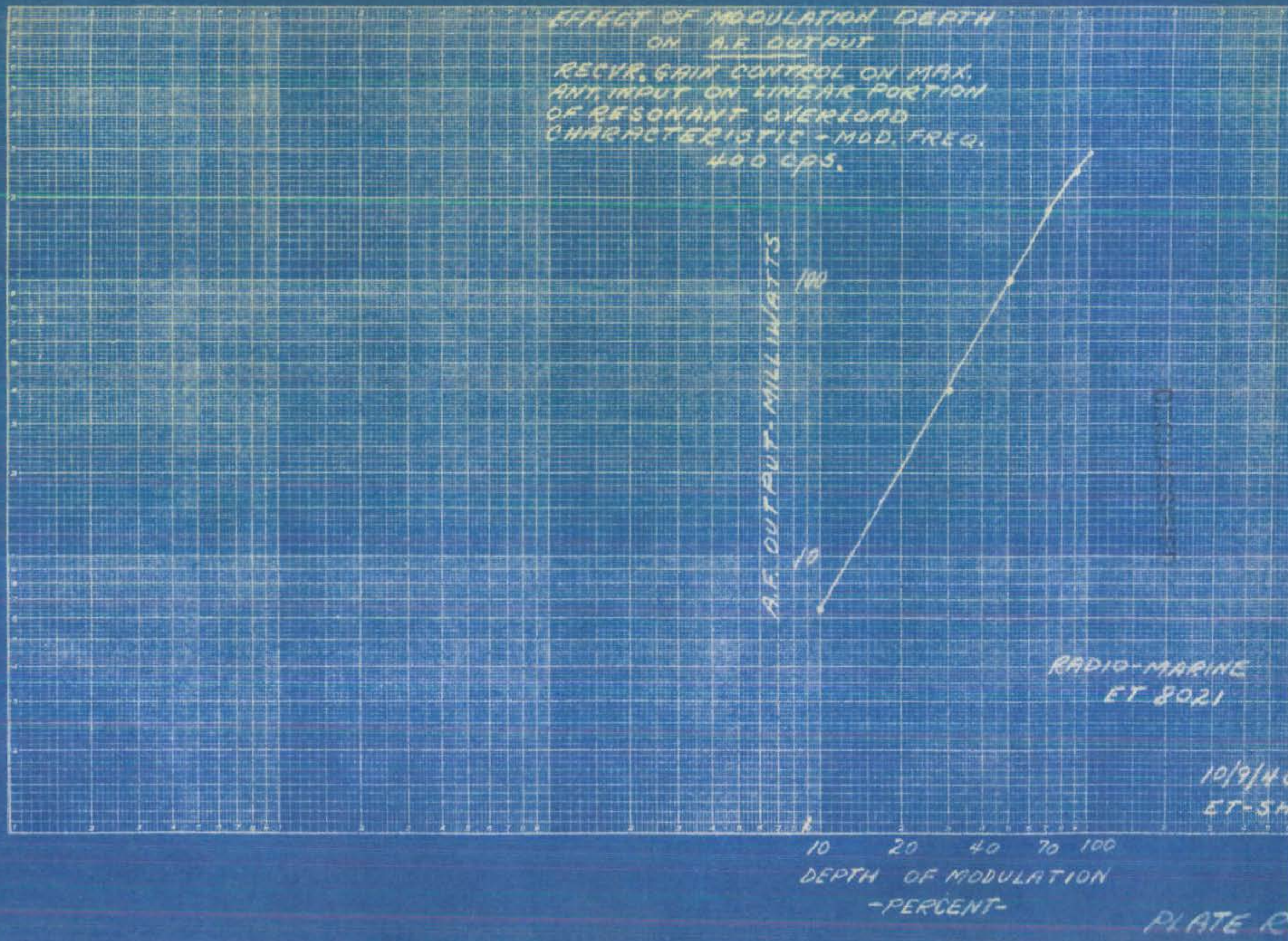


SELECTIVITY CHARACTERISTIC OF
RADIOTELEPHONE RECEIVER
RCVR GAIN CONTROL ON MAX.
ANT. INPUT 30% MOD @ 400 CPS
10,000
1,000
100
10
1
-3
-2
-1
0
+1
+2
+3
RATIO INPUT OFF MAX. RESPONSE / INPUT AT MAX. RESPONSE
PERCENT OFF FREQUENCY OF MAX. RESPONSE
DECLASSIFIED
DECLASSIFIED

PLATE R-1



RESONANT OVERLOAD CHARACTE
OF RADIOMARINE RECEIVER ET-8021
RECEIVER GAIN CONTROL AT MAX.
STD. G.R. DUMMY ANTENNA - MOD.
30% AT 400 CPS - f=2738 KC.
SIGNAL PLUS NOISE OUTPUT (MOD. ON)
CARRIER NOISE ONLY (MOD. OFF)
SIGNAL PLUS NOISE ONLY - MILLIWATTS
NOISE OUTPUT ONLY - MILLIWATTS
CARRIER INPUT AT PEAK FREQUENCY -
DECLASSIFIED
DECLASSIFIED


EFFECT OF MODULATION DEPTH
ON A.F. OUTPUT
RECVR. GAIN CONTROL ON MAX.
ANT. INPUT ON LINEAR PORTION
OF RESONANT OVERLOAD
CHARACTERISTIC - MOD. FREQ.
400 CPS.
A.F. OUTPUT - MILLIWATTS
100
10
10
20
40
70
100
DEPTH OF MODULATION
-PERCENT-
RADIO-MARINE
ET 8021
10/9/4
ET-SH
PLATE R

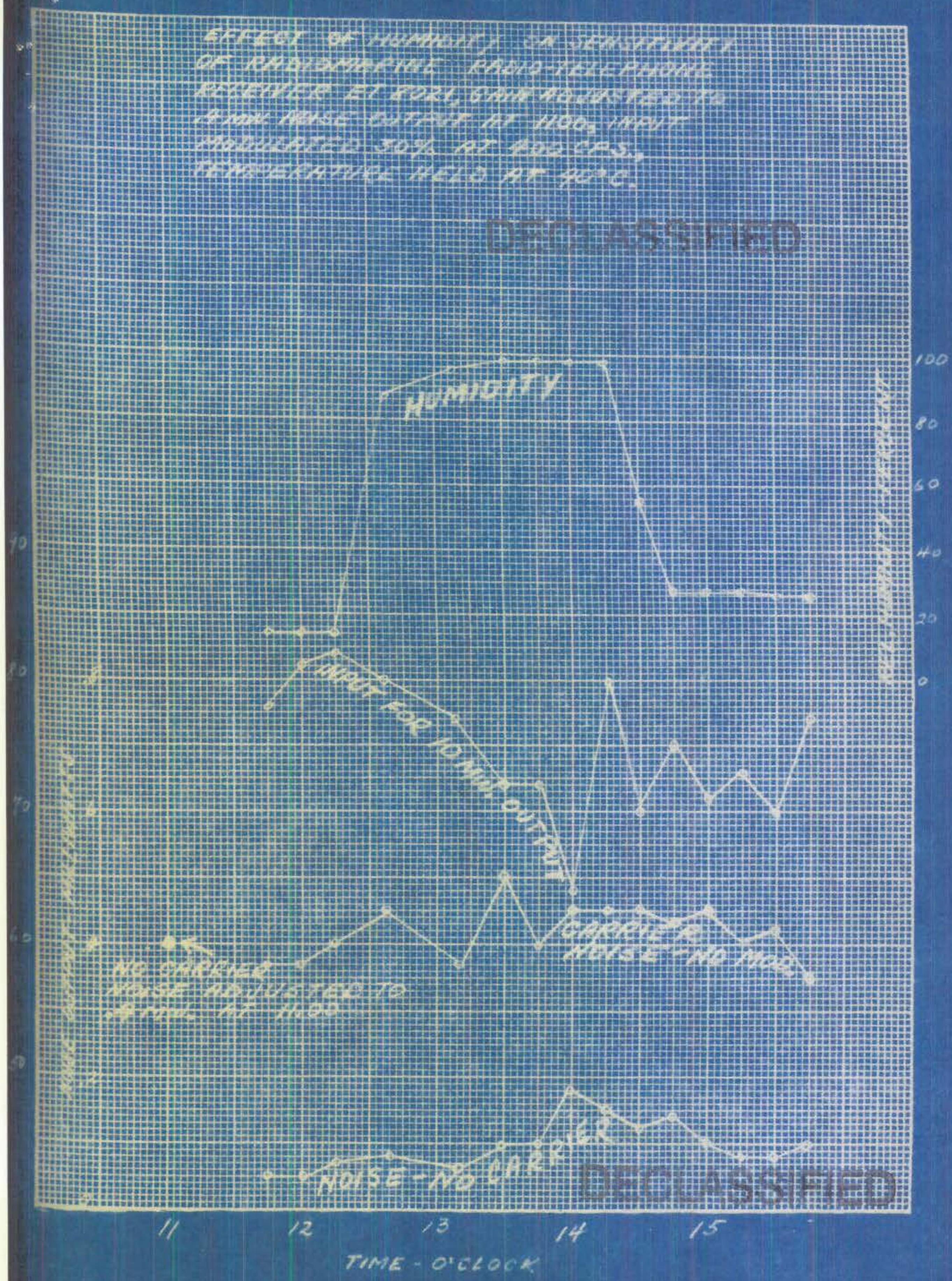

MODULATED 30% AT 400 CPS.
TEMPERATURE HELD AT 40°C.
DECLASSIFIED
HUMIDITY
100
80
60
40
20
0
INPUT FOR 10 MW OUTPUT
CARRIER NOISE - NO MOD.
NO CARRIER NOISE ADJUSTED TO
NOISE - NO CARRIER
DECLASSIFIED
11
12
13
14
15
TIME - O'CLOCK

PLATE R-4

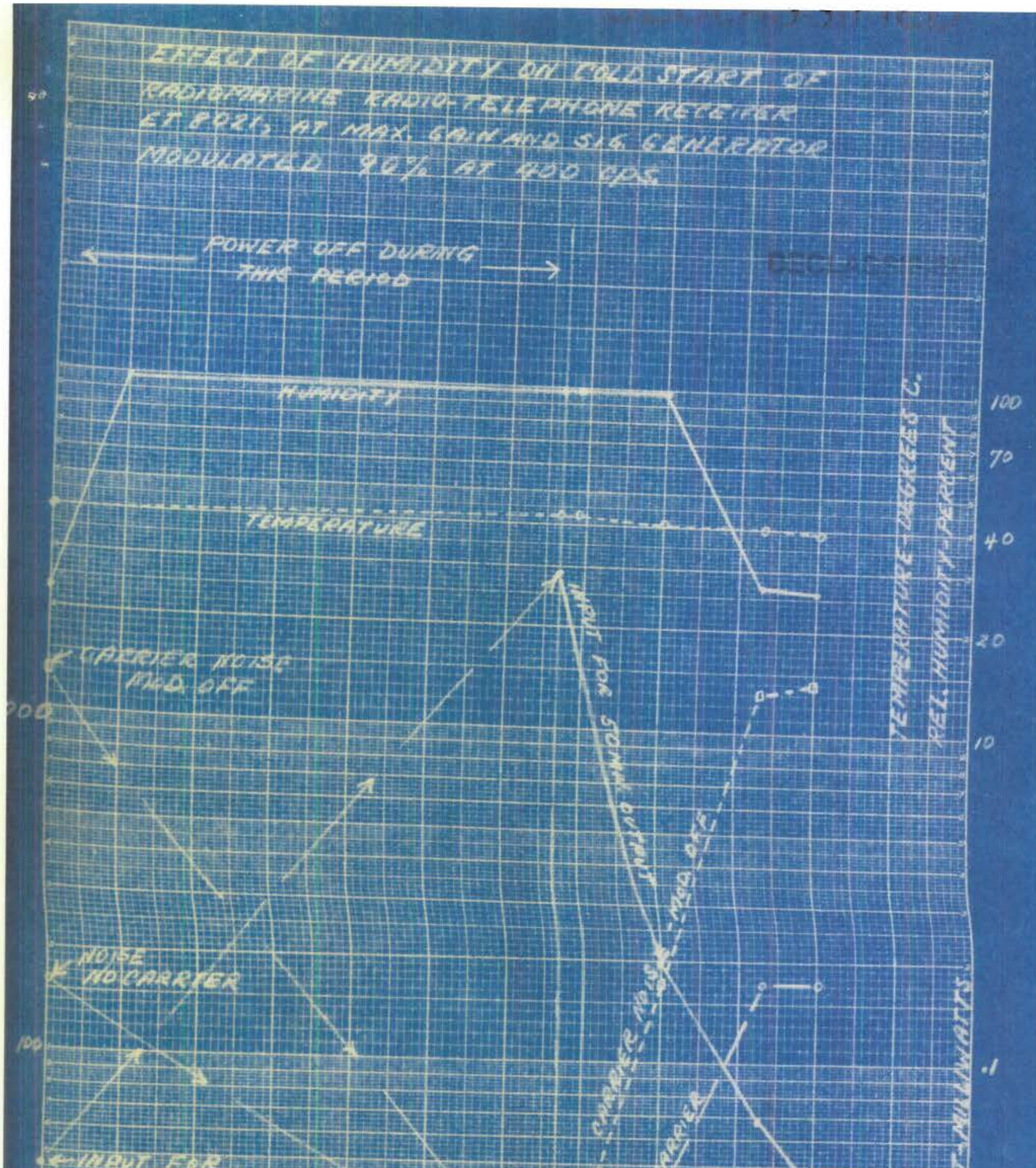
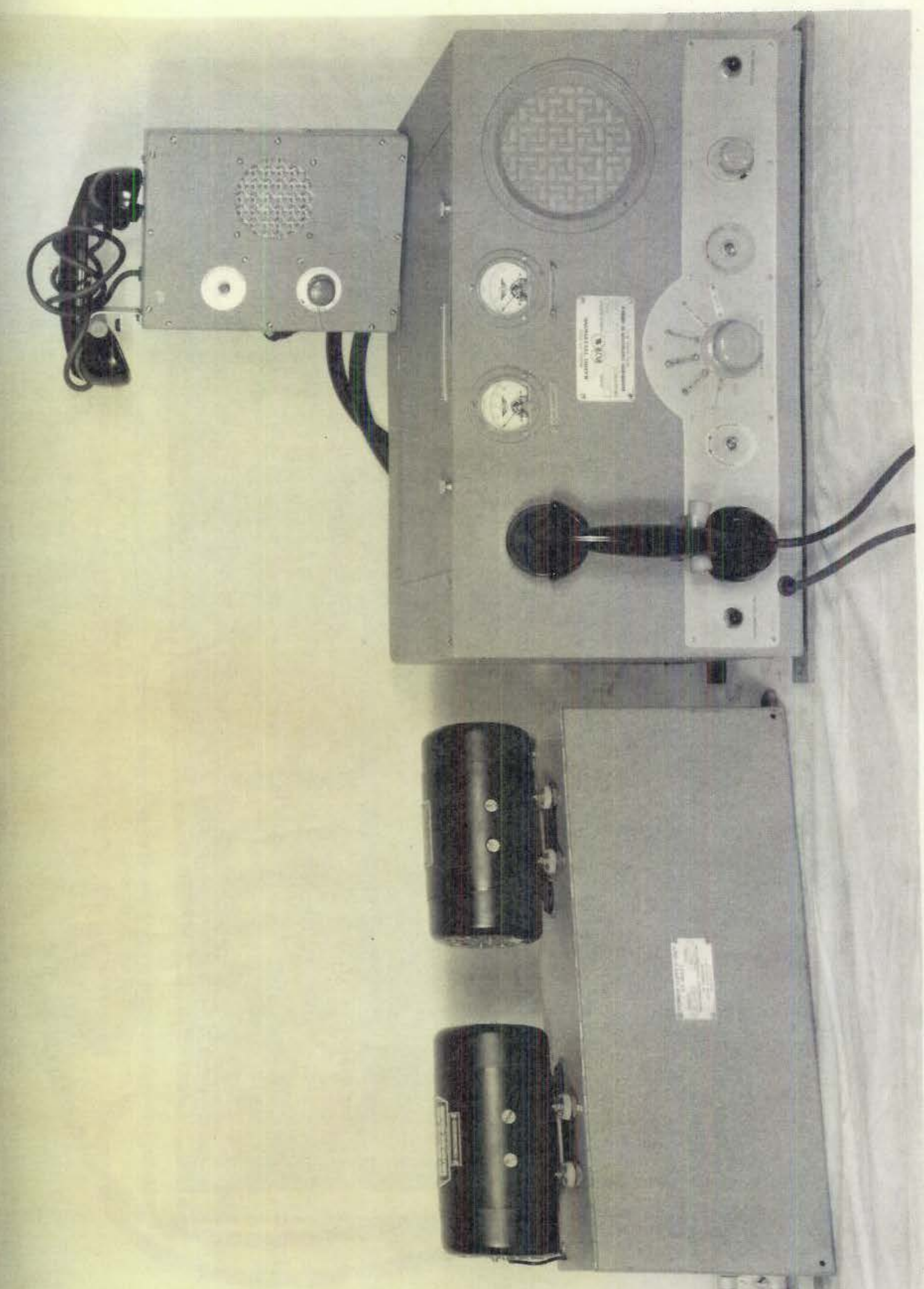
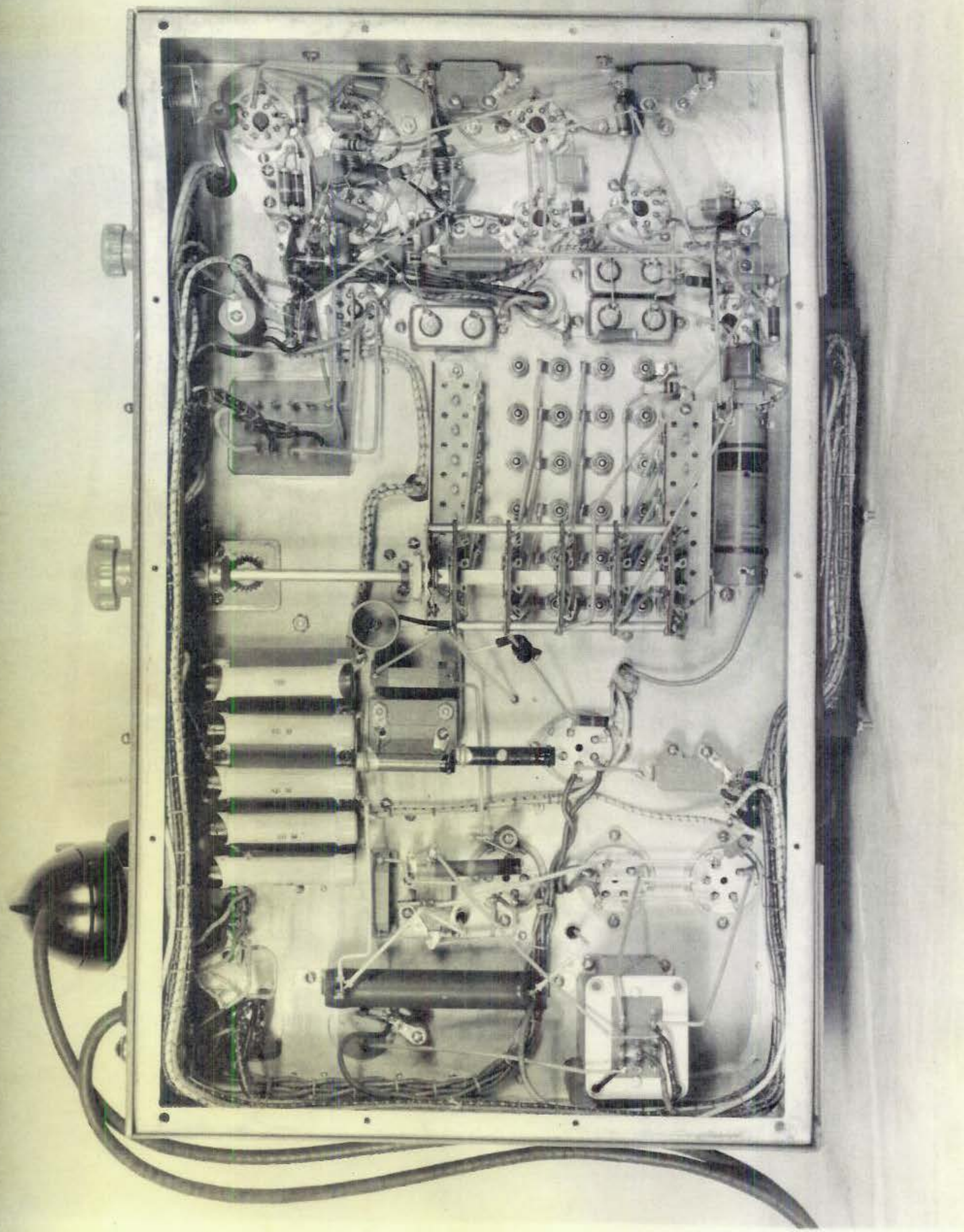

EFFECT OF HUMIDITY ON COLD START OF
RADIOMARINE RADIO-TELEPHONE RECEIVER
ET 8021, AT MAX. GAIN AND SIG. GENERATOR
MODULATED 90% AT 400 CPS.
POWER OFF DURING
THIS PERIOD
HUMIDITY
TEMPERATURE
CARRIER NOISE
MOD. OFF
NOISE
NO CARRIER
INPUT FOR
50 MW. OUTPUT
INPUT FOR 50MW OUTPUT
CARRIER NOISE - MOD. OFF
NOISE-NO CARRIER
TEMPERATURE-DEGREES C.
REL. HUMIDITY-PERCENT
NOISE OUTPUT-MILLIWATTS
10-28-40
ET-SHL
100
70
40
20
10
.1
.01
1000
100
10
9
10
11
12
13
14
15
TIME - O'CLOCK

PLATE R-5

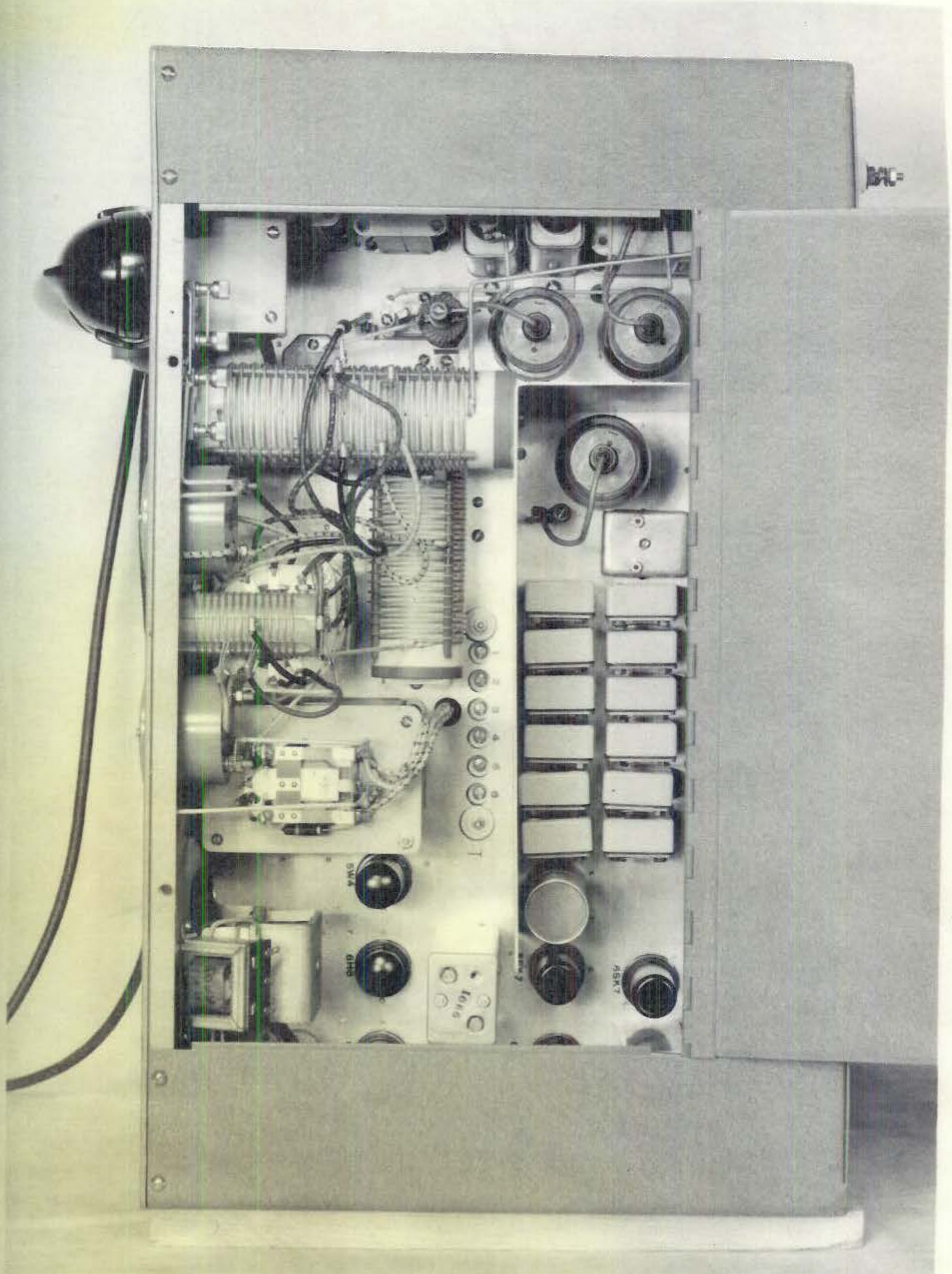


Radio Marine ET-8021 - Front View, Covers in Place
Plate TR-1



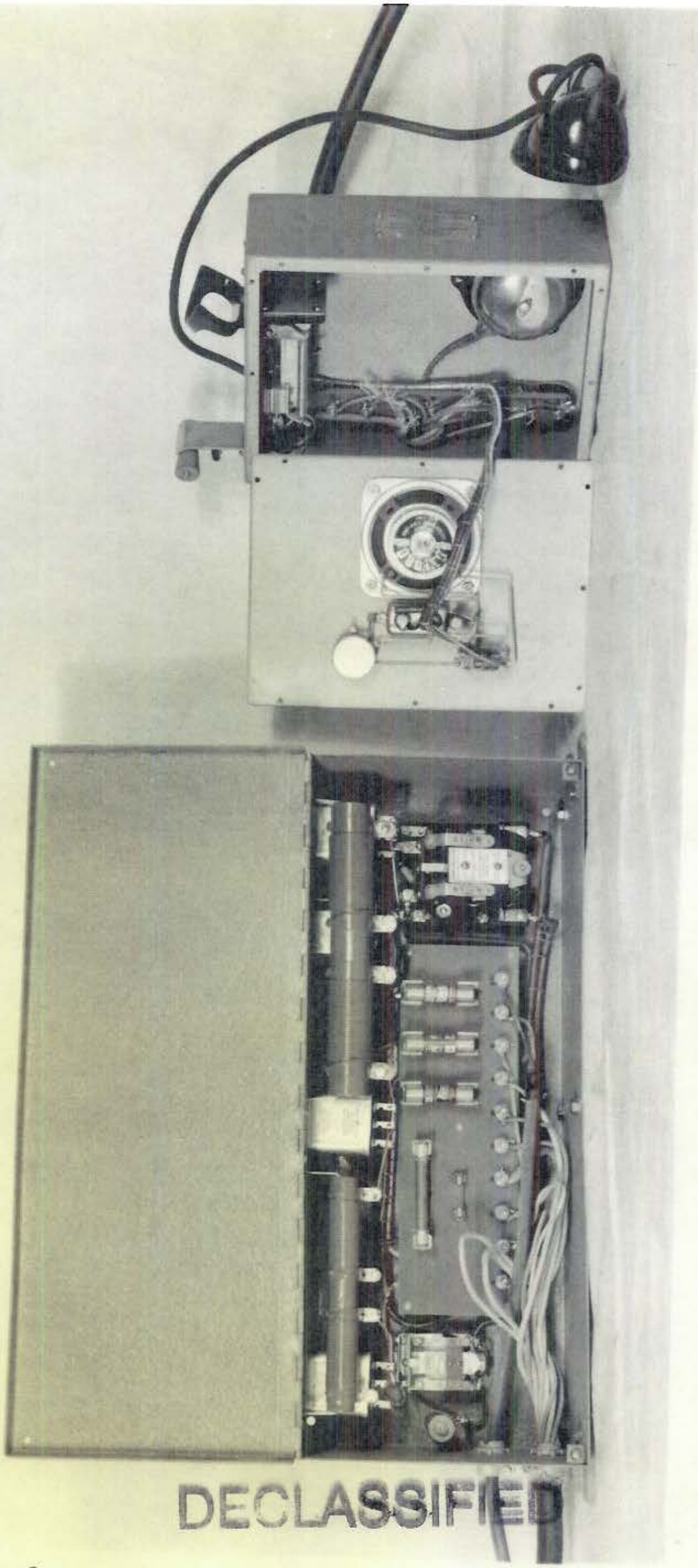
Radio Marine ET-8021 - Underside of Chassis, Covers Off

Plate TR-2



Radio Marine ET-8021 - Top View, Cover Open

 Plate TR-3



Radio Marine ET-8021 - Interior View of Power Supply Unit and Remote Unit

Plate TR-4

METHOD OF CONNECTING RECEIVER MEASURING EQUIPTMENT FOR TEMPERATURE AND HUMIDITY TESTS

EXTERNAL POWER CONTROL CIRCUITS NOT SHOWN

.0003MFD. CONDENSER AND 24 OHM RESISTOR, TOGETHER WITH AMMETER, FORM TRANSMITTER DUMMY LOAD.

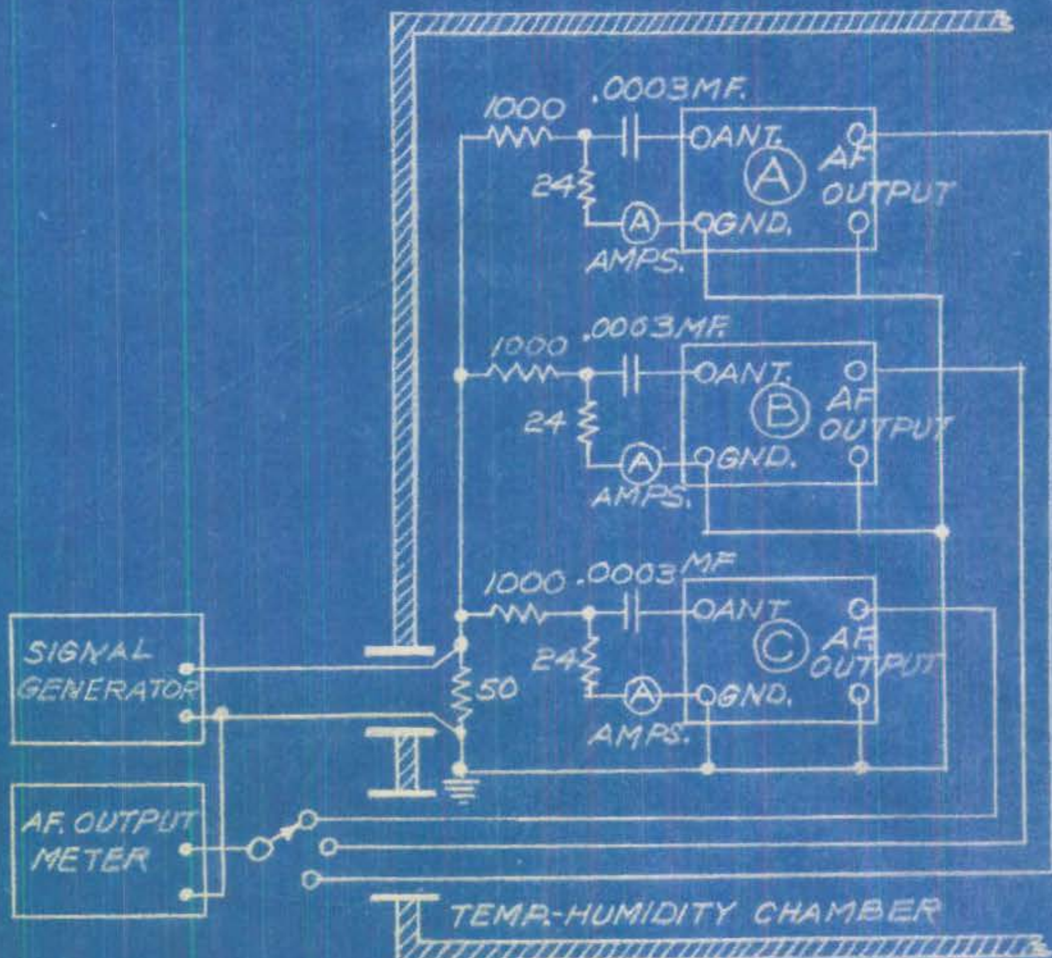
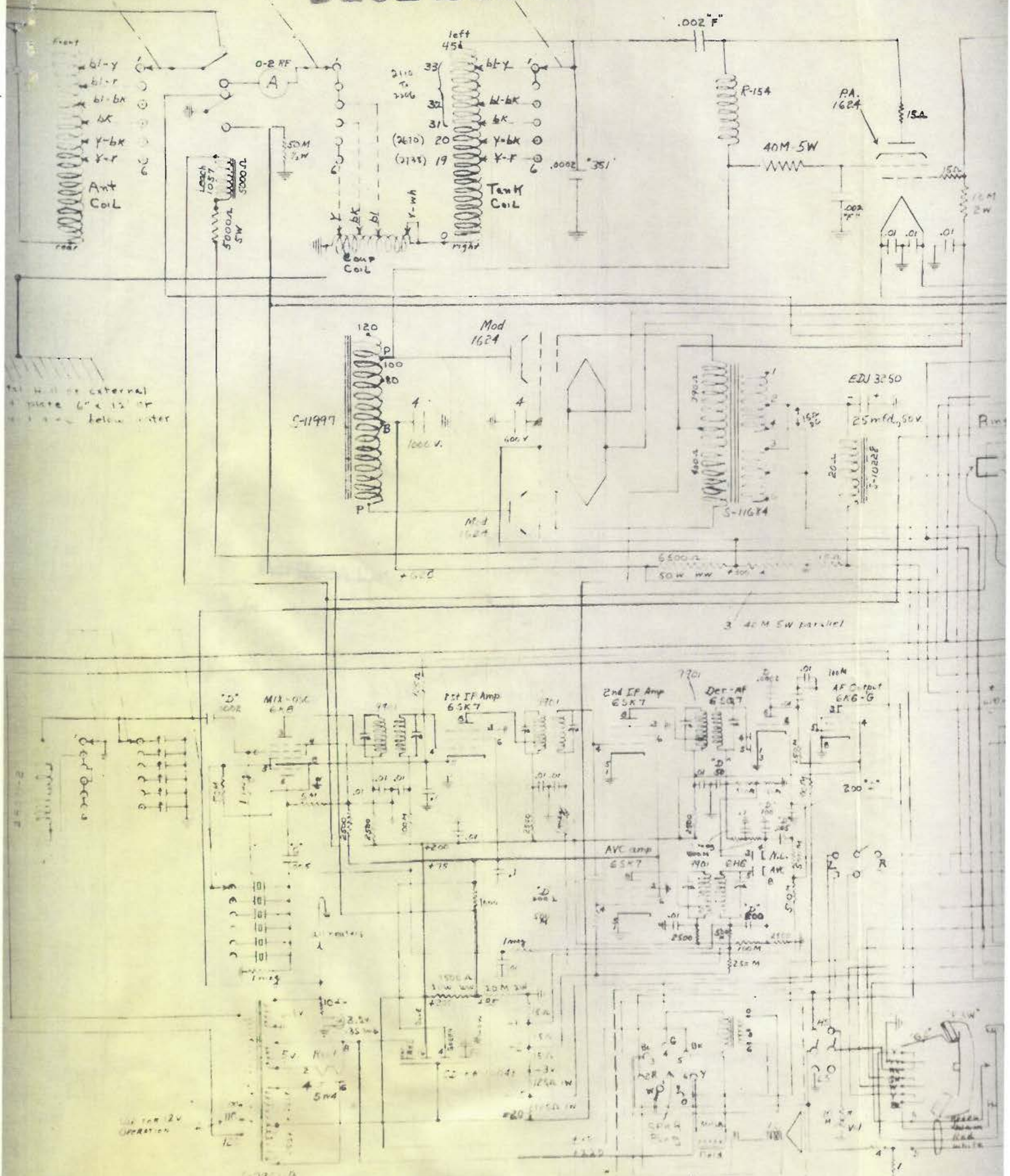
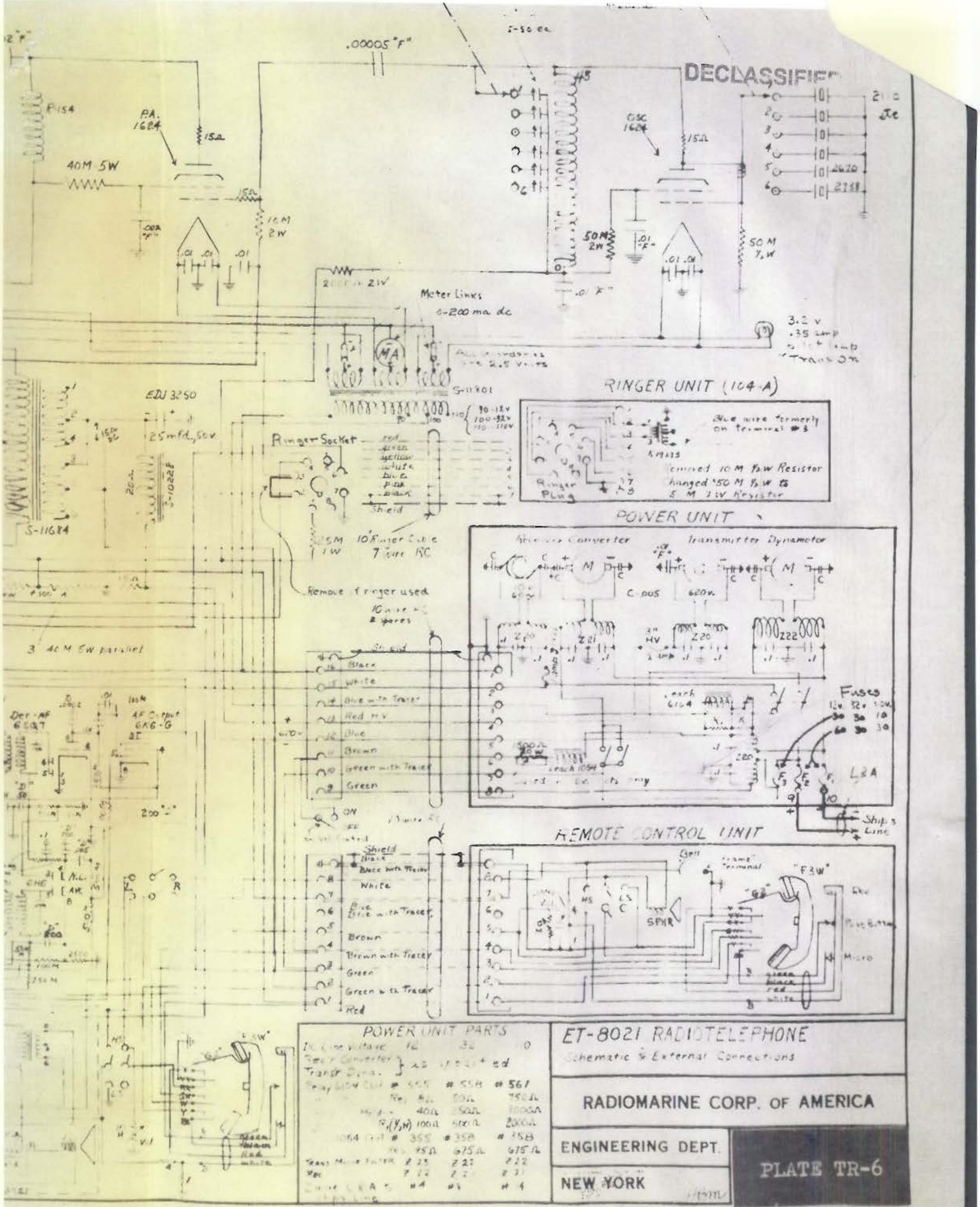


 PLATE TR-5



Front
bl-y
bl-r
bl-bk
bk
y-bk
y-r
6
Ant
CoiL
rear
0-2 RF
A
50M
Tank
CoiL
Coup
CoiL
right
left
45
33
32
31
(2610) 20
(2735) 19
bl-y
bl-bk
bk
y-bk
y-r
.0002
"351"
.002 "F"
R-154
P.A.
1624
15Ω
40M 5W
.002
"F"
.01
.01
.01
10M
2W
120
Mod
1624
P
100
80
B
P
S-11997
1000 V.
600 V
Mod
1624
S-11684
EDJ 3250
25 mfd, 50 V.
+ 600
6500 Ω
50 W ww
3 40 M 5W parallel
"D"
.0002
MIX-OSC
6A8
1st IF Amp
6SK7
2nd IF Amp
6SK7
Det-Af
6SQ7
AF Output
6K6-G
AVC amp
6SK7
6H6
A.L.
AM
+200
+75
1meg
200"Z"
250 M
1500 Ω
10 W ww
10 M 2W
2.5V
5W4
SPKR
Plug
+20
S-7951-B



DECLASSIFIED
.00005 "F"
P.A. 1624
OSC 1624
40M 5W
50 M 1/2 W
Meter Links
0-200 ma dc
3.2 v
.35 amp
EDJ 3250
25 mfd., 50v.
S-11684
S-11401
Ringer Socket
red
green
yellow
white
blue
black
Shield
10' Ringer Cable
7 wire RC
Remove if ringer used
RINGER UNIT (104-A)
Blue wire formerly on terminal #3
Removed 10 M 1/2 W Resistor
Changed 50 M 1/2 W to 5 M 1 W Resistor
Ringer Plug
POWER UNIT
Receiver Converter
Transmitter Dynamotor
Z20
Z21
Z22
620v.
Fuses
12v. 32v. 110v.
L&A
Ship's Line
3 40 M 5W parallel
Black
White
Blue with Tracer
Red H.V.
Blue
Brown
Green with Tracer
Green
Det.-AF 6SQ7
AF Output 6K6-G
REMOTE CONTROL UNIT
Bell
"F3W"
"G3"
SPKR
Micro
Black with Tracer
Blue with Tracer
Brown with Tracer
Green with Tracer
Red
POWER UNIT PARTS
ET-8021 RADIOTELEPHONE
Schematic & External Connections
RADIOMARINE CORP. OF AMERICA
ENGINEERING DEPT.
NEW YORK
PLATE TR-6
DECLASSIFIED