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NAVY DEPARTMENT

BUREAU OF ENGINEERING

Report of Test

on

Model RAM Receiving and

Model GN Transmitting Equipments

manufactured by

Western Electric Company

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Unclassified

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D. C.

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Table of Contents

Appendix I

Appendix II

Naval Air Station, Anacostia, D.C. Flight Test Report
F42-1/46-52/NA6(374) Ser.No.38031 of 10 March 1938
(Confidential)

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AUTHORIZATION

1. The tests herein reported were authorized by Bureau of Engineering letter, reference (a). Additional references pertinent to these tests are listed as references (b) to (f).

Reference: (a) BuEng let.C-NOs-43068(9-23-W3) of 25 Sept.1935.
(b) BuEng let.F42-1(11-8-W3) of 17 Nov.1934.
(c) Memorandum of Bureau of Engineering Conference held 15 April 1937.
(d) Specifications RE 13A 505A.
(e) Specifications RE 13A 504A.
(f) Naval Air Station, Anacostia,D.C., let. F42-1/46-52/NA6 (374) Serial #38031 of 10 March 1938 to NRL.

OBJECT OF TEST

2. The object of these tests is to determine the compliance of the equipment with the requirements of the specifications, reference (d).

ABSTRACT OF TEST

3. The equipment was checked for size and weight, mechanical construction, electrical performance, and its adaptability for use in the Naval Service as required by reference (d) and (e).

4. The receiving equipment was tested to determine the overlap of the frequency bands, sensitivity, loop sensitivity, selectivity, audio frequency response, audio distortion, image ratio, kilocycles spread per dial division, automatic volume control action, frequency drift at constant temperature, frequency change due to voltage variation, frequency drift at variable temperature, resettability, and frequency change on band switch contacts.

5. The transmitter was tested for frequency range, overlap, stability, power output, modulation characteristics, and power supply characteristics over the specified ranges of temperature and under conditions of severe humidity.

6. At the conclusion of the bench tests the equipment was submitted to the Naval Air Station at Anacostia for flight tests in accordance with reference (b).

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Conclusions

The tests of the Model RAM receiving equipment were conducted on two preliminary models. As a result of these tests the following conclusions were reached.

(a) The material used is of a high quality. The workmanship in general is excellent and the equipment with slight modification should give long and dependable service.

(b) Some units of the equipment are slightly oversize or overweight according to the requirements of reference (d).

(c) The equipment does not meet the requirements of reference (d) on the following:

Overlap of Frequency Bands
Sensitivity
Selectivity
Audio Frequency Response
Audio Distortion
Reset
Undistorted Output

(d) The equipment satisfactorily met the requirements of reference (d) on the following:

Loop Sensitivity
Image Ratio
Kilocycle spread per dial division
Automatic Volume Control
Frequency drift at constant temperature
Frequency change due to voltage variation
Frequency drift at variable temperature

(e) The points wherein the equipment does not meet the requirements of the specifications are, except for reset, of a minor nature and will not detract seriously from the suitability and serviceability for Naval aircraft use. The failure of the reset measurements to meet the requirements is due to faulty construction of the coupling control. This can readily be corrected to such a degree as to greatly improve the resettability.

Tests of the Model GN transmitting equipment lead to the following conclusions:

(a) The equipment is well made of high quality material.

(b) The equipment fails in certain instances to meet the specified performance requirements as regard frequency change with temperature change and reset. However, the frequency stability is, in general, superior to present aircraft equipment. The reset requirements can be met with more careful workmanship in the tuning device mechanism.

(c) The equipment is overweight. It, however, is completely self-contained obviating the necessity of carrying spare tuning units.

(d) The break-in operation is not wholly satisfactory but is workable.

(e) The accessibility of the equipment is bad but will be difficult to improve in so small a space.

The equipment as modified by the contractor in the preliminary model will be a wholly serviceable radio transmitting and receiving system.

Recommendations

It is recommended that:

(a) The antenna, ground, and loop terminals be arranged in alignment on top of the unit now housing them. If this change proves to be impractical, an alternate arrangement is to reverse the position of the binding posts and the plug receptacle.

(b) Due to the difficulty of replacing the split shield cans of the tubes, it is desirable that straight side single unit cans be provided. Removable tops would be satisfactory.

(c) To prevent the possibility of confusion, a dummy clip lead be provided for the 38085 tube in the I.F. - A.F. unit.

(d) The gear ratio of the remote control of the band switch be changed to the same ratio as the remote control of the tuner. A crank on the local control of the band switch would be desirable.

(e) A remote control coupling be provided at both sides of the tuner housing.

(f) The shield between the switch sections be made more rigid and have the corners rounded off.

(g) That the reset of the transmitter be improved.

(h) The contractor be allowed 0.05 per cent frequency drift for 25° C temperature change in production equipments.

(i) The equipments be considered satisfactory for use in the Naval Service provided the contractor satisfactorily incorporates the changes recommended herein and by the Naval Air Station, Anacostia, in the production equipments. These changes have all been discussed with his representatives at various conferences at the Bureau of Engineering.

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EQUIPMENT UNDER TEST

7. The Model RAM receiving equipment consists of two receivers capable of collecting cw-mcw and voice signals. One receiver covers the intermediate frequency range from 200 to 1500 kilocycles; and one, the high frequency range from 1500 to 13,575 kilocycles. The receivers comprise two units which may be mounted together forming a single unit or separated by means of a connecting cable. One, designated as the r-f tuner unit, comprises three type 38078 tubes and their associated circuits, which are a radio frequency amplifier, a modulator, and an oscillator. The other, designated as the I.F. - A.F. unit, comprises three type 38078, one type 38041, and one type 38085 tubes and their associated circuits, which are two stages of intermediate amplification, an intermediate oscillator, a combination detector and automatic volume control and an audio amplifier respectively.

8. The Model GN transmitting equipment consists of a dual transmitter and a single power supply system arranged to supply power to either transmitter but not both simultaneously. Each transmitter consists of a master oscillator and power amplifier. The one unit covers the range of 350 to 1500 kilocycles, while the other unit covers from 1500 to 9050 kilocycles. They provide cw, mcw, or voice transmission with a nominal output of 100 watts on cw and 40 watts on voice.

9. The transmitter power unit supplies plate and filament power from a type NEA-2 alternator through a suitable rectifier system and filament transformer.

10. A dynamotor driven by the ship's 12 volt storage battery supplies all the electrical power necessary to operate the receiver. Extension boxes and control cables permit remote control of the equipment in addition to local control.

METHOD OF TEST

11. A description of the method used in conducting the tests follows:

12. The equipment was checked for size, weight, and mechanical construction. It was then assembled and tested to determine its compliance with the electrical requirements of the specifications, references (d) and (e).

13. The sensitivity of the receiver was determined with the use of a standard signal generator to supply the input and a power output meter to measure the output. The standard signal generator was coupled to the receiver through an artificial antenna with characteristics as required by the specifications, reference (d). With the receiver adjusted so that not over standard noise output was obtained, the input necessary for standard output was recorded at various frequencies. The measurements were made on cw and mcw positions of the selector switch and on manual and automatic posi-

tions. The measurements were made at such points on the frequency band that the overlap, frequency range, and kilocycles spread per dial division were determined from the results.

14. The loop coupling sensitivity measurements were made the same as above. The standard signal generator was coupled to the loop terminals in accordance with the requirements of the specifications, reference (d).

15. The mcw selectivity measurements were made with the same apparatus as that used in making the sensitivity measurements. The procedure was as follows. The standard signal generator and the receiver were tuned to resonance and for standard output. The standard signal generator was detuned and the multiplier adjusted to the next higher step (the attenuator remaining fixed). The standard signal generator was then retuned until standard output was again obtained. The setting of the tuning control of the standard signal generator at both positions was recorded. These measurements were made at 10 times, 100 times, and 1,000 times the necessary input for standard output both above and below resonance. The selectivity was measured as the band width in kilocycles between the corresponding points on each side of resonance.

16. The audio frequency response measurements were made by using a beat frequency oscillator to supply external modulation to the standard signal generator. With the standard signal generator and receiver adjusted for standard output on the desired frequencies and all other controls remaining fixed the beat frequency oscillator was adjusted to various frequencies and the output of the receiver recorded.

17. The audio distortion was measured with the use of a beat frequency oscillator adjusted to modulate the standard signal generator at 400 cycles. The receiver output was coupled to a wave analyzer, the output of the receiver being adjusted to 1 milliwatt and 300 milliwatts. The wave analyzer was adjusted to successive harmonics of the modulation frequency. The results as indicated on the wave analyzer meter were recorded from which the percentage of the combined r-m-s harmonics was determined.

18. The image ratio was determined by adjusting the standard signal generator and receiver to resonance and standard output and then adjusting the standard signal generator to the image frequency and increasing the input until standard output in the receiver was again obtained. The ratio of the input voltage at these different settings is then determined.

19. The automatic volume control was determined by adjusting the standard signal generator and the receiver to resonance with the receiver in the a.v.c. position. The input was then increased by 10, 100, 1000, and 10,000 times, and the receiver output recorded.

20. The frequency drift measurements of the receivers were made at a constant ambient temperature and at variable temperature. In the latter case the receiver was mounted in a temperature controlled chamber and the temperature varied over the specified range. In both cases the procedure was the same. A Model LD-2 heterodyne calibrator was used for the input to the receiver and an interpolation oscillator to beat against the output of the receiver. Readings were taken at 5 minute intervals over a period of 60 minutes for the constant temperature test and at 5 minute intervals over a period of time necessary to change the temperature over the range specified for the variable temperature test.

21. The frequency change due to voltage variation was determined by adjusting the standard signal generator and receiver to resonance and standard output then varying the power supply to the dynamotor from 12 volts to 16 volts. The output of the receiver is beat against the output of an interpolation oscillator and the frequency change recorded.

22. The reset measurements of the receiver were made using a standard signal generator for the input source and a heterodyne calibrator to beat with the output of the receiver. The original settings of the controls of the receiver on a selected frequency were recorded and the receiver then detuned and reset from both clockwise and counter clockwise directions. From the results the frequency difference of the original and reset positions were determined. These tests were made on both local and remote controls of the receiver.

23. Manufacturer's figures were checked by use of a Model LD-2, Type CAG 74016, Serial No. 1 frequency indicator at the upper and lower end of each band of the transmitter.

24. Power measurements were made on one frequency of each band. Measurements were made using antenna constants corresponding to a fixed antenna as well as trailing wire. The procedure in measurement was as follows: The proper antenna constants were selected and a Weston panel type r-f ammeter of suitable range was connected in the ground return of the dummy antenna. The meter was first checked at 60 cycles to insure its accuracy. The inductance or capacity element of the dummy antenna was connected to the antenna post on the set. Then the transmitter was tuned in the cw position with a plate input of 180 milliamperes at 10 volts on the filament voltmeter. After all adjustments had been made, the readings were taken and then the emission selector was turned to the mcw position for a second set of readings and finally the emission selector was turned to phone for a final set of readings. After the set had been properly tuned on the cw position, no further adjustments were made for mcw and phone outputs except changing the emission selector. At the low frequencies, Ward Leonard plaques were used for dummy antenna resistors and zircon rods were used at the upper frequencies.

25. Frequency drift measurements were made by means of the Model LK drift indicator. On the first set tested, two frequencies were selected from each unit, but on the last test only one frequency per unit was tried. The procedure was to tune the Model GN to a suitable frequency which would give a beat note with the Model LK

indicator. After all adjustments had been made, the Model GN controls were locked and the entire transmitter was cooled to room temperature. Then the filaments of the transmitter were turned on for five minutes. After five minutes the key was locked and the frequency drift was recorded during the next thirty minutes. These runs were made on full power cw operation; that is, the plate input was 180 milliamperes with 10 volts on the filament voltmeter. The frequency drift was considered to be the difference between the maximum and minimum value of the beat note recorded during a period of 30 minutes and not the greatest deviation from the starting frequency as a reference point. Careful attention was exercised to keep the filament voltmeter at 10 volts during the entire test.

26. Variation of frequency due to change of antenna constants was measured in those cases where the antenna had a variable capacity in it. By use of a calibrated variable condenser, the capacity was shifted 25% above normal and 25% below normal. Frequency was noted at each extreme.

27. The voltage regulator on the NEA-1A had sufficient range to shift the filament voltage from 9.5 to 10.5 volts and the frequency was recorded at each voltage to determine shift due to 10% voltage change.

28. The antenna was open circuited and short circuited at each frequency where drift runs had been made and the plate current recorded. No attempt was made to measure frequency under this condition.

29. Keyed runs at 40 words per minute were made. A Creed automatic keyer was used to send dots corresponding to 40 words per minute. The Model LK recorder could not be used for this run but readings were taken at regular intervals by depressing the key momentarily. In all other respects the procedure was the same as above.

30. For recording reset the Model GN would be adjusted to a frequency which gave a beat with the Model LK. The settings would be carefully noted and then all controls shifted at random. When the controls were returned to their original settings the frequency would be recorded. An average of several trials was taken.

31. Again a frequency was selected which gave a beat note with the Model LK indicator. Since there were no stops on the master oscillator control, the master dial was turned clockwise 360° where setting and frequency were recorded. The master dial was then turned anticlockwise 360° to the same setting and the frequency again recorded. The difference between the two readings is the backlash in terms of frequency.

32. A 500 milliampere d-c meter was connected in the midtap of the rectifier transformer to record rectifier output. A d.c. voltmeter recorded the voltage. D-C voltage multiplied by d-c current gave the rectifier output. This was recorded at full power key locked.

The input to the set was read under the same conditions from a wattmeter. Then the plate transformer primary was opened and the input to the set again recorded. The difference between these two inputs is the power fed to the rectifier. The conversion factor is calculated from the equation:

$$\frac{\text{output of rectifier}}{\text{input to rectifier}} = \text{conversion factor}$$

33. Measurements of ripple voltage in the power supply were determined by means of a "string" oscillograph in connection with suitable auxiliary apparatus. A picture of the ripple voltage is taken, and a timing wave such as 60 cycles is photographed simultaneously by means of an additional element. By comparisons of the two traces the frequency or frequencies of the ripple in the power supply is determined. The oscillograph is calibrated by means of a source of a.c. and a voltmeter, the deflection of the oscillograph being observed and voltage producing such deflection, thereby expressing its sensitivity in volts per centimeter. The peak value of ripple voltage is readily computed by their distance from the axis by means of the oscillograph sensitivity. Percentage of ripple is expressed as the ratio of half the sum of the peak values to the d.c. output voltage.

34. Measurements of modulation percentage were made by using a cathode ray oscillograph. An audio oscillator was used to supply the modulating voltage to the microphone transformer and also to one set of plates of the cathode ray tube through a suitable mixing panel for control and impedance matching of the circuits. A portion of the radio frequency voltage in the antenna circuit is applied to the remaining pair of plates of the cathode ray tube. With no modulation a rectangular pattern is produced on the screen of the cathode ray tube the dimensions of which are proportional to the peak voltages applied to the plate. With modulation the pattern changes to one having a maximum and minimum dimension which is proportional to the maximum and minimum radio frequency voltage. Thus the percentage modulation may be determined from the formula

$$\frac{\text{max} - \text{min}}{\text{max} + \text{min}} \times 100 = \%\ \text{modulation}$$

35. Audio fidelity measurements were taken by measuring the power output of the modulator while maintaining the input constant at various frequencies.

36. Harmonic distortion was measured by means of a linear rectifier and wave analyzer. A portion of the modulated output of the transmitter was rectified and applied to the input of the wave analyzer. The percentage harmonic content was taken as the square root of the sum of the squares of the individual harmonic percentages.

DATA RECORDED DURING TEST

37. Data recorded during the tests in the form of tables, charts, and photographs are appended to this report. These data which are listed below and other data are discussed in RESULTS.

38. Tables including the actual and allowable weights and measurements were made.

39. Data were recorded on the following:

(a) Overlap
(b) Sensitivity of receiver
(c) Loop sensitivity
(d) Selectivity
(e) Audio frequency response
(f) Audio distortion
(g) Image ratio
(h) Kilocycles spread per dial division
(i) Automatic volume control action
(j) Frequency drift (constant temperature)
(k) Frequency change due to voltage variation
(l) Frequency drift (variable temperature)
(m) Reset measurements
(n) Frequency shift on band switch contacts
(o) Power output and input
(p) Modulation characteristics
(q) Power supply characteristics

DISCUSSION OF PROBABLE ERRORS

40. Following is a list of apparatus used with the margin of error according to the manufacturer's guarantee.

(a)	General Radio standard signal generator Model LC-A Serial No. 2	± 10%
(b)	General Radio power output meter Type 583-A Serial No. 72	± 5%
(c)	General Radio beat frequency oscillator Type 713-A Serial No. 209	± 2.5%
(d)	General Radio heterodyne oscillator Model LD-2 Serial No.1	± 0.005%
(e)	General Radio interpolation oscillator Type 617-A Serial No. 30	± 0.001%
(f)	Wave Analyzer Type 636-A Serial No. 102	± 0.5%
(g)	Model LK-1 frequency drift indicator Serial No.2	± 20 cycles
(h)	A.C. wattmeter Model 310 Serial No. 8922	± 0.25%

(i)	A.C. voltmeter Model 341 Serial No. 5017	± 0.25%
(j)	A.C. voltmeter Model 341 Serial No. 8661	± 0.25%
(k)	A.C. ammeter Model 370 Serial No. 4576	± 0.25%
(l)	D.C. ammeter Model 45 Serial No. 33045	± 0.5%
(m)	D.C. voltmeter Model 45 Serial No. 40640	± 0.5%
(n)	Ossiso oscillograph Serial No. 913659	
(o)	Cathode ray oscillograph Serial No. 132	
(p)	Temperature control cabinet	
(q)	Audio mixing equipment	

RESULTS OF TEST

41. The tests of the subject equipment were made with two preliminary models as submitted by the contractor.

42. The results of these tests wherein the equipment does not meet the requirements of the specifications, references (d) and (e), will be discussed in the order of the paragraphs in which they appear. In those paragraphs not discussed, the equipment will be regarded as in full compliance with the specifications. The numbers of the following sub-paragraphs are in agreement with the numbers of the paragraphs of the specifications.

RECEIVERS

I. INTRODUCTION

1-1 to 1-8 inclusive is introductory and is covered in more detail in the following sections.

II. GENERAL

2-3. The equipment is of rugged construction and of the best material suitable for each specific employment.

2-4. The workmanship is of a high order and is indicative of long and dependable service.

2-5. The material used is in accordance with this paragraph and where necessary has been treated to prevent corrosion.

2-7. The equipment operates satisfactorily in temperatures from -22.5 to +50° C which is the maximum range of the equipment used to make this test.

2-8. A 2 kilowatt pure cw output was not available at this Laboratory to conduct this test; however, the equipment is designed to withstand or has a suitable protective device incorporated to prevent damage due to overload.

2-9. Provision has been made for ventilation and cooling.

2-10. Actual service use over a lond period of time is necessary to determine the requirements of this paragraph.

2-11. Apparatus is not available at this Laboratory to conduct the tests required in this paragraph. However, during flight tests the equipment was subjected to numerous take-offs and landings and positions of various degrees from vertical and performed satisfactorily at all times.

2-13. All parts are interchangeable physically and electrically.

2-14. No nameplates were furnished with the equipment.

2-15. The equipment does not in all cases meet the requirements of the specifications as regards size and weight. A discussion of these discrepancies appears later in these results.

2-16. All machine screws and nuts are secured by lock washers and all soldering has been given a coating of red lacquer.

2-17. Provision has been made to prevent personnel from coming in contact with high voltages.

2-26 - 2-28. The items referred to in these paragraphs require testing before being approved for use in the construction of the equipment.

2-38. Electrolytic condensers are not used.

2-40. Eight vacuum tubes are used in each receiver.

2-41. Three types of tubes are used in each receiver.

2-45 - 2-48. These paragraph are "Type Test" requirements. Parts and equipment are not available to conduct these tests.

2-50. Equipment is not available at this Laboratory to conduct the humidity tests required by the specifications.

III. MECHANICAL REQUIREMENTS

3-2. The equipment submitted for test included all the items required in this paragraph except (6), (7), and (8).

3-3(1). The weight of the equipment specified in this paragraph exceeds the requirements by 7.3 pounds.

(2) The weight of the equipment specified in this paragraph exceeds the requirements by 0.3 pound.

3-4(1). The height of the dynamotor-filter unit exceeds the requirements by 3/4 inch. (This dimension includes the mounting base.) The dynamotors used for the tests meet the requirements of the specifications for mechanical and electrical construction and performed satisfactorily throughout the tests. At the conclusion of the tests the dynamotors were inspected and there was found to be considerable wear on the brushes and commutators, particularly on the high voltage end where a groove had been worn in the segments to a depth of approximately 1/64 inch. An accurate record of the operating time of the dynamotor was not kept. For the duration of these tests the total time of operation was approximately 75 hours. The contractor's representative stated that the dynamotors submitted were those used in the development of the equipment and no information is available as to the total time of operation. It is suspected that the brush material is too hard for satisfactory use with these dynamotors. The lubrication of the dynamotors seems to be satisfactory.

3-5(2). The r-f tuner unit is oversize 1-1/8 inches in depth and 1 inch in height.

(3). The I.F. - A.F. unit is oversize 1 inch in height.

3-6(2)(3). The discussion of these units is the same as 3-5 above.

3-10(5). The backlash and torque lash which do not meet the requirements of the specifications are discussed in more detail later in these results under the heading on "Reset."

(6). The local and remote controls are capable of being quickly and accurately set and "lined up" without the use of tools.

(8). All controls can be operated when wearing heavy gloves.

(9). Tuning is accomplished by a single control. The backlash which does not meet the requirements of the specifications, as stated above, is discussed in the following paragraph under "Reset."

(10). The reset measurements do not meet the requirements of the specifications in all cases. When the reset is made from the same direction as the original setting, the result is well within the specification requirements on both local and remote control. When the reset is made from the opposite direction from the original setting the results are not within the specification requirements but repeated trials show that the reset always returns to the same frequency within the specification limits. The results of this test are shown in Tables 35, 36, 37, and 38 appended to this report.

3-15. Suitable space is provided for the replacement of vacuum tubes. The contractor has provided split shielding cans for the tubes which are difficult to replace due to limited space. Straight side shield cans made in a single unit are desirable. Actual and allowable sizes and weights of the equipment are shown on Table 40.

[redacted]

IV. DEFINITIONS

This section describes methods and values to be used in conducting these tests and does not require comment.

V. OPERATING CHARACTERISTICS

The equipment satisfactorily meets all the requirements of this section.

VI. ELECTRICAL REQUIREMENTS

6-1. The equipment meets the requirements of this paragraph except for overlap. The results of the overlap measurements are shown on Table 1.

6-9(1) and (2). The sensitivity of the receivers does not at all frequencies meet the requirements of the paragraph. The results of this test are shown on Tables 2, 3, 4, and 5.

6-11. The selectivity of the receivers does not meet the requirements of this paragraph. The results of this test are shown on Tables 7 to 10 inclusive and Plates 1 to 14 inclusive.

6-12. The audio frequency response does not meet the requirements of this paragraph at all frequencies. The results of this test are shown on Tables 11, 12, 13, and 14, and Plates 15 to 26 inclusive.

6-13. The audio distortion does not meet the requirements of this paragraph at 300 milliwatts output. The results of this test are shown on Table 15.

6-14. The image ratio meets the requirements of this paragraph. The results of this test are shown on Table 16.

6-15. The maximum undistorted output does not meet the requirements of this paragraph. As observed on an oscillograph, the output is undistorted up to 125 milliwatts, slightly distorted up to approximately 250 milliwatts, and considerably distorted above the latter output.

6-17. The kilocycles covered per division of the indicating dial meet the requirements of this paragraph. The results of this test are shown on Tables 17, 18, 19, and 20.

6-29. The range of control of the automatic sensitivity control meets the requirements of this paragraph. The results of this test are shown on Tables 21 to 24 inclusive and Plates 27 to 34 inclusive.

6-32. The frequency drift at constant ambient temperature and the frequency change due to variation of the power source from 12 to 16 volts meet the requirements of this paragraph. The results of this test are shown on Tables 25, 26, and Plates 35 to 38 inclusive.

6-33. The frequency drift at variable temperature meets the requirements of this paragraph. The results of this test are shown on Tables 27 to 34 inclusive and Plates 39 to 45 inclusive.

NOTE: It was observed that movement of the contact on the band switches caused a change of frequency. The greatest change occurs at the extreme edges of the contacts. The change within these points is very small. Measurements show that the reset to the position marks engraved on the dial have a maximum difference of 320 cycles. The frequency remains constant on any position of the contact after once being set. The results of this test are shown on Table 39.

TRANSMITTERS
(Specifications RE 13A 504A)

2-3. The transmitters are well constructed and high quality material has been used throughout.

2-4. Workmanship in general is excellent.

2-5. Suitable resistance to corrosion has been incorporated in the finishes applied to all parts.

2-7. The dimensions and weights of the equipment are given in Table 41. The weight is greater than that allowed by this specification. However, the equipment does not use plug-in tuning units and the overall weight is probably less than that which would result if such plug-in coils were used and were all carried in an airplane.

2-9. No damage occurred to the equipment when operated over the specified temperature range. The effect of temperature on frequency will be discussed later.

2-11. The cabinet and all control shafts are at ground potential.

2-12. Ventilation is adequate.

2-13. No failure occurred when the equipment was operated continuously.

2-14. No equipment was available for acceleration tests. The equipment performed satisfactorily in an airplane from the standpoint of shock and freedom from mechanical failures.

2-16. Parts have been suitably identified by type numbers and circuit symbols placed on or near the component items.

2-17. Nameplates are satisfactory as shown on the latest manufacturing drawings.

2-18. No damage occurred from high humidity or temperature. Performance is discussed later in this report.

2-19. The equipment is designed and constructed to withstand vibration and shock encountered in aircraft.

2-21. Interlocks are provided which protect the operator from high voltage when changing tubes, etc.

2-23. The shock mounts are live rubber and designed so that the unit may readily be removed from an airplane.

2-25. The wire used for wiring is not strictly non-inflammable but will not support combustion.

2-41. The cables supplied were of the shielded type with an outer covering of rubber. This type is preferable to the metallic covered cables.

2-43. The construction and assembly of the equipments is such that replacement of parts is difficult. The size limitations are quite severe and thus prevents placement of parts for easy accessibility.

2-49. Flashovers occurred during flight at high altitude. These deficiencies were corrected by the contractor.

2-52. Protection from moisture and spray is adequate.

2-53. The equipment is designed to operate from the specified power supplies.

2-58. The antenna coupling circuit is such that grounding, opening, or shorting the antenna unloads the amplifier and causes no damage to the equipment.

3-1(1). The transmitter units contain all tubes and radio frequency circuits except the antenna loading coil for the lower end of the low frequency transmitter. Plug-in coils are not used but the range is divided into bands by switches in each unit.

3-1(2). The rectifier unit contains the necessary transformers and rectifier system for supplying power to either transmitter.

3-1(3). The equipment is arranged with the power supply unit as the central unit and one transmitter unit is mounted on either side of the power unit. Each transmitter is in itself a complete radio frequency unit.

3-1(5). Operation at any specified frequency may be obtained by the proper setting of controls on the front panel. Overlap between bands is shown in Table 42.

3-1(6). Power outputs are shown in Table 43. Operation at high altitudes was not satisfactory due to flashover in the original model. Modifications were made by the contractor to correct this condition.

3-24(1). Reset accuracy on the bench is as shown in Table 44. Flight resets are shown in Table 45. Reset accuracy when approaching from the same direction is excellent. This neglects backlash. The resets in flight were first from the same direction and then from the opposite direction.

(2)(a). Frequency driftswith key locked and keyed at 40 words per minute at constant ambient temperature are shown in Table 46.

(2)(b). Temperature-frequency drift measurements are shown in Table 47. The equipment does not fully meet the requirements of these specifications. The manufacturer in his descriptive specification agreed to reduce the drift to the specified values for any 25° C change in temperature and has accomplished this. Drift measurements taken with the equipment in flight and shown in Tables 53 to 59 inclusive.

(2)(c). The equipment meets the specifications as regards frequency change with change of antenna constants as shown in Table 48.

(2)(d). Frequency changes due to change of line voltage are quite small as shown by Table 49.

3-26. The antenna coupling system is quite flexible and will permit operation into the specified antenna systems.

3-32. Several failures of rectifier tubes occurred in the original models. These tubes were changed to Navy type 38266A tubes with satisfactory performance. The regulation is as shown in Table 50. Efficiency is also shown in this table. The regulation figures shown are for minimum load to full load which is applicable in this case since with the key up the rectifier output is zero.

3-33. As shown in Table 50, the ripple in the output of the rectifier is somewhat higher than specified in the phone position. However, satisfactory voice communication free from ripple modulation was obtained at all times.

3-34. The compensating means provided for maintaining constant filament voltage between key up and key down positions is satisfactory.

3-39. The radio test position operates satisfactorily. Frequency variations from the radio test position to full power output are shown in Table 51.

3-41. A trimmer is provided in the oscillator circuit which permits adjustment of the oscillator to calibration after changing tubes.

3-43. The characteristics of the audio frequency and modulator circuits are shown in Table 52. The equipment meets the specifications for audio performance in all respects.

CONCLUSIONS

43. The tests of the Model RAM receiving equipment were conducted on two preliminary models. As a result of these tests the following conclusions were reached.

(a) The material used is of a high quality. The workmanship in general is excellent and the equipment with slight modification should give long and dependable service.

(b) Some units of the equipment are slightly oversize or overweight according to the requirements of reference (d).

(c) The equipment does not meet the requirements of reference (d) on the following:

Overlap of frequency bands
Sensitivity
Selectivity
Audio frequency response
Audio distortion
Reset
Undistorted output

(d) The equipment satisfactorily met the requirements of reference (d) on the following:

Loop sensitivity
Image ratio
Kilocycles spread per dial division
Automatic volume control
Frequency drift at constant temperature
Frequency change due to voltage variation
Frequency drift at variable temperature

(e) The points wherein the equipment does not meet the requirements of the specifications are, except for rest, of a minor nature and will not detract seriously from the suitability and serviceability for Naval aircraft use. The failure of the reset measurements to meet the requirements is due to faulty construction of the coupling control. This can readily be corrected to such a degree as to greatly improve the resettability.

Table 1

Model RAM Receiving Equipment

OVERLAP

L.F. and H.F. Receivers #1		
L.F. Receiver	Kcs.	%
Band 1 and 2	7	2.13
2 and 3	7	1.27
3 and 4	22	2.42
L.F.Band 4		
and H.F. Band 1	92	6.32
Band 1 and 2	20	.91
2 and 3	55	1.7
3 and 4	30	.63
4 and 5	150	2.2
5 and 6	100	1.15

L.F. and H.F. Receivers #2		
L.F. Receiver	Kcs.	%
Band 1 and 2	5	1.51
2 and 3	7	1.27
3 and 4	20	2.21
L.F.Band 4		
and H.F.Band 1	80	5.5
Band 1 and 2	40	1.84
2 and 3	40	1.25
3 and 4	75	1.6
4 and 5	165	2.4
5 and 6	125	1.27

Required overlap is at least 2%.

Table 2

Model RAM Receiving Equipment

SENSITIVITY
L.F. Receiver #1

			MCW		CW	
Receiver Dial	Band	Frequency Kc	Input MCV	Noise MW	Input MCV	Noise MW
0	1	190	10	.4	2.3	.3
50	1	248	7	.5	1.0	.4
100	1	334	5	.4	1.4	.4
0	2	327	7	.5	1.8	.3
50	2	420	5	.4	.7	.4
100	2	575	3.8	.4	.6	.4
0	3	550	6.0	.5	1.4	.4
50	3	707	5.0	.4	.8	.4
100	3	930	4.2	.4	.55	.4
0	4	908	4.7	.4	1.0	.3
50	4	1170	4.35	.4	.7	.3
100	4	1545	4.5	.3	1.0	.1

Specification Requirements -

	Input	Frequency Range
MCW	5 MCV	200 - 1500 kc.
CW	2.5	200 - 1500

Table 3

RAM Receiving Equipment

SENSITIVITY
H.F. Receiver #1

Receiver Dial	Band	Frequency Kcs.	MCW		CW	
			Input MCV	Noise MW	Input MCV	Noise MW
0	1	1453	6.0	.7	2.8	.4
50		1794	5.0	.4	1.3	.4
100		2218	4.6	.4	1.0	.4
0	2	2198	4.5	.4	1.35	.4
50		2690	3.2	.4	1.0	.4
100		3280	2.9	.4	.85	.4
0	3	3225	4.5	.5	1.2	.4
50		3935	4.8	.3	1.2	.3
100		4810	3.6	.3	.95	.3
0	4	4780	5.0	.2	1.4	.3
50		5775	3.4	.3	1.4	.4
100		6960	2.1	.4	.7	.4
0	5	6810	6.0	.2	.85	.2
50		8350	4.0	.2	1.0	.2
100		9925	5.0	.1	1.1	.1
0	6	9825	8.5	.1	2.0	.1
50		11815	6.5	0	1.7	.1
100		14025	5.5	.3	2.25	.3

Specification Requirements -

	Input	Frequency Range
MCW	5 MCV	1500 - 6000 Kcs.
	10	6000 - 13,575
CW	2.5	1500 - 6000
	5.0	6000 - 13,575

Table 4

RAM Receiving Equipment

SENSITIVITY
L.F. Receiver #2

Receiver Dial	Band	Frequency Kcs.	MCW Input MCV	MCW Noise MW	CW Input MCV	CW Noise MW
0	1	193	9.0	.3	2.0	.4
50		247	7.0	.3	1.5	.3
100		335	5.0	.3	1.1	.3
0	2	330	7.0	.4	2.0	.4
50		420	6.0	.3	1.3	.3
100		555	4.0	.3	1.1	.3
0	3	548	6.0	.4	1.6	.4
50		702	4.5	.4	1.15	.4
100		923	4.6	.3	1.1	.3
0	4	903	4.9	.4	1.0	.4
50		1166	3.4	.4	.65	.4
100		1540	3.0	.4	.6	.4

Specification Requirements -

	Input	Frequency Range
MCW	5 MCV	200 - 1500 Kcs.
CW	2.5	200 - 1500

Table 5

RAM Receiving Equipment

SENSITIVITY
H.F. Receiver #2

			MCW		CW	
Receiver Dial	Band	Frequency Kcs.	Input MCV	Noise MW	Input MCV	Noise MW
0	1	1460	5.0	.5	2.2	.3
50		1806	5.0	.4	1.5	.3
100		2215	4.1	.4	1.0	.4
0	2	2175	6.0	.4	1.4	.4
50		2675	5.0	.4	1.1	.4
100		3250	4.0	.3	1.0	.3
0	3	3210	4.0	.4	1.0	.4
50		3935	3.5	.3	.9	.3
100		4775	3.1	.4	.85	.4
0	4	4700	6.0	.1	1.6	.1
50		5750	4.5	.5	1.85	.4
100		6975	5.5	.1	1.1	.1
0	5	6810	8.0	.1	1.5	.1
50		8370	5.0	.1	.7	.1
100		9950	5.0	0	1.0	0
0	6	9825	10.0	0	1.6	0
50		11875	9.0	0	2.4	0
100		14050	11.0	0	4.4	0

Specification Requirements -

	Input	Frequency Range
MCW	5 MCV	1500 - 6,000 Kcs.
	10	6000 - 13,575
CW	2.5	1500 - 6,000
	5.0	6000 - 13,575

Table 6

RAM Receiving Equipment

LOOP-SENSITIVITY

			Receiver #1				Receiver #2			
			MCW		CW		MCW		CW	
Receiver Dial	Band	Freq. Kcs.	Input MCV	Noise MW	Input MCV	Noise MW	Input MCV	Noise MW	Input MCV	Noise MW
0	1	190	1.9	.4	.3	.3	1.9	.4	.4	.4
50		248	2.2	.4	.3	.4	2.2	.3	.5	.3
100		334	2.7	.3	.75	.4	2.2	.4	.7	.3
0	2	327	2.3	.3	.3	.4	2.7	.3	.55	.3
50		420	2.2	.4	.4	.4	2.0	.4	.5	.4
100		557	2.4	.4	.4	.4	2.2	.4	.7	.4
0	3	550	4.35	.3	.65	.4	3.05	.4	1.0	.4
50		707	3.65	.4	.7	.4	3.1	.4	1.0	.4
100		930	3.6	.4	.8	.4	4.5	.2	1.6	.2
0	4	908	5.0	.4	1.1	.4	4.0	.4	2.0	.3
50		1170	5.0	.4	1.0	.3	4.0	.4	1.0	.4
100		1545	5.0	.4	1.3	.1	4.1	.4	.7	.4

Specification Requirements - At least 3/4 of the sensitivity in antenna position.

Table 7

RAM Receiving Equipment

SELECTIVITY
L.F. Receiver #1

Frequency Kcs.	Band Width at 10 Times	Band Width at 100 Times	Band Width at 1000 Times
191	8.2 Kcs.	10.3 Kcs.	13.5 Kcs.
249	8.5	11.1	13.5
337	9.1	11.7	14.6
422	9.2	12.3	15.2
560	10.0	13.0	17.4
710	10.35	13.7	17.4
930	10.9	14.7	18.9
1175	9.9	13.5	17.1
1550	11.7	15.3	18.9

Specification Requirements - not less than

200 - 600	8	12	16
600 - 1500	10	15	20

Table 8

RAM Receiving Equipment

SELECTIVITY
H.F. Receiver #1

Frequency Kcs.	Band Width at 10 Times	Band Width at 100 Times	Band Width at 1000 Times
1450	11.7 Kcs.	18.0 Kcs.	25.2 Kcs.
1790	12.7	16.9	24.6
2215	12.4	18.6	24.4
2675	11.5	16.1	20.7
3275	10.6	16.4	23.4
3935	11.7	16.4	21.1
4800	11.2	16.9	20.2
5775	12.1	14.3	22.0
6950	10.6	15.1	21.1
8225	13.4	18.3	26.8
9800	10.0	16.7	26.8
11675	9.7	16.2	22.7
13875	8.8	17.7	23.5

Specification Requirements - not less than

1500 - 3000	12	18	24
3000 - 13575	15	22.5	30

Table 9

RAM Receiving Equipment

SELECTIVITY
L.F. Receiver #2

Frequency Kcs.	Band Width at 10 Times	Band Width at 100 Times	Band Width at 1000 Times
191	7.2 Kcs.	10.1 Kcs.	12.5 Kcs.
248	7.5	10.2	12.7
335	8.3	11.4	14.2
425	8.2	10.9	14.0
560	8.7	11.7	15.1
705	9.4	12.6	16.4
925	10.2	13.9	21.8
1170	8.6	12.5	15.7
1540	9.0	12.6	16.2

Specification Requirements - not less than

200 - 600	8	12	16
600 - 1500	10	15	20

Table 10

RAM Receiving Equipment

SELECTIVITY
H.F. Receiver #2

Frequency Kcs.	Band Width at 10 Times	Band Width at 100 Times	Band Width at 1000 Times
1460	12.6 Kcs.	16.2 Kcs.	23.4 Kcs.
1805	12.9	18.0	25.7
2215	11.6	18.2	26.5
2675	11.5	16.1	20.7
3260	11.8	16.5	23.5
3940	11.8	18.8	25.8
4775	13.4	18.0	22.4
5750	13.2	17.6	26.4
6975	11.7	16.4	23.4
8350	10.0	16.7	26.8
9950	10.0	16.7	26.8
11880	12.8	19.2	27.2
14050	14.5	19.3	28.7

Specification Requirements - not less than

1500 - 3000	12	18	24
3000 - 13575	15	22.5	30

Table 11

Model RAM Receiving Equipment

AUDIO FREQUENCY RESPONSE
(Fidelity)
L.F. Receiver #1

Frequency Cycles	249 kc Output MW	249 kc DB	560 kc Output MW	560 kc DB	1175 kc Output MW	1175 kc DB
100	6.0	2.22	6.5	1.87	6.0	2.22
200	9.5	.21	9.5	.21	9.0	.45
300	10.0	0	10.0	0	10.0	0
400	10.0	0	10.0	0	10.0	0
500	9.5	.21	10.0	0	9.5	.21
600	8.5	.68	9.0	.45	9.0	.45
700	7.0	1.55	8.0	.96	8.0	.96
800	6.5	1.87	7.0	1.55	7.5	1.23
900	5.5	2.6	6.5	1.87	7.0	1.55
1000	5.0	3.0	6.0	2.22	6.0	2.22
1200	4.0	3.9	5.5	2.6	5.0	3.0
1400	3.5	4.5	5.0	3.0	5.0	3.0
1600	3.0	5.2	4.5	3.46	4.5	3.46
1800	2.5	6.0	4.0	3.9	4.0	3.9
2000	2.0	6.9	4.0	3.9	4.0	3.9
2500	1.5	8.2	3.5	4.5	4.0	3.9
3000	1.0	10.0	3.5	4.5	3.0	5.2
4000	0	Inf.	0	Inf.	0	Inf.
5000	0	Inf.	0	Inf.	0	Inf.

Specification Requirements -

Frequency Range	100 - 1000 cycles	1000 - 3000 cycles	DB down at 5000 cycles
200 - 600 kc	4 DB	6 DB	At least 60 DB
600 - 1500	3	4	At least 60 DB

Table 12

Model RAM Receiving Equipment

AUDIO FREQUENCY RESPONSE
(Fidelity)
H.F. Receiver #1

	2675 kc		5775 kc		11,675 kc	
Frequency Cycles	Output MW	DB	Output MW	DB	Output MW	DB
100	5.0	3.0	5.0	3.0	4.0	3.8
200	9.0	.45	9.0	.45	9.0	.45
300	10.0	0	9.5	.21	10.0	0
400	10.0	0	10.0	0	10.0	0
500	9.5	.21	9.5	.21	9.0	.45
600	8.5	.68	9.0	.45	8.0	.96
700	8.0	.96	8.0	.96	7.0	1.55
800	7.0	1.55	7.5	1.23	6.0	2.22
900	6.5	1.87	7.0	1.55	5.5	2.6
1000	6.0	2.22	6.5	1.87	5.0	3.0
1200	5.0	3.0	6.0	2.22	4.0	3.9
1400	4.5	3.46	5.5	2.6	3.5	4.5
1600	4.5	3.46	5.5	2.6	3.5	4.5
1800	4.5	3.46	5.5	2.6	3.5	4.5
2000	4.5	3.46	6.0	2.22	3.5	4.5
2500	7.5	1.23	10.0	0	4.0	3.9
3000	5.0	3.0	7.5	1.23	3.0	5.2
4000	0	Inf.	0	Inf.	0	Inf.
5000	0	Inf.	0	Inf.	0	Inf.

Specification Requirements -

Frequency Cycles	100 - 1000 Cycles	1000 - 3000 Cycles	DB down at 5000 cycles
1500 - 13,575 kcs	2 DB	2DB	At least 60 DB

Unclassified

~~CONFIDENTIAL~~

Table 13

Model RAM Receiving Equipment

AUDIO FREQUENCY RESPONSE
(Fidelity)
L.F. Receiver #2

	248 kc		560 kc		1170 kc	
Frequency Cycles	Output MW	DB	Output MW	DB	Output MW	DB
100	6.0	2.22	6.5	1.87	6.0	2.22
200	9.5	.21	9.5	.21	9.0	.45
300	10.0	0	10.0	0	10.0	0
400	10.0	0	10.0	0	10.0	0
500	9.5	.21	9.5	.21	9.5	.21
600	8.5	.68	9.0	.45	9.0	.45
700	7.5	1.23	8.5	.68	8.0	.96
800	6.5	1.87	7.5	1.23	7.5	1.23
900	5.5	2.6	6.5	1.87	7.0	1.55
1000	5.0	3.0	5.5	2.6	6.5	1.87
1200	4.0	3.9	5.0	3.0	5.5	2.6
1400	3.0	5.2	4.5	3.46	5.0	3.0
1600	2.5	6.0	4.5	3.46	4.0	3.9
1800	2.0	6.9	4.0	3.9	4.0	3.9
2000	2.0	6.9	4.0	3.9	4.0	3.9
2500	1.5	8.2	4.0	3.9	4.0	3.9
3000	0	Inf.	2.5	6.0	2.0	6.9
4000	0	Inf.	0	Inf.	0	Inf.
5000	0	Inf.	0	Inf.	0	Inf.

Specification Requirements -

Frequency Range	100 - 1000 Cycles	1000 - 3000 Cycles	DB down at 5000 Cycles
200 - 600 kc.	4 DB	6 DB	At least 60 DB
600 - 1500	3	4	At least 60 DB

Table 14

Model RAM Receiving Equipment

AUDIO FREQUENCY RESPONSE
(Fidelity)
H.F. Receiver #2

Frequency Cycles	2675 kc Output MW	2675 kc DB	5750 kc Output MW	5750 kc DB	11,880 kc Output MW	11,880 kc DB
100	5.0	3.0	5.0	3.0	5.5	2.6
200	9.0	.45	9.5	.21	9.5	.21
300	10.0	0	10.0	0	10.0	0
400	10.0	0	10.0	0	10.0	0
500	10.0	0	10.0	0	9.5	.21
600	9.0	.45	9.0	.45	8.5	.68
700	8.0	.96	8.0	.96	7.0	1.55
800	7.5	1.23	7.5	1.23	6.0	2.22
900	7.0	1.55	7.0	1.55	5.0	3.0
1000	6.5	1.87	6.5	1.87	4.5	3.46
1200	5.5	2.6	6.0	2.22	4.0	3.9
1400	5.0	3.0	5.5	2.6	3.5	4.5
1600	5.0	3.0	5.0	3.0	3.0	5.2
1800	5.0	3.0	5.0	3.0	3.0	5.2
2000	5.0	3.0	6.0	2.22	3.0	5.2
2500	7.0	1.55	9.5	.21	3.5	4.5
3000	5.5	2.6	10.0	0	3.5	4.5
4000	0	Inf.	1.0	10.0	0	Inf.
5000	0	Inf.	0	Inf.	0	Inf.

Specification Requirements -

Frequency Range	100 - 1000 Cycles	1000 - 3000 Cycles	DB down at 5000 cycles
1500 - 13,575 kc	2 DB	2 DB	At least 60 DB

Table 15

Model RAM Receiving Equipment

AUDIO DISTORTION

Frequency kc	Output 1 MW				Output 300 MW							
	Harmonics %				Harmonics %							
	2	3	4	RMS%	2	3	4	5	6	7	8	RMS%
L.F. #1 Receiver												
249	.97	.60	0	1.14	2.2	4.8	2.0	.66	.1	.13	0	5.6
1175	.61	.61	0	.86	2.2	4.8	2.0	.65	.1	.13	0	5.6
L.F. #2 Receiver												
248	1.5	.52	0	1.58	2.8	4.3	1.7	.6	.17	0	0	5.4
1170	1.14	.61	0	1.29	3.0	4.3	1.7	.6	.17	.26	.17	5.5
H.F. #1 Receiver												
2675	.57	.64	0	.85	2.8	4.15	1.6	.5	0	0	0	5.2
8225	.79	.71	0	1.05	3.0	4.15	1.6	.5				5.3
H.F. #2 Receiver												
2675	.38	.76	0	.84	3.9	4.6	2.1	.75	.25	.33	.23	6.4
8350	.3	.63		.69	4.6	3.6	1.9	.75	.23	0	0	6.1

Specification Requirements - not to exceed 5%.

Table 16

RAM Receiving Equipment

IMAGE RATIO

L.F.Receiver #1		H.F.Receiver #1		L.F.Receiver #2		H.F.Receiver #2	
Frequency Kcs.	DB.	Frequency Kcs.	DB.	Frequency Kcs.	DB.	Frequency Kcs.	DB.
248	113	1794	98	247	108	1806	100
420	102	2690	99	420	106	2675	100
707	91	3935	91	702	88	3935	90
1170	80	5775	77	1166	82	5750	80
		8350	86			8375	82
		11815	74			11875	73

Specification Requirements -

Frequency Range	Image Radio	DB
200 - 600 Kcs.	1000	60
600 - 1500	2000	66
1500 - 3000	4000	72
3000 - 6000	2000	66
6000 - 9000	4000	72
9000 - 13575	2000	66

Table 17

RAM Receiving Equipment

KILOCYCLES SPREAD PER DIAL DIVISION
L.F. Receiver #1

Frequency Kcs.	Kcs. per Division 0 - 10	10 - 90	90 - 100	Average 0 - 100
190 - 335	.9	1.4	1.7	1.45
327 - 555	1.3	2.3	2.5	2.28
550 - 927	2.0	3.9	4.0	3.77
905 - 1545	3.8	6.7	6.5	6.4

Table 18

RAM Receiving Equipment

KILOCYCLES SPREAD PER DIAL DIVISION
H.F. Receiver #1

Frequency Kcs.	Kcs. per Division 0 - 10	10 - 90	90 - 100	Average 0 - 100
1455 - 2215	1.8	8.2	8.5	7.6
2195 - 3280	6.5	11.3	11.5	10.85
3228 - 4815	8.7	16.5	18.0	15.87
4785 - 6950	13.0	22.75	21.5	21.65
6810 - 9820	17.5	31.6	29.0	30.10
9725 - 13875	25.5	43.3	42.5	41.5

Specification Requirements -

Frequency Range	Kcs. per Division
200 - 1500	10
1500 - 3000	15
3000 - 9000	30
9000 - 13575	45

Table 19

Model RAM Receiving Equipment

KILOCYCLES SPREAD PER DIAL DIVISION
L.F. Receiver #2

Frequency kc	Kilocycles per Division 0-10	10-90	90-100	Average 0 - 100
191 - 335	.7	1.4	1.9	1.44
330 - 555	1.2	2.3	2.5	2.25
545 - 920	2.5	3.8	4.5	3.75
900 -1540	3.5	6.7	7.0	6.4

Table 20

Model RAM Receiving Equipment

KILOCYCLES SPREAD PER DIAL DIVISION
H.F. Receiver #2

Frequency kc	Kilocycles per Division 0-10	10-90	90-100	Average 0 - 100
1460 - 2218	5.0	7.9	7.3	7.58
2175 - 3255	7.5	11.3	9.5	10.8
3210 - 4780	10.5	16.5	14.5	15.7
4700 - 6965	17.5	23.6	19.0	22.65
6800 - 9825	22.5	32.2	22.5	30.25
9720 -13875	30.5	44.0	32.5	41.55

Specification Requirements -

Frequency Range	Kilocycles per Division
200 - 1500	10
1500 - 3000	15
3000 - 9000	30
9000 -13575	45

Unclassified

[redacted]

Table 21

RAM Receiving Equipment

AUTOMATIC VOLUME CONTROL
L.F. Receiver #1

		CW		MCW	
		Output Adjusted for		Output Adjusted for	
Frequency Kcs.	Input	10 MW Volts	50 MW Volts	10 MW Volts	50 MW Volts
248	Std.	2.3	6.5	2.3	6.5
"	x10	2.6	7.5	2.8	7.75
"	x100	2.8	7.75	3.2	9.25
"	x1000	2.85	8.0	3.6	11.0
"	x10,000	2.9	8.25	4.1	13.75
1170	Std.	2.3	6.5	2.3	6.5
"	x10	2.8	8.5	3.45	9.25
"	x100	2.9	8.75	3.9	13.5
"	x1000	3.0	9.25	4.3	14.0
"	x10,000	3.2	9.75	4.7	16.5

Specification Requirements - The output voltage shall not increase by a factor of more than 4 to 1 when R.F. signal is increased by 10,000 to 1.

Table 22

RAM Receiving Equipment

AUTOMATIC VOLUME CONTROL
H.F. Receiver #1

		CW		MCW	
		Output Adjusted for		Output Adjusted for	
Frequency Kcs.	Input	10 MW Volts	50 MW Volts	10 MW Volts	50 MW Volts
2960	Std.	2.3	6.5	2.3	6.5
"	x10	3.45	11.0	3.6	8.5
"	x100	3.6	13.5	4.4	13.5
"	x1000	3.8	13.75	4.9	15.0
"	x10,000	4.0	14.00	6.5	17.5
8350	Std.	2.3	6.5	2.3	6.5
"	x10	6.5	15.75	3.8	7.0
"	x100	7.5	17.5	4.6	7.5
"	x1000	8.0	19.0	5.2	9.25
"	x10,000	8.5	19.5	6.85	15.0

Specification Requirements - The output voltage shall not increase by a factor of more than 4 to 1 when R.F. signal is increased by 10,000 to 1.

Table 23

RAM Receiving Equipment

AUTOMATIC VOLUME CONTROL
L.F. Receiver #2

		CW		MCW	
		Output Adjusted for		Output Adjusted for	
Frequency Kcs.	Input	10 MW Volts	50 MW Volts	10 MW Volts	50 MW Volts
247	Std.	2.3	6.5	2.3	6.5
"	x10	2.5	6.85	2.6	7.5
"	x100	2.55	7.0	2.9	8.0
"	x1000	2.6	7.25	3.3	10.5
"	x10,000	2.7	7.5	3.8	13.75
1160	Std.	2.3	6.5	2.3	6.5
"	x10	2.8	8.0	4.0	13.75
"	x100	3.0	8.25	4.5	14.5
"	x1000	3.1	8.5	4.8	16.5
"	x10,000	3.2	8.75	5.4	18.5

Specification Requirements - The output shall not increase by a factor of more than 4 to 1 when R.F. signal is increased by 10,000 to 1.

Table 24

RAM Receiving Equipment

AUTOMATIC VOLUME CONTROL
H.F. Receiver #2

		CW		MCW	
		Output Adjusted for		Output Adjusted for	
Frequency Kcs.	Input	10 MW Volts	50 MW Volts	10 MW Volts	50 MW Volts
2675	Std.	2.3	6.5	2.3	6.5
"	x10	2.6	8.0	3.6	7.75
"	x100	2.8	8.5	4.2	10.5
"	x1000	2.9	8.75	4.7	13.75
"	x10,000	3.0	9.25	5.6	16.5
8370	Std.	2.3	6.5	2.3	6.5
"	x10	4.5	17.5	4.4	7.0
"	x100	4.75	19.0	5.2	7.5
"	x1000	4.9	19.5	6.85	8.5
"	x10,000	5.0	20.0	8.0	13.5

Specification Requirements - The output shall not increase by a factor of more than 4 to 1 when R.F. signal is increased by 10,000 to 1.

Table 25

RAM Receiving Equipment

FREQUENCY DRIFT CONSTANT TEMPERATURE
L.F. Receiver #2
H.F. Receiver #2
(Ambient Temperature +26°C.)

Time Minutes	300 Kcs. Frequency	1200 Kcs. Frequency	2600 Kcs. Frequency	8400 Kcs. Frequency
Start	1475 Cycles	765 Cycles	1200 Cycles	980 Cycles
1	1500	870	1700	1995
2	1515	968	1780	2505
3	1530	1072	1870	2790
4	1540	1155	1905	2850
5	1555	1260	1925	2900
10	1605	1370	1985	3300
15	1627	1430	2025	3515
20	1645	1465	2045	3615
25	1662	1480	2030	3770
30	1677	1485	2000	3880
35	1685	1485	1970	3900
40	1695	1480	1920	3870
45	1705	1475	1865	3665
50	1715	1455	1820	3590
55	1720	1450	1770	3400
60	1725	1475	1710	3300

Maximum deviation first 10 minutes -

130 cycles - .04%   605 cycles - .05%   785 cycles - .03%
2320 cycles - .027%.

Maximum deviation over next 50 minutes -

120 cycles - .04%   115 cycles - .01%   60 cycles - .002%
600 cycles - .007%.

Specification Requirements -

First 10 minutes - 250 cycles or .05%
Next 50 minutes - 250 cycles or .02%

Table 26

RAM Receiving Equipment

FREQUENCY CHANGE DUE TO VOLTAGE VARIATION
L.F. Receiver #2
H.F. Receiver #2

Frequency		12 V to 14 V		14 V to 16 V		12 V to 16 V	
Kcs.		Cycles	%	Cycles	%	Cycles	%
247	Instantaneous	150	.06	125	.05	270	.1
"	After 5 minutes	170	.069	150	.06	295	.12
1166	Instantaneous	75	.006	50	.004	125	.01
"	After 5 minutes	200	.017	100	.008	400	.034
2675	Instantaneous	75	.003	25	.001	100	.0037
"	After 5 minutes	50	.002	150	.0056	300	.011
8370	Instantaneous	200	.0024	100	.0012	300	.0036
"	After 5 minutes	600	.0072	400	.0048	700	.0096

Specification Requirements - .02% or 250 cycles (whichever is least exacting.)

Table 27

RAM Receiving Equipment

FREQUENCY VARIATION - VARIABLE TEMPERATURE
Decreasing Temperature
400 Kcs.
L.F. Receiver #2

Time Minutes	Frequency Cycles	Temperature °C.	Time Minutes	Frequency Cycles	Temperature °C.
0	1815	+32	75	2090	-10
5	1875	+24*	80	2085	-11
10	1910	+19*	85	2080	-12
15	1935	+16*	90	2065	-13
20	1960	+11*	95	2055	-13.5
25	1980	+ 8*	100	2050	-14
30	2005	+ 5*	105	2040	-15
35	2030	+ 2*	110	2035	-15.5
40	2050	0	115	2025	-16
45	2060	-2	120	2020	-16.5
50	2075	-4	130	1995	-17
55	2080	-5	140	1985	-18
60	2085	-6	150	1970	-18.5
65	2090	-8	160	1985	-19.5
70	2090	-9	170	1990	-20.5

* 155 cycles.

Maximum total deviation (52.5°C.)
275 cycles .069%

Maximum deviation over any 20°
155 cycles .039%

Specification Requirements -
Not to exceed .05% over any 20°.

Table 28

RAM Receiving Equipment

FREQUENCY VARIATION - VARIABLE TEMPERATURE
Increasing Temperature
400 Kcs.
L.F. Receiver #2

Time Minutes	Frequency Cycles	Temperature °C.
0	1895	-24
5	1870	-18*
10	1790	-10*
15	1760	- 7*
20	1725	- 2*
25	1670	+ 3*
30	1650	+ 5
35	1640	+ 9
40	1670	+13
45	1705	+16
50	1720	+18
55	1730	+21
60	1725	+23
65	1685	+25
70	1650	+27
75	1620	+29
80	1610	+30

Maximum total deviation (54°C.)
285 cycles .071%

Maximum deviation over any 20°
200 cycles .05%

Specification Requirements -
Not to exceed .05% over any 20°.

* 200 Cycles.

Table 29

RAM Receiving Equipment

FREQUENCY VARIATION - VARIABLE TEMPERATURE
Decreasing Temperature
1200 Kcs.
L.F. Receiver #2

Time Minutes	Frequency Cycles	Temperature °C.	Time Minutes	Frequency Cycles	Temperature °C.
0	2755	+32	75	3215	-12
5	2800	+25	80	3160	-13
10	2875	+20	85	3125	-13.5
15	2950	+15*	90	3105	-14
20	3100	+ 9*	95	3095	-15
25	3210	+ 6*	100	3075	-15.5
30	3280	+ 3*	105	3055	-16.5
35	3335	0*	110	3035	-17
40	3390	- 2*	115	3045	-17.5
45	3435	- 4*	120	3030	-17.5
50	3485	- 6*	130	3020	-18
55	3480	- 7.5	140	3015	-19.5
60	3425	- 9	150	3005	-20
65	3355	-10	160	2980	-20.5
70	3255	-11.5	170	2980	-21

* 535 Cycles.

Maximum total deviation (53°C.)
730 cycles .06%

Maximum deviation over any 20°
535 cycles .044%

Specification Requirements -
Not to exceed .05% over any 20°.

Table 30

RAM Receiving Equipment

FREQUENCY VARIATION - VARIABLE TEMPERATURE
Increasing Temperature
1200 Kcs.
L.F. Receiver #2

Time Minutes	Frequency Cycles	Temperature °C.
0	2765	-25
5	2735	-23*
10	2705	-22*
15	2650	-20*
20	2610	-18*
25	2570	-15*
30	2520	-13*
35	2495	-12*
40	2440	-11*
45	2380	- 4*
50	2225	0*
55	2100	+ 5
60	2075	+ 8
65	2055	+11
70	2075	+15
75	2130	+18
80	2185	+20
85	2120	+23
90	2255	+25
95	2200	+26
100	2150	+27
105	2100	+28
110	2040	+29
115	2040	+30

* 510 Cycles.

Maximum total deviation (55°C.)
725 cycles .06%

Maximum deviation over any 20°
510 cycles .042%

Specification Requirements -
Not to exceed .05% over any 20°.

Table 31

RAM Receiving Equipment

FREQUENCY VARIATION - VARIABLE TEMPERATURE
Decreasing Temperature
2600 Kcs.
H.F. Receiver #2

Time Minutes	Frequency Cycles	Temperature °C.
0	2325	+30
5	2230	+21
10	2050	+14
15	1805	+10
20	1540	+ 6
25	1335	+ 2
30	1235	0
35	1165	- 2
40	1170	- 5
45	1210	- 6.5
50	1260	- 8
55	1290	- 9
60	1320	- 9.5
65	1350	-10
70	1420	-10.5
75	1480	-11
80	1600	-11.5
85	1670	-12
90	1720	-13
95	1775	-13.5
100	1830	-14
105	1890	-14.25
110	1935	-14.5
115	1985	-14.75
120	2010	-15
130	2105	-16
140	2155	-17.25
150	2190	-17.75
160	2235	-18.25
170	2275	-19.25
180	2290	-20.25

Maximum total deviation (50°C.)
1160 cycles .045%

Specification Requirements -
Not to exceed .05% over any 20°.

Table 32

RAM Receiving Equipment

FREQUENCY VARIATION - VARIABLE TEMPERATURE
Increasing Temperature
2600 Kcs.
H.F. Receiver #2

Time Minutes	Frequency Cycles	Temperature °C.
0	1030	-24
5	1085	-22
10	1140	-20
15	1180	-18
20	1200	-17
25	1220	-14
30	1225	-10
35	1265	- 8
40	1310	- 6
45	1320	- 4
50	1330	- 2
55	1345	+ 6
60	1420	+ 7
65	1480	+ 9
70	1560	+15
75	1785	+19
80	1880	+21
85	2015	+23
90	2150	+26
95	2195	+28
100	2200	+30

Maximum total deviation (54°C.)
1170 Cycles .045%

Specification Requirements -
Not to exceed .05% over any 20°.

Table 33

RAM Receiving Equipment

FREQUENCY VARIATION - VARIABLE TEMPERATURE
Decreasing Temperature
8400 Kcs.
H.F. Receiver #2

Time Minutes	Frequency Cycles	Temperature °C.	Time Minutes	Frequency Cycles	Temperature °C.
0	2035	+31	85	-1130	-12*
5	2175	+23	90	-1285	-12.5*
10	1790	+15	95	-1320	-13*
15	1270	+10	100	-1520	-13.5*
20	750	+ 7	110	-1590	-14*
25	200	+ 3	115	-1750	-14.5*
30	0	+ 1	120	-1885	-15*
35	- 100	- 1*	130	-1985	-16*
40	- 150	- 3*	140	-2165	-17*
45	- 200	- 4*	150	-2225	-18*
50	- 100	- 6*	160	-2125	-19*
55	- 200	- 7*	170	-2300	-19.5*
60	- 300	- 8*	180	-2360	-20.5*
65	- 385	- 9*	190	-2555	-21*
70	- 500	-10*	200	-2215	-22
75	- 715	-10.5*	210	-2000	-22.5
80	- 945	-11.5*			

* 2455 Cycles.

Maximum total deviation (53.5°C.)
4730 cycles .056%

Maximum deviation over any 20°
2455 cycles .029%

Specification Requirements -
Not to exceed .05% over any 20°.

Table 34

RAM Receiving Equipment

FREQUENCY VARIATION - VARIABLE TEMPERATURE
Increasing Temperature
8400 Kcs.
H.F. Receiver #2

Time Minutes	Frequency Cycles	Temperature °C.
0	750	-24
5	975	-14
10	1200	-13
15	1400	- 9
20	1580	- 7
25	1735	- 5
30	1915	- 3
35	2130	+ 2
40	2300	+ 5
45	2475	+ 8*
50	2885	+13*
55	3175	+16*
60	4100	+19*
65	4500	+22*
70	4900	+25*
75	5425	+27*
80	5835	+30*

* 3360 Cycles.

Maximum total deviation (54°C.)
5085 cycles .06%

Maximum deviation over any 20°
3360 cycles .04%

Specification Requirements -
Not to exceed .05% over any 20°.

Table 35

RAM Receiving Equipment

RESET
422 Kcs.
L.F. Receiver #1

Original Frequency Cycles	Local Control					
	Clockwise			Counter-Clockwise		
	Reset Cycles	Difference Cycles	Per Cent	Reset Cycles	Difference Cycles	Per Cent
3000	2975	25	.006	2000	1000	.24
	3000	0	0	1950	1050	.25
	3000	0	0	2100	900	.21
	3075	75	.018	2125	875	.2
	3100	100	.024	2000	1000	.24
	3050	50	.012	2000	1000	.24
	3050	50	.012	2000	1000	.24
	3000	0	0	1900	1100	.26
	Remote Control					
3200	3175	25	.006	2025	1175	.28
	3175	25	.006	2025	1175	.28
	3100	100	.024	2000	1200	.29
	3250	50	.012	1950	1250	.3
	3200	0	0	2000	1200	.29
	3200	0	0	1950	1250	.3
	3175	25	.006	2000	1200	.29
	3250	50	.012	1900	1300	.31

Specification Requirements -
Within .05% on local control.
Within .1% on remote control.

Table 36

RAM Receiving Equipment

RESET
8225 Kcs.
H.F. Receiver #1

Original Frequency Cycles	Local Control Clockwise Reset Cycles	Difference Cycles	Per Cent
2650	2100	550	.006
	1975	675	.008
	1550	1100	.013
	2100	550	.006
	2350	300	.004
	1775	875	.01
	2450	250	.003
	2200	450	.005

NOTE: Counter-clockwise out of audibility by approximately 1/2 division.

Remote Control

2700	2400	300	.004
	2400	300	.004
	2100	600	.007
	2400	300	.004
	2925	225	.003
	2950	250	.003
	3100	400	.004
	2600	100	.002

NOTE: Counter-clockwise out of audibility by approximately 3/4 division.

Specification Requirements -
Within .05% on local control.
Within .1% on remote control.

Table 37

RAM Receiving Equipment

RESET
400 Kcs.
L.F. Receiver #2

	Local Control					
Original Frequency Cycles	Clockwise			Counter-Clockwise		
	Reset Cycles	Difference Cycles	Per Cent	Reset Cycles	Difference Cycles	Per Cent
3160	3190	30	.007	2760	400	.1
	3195	35	.008	2615	545	.13
	3215	55	.014	2595	565	.14
	3250	90	.022	2560	600	.15
	3055	105	.026	2560	600	.15
	3080	80	.02	2510	650	.162
	3135	25	.006	2525	635	.158
	3205	45	.011	2500	660	.165
			Remote Control			
3160	3130	30	.007	2130	1030	.257
	3020	140	.035	2110	1050	.262
	3030	130	.032	2145	1015	.254
	3025	135	.033	2155	1005	.251
	3005	155	.039	2190	970	.242
	3075	85	.021	2130	1030	.258
	3015	145	.036	2130	1030	.258
	3035	125	.031	2170	990	.247

Specification Requirements -
Within .05% on local control.
Within .1% on remote control.

Table 38

RAM Receiving Equipment

RESET
8400 Kcs.
H.F. Receiver #2

Original Frequency Cycles	Local Control					
	Clockwise			Counter-Clockwise		
	Reset Cycles	Difference Cycles	Per Cent	Reset Cycles	Difference Cycles	Per Cent
2500	1500	1000	.012	-4530	7030	.084
	1695	805	.009	-4245	6745	.08
	1700	800	.009	-4260	6760	.08
	1820	680	.008	-4355	6855	.082
	1150	1350	.016	-5100	7600	.09
	1420	1080	.012	-4300	6800	.082
	1000	1500	.017	-5200	7700	.092
	1575	925	.011	-5100	7600	.09

Remote Control

1740	3410	1670	.02
	2060	320	.004
	2700	960	.011
	2420	1680	.02
	2075	335	.004
	2780	1040	.012
	2690	950	.011
	2425	685	.008

NOTE: Counter-clockwise out of audibility by approximately 1/2 division.

Specification Requirements -
Within .05% on local control.
Within .1% on remote control.

Table 39

RAM Receiving Equipment

FREQUENCY SHIFT ON BAND SWITCH CONTACTS
L.F. Receiver #2

Clockwise					Counter-Clockwise				
Left		Center		Right	Left		Center		Right
Band 2, 400 Kcs.									
2565∼		2470∼		2815∼	2575∼		2475∼		2870∼
	95∼		345∼			100∼		395∼	
Band 4, 1200 Kcs.									
2910∼		1990∼		3320∼	2920∼		2155∼		3385∼
	920∼		1330∼			765∼		1230∼	
H.F. Receiver #2									
Band 2, 2600 Kcs.									
2300∼		1000∼		-600∼	1750∼		700∼		-400∼
	1300∼		1600∼			1050∼		1100∼	
Band 5, 8400 Kcs.									
3065∼		1095∼		-3300∼	3600∼		1415∼		-3550∼
	1970∼		4395∼			2185∼		6965∼	

The greatest change in frequency occurs at the extreme edges of the contact. The change within these points is very small. The above data show that the reset to the position marks engraved on the dial have a maximum difference of 320 cycles. The frequency remains constant on any position of the contact after once being set.

Table 40

SIZES AND WEIGHTS

		Actual	Allowable
Dynamotor - Filter Unit	(with cable)	10.8 pounds	10 pounds
	Depth	4-3/8 inches	4-1/2 inches
	Width	7-3/8	7-1/2
	Height	6-3/4	6
Medium Frequency Receiver			
R.F. Tuner Unit	Depth	9-1/8 inches	8 inches
	Width	7	7
	Height	9	8
I.F.and A.F. Unit	Depth	7-3/8	8
	Width	7	7
	Height	9	8

The High Frequency Receiver Units are the same as the Medium Frequency Units above.

Complete equipment for operation on local control	57.3 pounds	50 pounds
Remote control units, cables and linkage	10.3	10

Table 41

Model GN Transmitter

Serial #1

WEIGHT BEFORE MODIFICATION

	Transmitter complete
High frequency Unit	25.1 pounds
Intermediate frequency unit	26.8
Power unit	38.0
Intermediate frequency load coil	3.1
2 side shields	2.9
3 mountings	1.6
#1 cable	1.9
#2 "	1.3
#3 "	2.8
#4 "	1.2
Total -	104.7 pounds

	Control boxes
Operator's	6.55 pounds
Pilot's	1.55
Total	8.10 pounds

Table 42

Frequency Range and Overlap

Band	Minimum Frequency	Maximum Frequency	% Overlap
	Low Frequency Transmitter		
1	339.65 kilocycles	530.3 kilocycles	2.96
2	495.00	785.8	6.9
3	714.8	1120.2	9.5
4	1019.3	1530.0	9.4
	High Frequency Transmitter		
1	1406.0	2505.0	6.2
2	2205.0	3900.0	12.7
3	3507.5	6013.0	10.6
4	5600.0	9505.0	7.1

Specified overlap 2%

Table 43

Model GN Transmitter

R-F Power Output and A-C Power Input

Frequency	A-C Power	Ant.Cap.	Antenna Resistance	Antenna Current	Antenna Watts	Required
			CW			
350 Kc)	670 Va	500 mmf.	23.3	2.18	111	85
600)IF	637	350	"	2.16	109	100
1500)	642	"	"	2.1	103	50
1500)	620	"	42.2	1.66	116	50
3000)HF	659	"	"	1.75	130	"
5500)	653	"	"	1.8	137	"
9000	689	"	"	1.82	140	"
			MCW			
350 kc)	634 Va	500 mmf	23.3	2.05	98	85
600)IF	676	350	"	2.06	99	100
1500)	647	"	"	2.05	98	50
1500)	695	"	42.2	1.66	116	"
3000)HF	656	"	"	1.67	118	"
5500)	659	"	"	1.74	128	"
9000)	688	"	"	1.74	128	"
			Phone			
350 kc	522 Va	500 mmf	23.3	1.3	40	15
600	541	350	"	1.35	42	"
1500	508	"	"	1.3	40	"
1500	570	"	42.2	1.0	42	"
3000	528	"	"	1.0	42	"
5500	522	"	"	1.0	42	"
9000	564	"	"	1.05	46	"

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Unclassified

Table 44

Model GN Transmitter

RESET AND BACKLASH

Increasing Frequency		Decreasing Frequency		Reset Error		Backlash	
Set	Reset	Set	Reset	Cycles	%	Cycles	%
I.F. Unit							
350.512	350.512	350.452	350.458	6	.0017	60	0.017
600.332	600.348	600.278	600.265	16	.0027	83	0.011
800.630	800.610	800.550	800.540	20	.0025	130	0.011
1500.585	1500.565	1501.050	1501.075	25	.0017	510	0.034
H.F.Unit							
1500.790	1500.810	1501.640	1501.660	20	.0013	150	0.01
3000.570	3000.500	3003.800	3004.000	200	.0067	3500	0.117
5504.800	5504.760	5495.075	5495.345	270	.0049	9725	0.177
8995.050	8995.200	9005.000	9005.000	150	.0017	9950	0.11

Reset and backlash requirements 0.05%

Table 45

FLIGHT TEST RESETS

Set Frequency		1st Reset	2nd Reset	Reset Error	Percentage
IF	354.10 kc	354.06 kc	-	-40 cycles	.011
	545.07	545.16	-	+90	.016
	840.58	840.86	-	+280	.028
	1532.96	1533.48	-	+520	.034
HF	1528.33	1528.33	1529.65	+1320	.086
	3065.05	3065.12	3069.26	+4210	.14
	4516.84	4516.26	4521.46	+4620	.102
	9033.60	9029.86	9039.64	+6040	.065

[redacted]

Table 46

30 Minute Frequency Drift

Frequency	Key locked Drift		40 w.p.m. keying drift	
I-F Unit	Cycles	%	Cycles	%
350 kc	35	0.01	25	0.0071
600	105	0.0175	30	0.005
800	57	0.0071	45	0.0056
1500	130	0.0087	190	0.0126
H-F Unit				
1500	350	0.0233	180	0.012
3000	610	0.0203	540	0.018
5500	1650	0.03	325	0.0059
9000	2750	0.0306	1350	0.015

Required 0.05%

Table 47

Model GN Transmitter

Frequency Drift for Temperature Change

Frequency	Temperature Change	Cycles Change	% Change	Max. Allowed Drift
IF 350 kc	-25.5°C to +50°C	150	.043	
600	-24.5 to +50	210	.035	0.05
800	-30 to +50	410	.051	
1500	-30°C to +50°C	2590	.172	
1500	-30 to +10	1740	.116	0.05
1500	+10 to +50	850	.057	
HF 1500	-30°C to +50°C	2200	.147	
1500	-30 to +10	330	.022	0.05
1500	+10 to +50	1870	.124	
3000	-30°C to +50°C	3060	.102	
3000	-30 to +10	1700	.0566	0.05
3000	+10 to +50	1360	.0453	
5500	-30°C to +50°C	6075	.11	
5500	-30 to +10	2675	.0486	0.05
5500	+10 to +50	3400	.0618	
9000	-29°C to +50°C	11850	.131	
9000	-30 to +10	4500	.05	0.05
9000	+10 to +50	7350	.0816	

Table 48

Frequency Change with 25% Change of Antenna Constants

Frequency	Frequency Change with Change of Antenna	
I-F Unit	Cycles	%
350 kc	55	0.0157
600	44	0.0073
800	8	0.001
1500	25	0.0017
H-F Unit		
1500	25	0.0017
3000	650	0.022
5500	600	0.011
9000	1700	0.019

Allowed 0.02%

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Unclassified

Table 49

Frequency Change with Line Voltage Variation

Frequency	Frequency Change for 10% Line Voltage Change	
	Cycles	%
I-F Unit		
350 kc	8	0.0023
600	12	0.002
800	10	0.00125
1500	30	0.002
H-F Unit		
1500	10	0.00067
3000	35	0.00117
5500	250	0.0045
9000	100	0.0011

Allowed 0.02%

Table 50

Rectifier Characteristics

Regulation

D-C Current	D-C Voltage
0 ma	2150 volts
50	1520
80	1390
100	1300 min.load
200	1190
350	1090 full load

Regulation no load to full load 40%
Regulation min.load to full load 15%
Allowed 25%

Efficiency at full load

A-C input	D-C output
440 watts	362
Efficiency 82%	Allowed 80%

Ripple in Plate Supply

Emission	Plate Voltage	Ripple	
		Volts, 1/2 peak to peak	%
CW	1105	4.98	0.44
Phone	1120	6.98	0.62
Radio Test	1010	4.98	0.48

Allowed 0.5%

[redacted]

Table 51

Model GN Transmitter

Frequency Drift for Radio Test to Full Power

Radio Test		Full Power	Cycles Change	%
IF	350.500 kc	350.525 kc	25	0.0071
	600.445	600.490	45	0.0075
	800.498	800.505	7	0.0009
	1500.490	1500.500	10	0.0007
HF	1500.440	1500.510	70	0.0047
	3000.200	3000.800	600	0.02
	5503.100	5502.850	250	0.0045
	9003.250	9002.750	500	0.0055

Allowed 0.02%

Table 52

Audio Characteristics of Modulator

Input at Microphone Primary

Constant at 0.92 volts

Frequency	Modulator output	Variation
200 cycles	120 milliwatts	-4.7 db
300	330	-0.2
500	365	+0.2
1000	345	0
1500	335	-0.2
2000	340	-0.1
2500	350	0
3000	365	+0.2

Allowed 2 db from 300 to 3000 cycles

Harmonic Distortion
400 cycles input 90% modulation

Carrier Frequency	Harmonic percentage					
	2nd	3rd	4th	5th	6th	Total
350 kc	7.2	7.5	3.4	0.7	0.15	10.9
9000	6.0	8.4	4.0	2.1	1.3	11.3

Allowed 10%

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Unclassified

Table 53

Frequency Drift with Altitude
544 kc

Altitude	Temperature	Frequency
2000 ft.	56° F	544.286 kc
4000	54	.019
5000	50	.036
7000	42	.031
9000	36	.013
11000	30	.013
13000	28	.007
15000	20	.007
17000	14	.036
	Shut down 15 minutes	
17500	10	544.102
15000	12	.072
13000	15	.043
11000	20	.031
9000	23	.031
7000	26	.043
5000	34	.031
3000	44	.025

Maximum change 280 cycles or 0.051%

Table 54

Frequency Drift with Altitude
840 kc

Altitude	Temperature	Frequency
1000	78° F	840.039 kc
3000	76	.038
5000	68	.058
7000	62	.048
9000	55	.039
11000	51	.058
13000	48	.068
15000	44	.058
17000	34	.068
	Shut down 15 minutes	
17500	28	840.010
15000	32	.010
13000	34	.010
11000	39	.020
9000	44	.020
7000	48	.029
5000	52	.039
3000	59	.048

Maximum change 58 cycles or 0.007%

Table 55

Frequency Drift with Altitude
1530 kc
I-F Unit

Altitude	Temperature	Frequency
1000 ft	56° F	1531.51 kc
3000	50	.34
5000	43	.17
7000	38	.13
9000	36	.13
11000	34	.04
13000	27	1530.92
15000	20	.82
17000	16	.75
Shut down 15 minutes.		
17500	6° F	1530.71
15000	10	.63
13000	14	.64
11000	19	.75
9000	24	.94
7000	29	1531.08
5000	32	.22
3000	37	.30

Maximum change 800 cycles or 0.052%

Table 56

Frequency Drift with Altitude
1530 kc
H-F Unit

Altitude	Temperature	Frequency
3000	68° F	1532.30 kc
5000	64	.31
7000	59	.33
9000	53	.31
11000	48	.42
13000	42	.42
15000	36	.47
17000	28	.43
Shut down 15 minutes		
17500	26	1532.61
15000	28	.38
13000	31	.37
11000	36	.31
9000	40	.33
7000	44	.33
5000	52	.31
3000	56	.30

Maximum change 310 cycles or 0.020%

Table 57

Frequency Drift with Altitude
3065 kc

Altitude	Temperature	Frequency
1000 ft	64° F	3065.37 kc
3000	58	4.31
5000	50	4.18
7000	43	4.09
9000	39	3.93
11000	34	3.87
13000	28	3.81
15000	24	3.62
17000	15	3.59
	Shut down 15 minutes	
17500	6	3064.28
15000	10	3.62
13000	15	3.71
11000	22	3.87
9000	26	4.03
7000	31	4.12
5000	36	4.15
3000	41	4.18

Maximum change 1780 cycles or 0.058%

Table 58

Frequency Drift with Altitude
4135 kc

Altitude	Temperature	Frequency
2000 ft	70° F	4137.61 kc
3000	70	7.54
5000	67	7.56
7000	58	7.61
9000	52	7.37
11000	46	7.47
13000	36	7.54
15000	29	7.59
17000	22	7.71
	Shut down 15 minutes	
17500	22	4137.66
15000	25	7.35
13000	29	7.32
11000	32	7.13
9000	37	7.20
7000	44	7.23
5000	50	7.18
3000	58	7.20

Maximum change 580 cycles or 0.014%

Table 59

Frequency Drift with Altitude
9030 kc

Altitude	Temperature	Frequency
1000 ft	65° F	9034.34 kc
3000	58	3.71
5000	51	3.18
7000	46	2.86
9000	41	2.65
11000	34	2.12
13000	26	1.70
15000	20	1.48
17000	12	0.85
Shut down 15 minutes		
17500	2	9031.12
15000	4	29.68
13000	10	29.68
11000	15	29.79
9000	24	30.21
7000	28	30.32
5000	34	30.42
3000	40	30.74

Maximum change 4660 cycles or 0.051%

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Unclassified

MODEL RAM RECEIVING EQUIPMENT
SELECTIVITY
L.F. RECEIVER NO.1

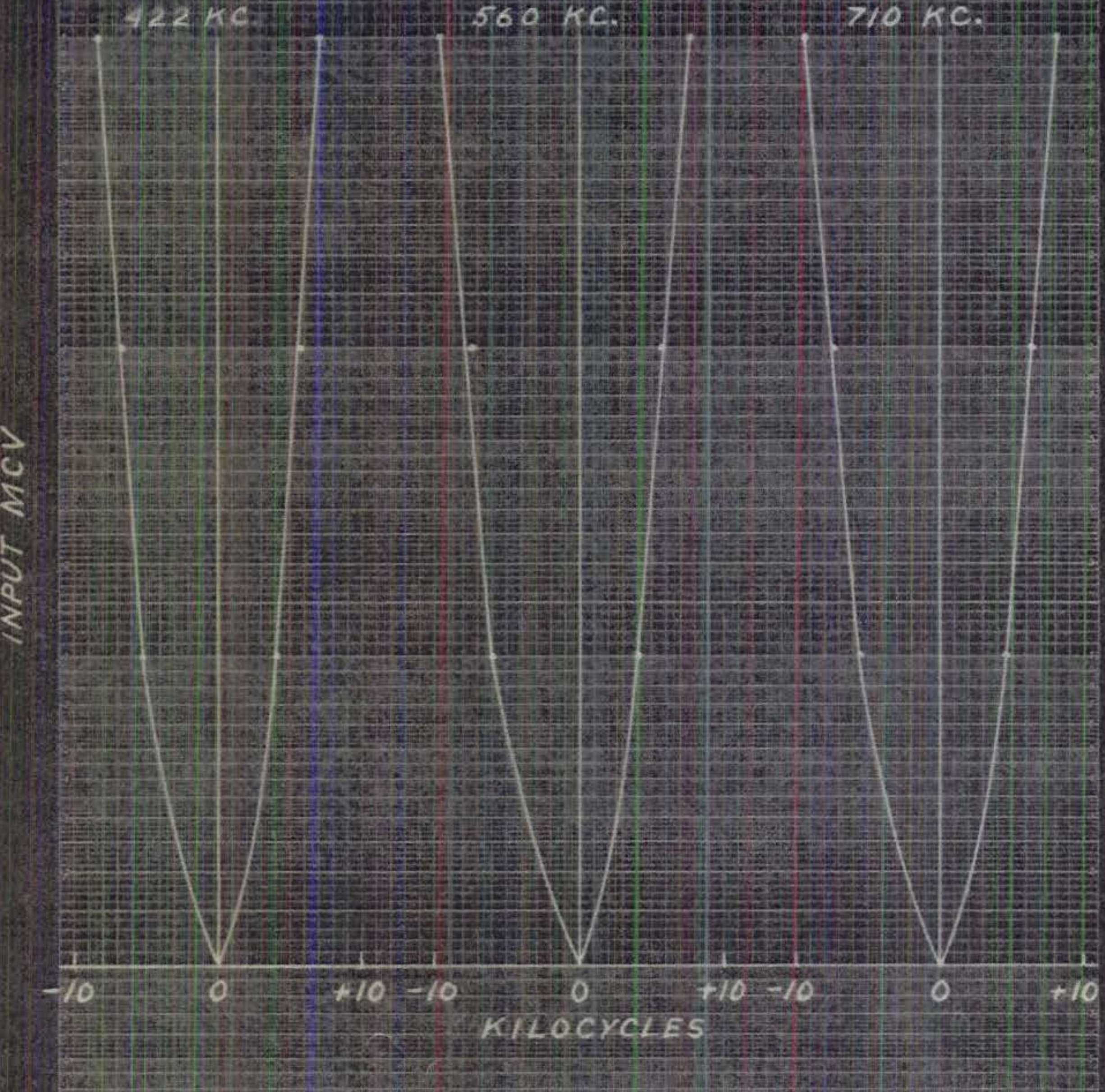


PLATE 2

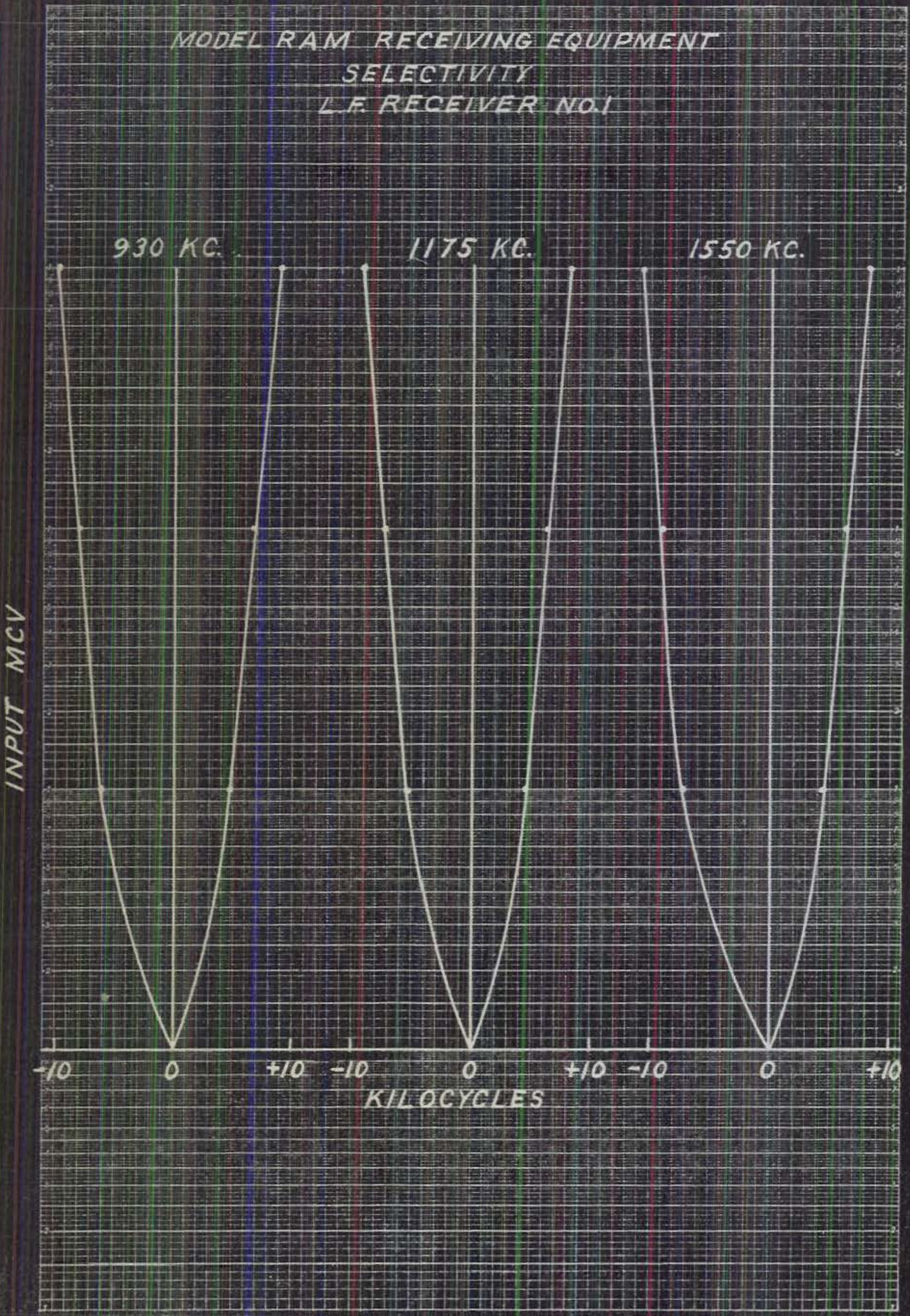
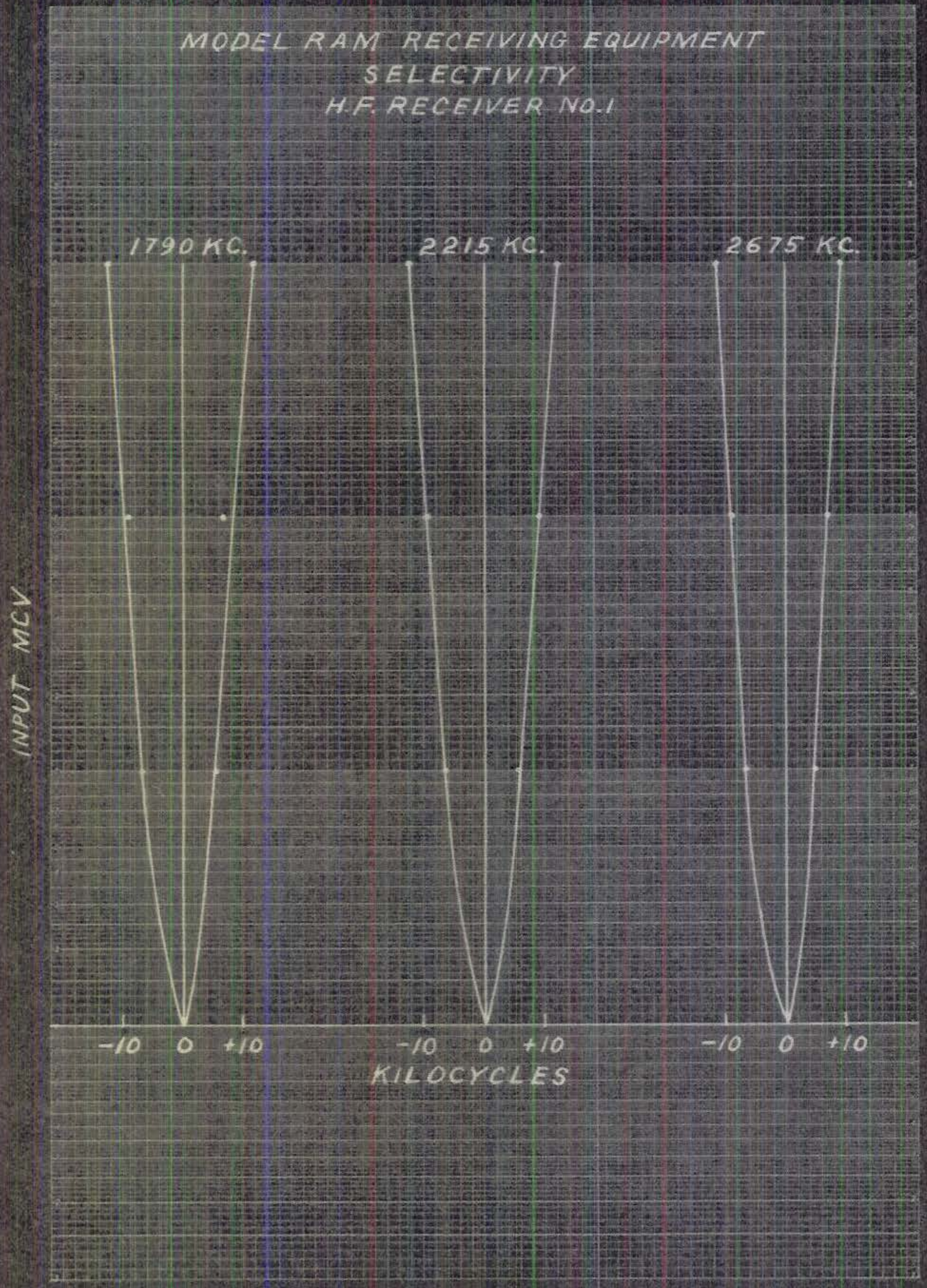
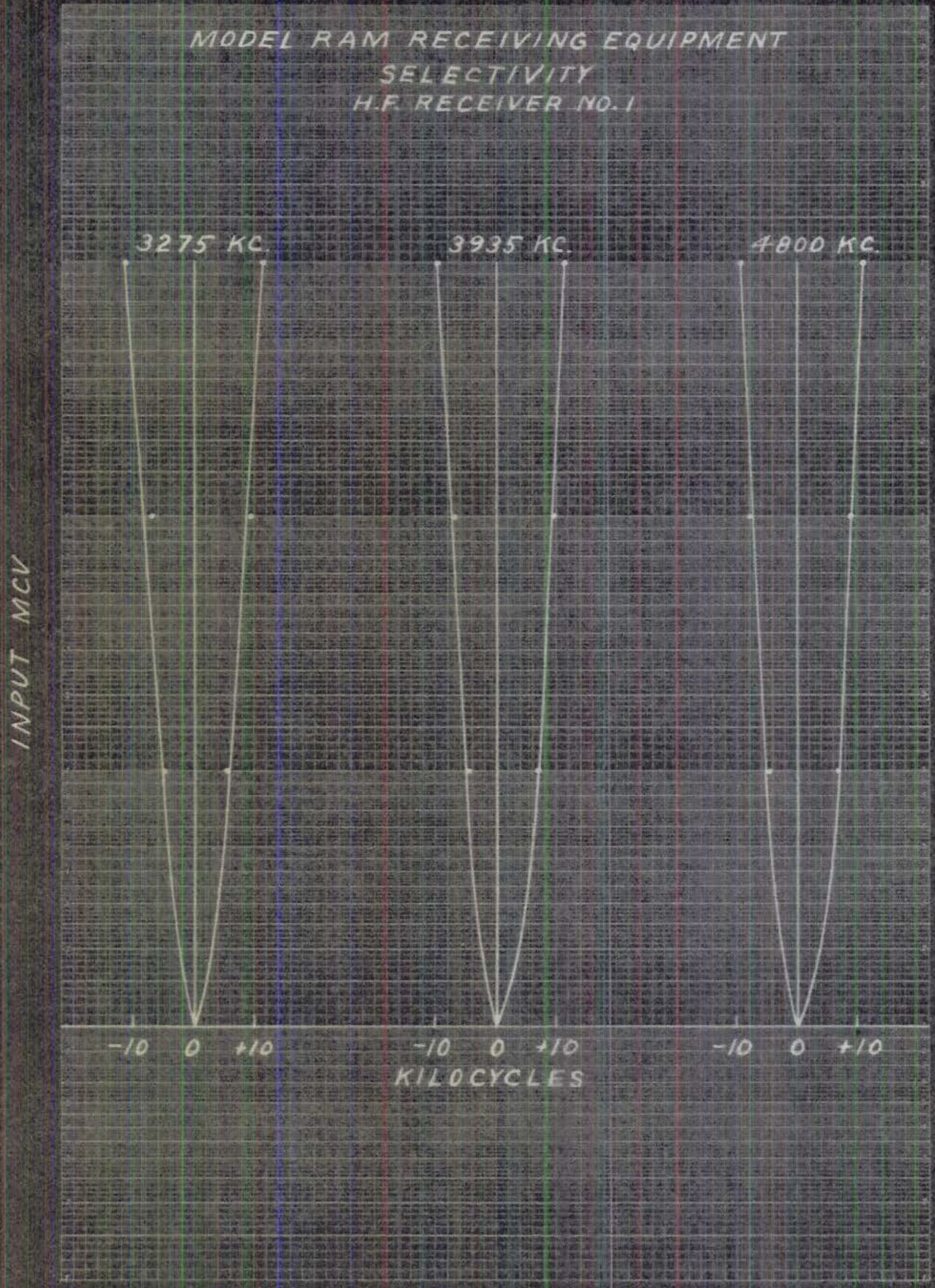

MODEL RAM RECEIVING EQUIPMENT
SELECTIVITY
L.F. RECEIVER NO.1
930 KC.
1175 KC.
1550 KC.
INPUT MCV
-10
0
+10
-10
0
+10
-10
0
+10
KILOCYCLES

PLATE 3



MODEL RAM RECEIVING EQUIPMENT
SELECTIVITY
H.F. RECEIVER NO.1

PLATE 4



MODEL RAM RECEIVING EQUIPMENT
SELECTIVITY
H.F. RECEIVER NO. 1

PLATE 5

MODEL RAM RECEIVING EQUIPMENT
SELECTIVITY
H.F. RECEIVER NO.1

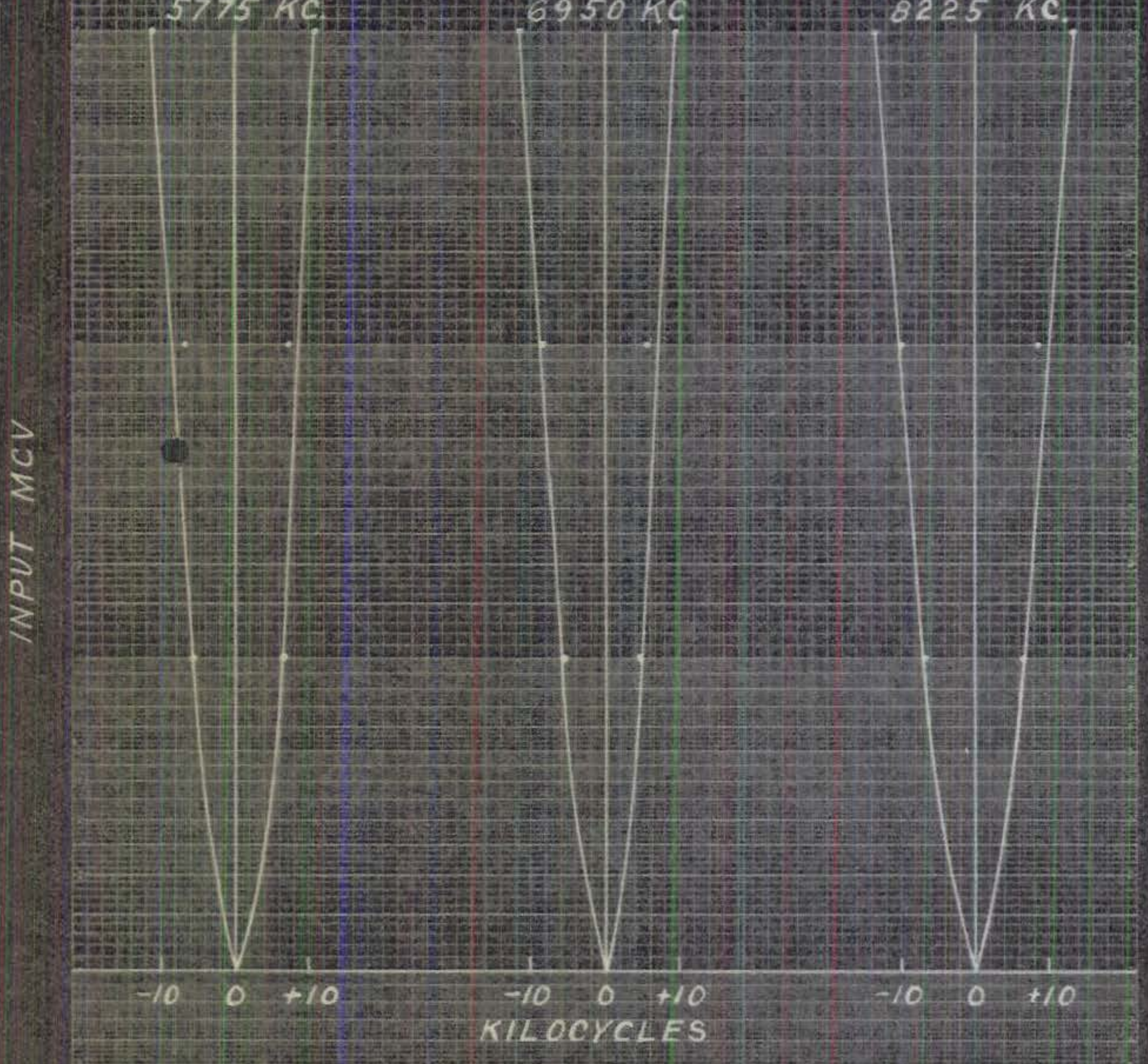
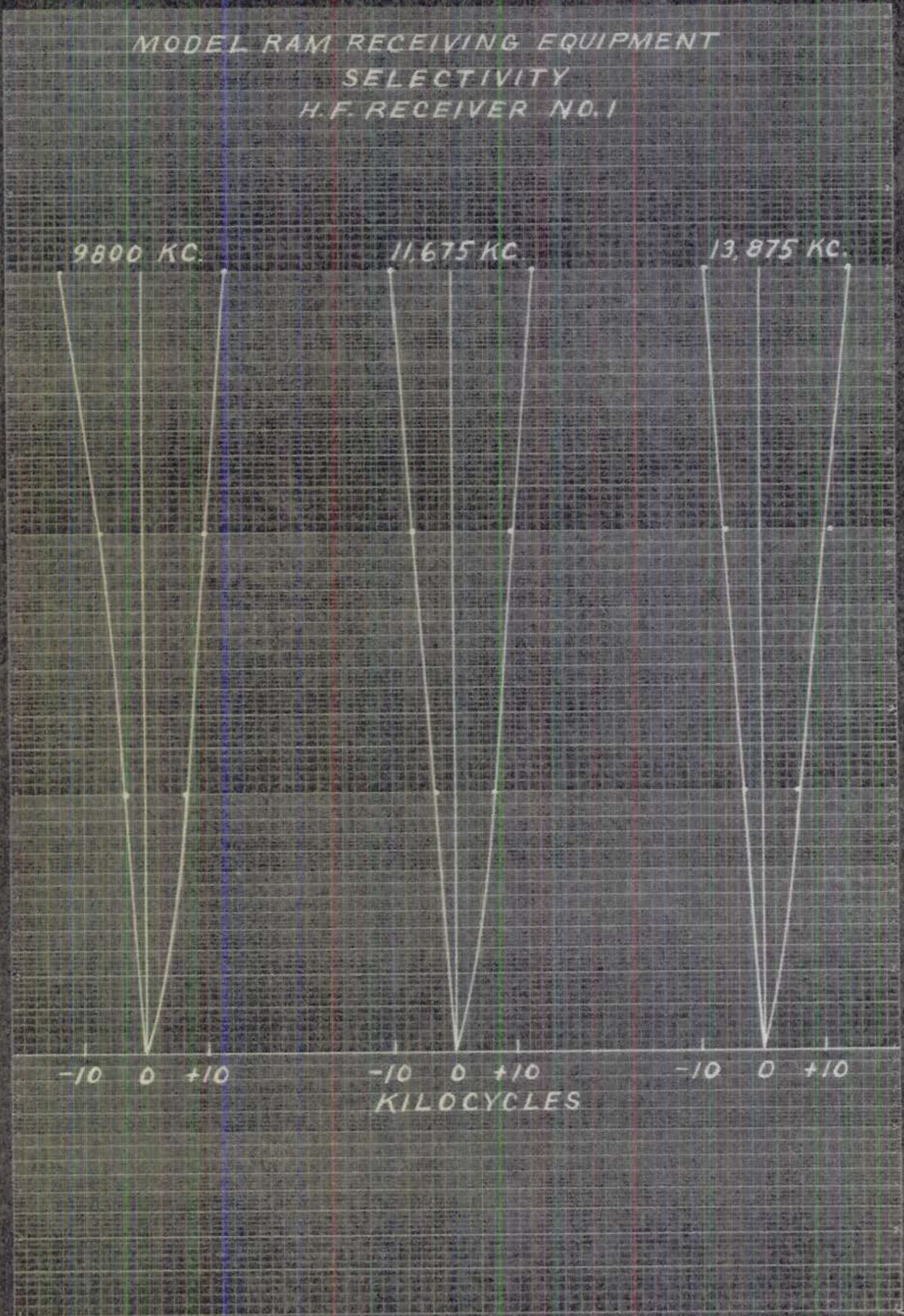


PLATE 6



MODEL RAM RECEIVING EQUIPMENT
SELECTIVITY
H.F. RECEIVER NO.1

PLATE 7

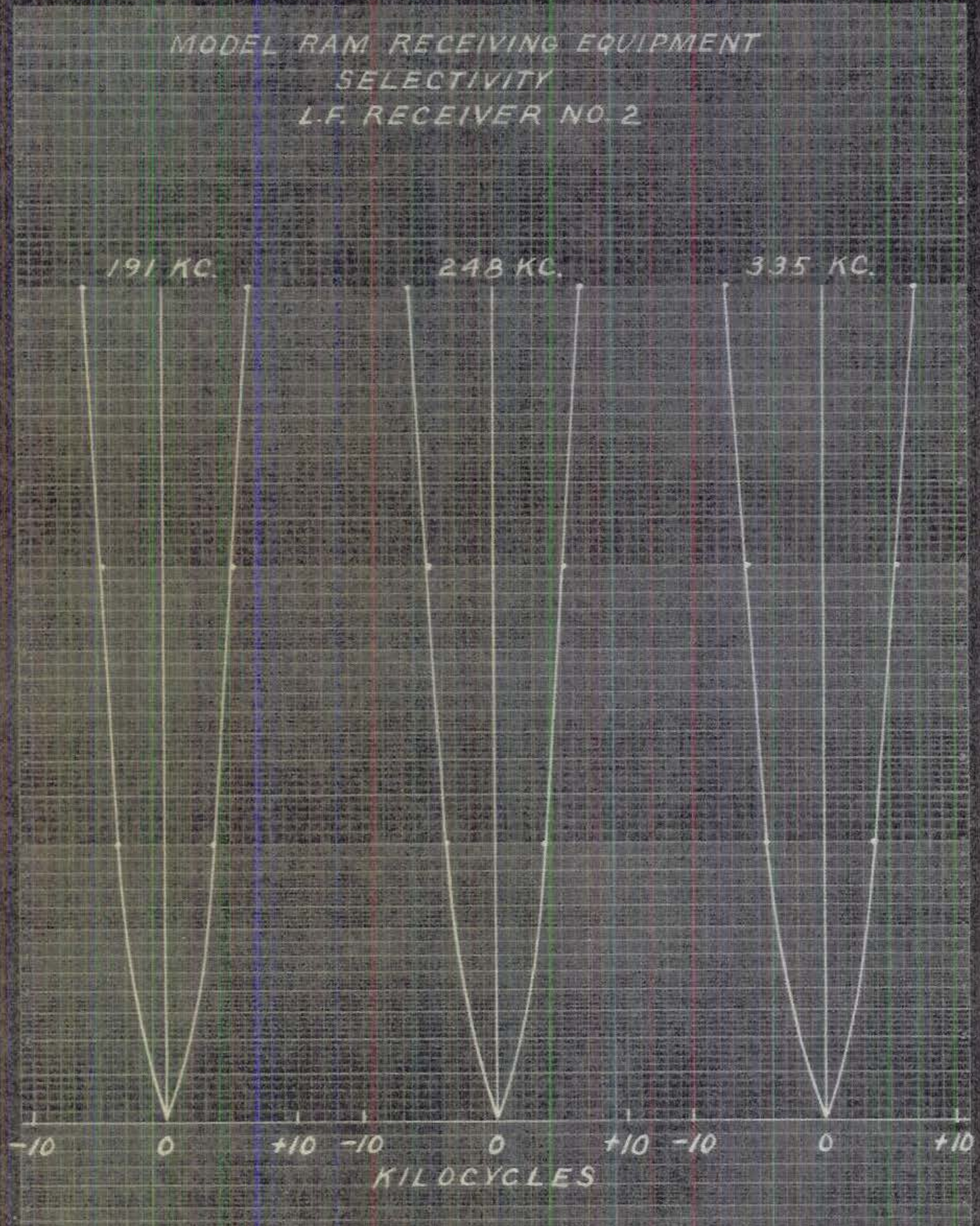

MODEL RAM RECEIVING EQUIPMENT
SELECTIVITY
L.F. RECEIVER NO. 2
191 KC.
248 KC.
335 KC.
INPUT MCV
-10
0
+10
-10
0
+10
-10
0
+10
KILOCYCLES

PLATE 8

MODEL RAM RECEIVING EQUIPMENT
SELECTIVITY
L.F. RECEIVER NO.2

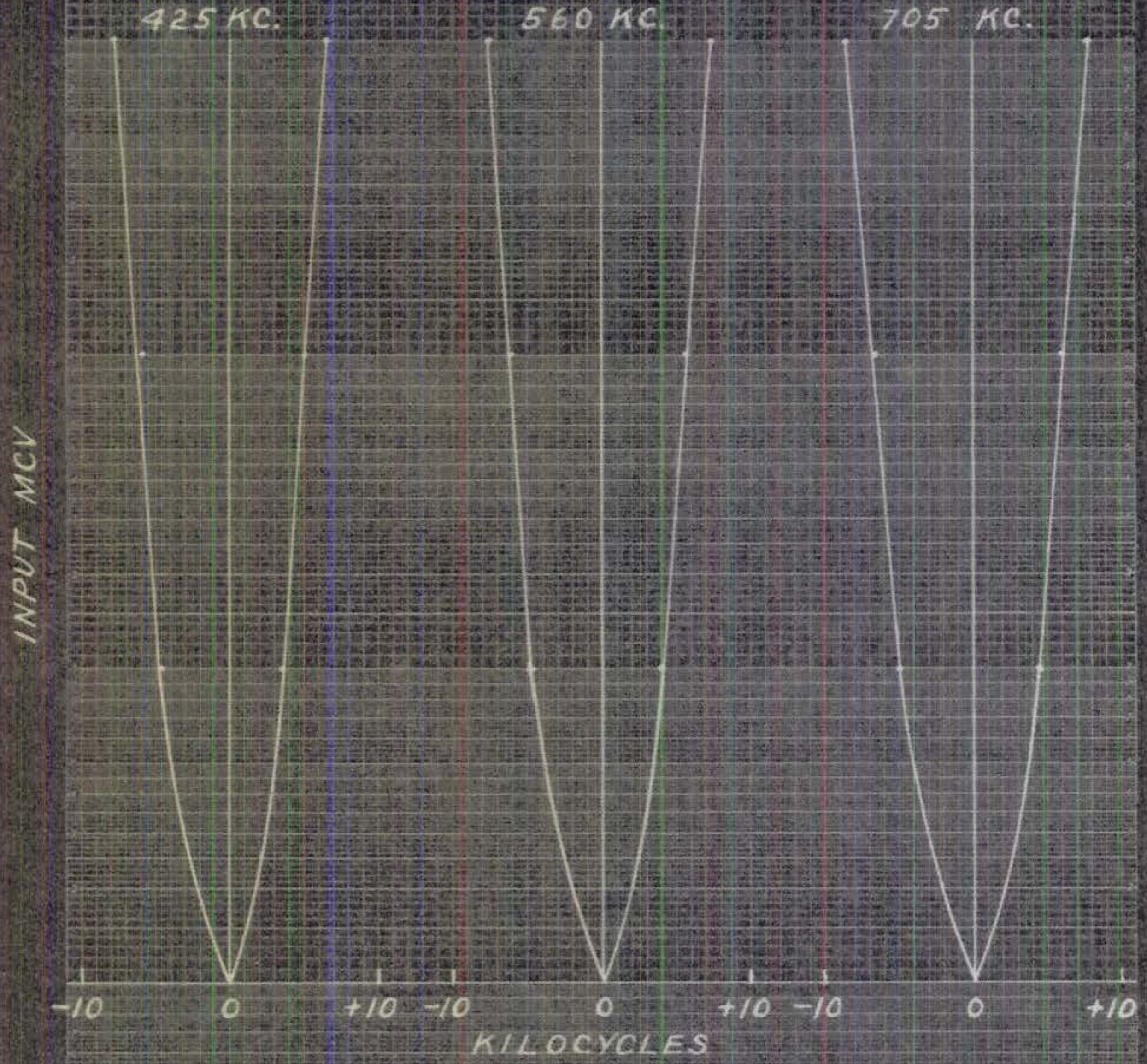


PLATE 9

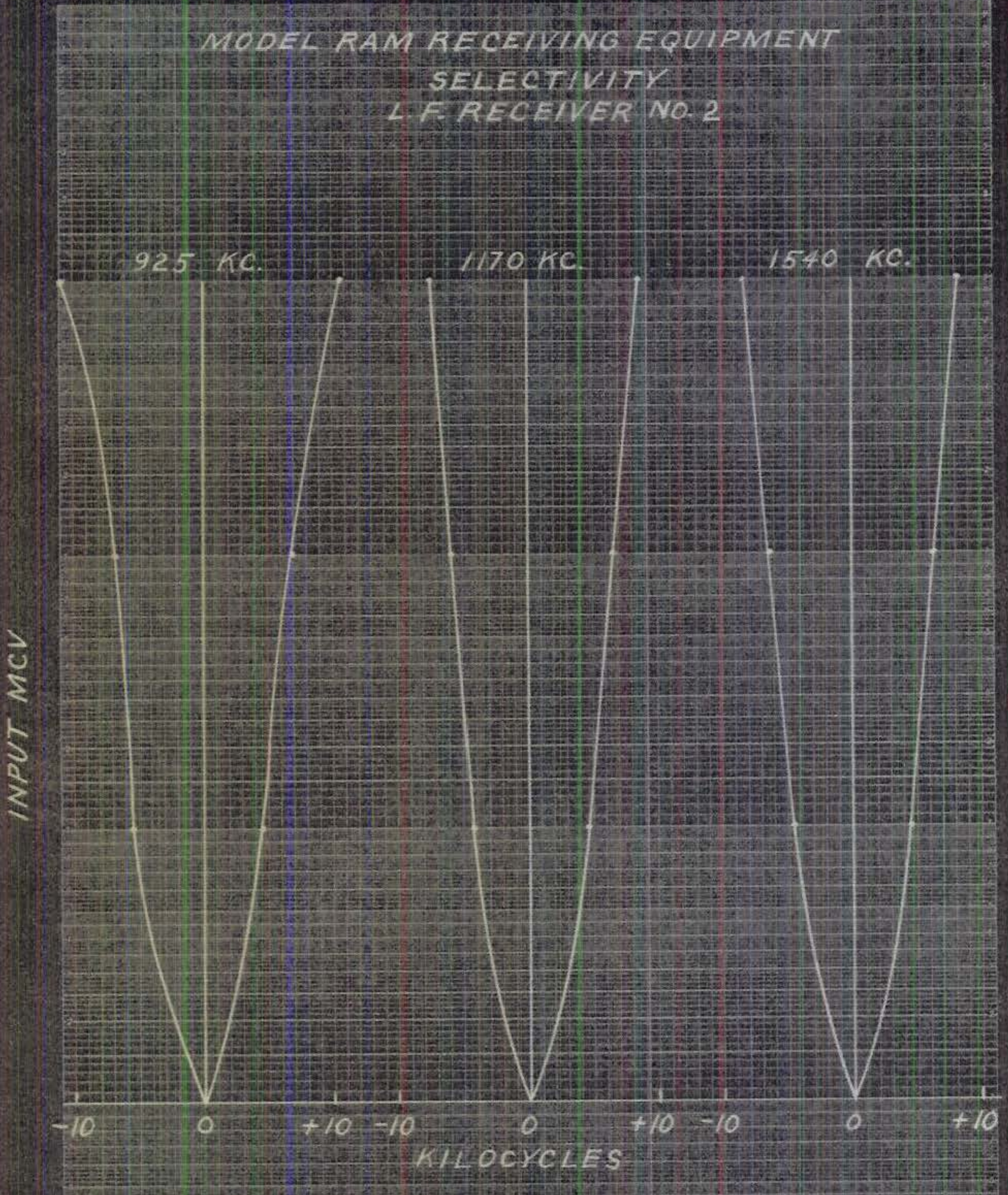
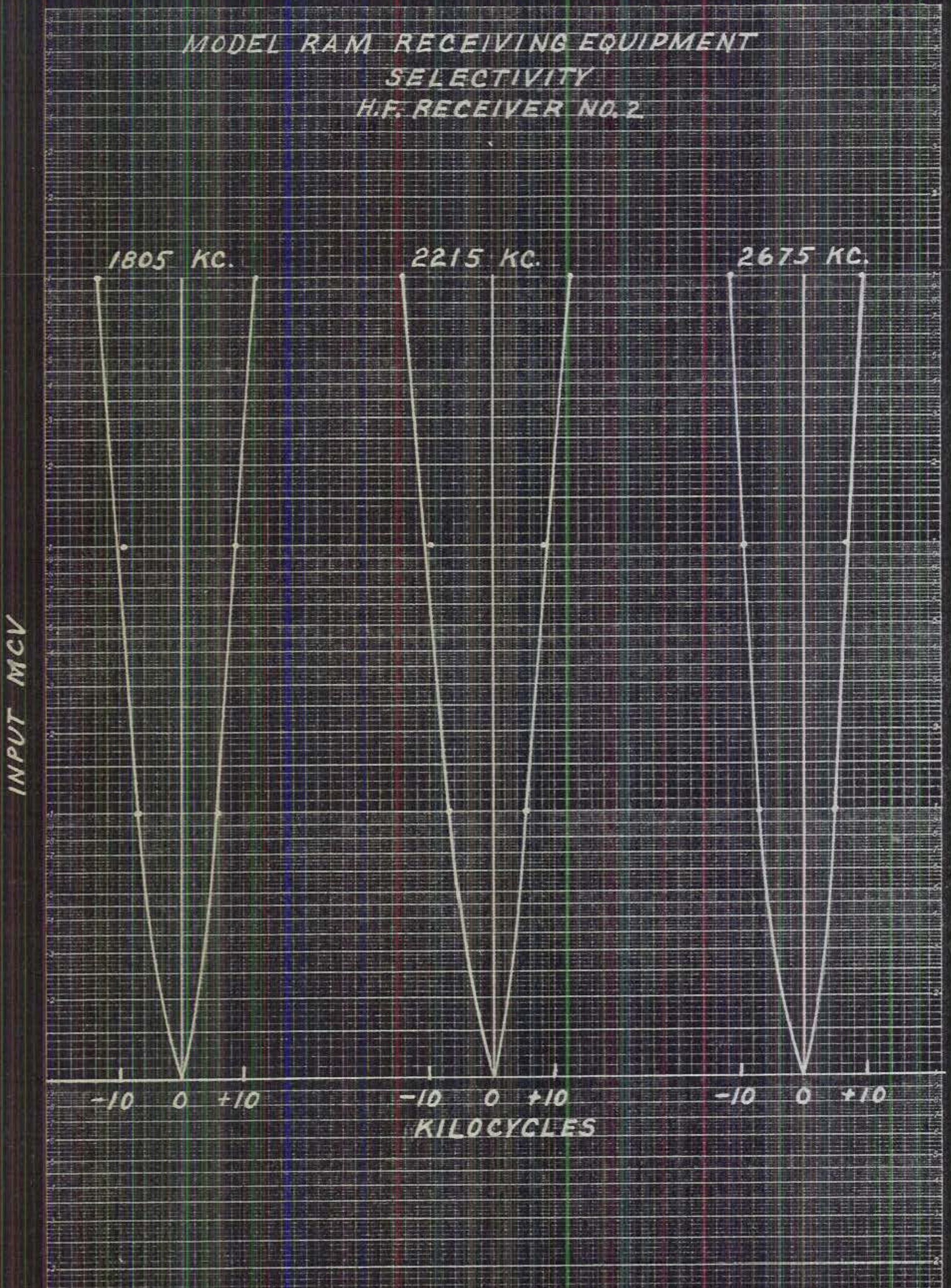

MODEL RAM RECEIVING EQUIPMENT
SELECTIVITY
L.F. RECEIVER NO. 2
925 KC.
1170 KC.
1540 KC.
INPUT MCV
-10
0
+10
-10
0
+10
-10
0
+10
KILOCYCLES

PLATE 10



MODEL RAM RECEIVING EQUIPMENT
SELECTIVITY
H.F. RECEIVER NO. 2

PLATE 11

MODEL RAM RECEIVING EQUIPMENT
SELECTIVITY
H.F. RECEIVER NO. 2

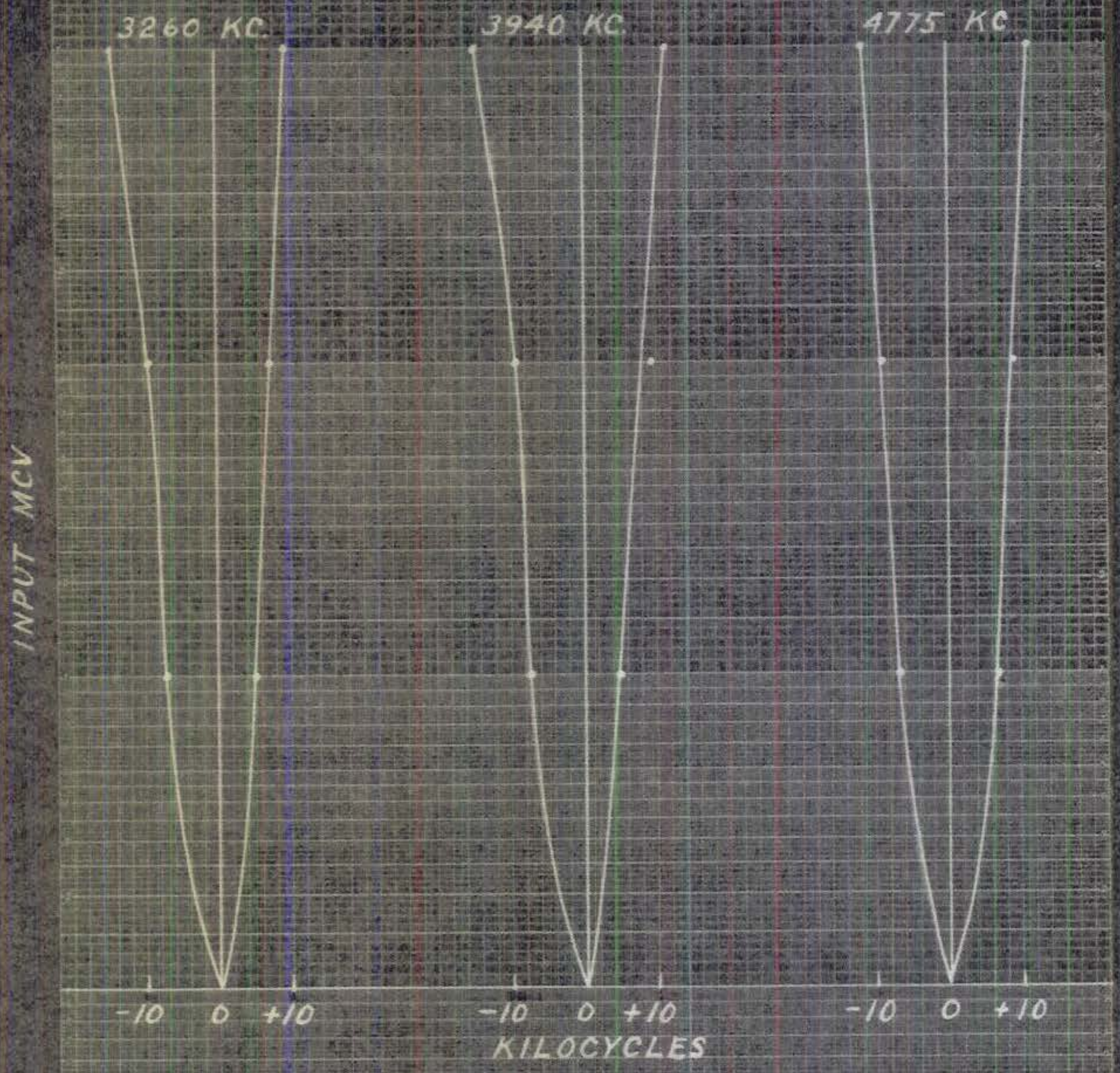
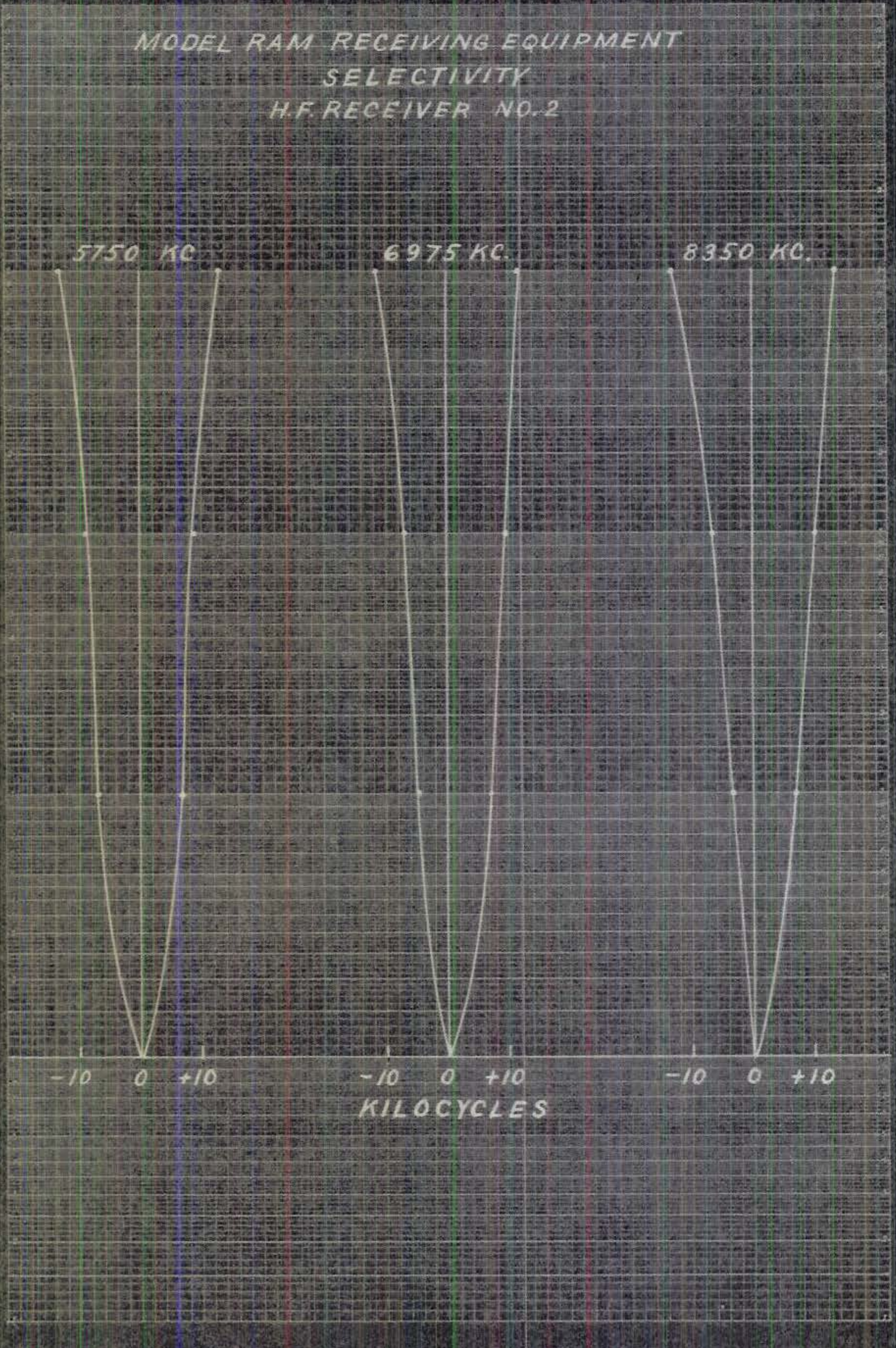


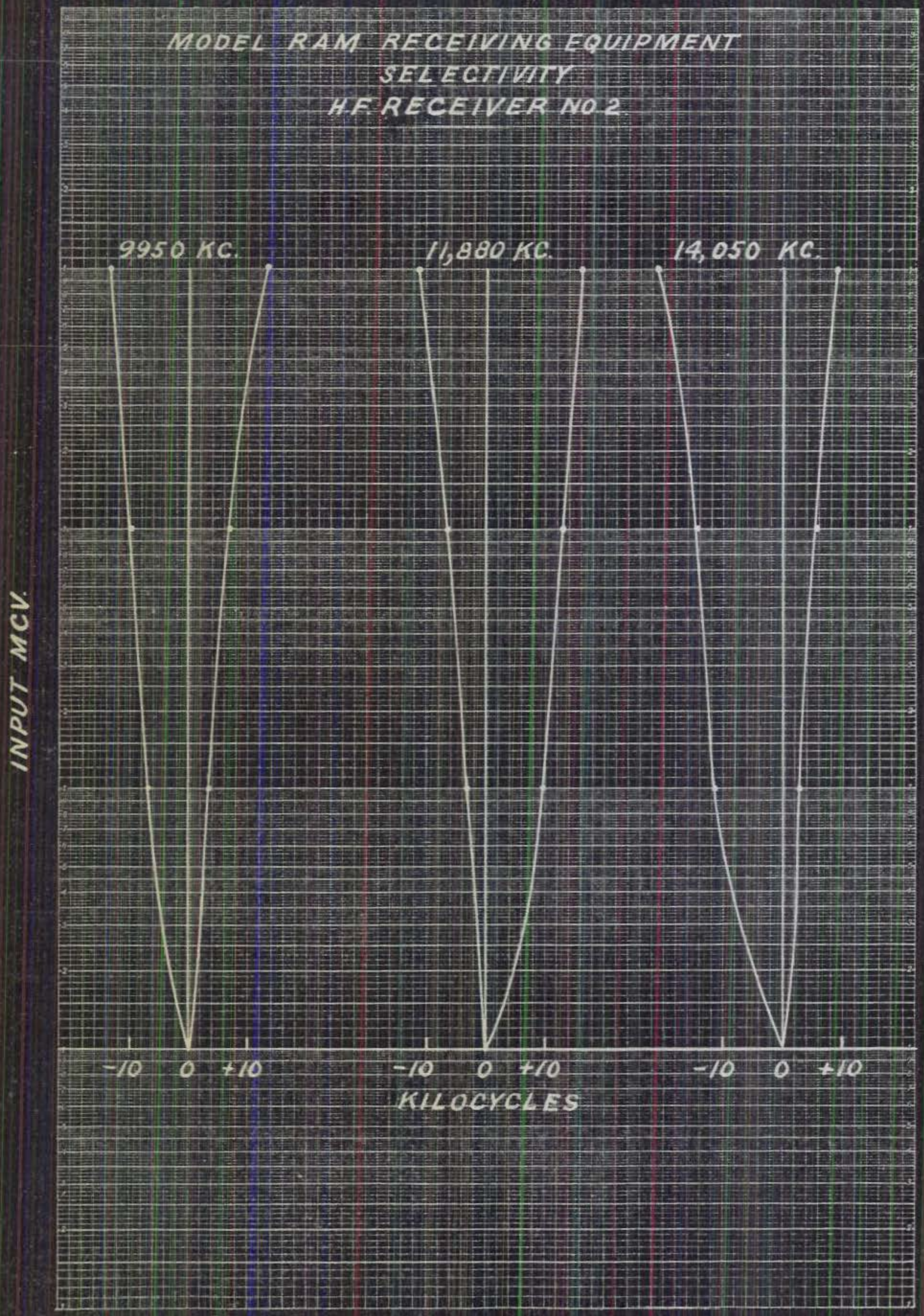
PLATE 12



MODEL RAM RECEIVING EQUIPMENT
SELECTIVITY
H.F. RECEIVER NO. 2

PLATE 13

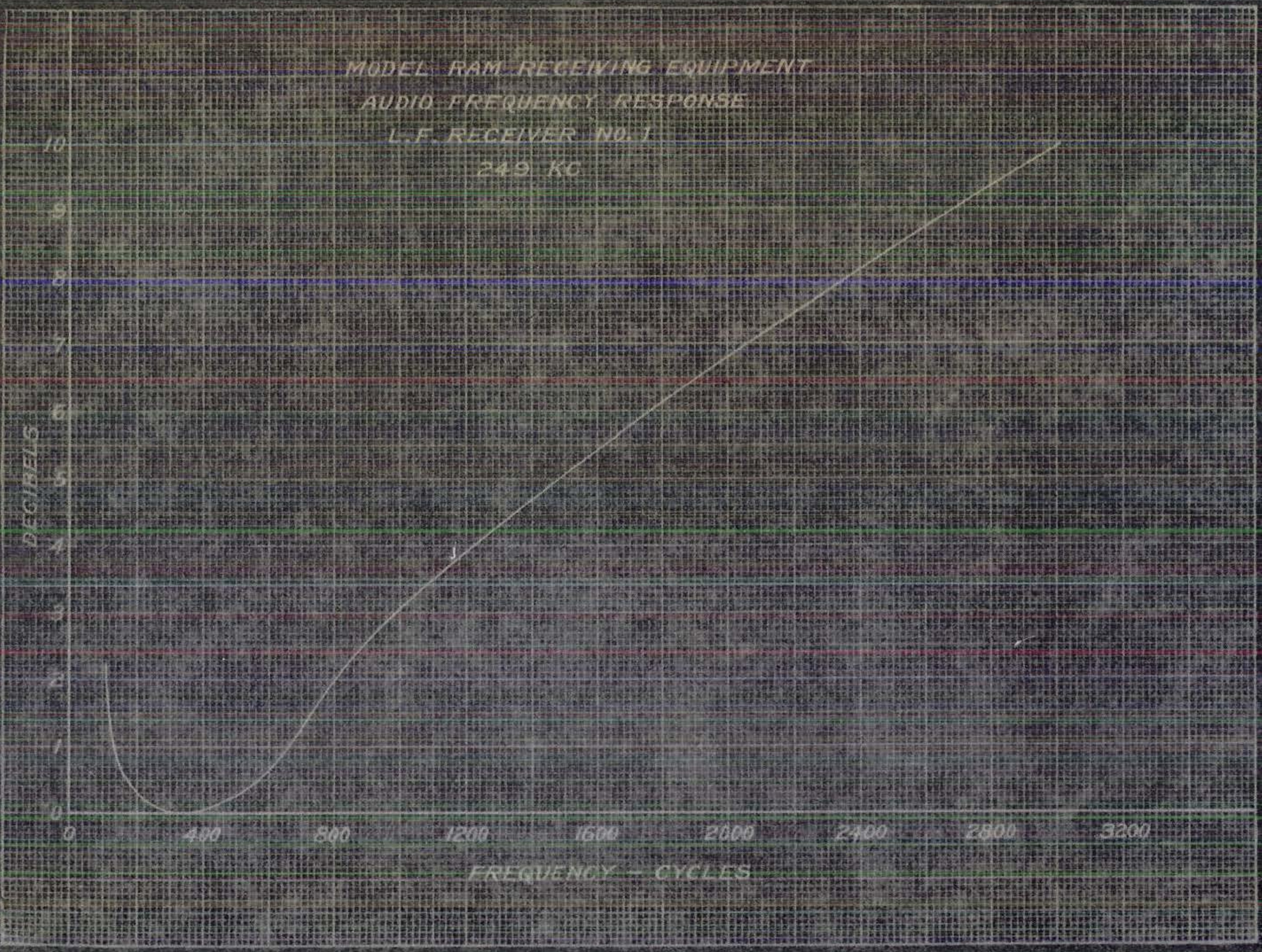
PLATE 14



MODEL RAM RECEIVING EQUIPMENT
SELECTIVITY
H.F. RECEIVER NO 2

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE

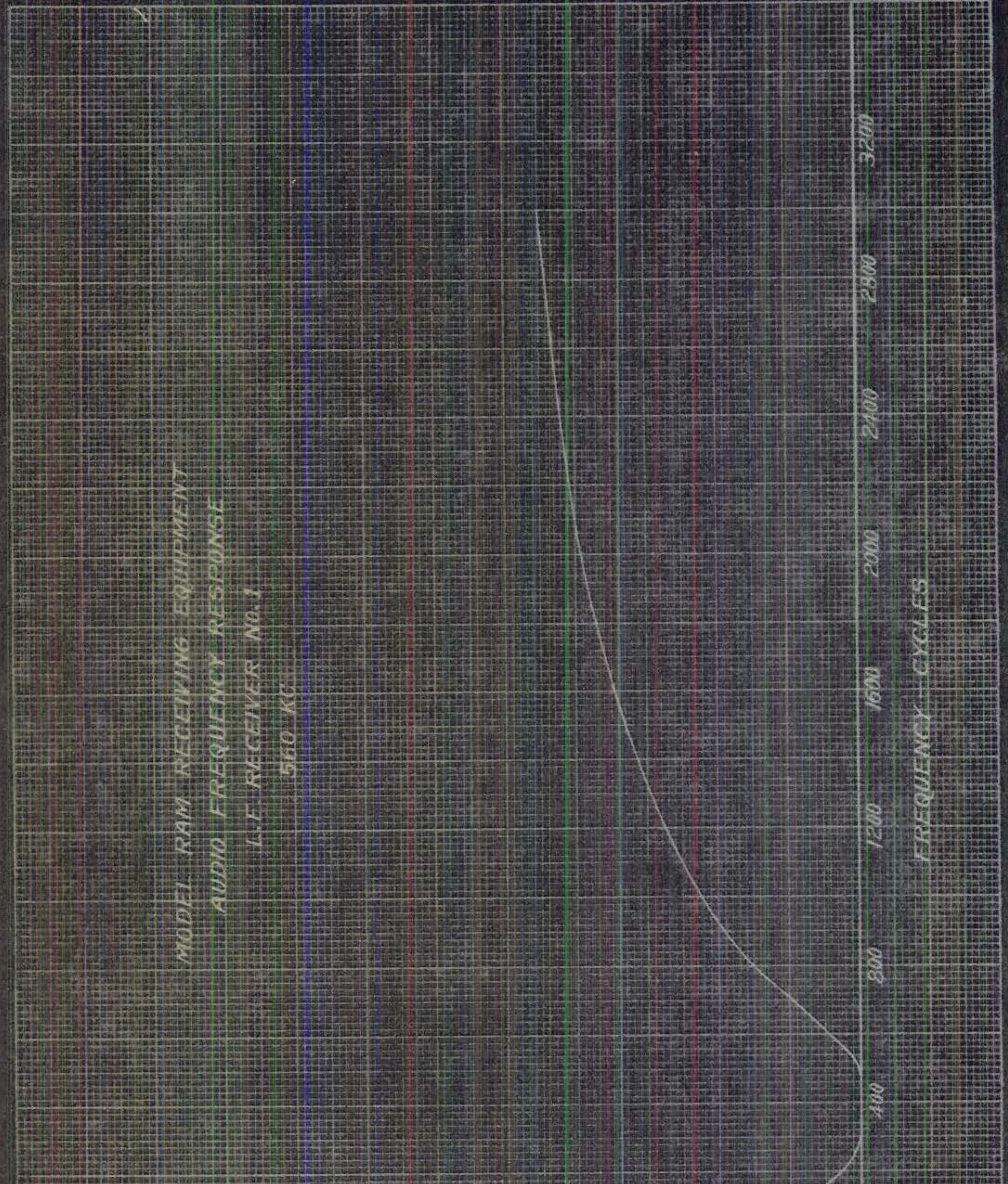


MODEL RAM RECEIVING EQUIPMENT
AUDIO FREQUENCY RESPONSE
L.F. RECEIVER NO. 1
249 KC

SHEET

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

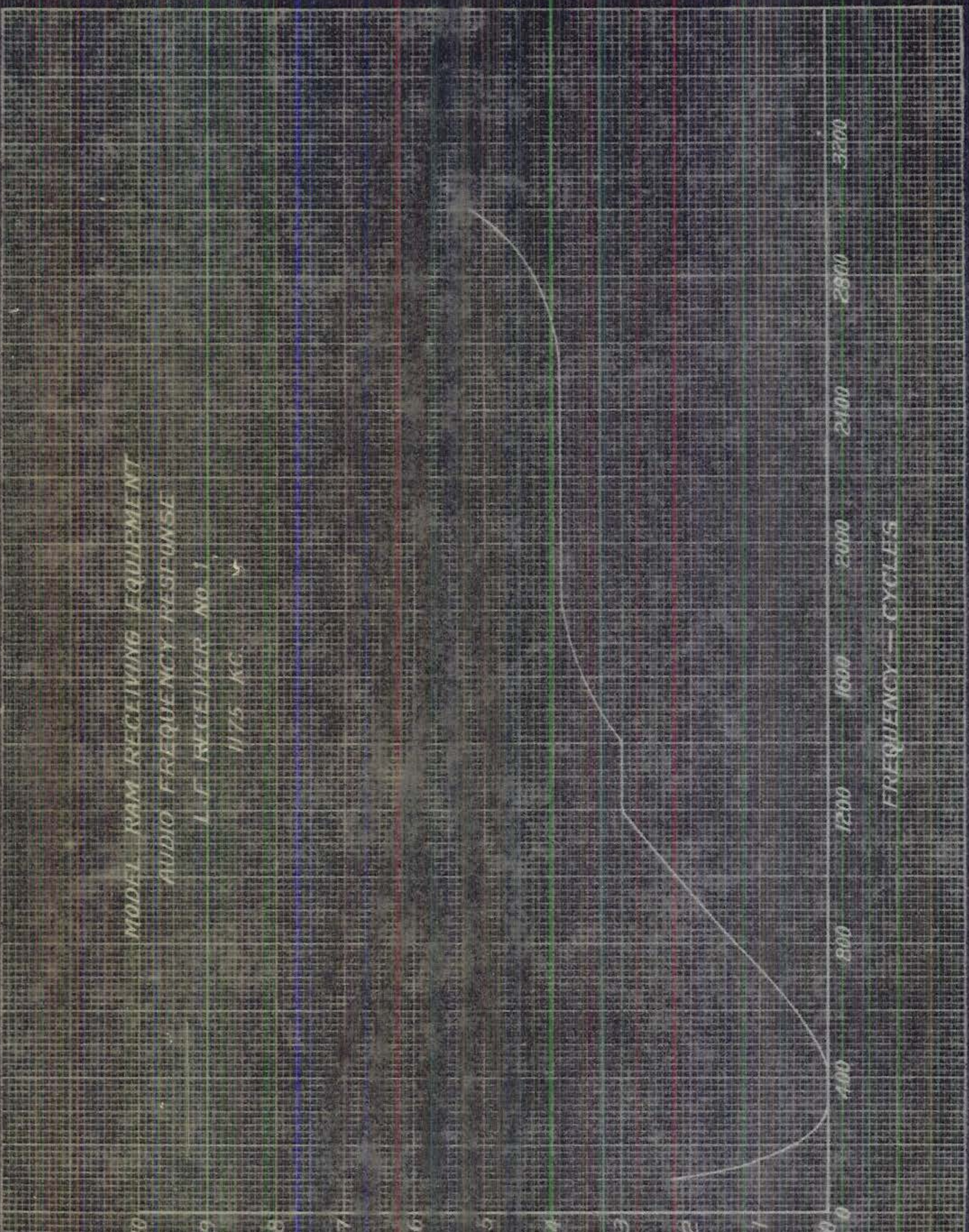
DATE


MODEL RAM RECEIVING EQUIPMENT
AUDIO FREQUENCY RESPONSE
L.F. RECEIVER No.1
560 KC

SHEET

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE



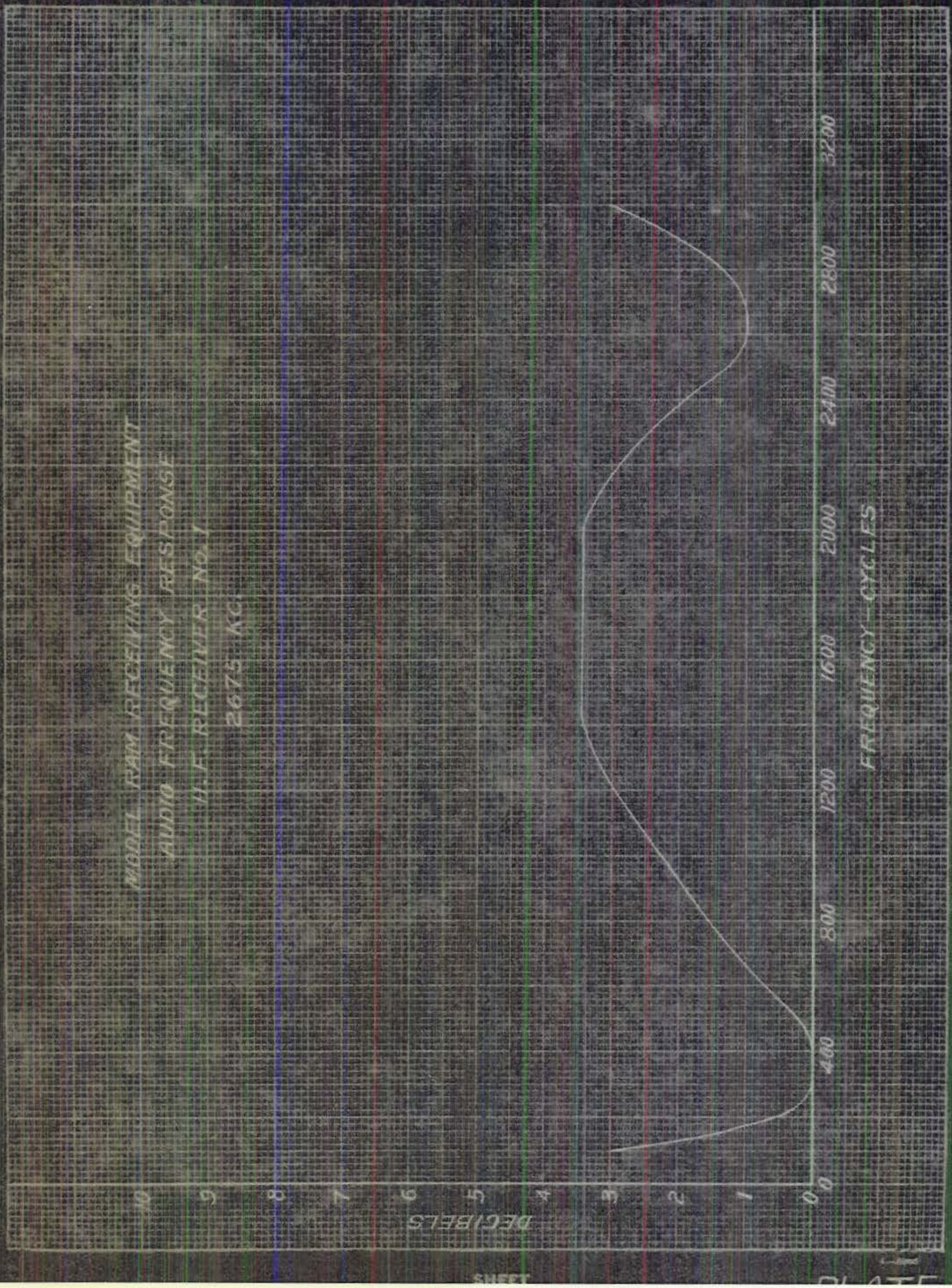
MODEL RAM RECEIVING EQUIPMENT
AUDIO FREQUENCY RESPONSE
L.F. RECEIVER No 1
175 KC

SHEET

PLATE 17

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE



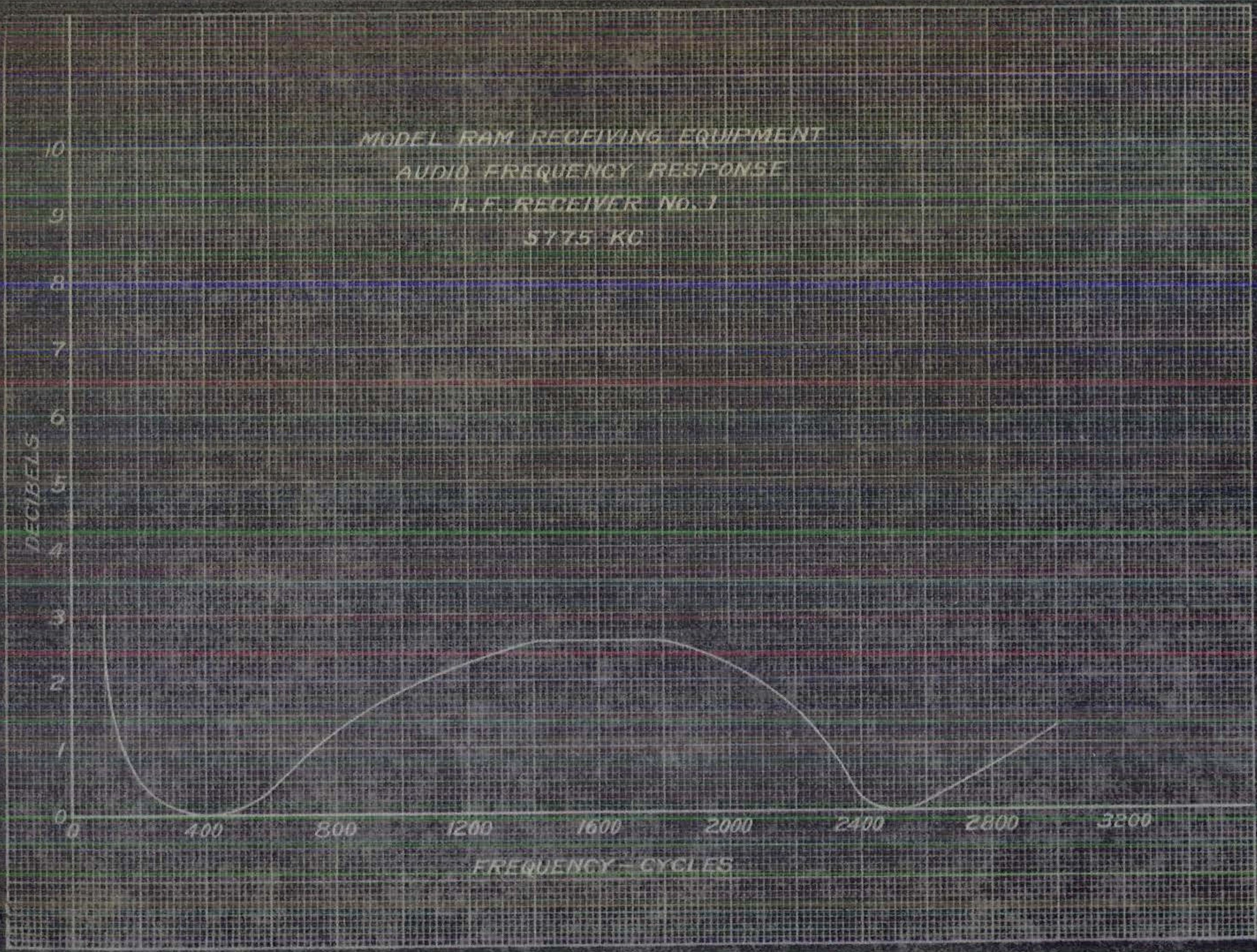
MODEL RAM RECEIVING EQUIPMENT
AUDIO FREQUENCY RESPONSE
H.F. RECEIVER NO.1
2675 KC.

SHEET

PLATE 1

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE

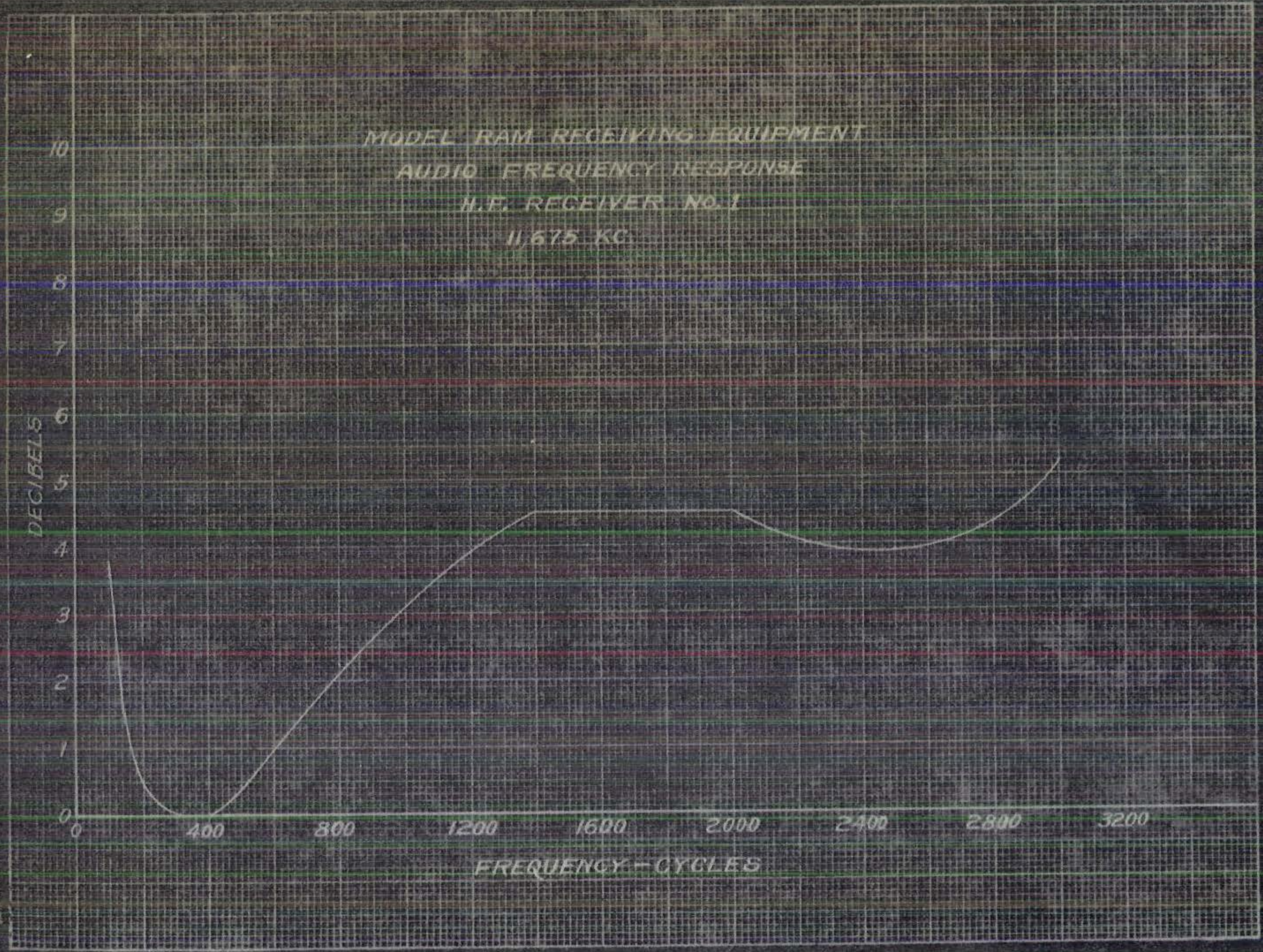


MODEL RAM RECEIVING EQUIPMENT
AUDIO FREQUENCY RESPONSE
H. F. RECEIVER No. 1
5775 KC

SHEET

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE

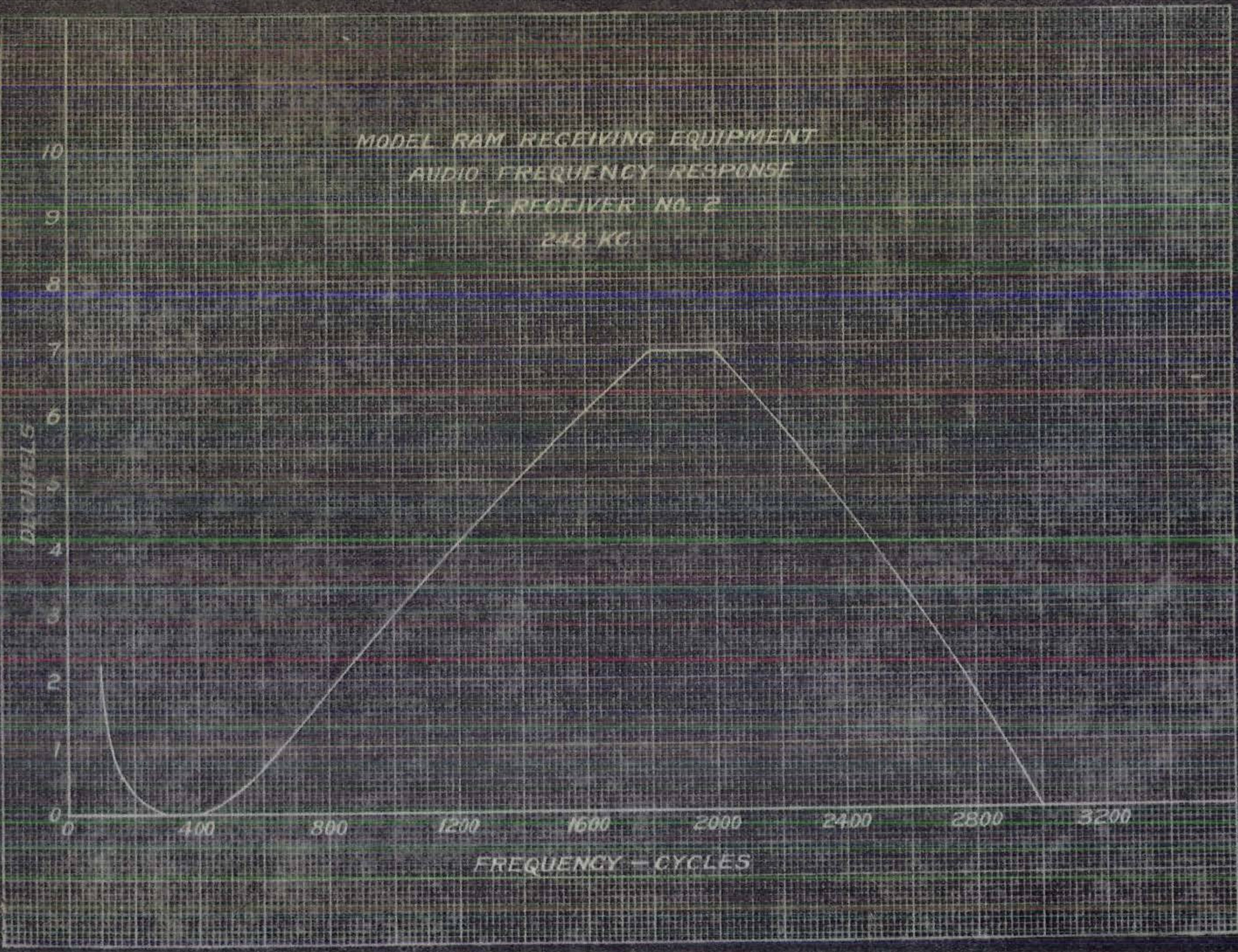


MODEL RAM RECEIVING EQUIPMENT
AUDIO FREQUENCY RESPONSE
H.F. RECEIVER No. 1
11,675 KC

N.R.L. 34

SHEET

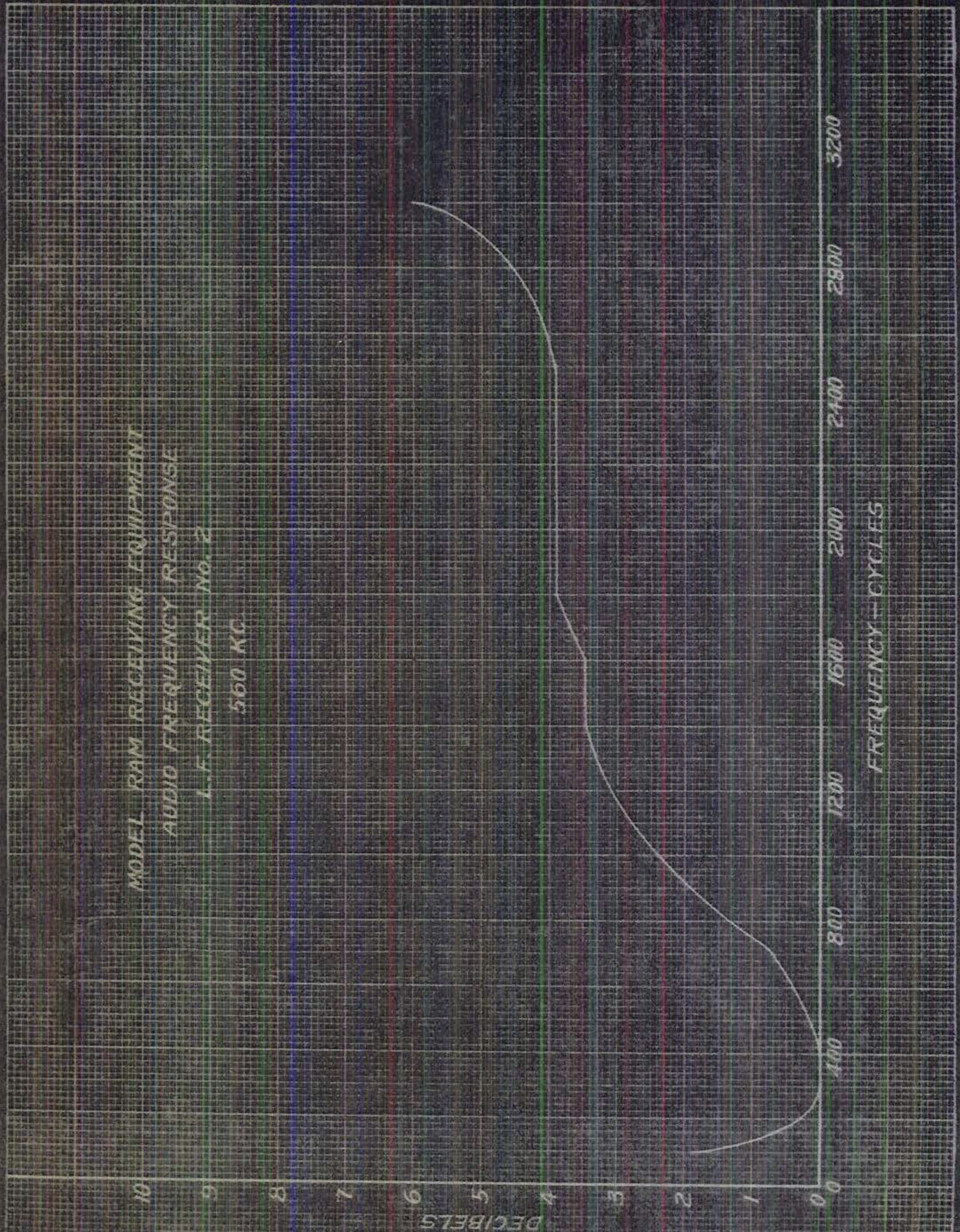
PLATE 20



MODEL RAM RECEIVING EQUIPMENT
AUDIO FREQUENCY RESPONSE
L.F. RECEIVER No. 2
248 KC.

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE

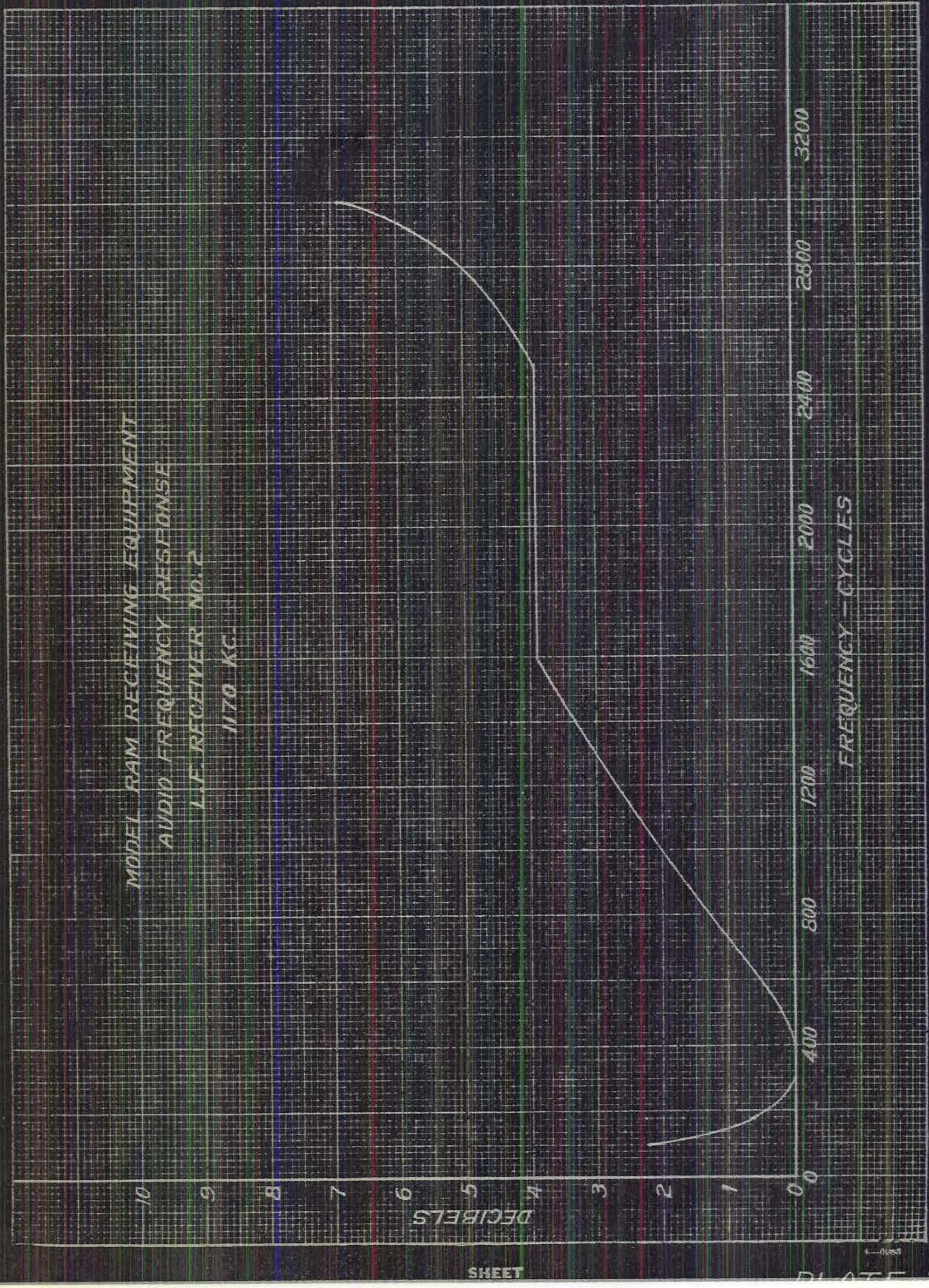


MODEL RAM RECEIVING EQUIPMENT
AUDIO FREQUENCY RESPONSE
L.F. RECEIVER No. 2
560 KC

SHEET

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE

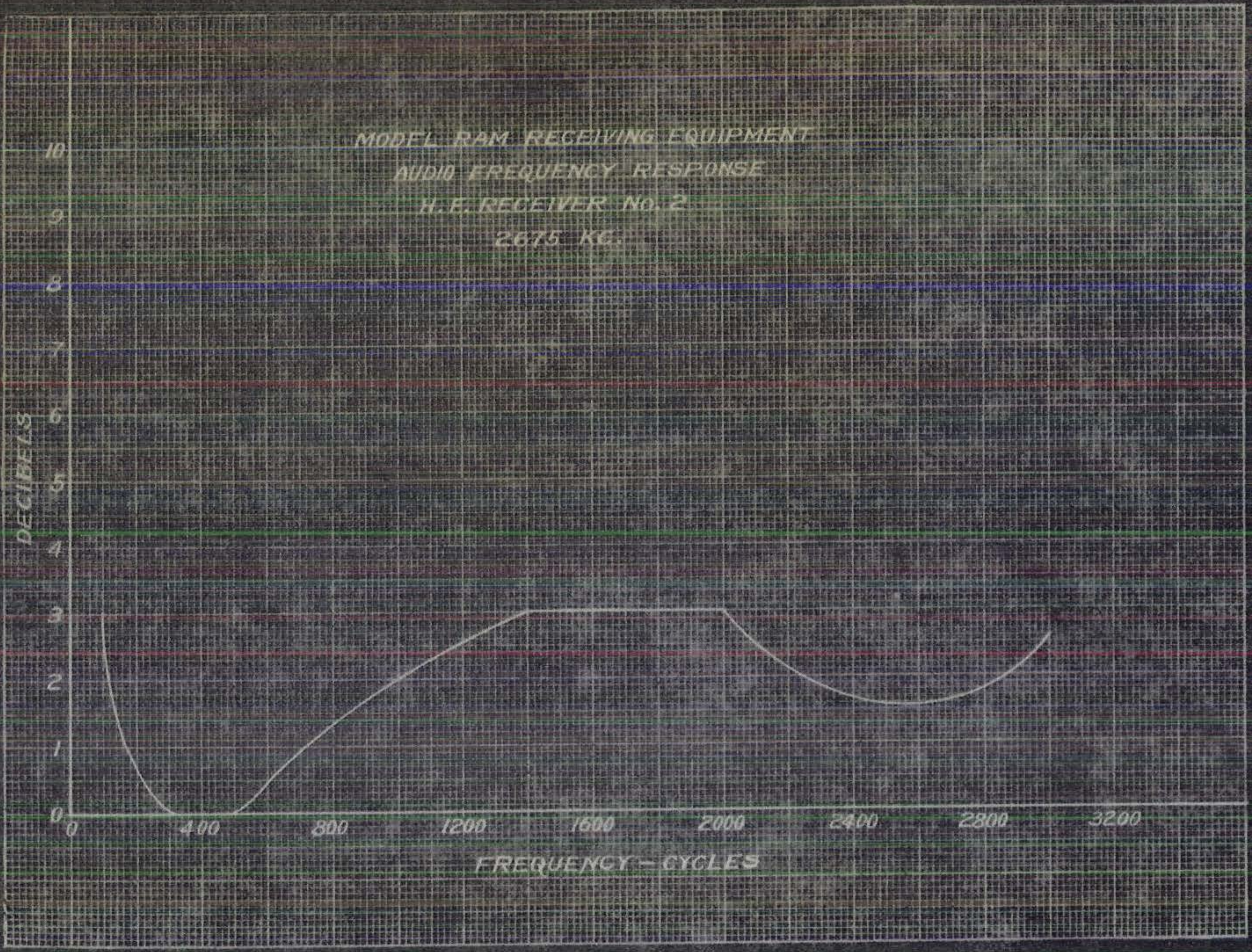


MODEL RAM RECEIVING EQUIPMENT
AUDIO FREQUENCY RESPONSE
L.F. RECEIVER No. 2
1170 KC.

N. R. L. 31

SHEET

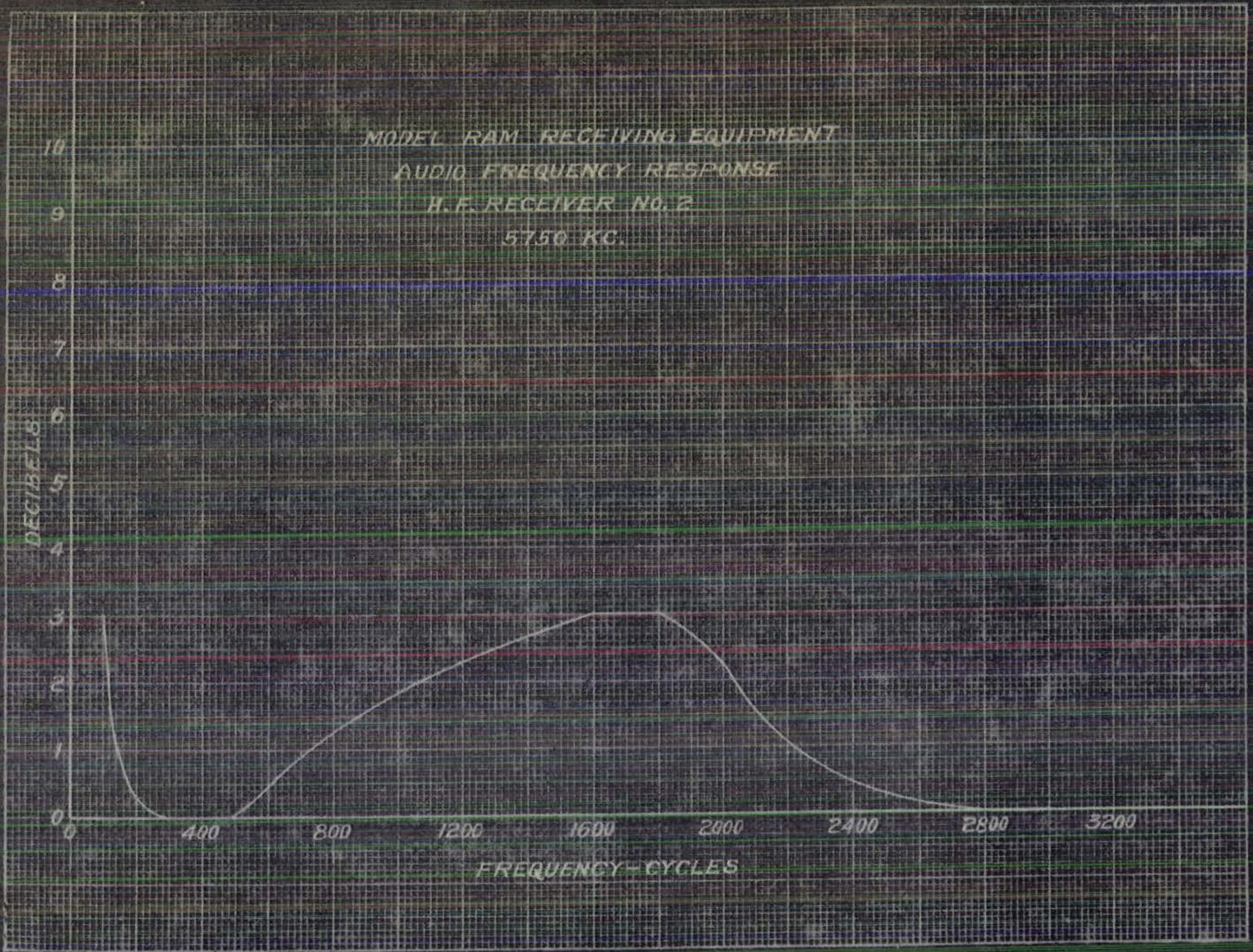
PLATE 3



MODEL RAM RECEIVING EQUIPMENT
AUDIO FREQUENCY RESPONSE
H. F. RECEIVER No. 2
2675 KC.

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE



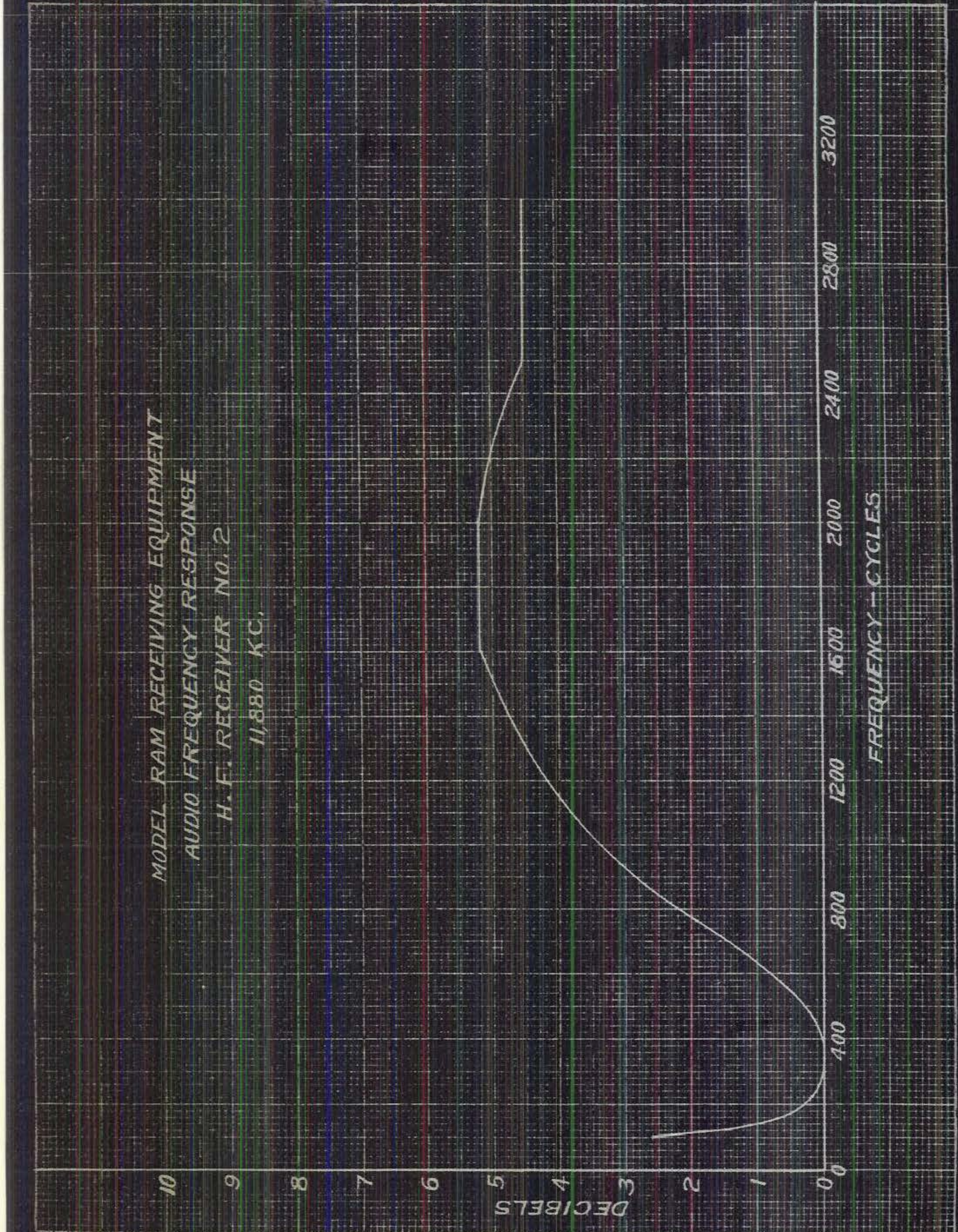
MODEL RAM RECEIVING EQUIPMENT
AUDIO FREQUENCY RESPONSE
H.F. RECEIVER No. 2
5750 KC.

SHEET

PLATE 35

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE



MODEL RAM RECEIVING EQUIPMENT
AUDIO FREQUENCY RESPONSE
H. F. RECEIVER NO. 2
11,880 KC.

SHEET

PLATE 26

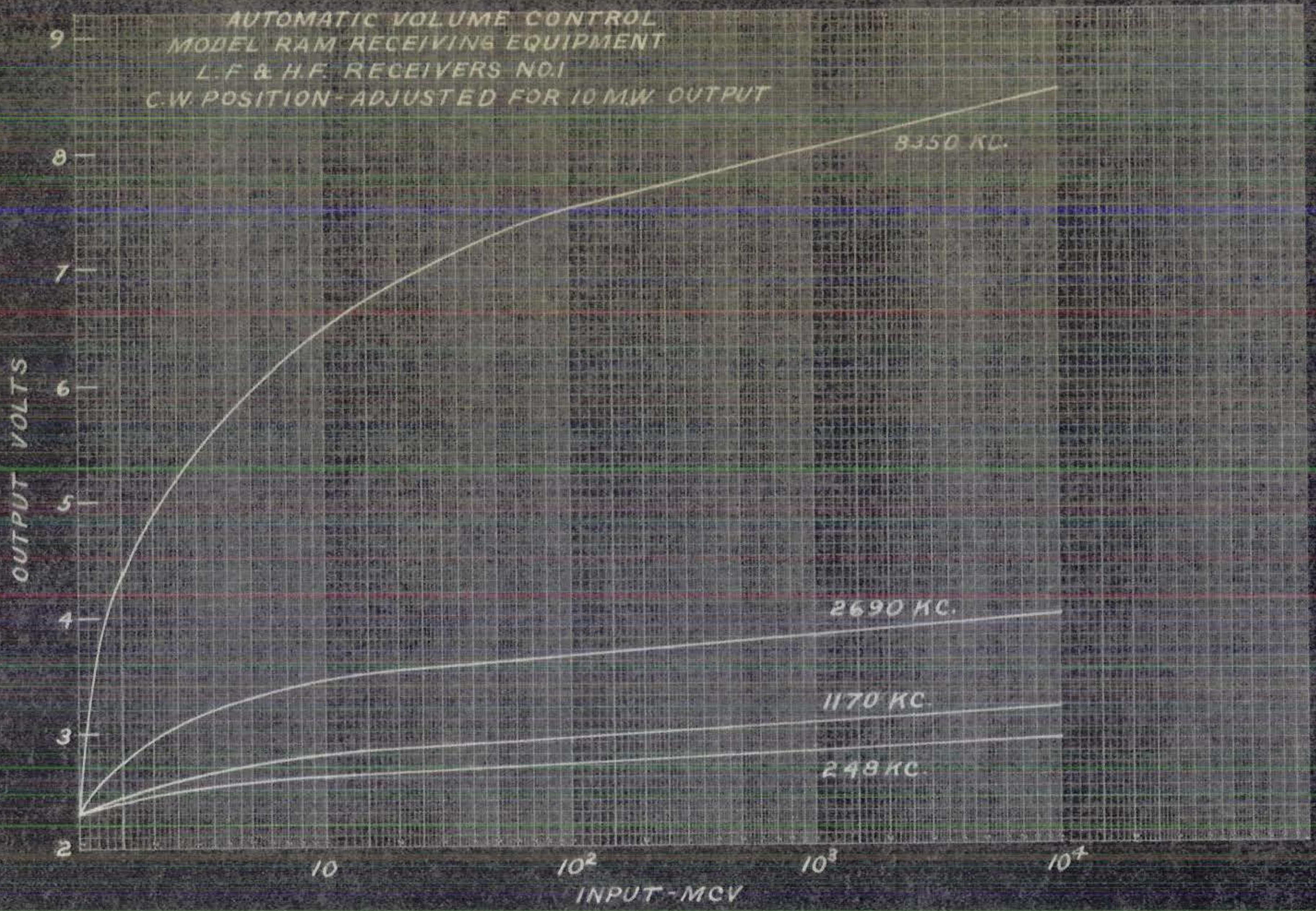

AUTOMATIC VOLUME CONTROL
MODEL RAM RECEIVING EQUIPMENT
L.F. & H.F. RECEIVERS NO.1
C.W. POSITION - ADJUSTED FOR 10 M.W. OUTPUT
8350 KC.
2690 KC.
1170 KC.
248 KC.
OUTPUT VOLTS
9
8
7
6
5
4
3
2
10
10^2
10^3
10^4
INPUT - MCV

PLATE 27

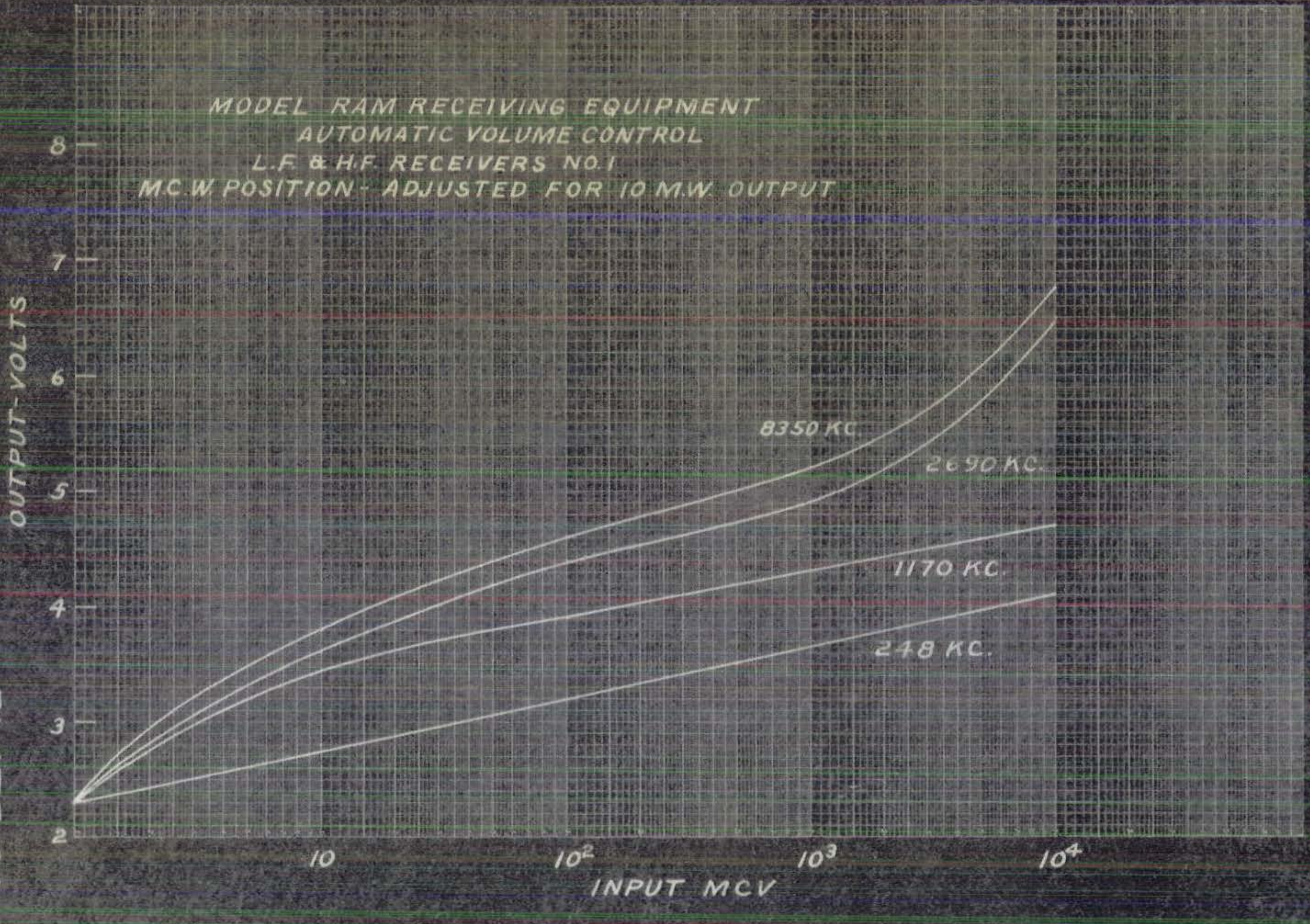

MODEL RAM RECEIVING EQUIPMENT
AUTOMATIC VOLUME CONTROL
L.F. & H.F. RECEIVERS NO.1
M.C.W. POSITION - ADJUSTED FOR 10 M.W. OUTPUT
8350 KC.
2690 KC.
1170 KC.
248 KC.
OUTPUT-VOLTS
8
7
6
5
4
3
2
10
10^2
10^3
10^4
INPUT MCV

PLATE 28

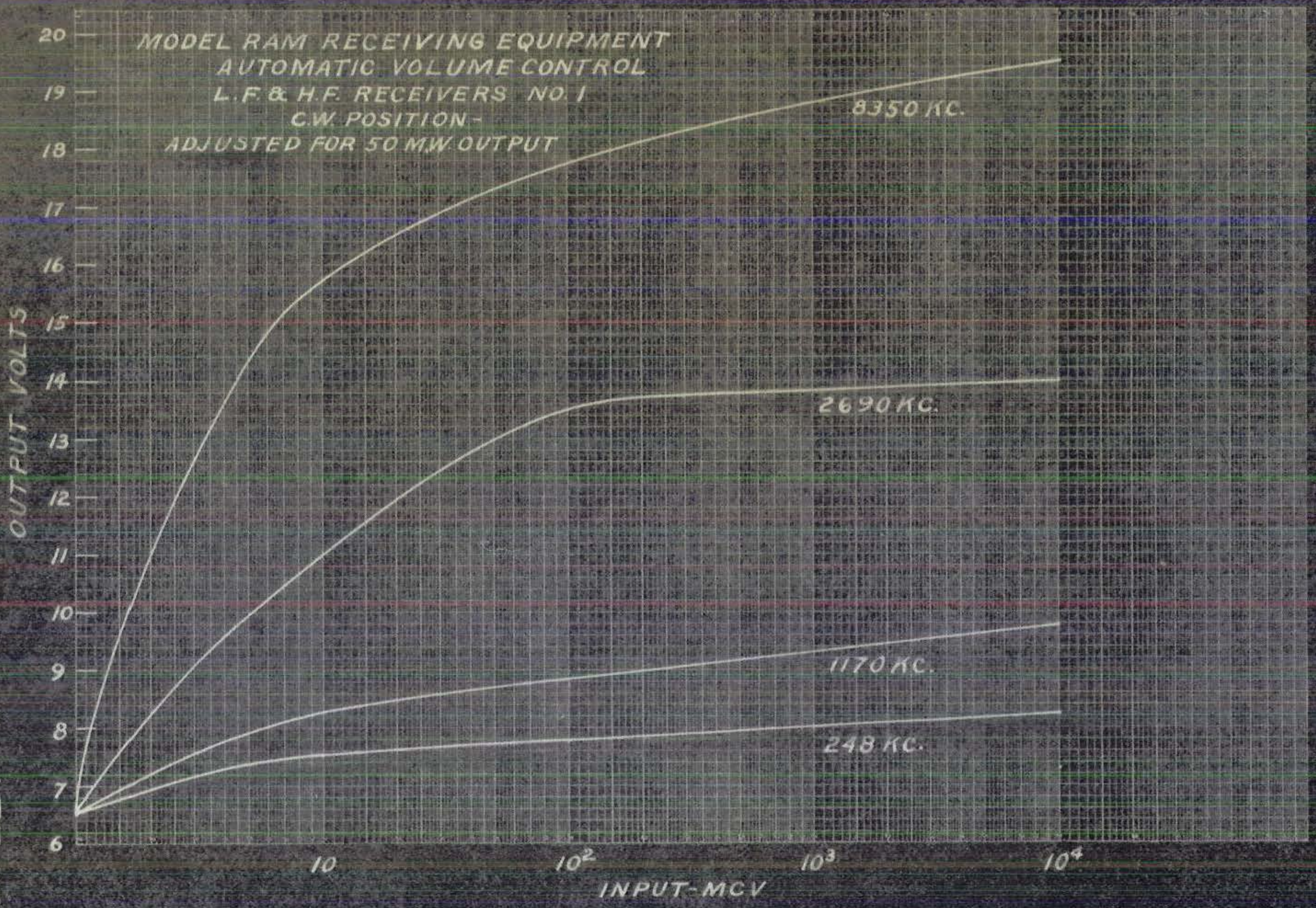

MODEL RAM RECEIVING EQUIPMENT
AUTOMATIC VOLUME CONTROL
L.F. & H.F. RECEIVERS NO. 1
C.W. POSITION-
ADJUSTED FOR 50 M.W. OUTPUT
8350 KC.
2690 KC.
1170 KC.
248 KC.
OUTPUT VOLTS
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
10
10^2
10^3
10^4
INPUT-MCV

PLATE 29

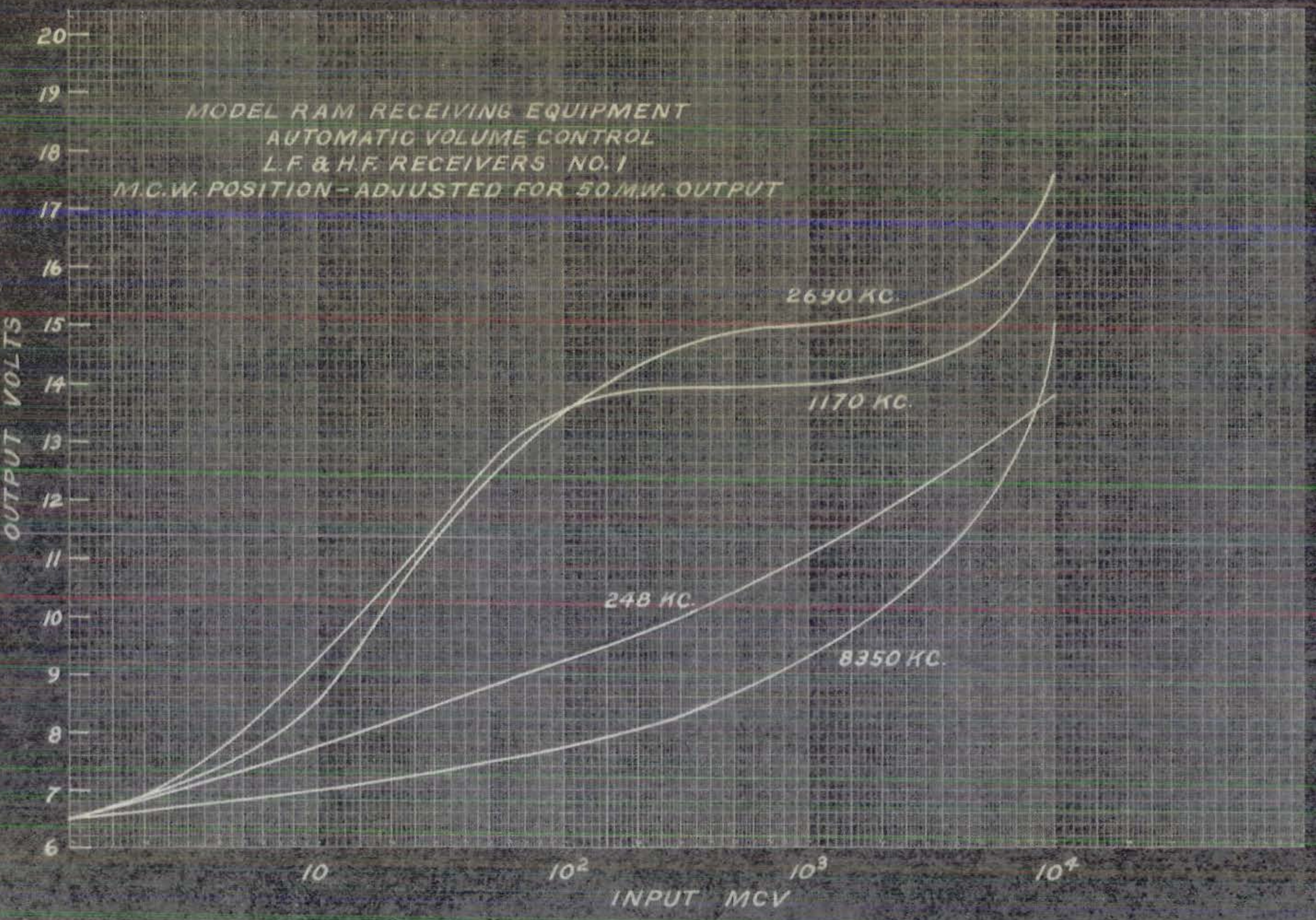
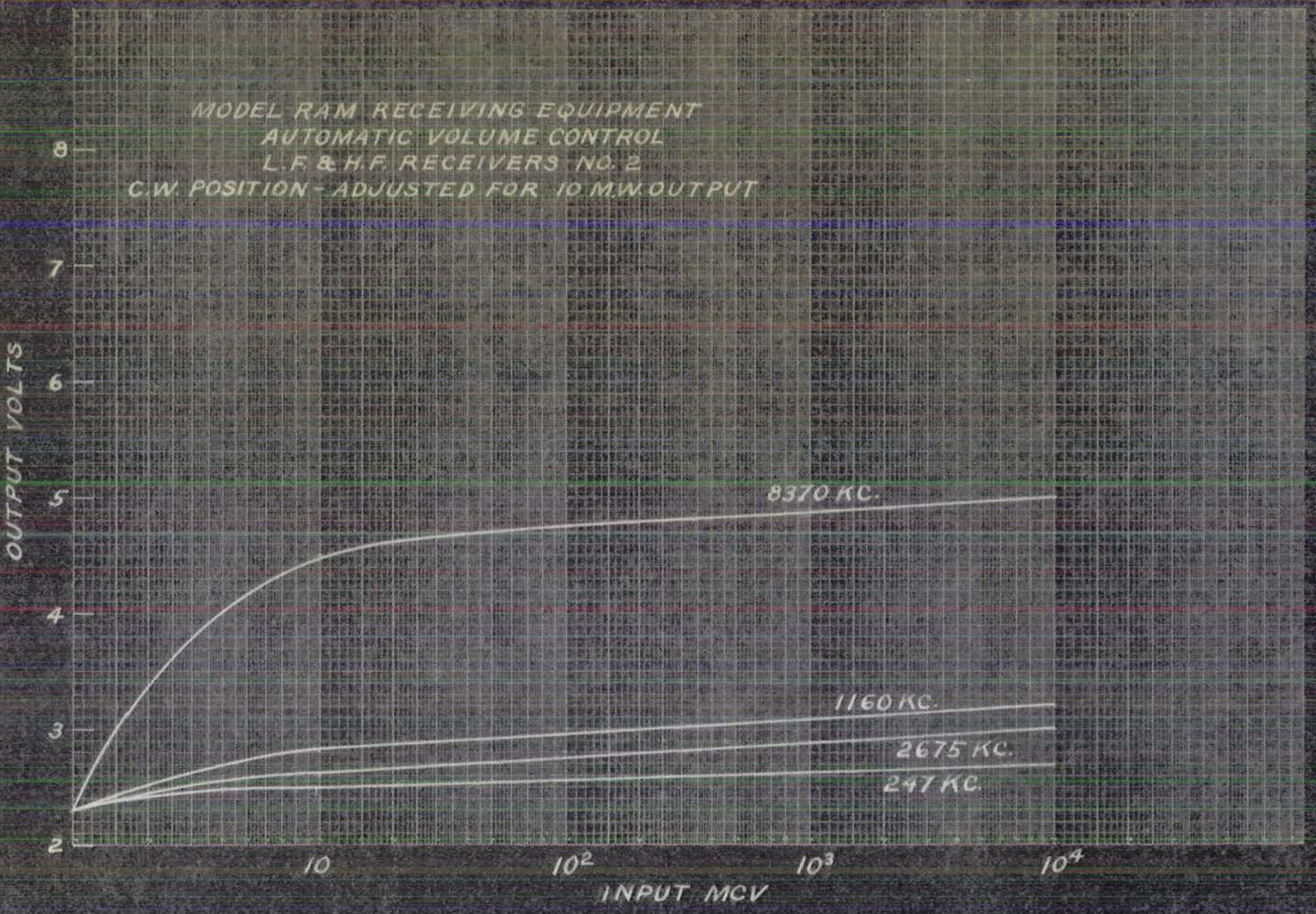
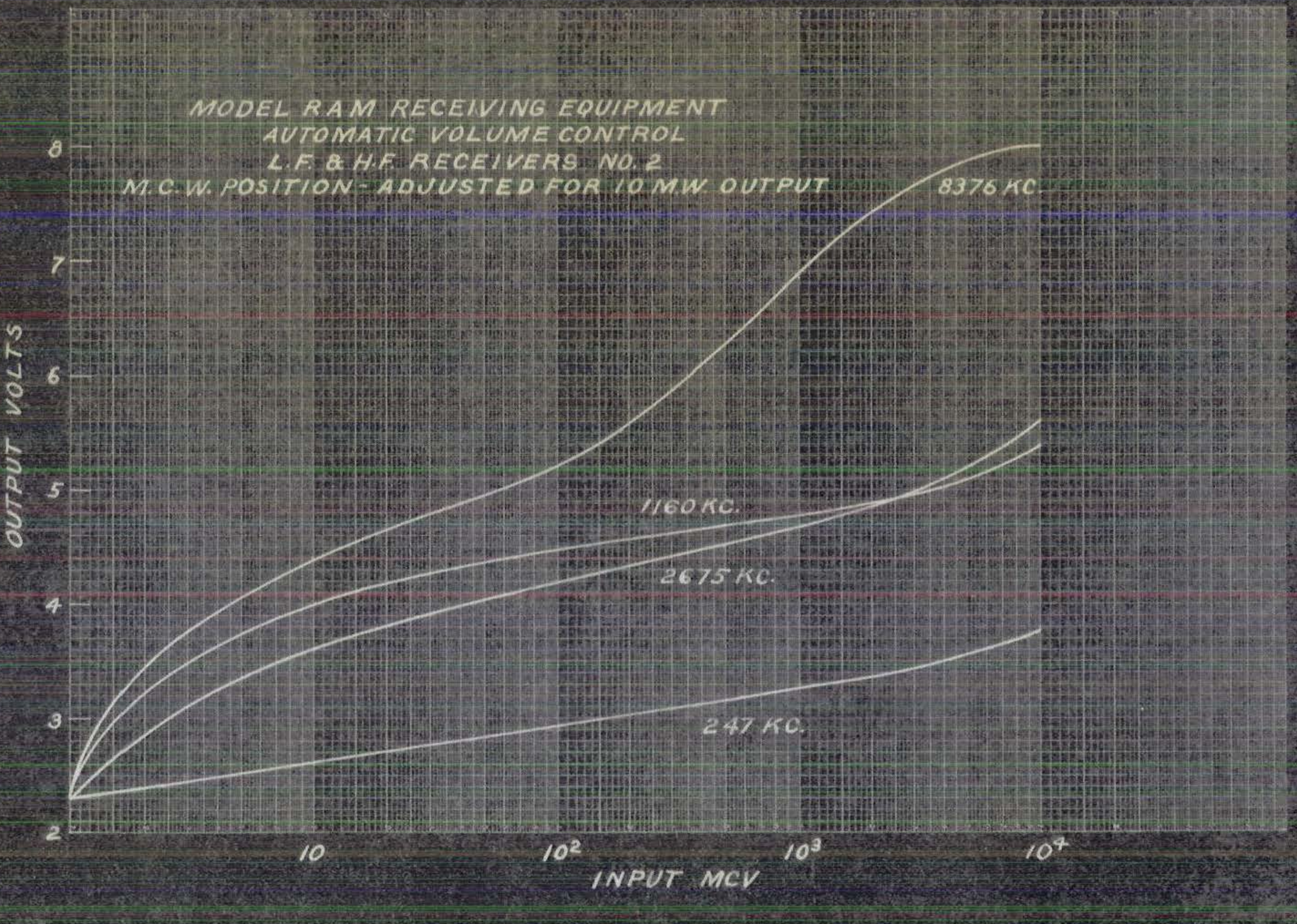

MODEL RAM RECEIVING EQUIPMENT
AUTOMATIC VOLUME CONTROL
L.F. & H.F. RECEIVERS NO. 1
M.C.W. POSITION - ADJUSTED FOR 50 MW. OUTPUT
OUTPUT VOLTS
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
INPUT MCV
10
10^2
10^3
10^4
2690 KC.
1170 KC.
248 KC.
8350 KC.

PLATE 30



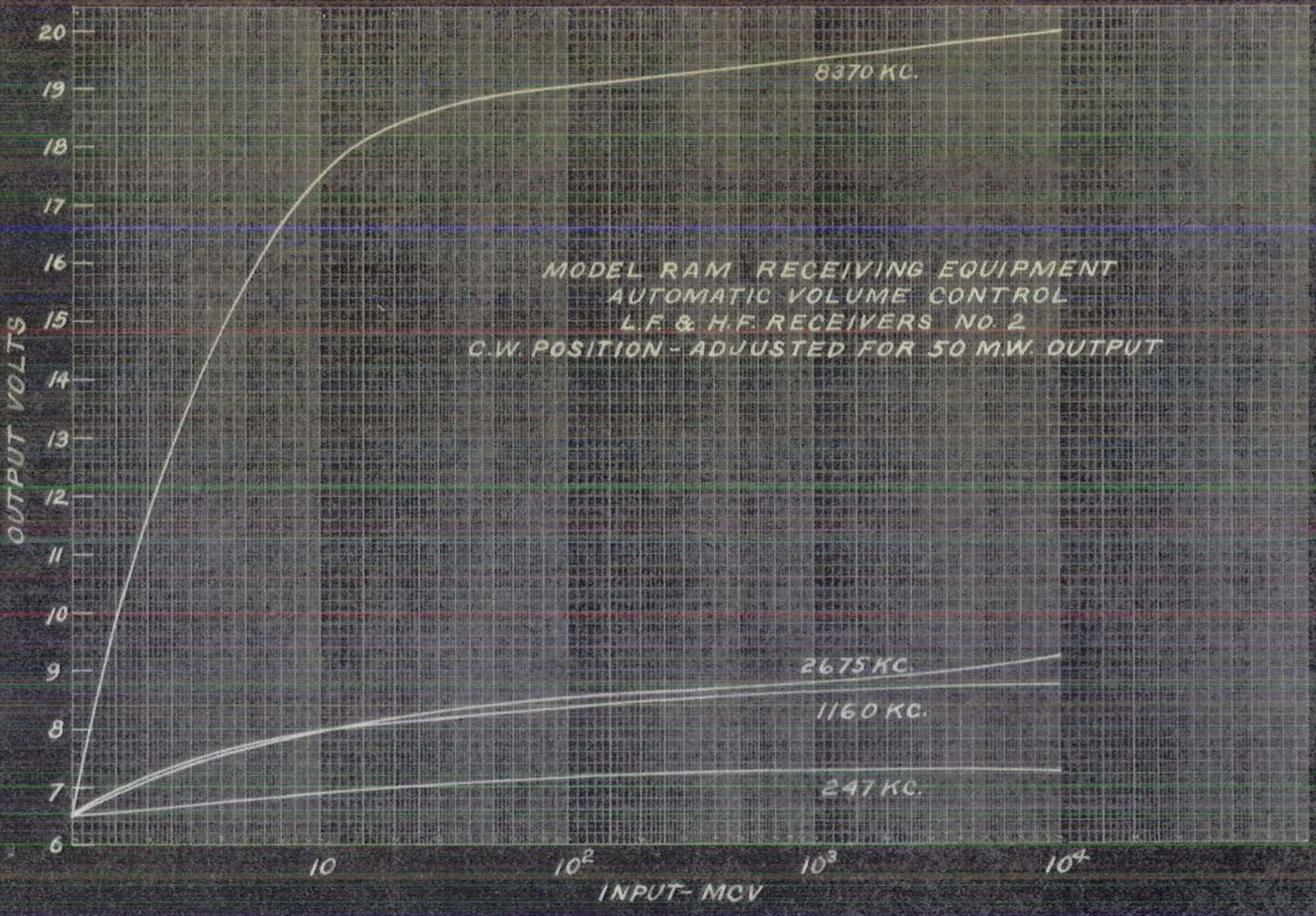
MODEL RAM RECEIVING EQUIPMENT
AUTOMATIC VOLUME CONTROL
L.F. & H.F. RECEIVERS NO. 2
C.W. POSITION - ADJUSTED FOR 10 M.W. OUTPUT

PLATE 31



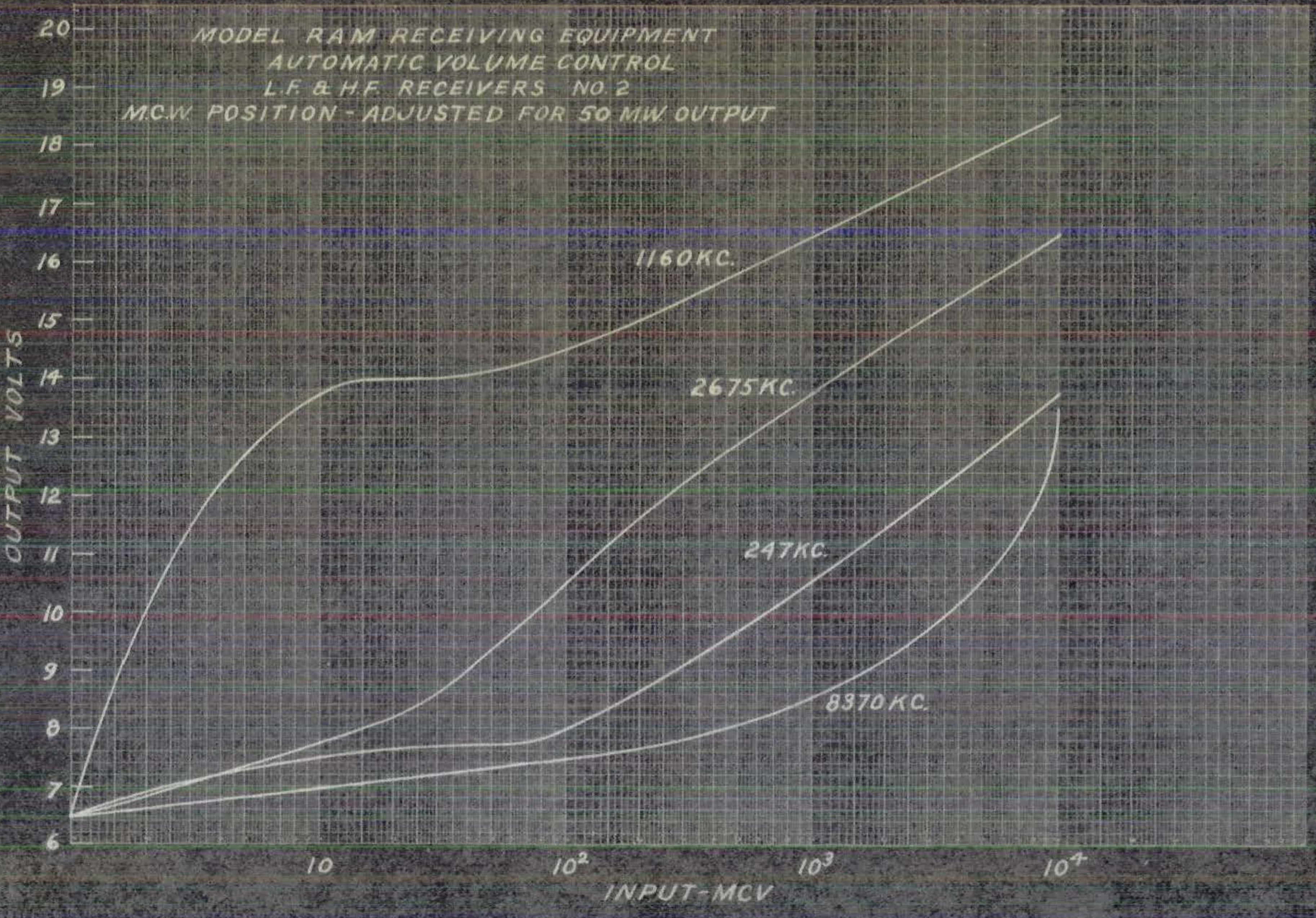
MODEL RAM RECEIVING EQUIPMENT
AUTOMATIC VOLUME CONTROL
L.F. & H.F. RECEIVERS NO. 2
M.C.W. POSITION - ADJUSTED FOR 10 M.W. OUTPUT

PLATE 32



MODEL RAM RECEIVING EQUIPMENT
AUTOMATIC VOLUME CONTROL
L.F. & H.F. RECEIVERS NO. 2
C.W. POSITION - ADJUSTED FOR 50 M.W. OUTPUT

PLATE 33

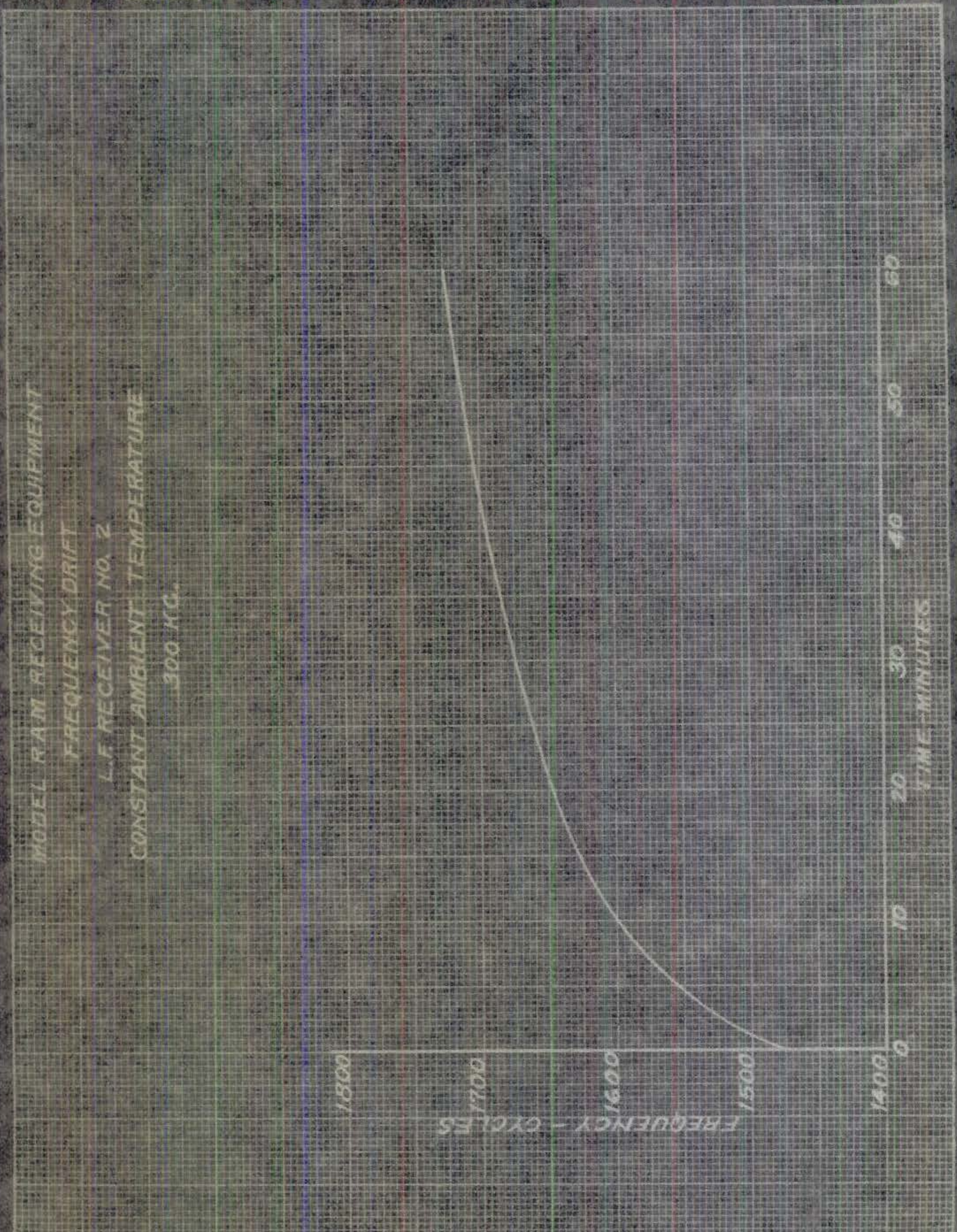


MODEL RAM RECEIVING EQUIPMENT
AUTOMATIC VOLUME CONTROL
L.F. & H.F. RECEIVERS NO. 2
M.C.W. POSITION - ADJUSTED FOR 50 MW OUTPUT

PLATE 34

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE



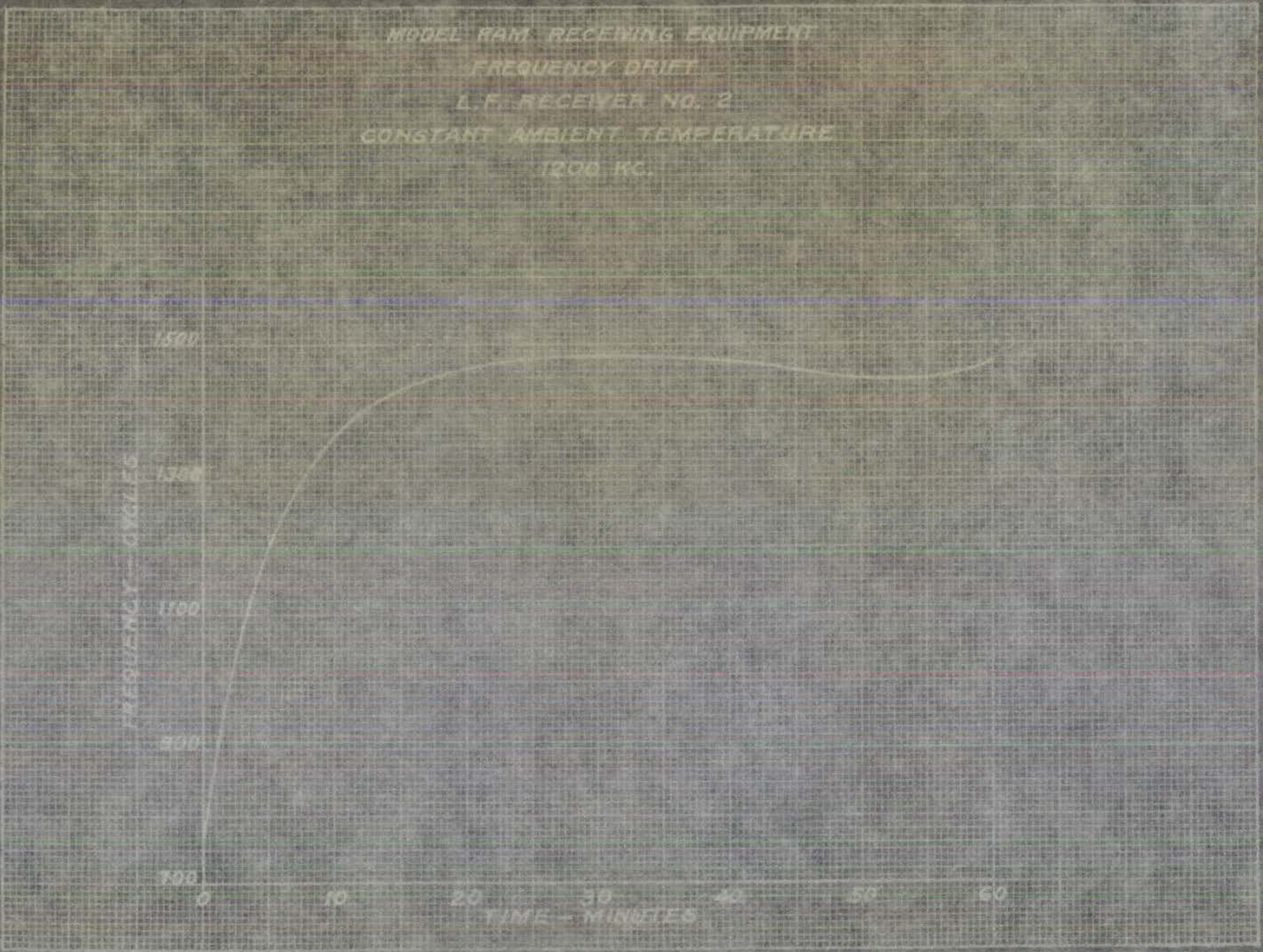
MODEL RAM RECEIVING EQUIPMENT
FREQUENCY DRIFT
L.F. RECEIVER NO. 2
CONSTANT AMBIENT TEMPERATURE
300 KC.

SHEET

PLATE 35

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE


MODEL RAM RECEIVING EQUIPMENT
FREQUENCY DRIFT
L.F. RECEIVER NO. 2
CONSTANT AMBIENT TEMPERATURE
1200 KC.

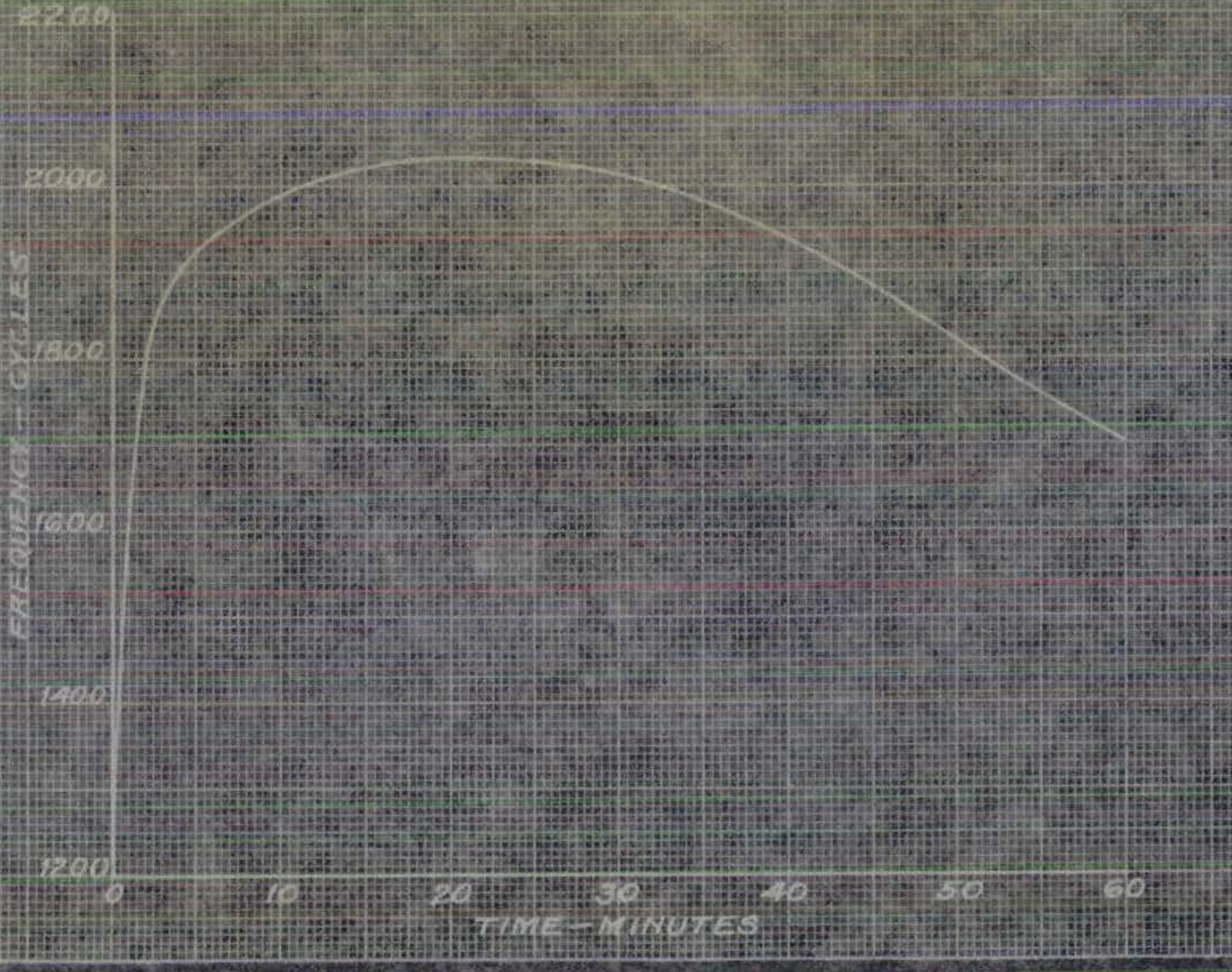
SHEET

PLATE 3

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE

MODEL R A M RECEIVING EQUIPMENT
FREQUENCY DRIFT
H.F. RECEIVER NO. 2
CONSTANT AMBIENT TEMPERATURE
2000 KC.



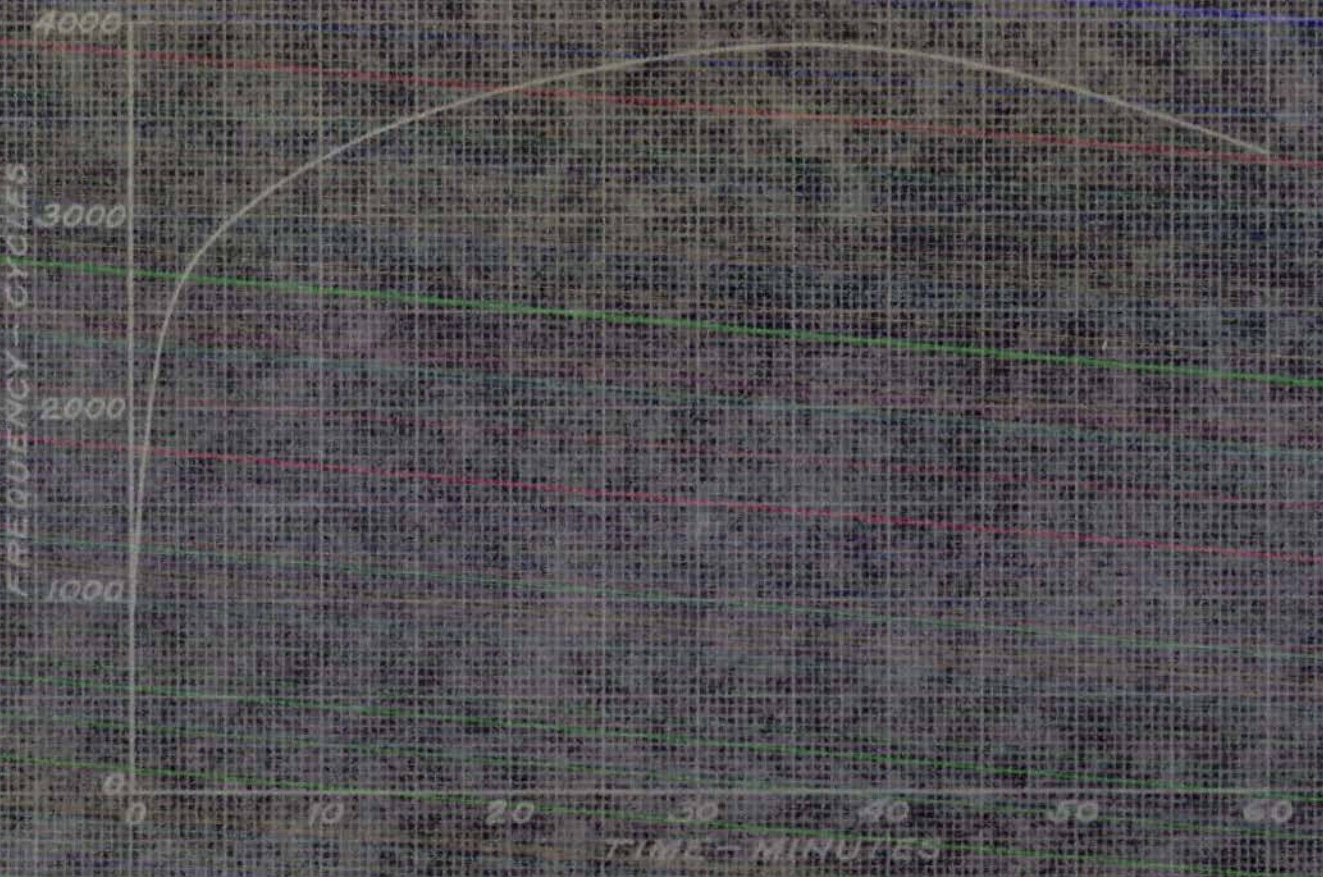
SHEET

PLATE 37

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

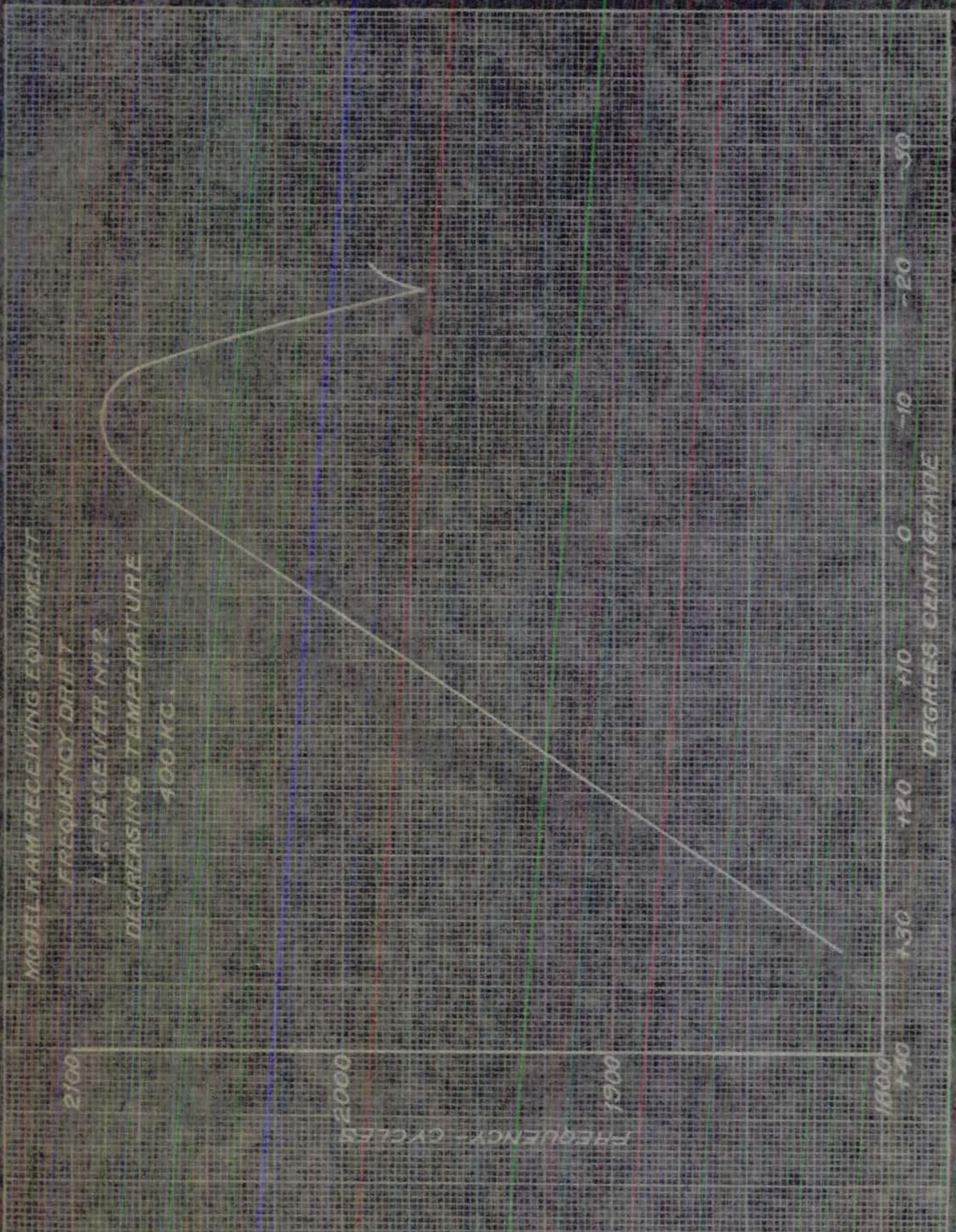
DATE

MODEL RAM RECEIVING EQUIPMENT
FREQUENCY DRIFT
H.F. RECEIVER Nº 2
CONSTANT AMBIENT TEMPERATURE
8400 KC.



SHEET

PLATE 38



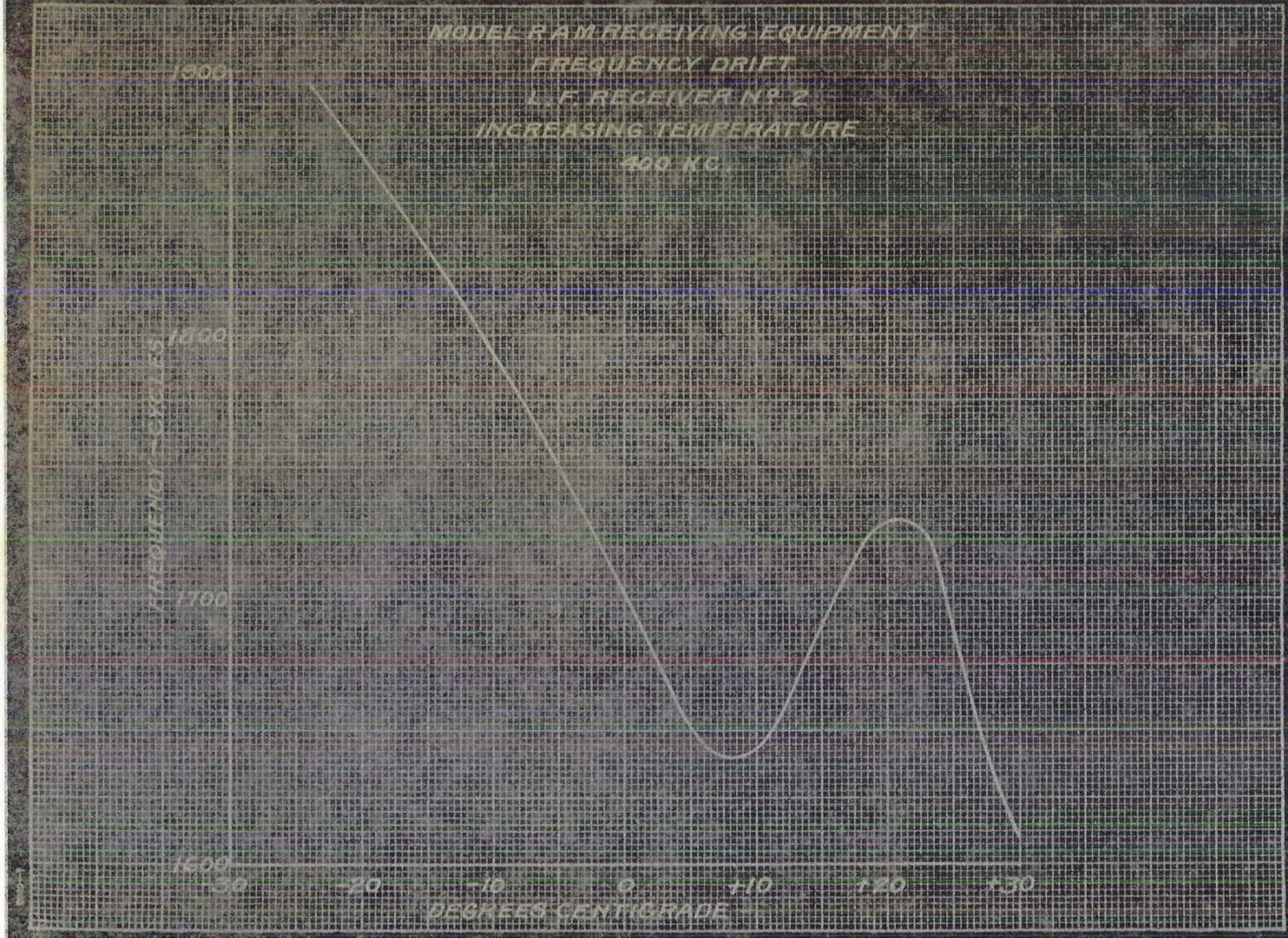
MODEL RAM RECEIVING EQUIPMENT
FREQUENCY DRIFT
L.F. RECEIVER No. 2
DECREASING TEMPERATURE
400 KC.

SHEET

PLATE 39

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE



MODEL RAM RECEIVING EQUIPMENT
FREQUENCY DRIFT
L. F. RECEIVER Nº 2
INCREASING TEMPERATURE
400 KC.

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

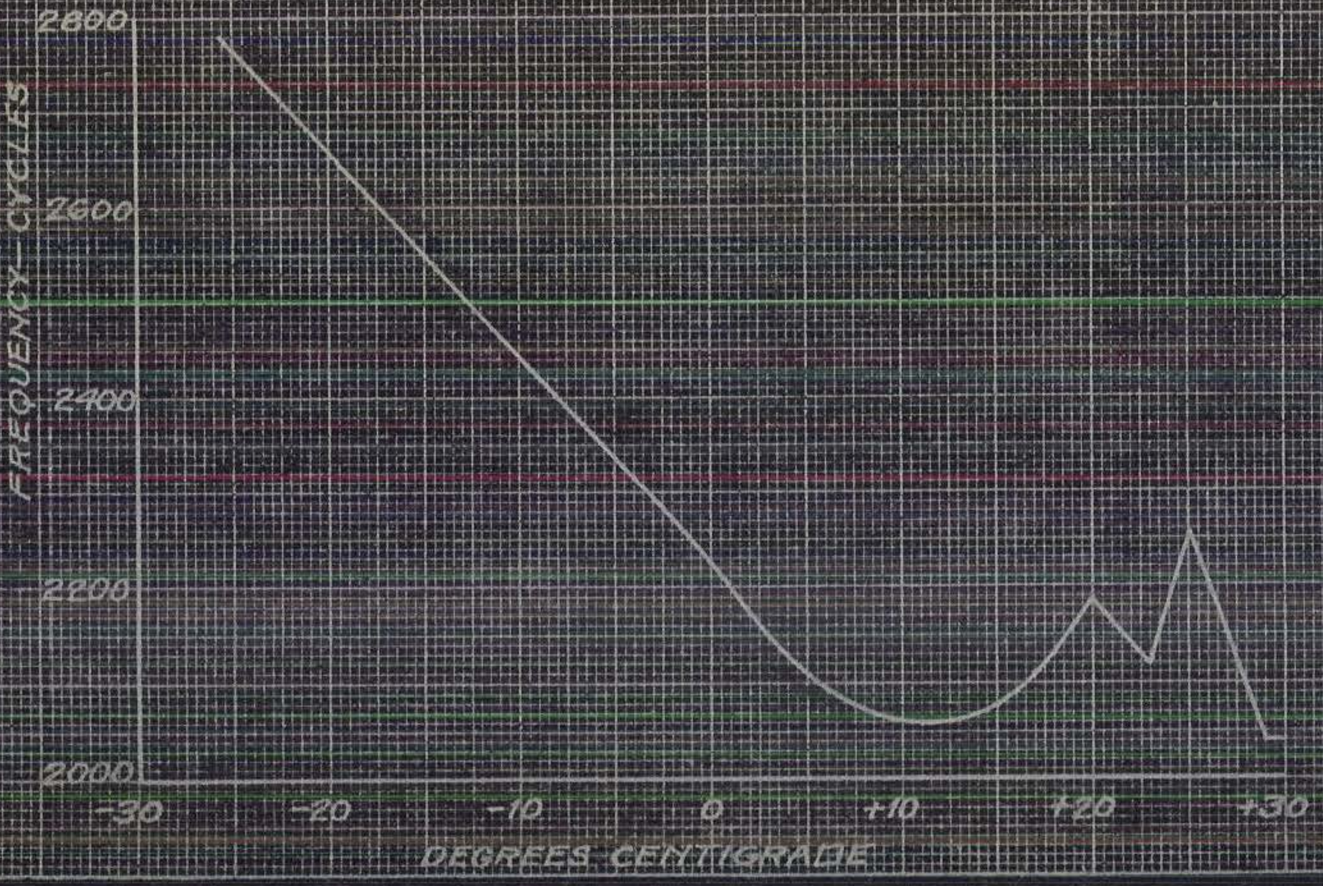
DATE

4—6983 N. R. L. 34

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

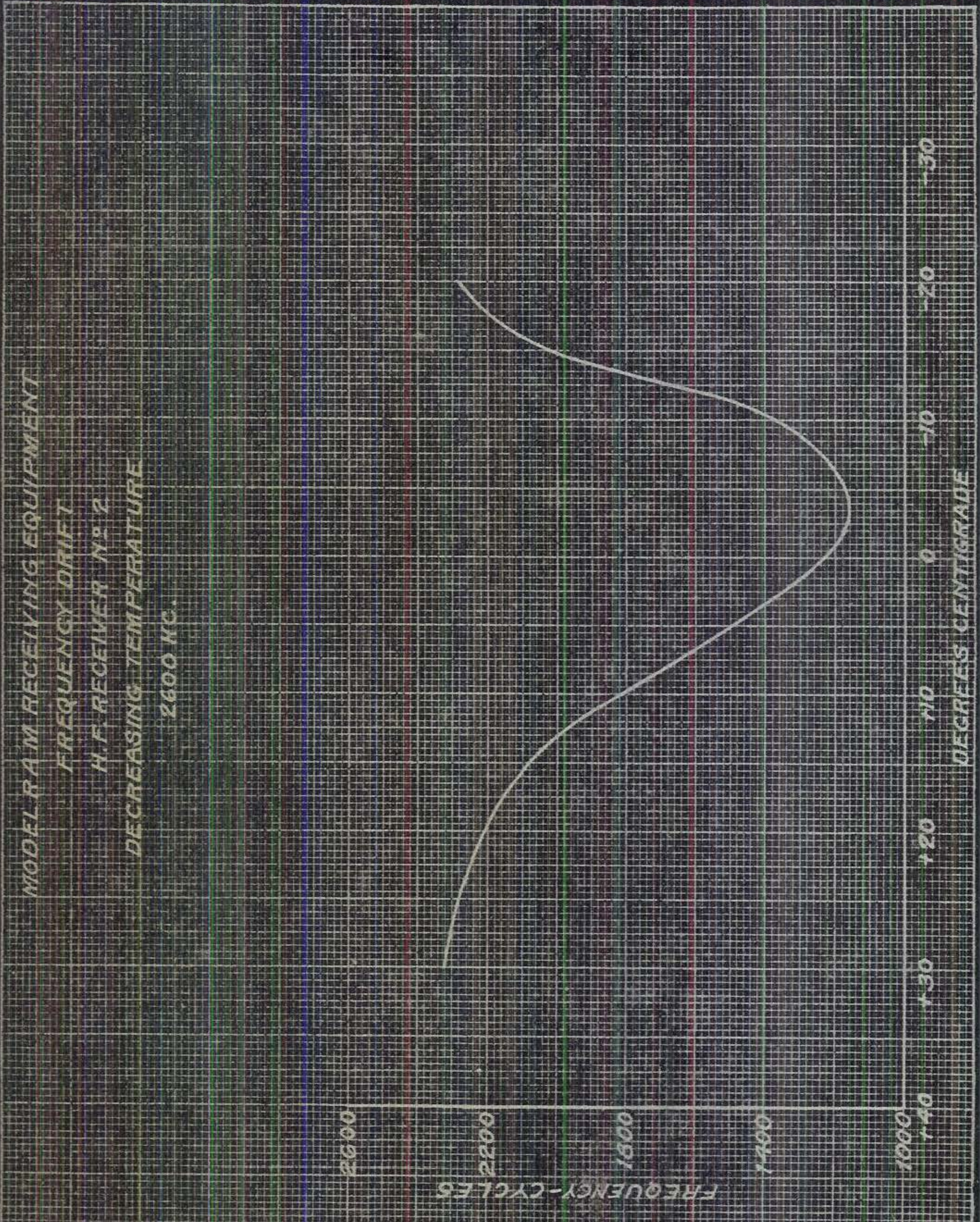
DATE

MODEL RAM RECEIVING EQUIPMENT
FREQUENCY DRIFT
L. F. RECEIVER Nº 2
INCREASING TEMPERATURE
1200 KC.



U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE

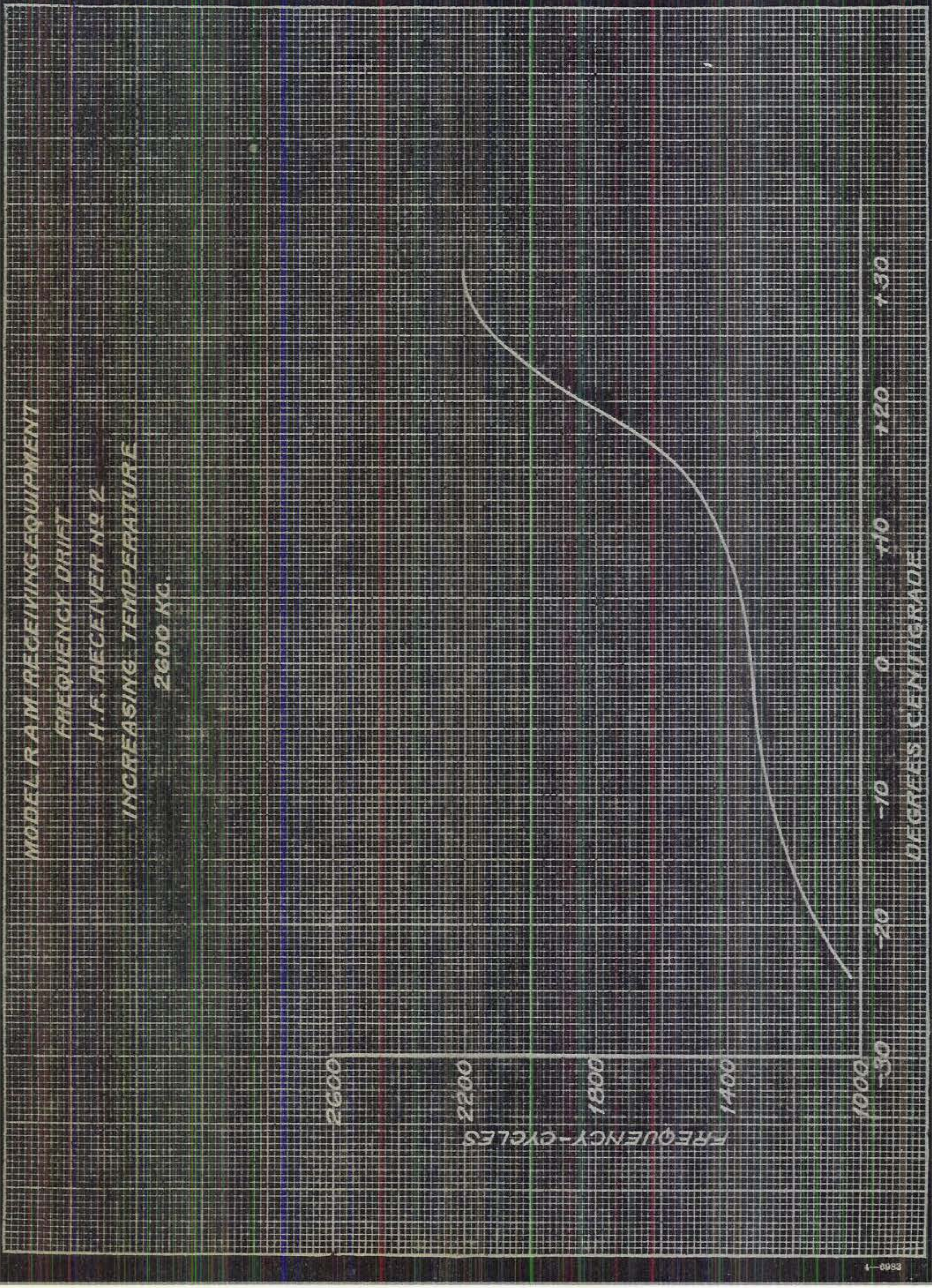


MODEL RAM RECEIVING EQUIPMENT
FREQUENCY DRIFT
H.F. RECEIVER Nº 2
DECREASING TEMPERATURE
2600 KC.

1—6083

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

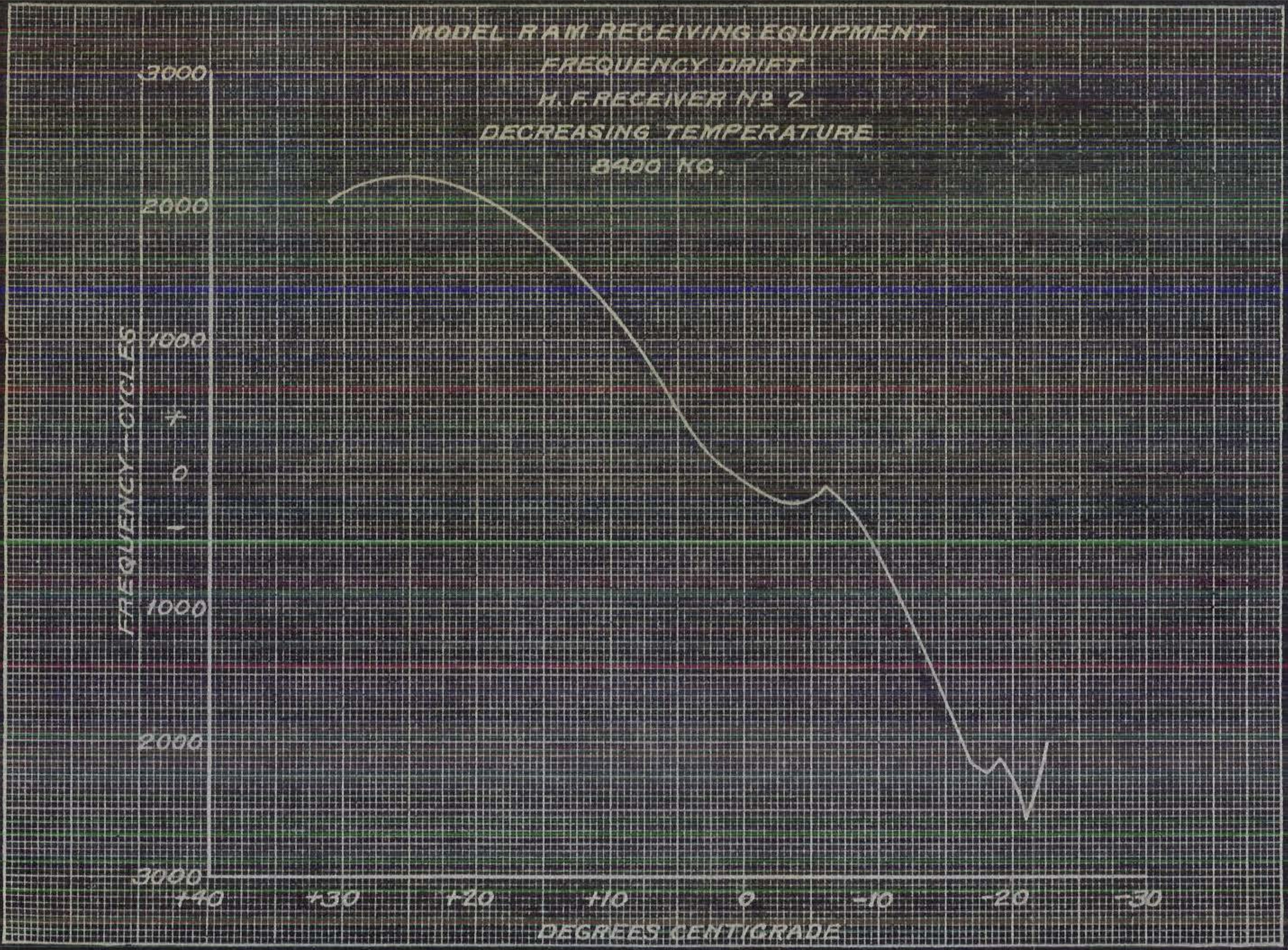
DATE



N. R. L. 34

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

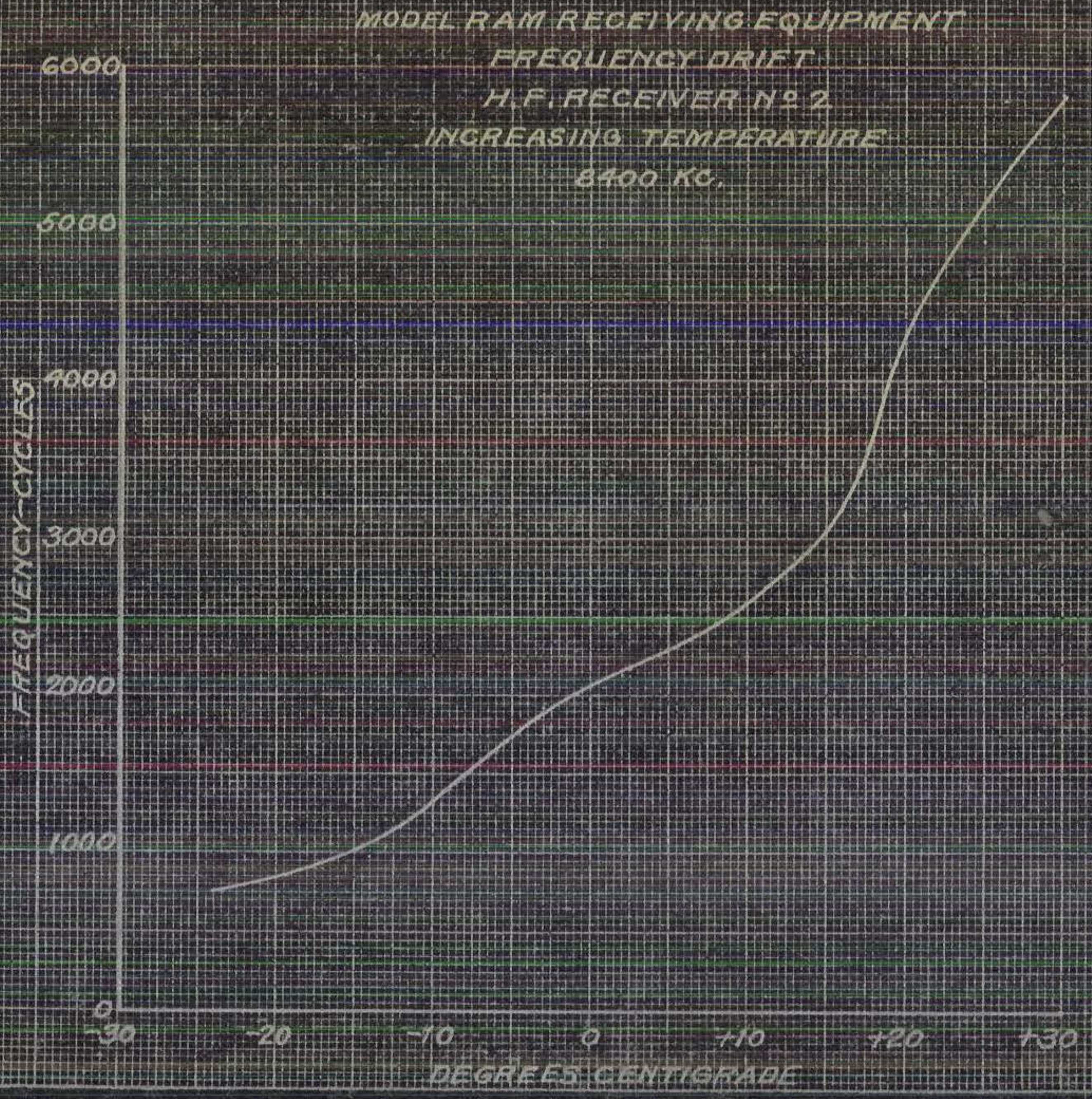
DATE



MODEL RAM RECEIVING EQUIPMENT
FREQUENCY DRIFT
H. F. RECEIVER № 2
DECREASING TEMPERATURE
8400 KC.

U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE



MODEL RAM RECEIVING EQUIPMENT
FREQUENCY DRIFT
H.F. RECEIVER Nº 2
INCREASING TEMPERATURE
8400 KC.

Plate 47

COPY GBHH/adl

U.S. NAVAL AIR STATION
Anacostia, D.C.

F42-1/46-52/NA6
(374) Serial #38031
~~CONFIDENTIAL~~ March 10, 1938.

Unclassified

From: Commanding Officer.
To: Director, Naval Research Laboratory, Bellevue, Anacostia, D.C.

SUBJECT: Aircraft Radio - Preliminary Model XGN Transmitting and Model XRAM Receiving Equipment - Report on Tests of.

Reference:
(a) BuAero. ltr. Aer-E-31-FAM, F42-1, F1-5(1) of 27 November 1934.
(b) BuEng. ltr. F42-1 (11-8-W3) of 17 Nov. 1934.
(c) BuEng. ltr. NOs-43068 (4-17-W3) of 23 April 1937 with Enclosure (A).
(d) NAS, Anacostia, ltr. F42-1/32/NA6 (184) of 21 July 1937 with Enclosure (A).
(e) BuEng. Conf. ltr. C-NOs-43068 (8-23-W3) of 27 August 1937 with Enclosure (A).
(f) BuEng. Res. ltr. NOs-43068 (11-5-W8) of 10 Nov. 1937 with Enclosure (A).
(g) NAS, Anacostia, Res. ltr. F42-1/46-52/NA6 (283) of 24 Nov. 1937 with Enclosures (A) to (H) inclusive.
(h) BuEng. Specification RE 13A 504A for Model GN Transmitting Equipment.
(i) BuEng. Specification RE 13A 505A for Model RAM Receiving Equipment.

Enclosure: (Herewith)
(A) Photograph #AN-50948 - Model XGN/XRAM Radio Equipment Component Parts.
(B) Photograph #AN-50949 - Model XGN/XRAM Radio Equipment - with cables connected.
(C) Photograph #AN-50950 - Model XGN/XRAM Radio Equipment Installation in XRE-2 Airplane #9207 - View through left door.
(D) Photograph #AN-50951 - Model XHN/XRAM Radio Equipment Installation in XRE-2 Airplane #9207 - View through right door.
(E) Photograph #AN-50952 - Model XGN/XRAM Radio Equipment Installation in XRE-2 Airplane #9207 - Inside view looking aft.
(F) Photograph #AN-50933 - Model XGN/XRAM Radio Equipment Installation in XRE-2 Airplane #9207 - Pilot's radio controls seen through right window.

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(G) Photograph #AN-50954 - Model XGN/XRAM Radio Equipment Installation in XRE-2 Airplane #9207 - Receiver Dynamotor and Intermediate Amplifier under cabin seat.
(H) Photograph #AN-50955 - Model XGN/XRAM Radio Equipment Installation in XRE-2 Airplane #9207 - Antenna Loading Coil and H.F. Receiver Unit aft on cabin deck.
(I) Photograph #AN-50956 - Model XGN Radio Transmitter installed in SU-2 Airplane #9104.
(J) Photograph #AN-50957 - Model XGN Radio Installation in SU-2 Airplane #9104 - Pilot's Transmitter Control Box.
(K) Photograph #AN-50958 - Model XGN/XRAM Radio Installation in SU-2 Airplane #9104 - Operator's Controls.
(L) Photograph #AN-50959 - Model XGN Radio Installation in SU-2 Airplane #9104 - Antenna connections with added r.f. ammeter.
(M) Photograph #AN-50960 - Model XGN/XRAM Radio Installation in SU-2 Airplane #9104 - Receiver and Dynamotor under observer's seat.
(N) Photograph #AN-50961 - Model XGN Radio Transmitting Equipment, showing assembly consisting of I.F. Transmitter, Rectifier, and H.F. Transmitter Units.
(O) Photograph #AN-50962 - Model XGN Radio Transmitting Equipment - Right interior view of CW-20052 Rectifier Unit.
(P) Photograph #AN-50963 - Model XGN Radio Transmitting Equipment - Left interior view of CW-20052 Rectifier Unit.
(Q) Photograph #AN-50964 - Model XGN Radio Transmitting Equipment - CW-20052 Rectifier Unit - Top view into Relay Compartment.
(R) Photograph #AN-50965 - Model XGN Radio Transmitting Equipment - CW-52068 H.F. Transmitter Unit - Front oblique view.
(S) Photograph #AN-50966 - Model XGN Radio Transmitting Equipment - CW-52068 H.F. Transmitter Unit - Oblique top view.
(T) Photograph #AN-50967 - Model XGN Radio Transmitting Equipment - CW-52068 H.F. Transmitter Unit - Rear oblique bottom view.
(U) Photograph #AN-50968 - Model XGN Radio Transmitting Equipment - CW-52068 H.F. Transmitter Unit - Interior from right side.

(V) Photograph #AN-50969 - Model XGN Radio Transmitting Equipment - CW-52068 H.F. Transmitter Unit - Interior bottom view.
(W) Photograph #AN-50902 - Model XGN Radio Transmitting Equipment - Connection in H.F. Transmitter Unit for Crystal Frequency Indicator.
(X) Photograph #AN-50970 - Model XGN Radio Transmitting Equipment - Type CW-52067 I.F. Transmitter Unit - Interior left side view.
(Y) Photograph #AN-50971 - Model XGN Radio Transmitting Equipment - Type CW-52067 I.F. Transmitter Unit - Interior top view.
(Z) Photograph #AN-50972 - Model XGN Radio Transmitting Equipment - Type CW-52067 I.F. Transmitter Unit - Bottom view with outer shield removed.
(AA) Photograph #AN-50973 - Model XGN Radio Transmitting Equipment - Type CW-52067 I.F. Transmitter Unit - Interior bottom view, with preliminary CFI coupling.
(BB) Photograph #AN-50903 - Model XGN Radio Equipment - Connections for C.F.I. in I.F. transmitter unit - Front view through bottom.
(CC) Photograph #AN-50904 - Model XGN Radio Equipment - Connections for C.F.I. in I.F. Transmitter Unit - Oblique rear view through bottom.
(DD) Photograph #AN-50974 - Model XGN Radio Transmitting Equipment - Interior view of Antenna Loading Unit.
(EE) Photograph #AN-50975 - Model XGN Radio Transmitting Equipment - Operator's and Pilot's Control Boxes.
(FF) Photograph #AN-50976 - Model XGN Radio Transmitting Equipment - Rear view into operator's Control Box.
(GG) Photograph #AN-50977 - Model XGN Radio Transmitting Equipment - View into Pilot's Control Box with cover open.
(HH) Photograph #AN-50978 - Model XRAM Radio Receiving Equipment - I.F. Receiver combined and locally controlled, H.F. Receiver separated and remotely controlled.
(II) Photograph #AN-50979 - Model XRAM Radio Receiving Equipment - Main Units with spray-proof covers.
(JJ) Photograph #AN-50980 - Model XRAM Radio Receiving Equipment - Front portions of I.F. and H.F. Receivers, showing detachable switch box.
(KK) Photograph #AN-50981 - Model XRAM Radio Receiving Equipment - Interior right side views of I.F. and H.F. Receiver Units.

SUBJECT: Aircraft Radio - Preliminary Model XGN Transmitting and Model XRAM Receiving Equipment - Report on Tests of.

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(LL) Photograph #AN-50982 - Model XRAM Radio Receiving Equipment - Interior left side views of I.F. and H.F. Receiver Units.
(MM) Photograph #AN-50983 - Model XRAM Radio Receiving Equipment - Interior rear top views of I.F. and H.F. Receiver Units.
(NN) Photograph #AN-50984 - Model XRAM Radio Receiving Equipment - H.F. Receiver Unit with Amplifier Unit, with shielding cases and mounting plates disassembled.
(OO) Photograph #AN-50985 - Model XRAM Radio Receiving Equipment - Amplifier Unit for H.F. Receiver - Front end with shield removed.
(PP) Photograph #AN-50986 - Model XRAM Radio Receiving Equipment - Amplifier Unit for H.F. Receiver - Bottom rear view with shield removed.
(QQ) Photograph #AN-50987 - Model XRAM Radio Receiving Equipment - Amplifier Unit for H.F. Receiver - Separable shielding cases and mounting frames for Receiver-Amplifier Units.
(RR) Photograph #AN-50988 - Model XRAM Radio Receiving Equipment - Dynamotor on shock-proof mounting.
(SS) Photograph #AN-50989 - Model XRAM Radio Receiving Equipment - Bottom view through dynamotor base.
(TT) Photograph #AN-50990 - Model XRAM Radio Receiving Equipment - Receiver band-change and tuning remote control head.
(UU) Photograph #AN-50991 - Model XRAM Radio Receiving Equipment - Rear view into remote receiver control head.
(VV) Photograph #AN-50992 - Model XRAM Radio Receiving Equipment - Rear view into Receiver Switch Box, with back plate removed.
(WW) Photograph #AN-50884 - Model XRAM Radio Receiving Switch Box, with Anacostia mounting modifications.
(XX) Photograph #AN-50885 - Interior of XRAM Radio Receiver Switch Box, showing inadequate resistor mounting.
(YY) Photograph #AN-50886 - Model XRAM Radio Receiver, showing damage to Switch Box plug shell.
(ZZ) Photograph #AN-50905 - Model XRAM Radio Receiver - Dial drive and tuning mechanism.
(AAA) Photograph #AN-51027 - Schematic Wiring Diagram, XRAM Radio Receiver, 200-1500 kcs.
(BBB) Photograph #AN-51028 - Schematic Wiring Diagram, XRAM Radio Receiver, 1500-13575 kcs.

SUBJECT: Aircraft Radio - Preliminary Model XGN Transmitting and Model XRAM Receiving Equipment - Report on Tests of.

- -

(CCC) Photograph #AN-51029 - Schematic Wiring Diagram, XGN Radio Transmitter Circuit (Original Submission).
(DDD) Photograph #AN-51030 - Proposed Modifications to Relays and Rectifier Unit of XGN Radio Transmitter.
(EEE) N.A.S. Anacostia Oscillogram 47A2 showing XGN break-in keying action. Full power CW transmission on 8270 kcs; receiver on 8270 kcs, CW, 2 volts output across 500 ohms from 8 uV signal.
(FFF) N.A.S. Anacostia Oscillogram 48C2 showing XGN break-in keying action. Transmission on full power MCW, 516 kcs; receiver on 542 kcs CW, 2 volts output across 500 ohms from 5 uV signal.
(GGG) Memorandum of Bureau of Engineering Conference held April 15, 1937.
(HHH) N.A.S. Anacostia letter F42-1/52/NAS (184) of 21 July 1937 with Enclosure (A).
(III) Memorandum of Conference held at Bureau of Engineering on 12 August 1937.
(JJJ) Notes on Test Data, Deficiencies and Preferences Re GN/RAM Equipment based on Conference of 21 and 22 October 1937 in Bureau of Engineering.
(KKK) N.A.S. Anacostia Restricted letter F42-1/46-52/NA6 (283) of 24 November 1937, less enclosures.

1. This letter reports upon the tests performed at this station in conformity with references (b), (h), and (i) upon preliminary models of XGN transmitting equipment and XRAM receiving equipment.

2. Description of Equipment:

The subject equipment consists essentially of a dual range transmitter, two receivers, operator's control box, pilot's control box, associated cables, mechanical linkages, receiver dynamotor, remote tuning controls for each receiver, mounting brackets, and slip covers. (See Enclosures (A) and (B)). In addition there is an interphone system with the interphone tube a part of the operator's control box and deriving its power from the receiver dynamotor. The transmitter (Enclosure (N)) consists of a central rectifier unit (Enclosure (O)) with a high frequency unit (Enclosure (S)) attached to the right side and an intermediate frequency unit (Enclosure (Y)) attached to the left side. The I.F. unit covers a continuous frequency range extending from 350 to 1500 kilocycles. The range of the H.F. unit extends continuously from 1500 to 9050 kilocycles. Both transmitters are designed to operate on CW, MCW, and phone transmission with a nominal output of 100 watts on CW and MCW and 40 watts phone carrier. Either unit of the transmitter can be selected for operation by means of a single switch located on the front panel of the rectifier unit, but both transmitters cannot be operated at the same time. The two transmitters are built on the master oscillator, power amplifier principle (Enclosure (CCC)) with the master oscillator operating on the same frequency as the power amplifier throughout the frequency range. The transmitter does not require plug-in coils to secure frequency coverage.

The central rectifier unit (ENCLOSURE (O)) is designed to take power from an NEA series or similar generator and provide suitable rectified output for either transmitter unit. In its final form the rectifier circuit employed two 38266A rectifier tubes. Also incorporated in the rectifier unit are the speech amplifier circuits which can be used in conjunction with either transmitter. Conventional compensation circuits of the parallel type are used to regulate the voltage.

Two receivers, known in their preliminary form as the XRAM receivers, are a part of the subject equipment. (See Enclosures (HH) to (BBB) inclusive). The two receivers do not require plug-in coils, and cover frequency ranges of 200 to 1500 kilocycles and 1500 to 13575 kilocycles respectively. Power supply for the receivers is derived from a dynamotor which operates on a 12-14 volt source and is adequate for supplying power for the two receivers at the same time. Provisions are made for either remote or local operation for either or both receivers and, in addition, each receiver is built in two units, a radio frequency and an audio frequency unit, which can be mounted together as in a normal receiver or be cable connected and mounted separately. The receiver switch box, which contains the Auto-off - manual switch, the CW - voice switch, the two parallel headphone outlets and the receiver volume control, can also be cable connected and mounted remotely or directly on the front of the receiver without the cable. On the front of each receiver, a power outlet is provided which can be used to operate auxiliary equipment such as a direction finder or crystal frequency indicator. Enclosures (AAA) and (BBB) show the schematic diagram. Special attention is invited to the fact that both of these receivers employ the super-heterodyne circuit.

The operator's and pilot's control boxes are shown on Enclosure (EE). Some revisions have been made in the ICS system which appear elsewhere in this report. The ICS amplifier tube is mounted in the operator's control box.

- -

An external antenna load unit (Enclosure (DD)) is provided with the transmitter for resonating the lower frequencies to the low capacity antennas. The receiver dynamotor is shown on Enclosure (RR) and other component parts such as cables, slip covers, and mounting brackets are shown in Enclosures (A) and (B).

3. History of Tests:

A summary of the more important points of the XGN-XRAM tests performed at this station is given herewith:

27 January, 1937 - XGN transmitting equipment received from the Naval Research Laboratory.
26 February, 1937 - Two XRAM receivers received from the Naval Research Laboratory.
8 March, 1937 - Bench tests begun.
10 March, 1937 - Installation started in XRE-2 airplane.
11 March, 1937 - Flight tests begun.
15 April, 1937 - Bureau of Engineering Conference (Enclosure (GGG)).
22 April, 1937 - XGN sent back to contractor for modification.
14 June, 1937 - Flight tests resumed.
8 July, 1937 - Roller coils from XGN taken to New York for correction.
21 July, 1937 - NAS Anacostia ltr. F42-1/52/NA6 (184) of 21 July, 1937 with Enclosure (A) prepared. This letter appears as Enclosure (HHH) of this report.
24 July, 1937 - Anacostia, Bureau of Engineering Conference.
12 August, 1937 - Bureau of Engineering Conference. See Enclosure (III).
16 August, 1937 - Work started on ICS system.
9 September, 1937 - Bureau of Engineering Conference on relays.
20 September, 1937 - XGN set up for oscillograms.
21-22 Sept., 1937 - Bureau of Engineering Conference. See Enclosure (JJJ).
25 October, 1937 - Photographs.
24 November, 1937 - NAS Anacostia Restricted letter F42-1/46-52/NA6 (283) of 24 November, 1937, prepared. See Enclosure (KKK).
26 November, 1937 - Graybar called for equipment.

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4. Tube Lineup:

The XGN rectifier tube lineup was changed from a single full wave 38222 to two half wave 38266A tubes. In its final form the tube lineup of the subject equipment was as follows:

XGN

	VACUUM TUBES	
Purpose	Number	Type
I.F. Master Oscillator	1	38412
I.F. Power Amplifier	2	38412
H.F. Master Oscillator	1	38412
H.F. Power Amplifier	2	38412
Rectifier	2	38266A
Speech Amplifier	1	38101

VACUUM TUBES FOR EACH XRAM RECEIVER

Number	Type
6	38078
1	38085
1	38041

INTERPHONE

1	38037

5. XGN-XRAM Weights:

	Lbs.	Ozs.
1 - GN Transmitter, Tubes, and Mounting Slides	91	10
1 - Operator's Control Box with Mounting Plate and Tube	6	09
1 - Xtension Control Box	1	08
1 - Antenna Load Coil	3	00
1 - Dynamotor, Mounting Plate and Battery Cable	10	08
1 - RAM IF Receiver, Receiver Switch Box, Mounting Plates and Tubes (Receiver assembled as a unit)	21	10

- -

	Lbs.	Ozs.
1 - Cover plate Used to Cover Rear End of RF Unit when Receiver is separated into two units	0	05
1 - RAM HF Receiver, Receiver Switch Box, Mounting Plates and Tubes (Receiver separated into two units)	22	12
2 - Receiver Remote Tuners and Four Mechanical Linkages	8	08
10 - Interconnecting Cables	20	03
1 - Set of Slip Covers for Receivers and Dynamotor	2	12
	189	05

Note: If the receivers are operated as a unit two of the cables listed above in the interconnecting cable weights are not used. The weight of these two cables is 5 pounds 12 ounces.

6. XGN/XRAM Dimensions (Overall):

In the following table the terms height, width, and depth are used to indicate dimensions of component parts when located as shown in Enclosure (A). All dimensions are in inches.

	Height	Width	Depth
XGN Transmitter	11-1/2	23-15/16	15-13/32
Pilot's Control Box	2-1/2	5-11/16	4-19/32
Operator's Control Box	3-15/16	8	7-9/16
Antenna Load Coil	7	4	7-3/4
XRAM Receiver mounted as one unit	9-11/16	7-7/16	16
Receiver R.F. Unit	9-11/16	7-7/16	9-1/2
Receiver A.F. Unit	9-11/16	7-7/16	7-3/16
Receiver Switch Box	6-3/8	2-3/8	2-3/8
Dynamotor with Mount	6-13/16	4-3/8	7-3/8
Remote Tuner	3-3/16	3-3/16	5-3/16

An additional allowance is necessary for the removal of plugs, etc. at the following places:

Dimension	Additional Allowance	Purpose
Pilot's control box height	4"	To open box
Pilot's control box depth	4"	To remove plug

- -

Dimension	Additional Allowance	Purpose
Transmitter depth	14-3/4"	To remove unit
Transmitter height	3/8"	To remove relay compartment cover.
Operator's control box depth	4"	To remove plug
Antenna load coil height	3/4"	To remove leads
Antenna load coil depth	3/4"	To remove leads
Receiver width	6"	Local or Remote Tuning
Receiver depth (rear)	4"	To remove power plug
Receiver depth (front)	4"	To remove phone plug
Receiver height	5"	To remove tubes
Receiver R.F. unit depth	4"	To remove plug
Receiver A.F. unit depth	4"	To remove plug
Dynamotor width	4"	To remove plug
Dynamotor depth	4"	To remove plug
Remote tuner depth	6"	Linkage bend
Remote tuner controls	5" radius	Tuning

For cable lengths see Enclosure (JJJ).

In the production models the transmitter width will be increased by 1/2" and the depth by 1/4". XRAM dimensions are to be as indicated.

7. Airplane Installations:

The equipment was installed and flight tested successively in three different airplanes. Tests between 11 March and 22 June 1937 were conducted in a Bellanca Cabin airplane, XRE-2 No. 9207; from 29 June to 15 September 1937 the tests were made in SU-1 Scouting Plane No. 8837; after damage to the latter plane on 16 September 1937, the equipment was installed in SU-2 Scouting Plane No. 9104 in which the final flight tests were made from 29 September 1937 to 12 October 1937. Photographs of the airplane installations are shown as Enclosures (C) to (M) inclusive. An NEA-2 generator was used for power supply in all plane installations.

8. Flight Time:

The subject equipment was flown on 62 flights, aggregating a total of 95 hours flying time.

SUBJECT: Aircraft Radio - Preliminary Model XGN Transmitting and Model XRAM Receiving Equipment - Report on Tests of.

Test Objects:

(a) Installation facility
(b) Accessibility
(c) Operating facility
(d) Antenna matching
(e) Harmonic radiation
(f) Signal quality
(g) Resetability and frequency drift
(h) Operation of key relay
(i) Operation at altitude
(j) Voltage compensation
(k) Mechanical ruggedness
(l) Test of XRAM receivers

9. Installation Facility:

Installation of the XGN in the SU series planes in which most of the flight tests were made, provided some very serious problems. The planes were originally mocked-up for GP series equipment and the XGN dimensions were too great to permit installation without modification of the mounting tables. In addition, the slides upon which the equipment mounted were so built that the set had to be slid forward the entire depth of the set before it could be removed. This requirement, in addition to the fact that the transmitter must be handled as a single unit, made the installation of the equipment in scouting planes a matter of considerable difficulty.

10. Accessibility:

Under flight conditions the XGN is extremely inaccessible and it is doubtful if an operator could even change tubes. In the plane the entire transmitter is always a single unit and weighs nearly one hundred pounds and consequently it is dangerous to remove it from its mount during flight, even if the space for doing so were provided. On the bench the equipment still remains relatively inaccessible due to the fact that the equipment does not separate readily into three units and all shields are attached with screws and not snap slides. This type of construction lends itself to rigidity rather than accessibility.

11. Operating Facility:

The design of the XGN is generally straightforward and the operability is satisfactory. No difficulty was encountered in tuning to the right harmonic in the power amplifier and the action of the antenna coupling circuit was likewise satisfactory. One condition was noted which may give trouble, but is is not believed to be serious, and that is the fact that with the antenna post grounded, the antenna coupling circuits could be resonated to the transmitter frequency and the equipment would load exactly as if operating into a low resistance antenna. This condition, however, exists in all transmitters which operate over a considerable frequency range into a variety of antennas and has never been known to cause trouble.

12. Antenna Matching:

Typical figures are given below which show the various lengths of trailing wire which the XGN will resonate under various conditions. At two points - 3065 kcs and 4515 kcs - the coupling was not adequate for loading up the power amplifier to full input when operating on a three quarter wave antenna at the shortest value which the transmitter would resonate. The figures given were taken in March 1937 and considerable work has been done on the fircuits since then, so the figures may vary somewhat for the production equipments. All measurements were made in the XRE-2 Bellanca airplane. A standard antenna length of 350 feet was the maximum used in these tests.

Frequency	H.F. Unit Antenna Length	Description
9030	0'	Shortest 1/4 wave
	21.5'	Longest 1/4 wave
	45'	Shortest 3/4 wave
	74'	Longest 3/4 wave
5950	0'	Shortest 1/4 wave
	40'	Longest 1/4 wave
	72'	Shortest 3/4 wave
	116'	Longest 3/4 wave
	25'	Equivalent to fixed
4515	0'	Shortest 1/4 wave
	47'	Longest 1/4 wave
	82' *	Shortest 3/4 wave
	153'	Longest 3/4 wave
	21'	Equivalent to fixed

Frequency	H.F. Unit Antenna Length	Description
3065	0'	Shortest 1/4 wave
	78'	Longest 1/4 wave
	145' *	Shortest 3/4 wave
	235'	Longest 3/4 wave
	16'	Equivalent to fixed
1532.5	107'	Shortest 1/4 wave
	193'	Longest 1/4 wave

* Power amplifier no longer drew full power.

	I.F. Unit	
1532.5	0'	Shortest antenna
	192'	Longest antenna
1030	64'	Shortest antenna
	315'	Longest antenna
840	160'	Shortest antenna
730	275'	Shortest antenna
544	20'	Shortest antenna (Loaded)
	350'	Operates without loading
520	27'	Shortest antenna (Loaded)
	350'	Shortest antenna (Unloaded)
355	185'	Shortest antenna (Loaded)

13. Harmonic Radiation:

Performance of the XGN with respect to harmonic radiation was excellent. On 4080 kcs the second harmonic was 80 db below the fundamental. On 352 kcs the second harmonic was 50 db below the fundamental.

14. Signal Quality:

The quality of the signal emitted by the XGN in flight was good. The construction is rigid and performs very well under the conditions encountered in flight but is so inaccessible that repair work becomes difficult.

15. Resetability and Frequency Drift:

Resetability and frequency drift tests were made in cooperation with the Naval Research Laboratory. Results were generally satisfactory.

16. Operation of Keying Circuits:

Certain deficiencies of the keying system are covered in paragraph (d) of Enclosure (III). Enclosures (EEE) and (FFF) show oscillograms of the keying action and the operation appears good. The relay design incorporates a feature which is used in the keying relays of the Model GP-1 and the Model GO-2 transmitters which helps to eliminate the bounce of the receiver antenna contact. This consists of a holding coil which is energized in the 'key up' position and thus provides more positive action of the relay contacts and improves the 'break-in' action of the relay. There are, however, two objections to this design; The key relay draws a steady though small current in the 'key up' position and secondly it has happened in the case of the Model XGO-2 that the receiver antenna contact failed to close until the transmitter had been energized. This means that the transmitter filaments must be energized before signals can be received on a companion receiver in a normal service installation.

17. Electrical Failures:

The major electrical difficulty encountered during test was the failure of the rectifier system originally incorporated in the Model XGN. Redesign of the rectifier (See Enclosure (DDD)) by replacing one 38222 with two 38266A tubes has cured this deficiency. Other troubles encountered were flashover of M.O. condenser when set was misadjusted, breakdown of antenna series condenser, breakdown of antenna load coil and failure of keying relay. These and other deficiencies are covered in Enclosure (JJJ).

18. Voltage Compensation:

Generally satisfactory compensation was secured on all three conditions of transmission with Type NEA-2, NEA-1A, and

NEB-1A generators. The circuit employed is of the parallel type and exhibits the usual characteristic of requiring different values of compensating capacity for different power levels.

19. Mechanical Ruggedness:

Enclosure (JJJ) lists numerous mechanical deficiencies but in general the construction of the set is strong and rigid. It is this rigidity which enables the XGN to produce signals of a superior quality under flight conditions. The defects enumerated should be corrected in production models.

20. XRAM Tests:

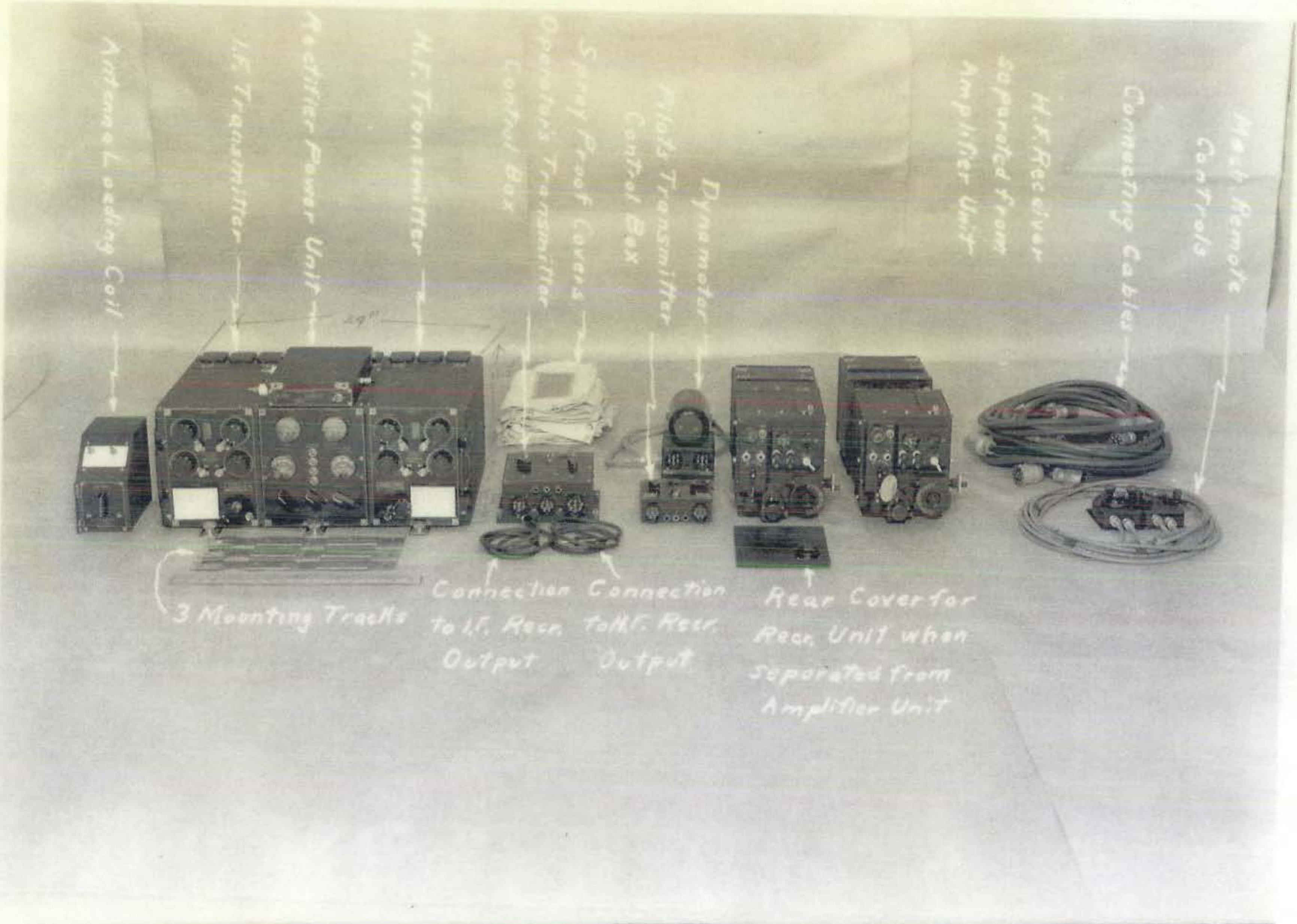
Enclosure (JJJ) lists numerous deficiencies pertaining to the XRAM receivers, chiefly of a mechanical nature which should be corrected in production. Electrical deficiencies of the receiver and particularly of the interphone system are covered in Enclosure (KKK).

Flight tests were made to check operational characteristics of the receiving equipment and in general the results were satisfactory, particularly after the interphone system had been corrected. Originally some difficulty was encountered with the backlash in the mechanical linkage used in connection with the remote tuner. The XRAM receivers represent a distinct advance in receiver design over previous models used in naval aircraft. The added sensitivity and selectivity is in no way objectionable when the equipment is used by a radioman, and the added performance is very useful. The elimination of plug-in coils is another excellent feature which should be incorporated in future designs wherever possible. Operation of the I. F. receiver with the RDF-4 gave satisfactory results. With the output plug on the front of either receiver properly wired the Model LM crystal frequency indicator will also operate satisfactorily.

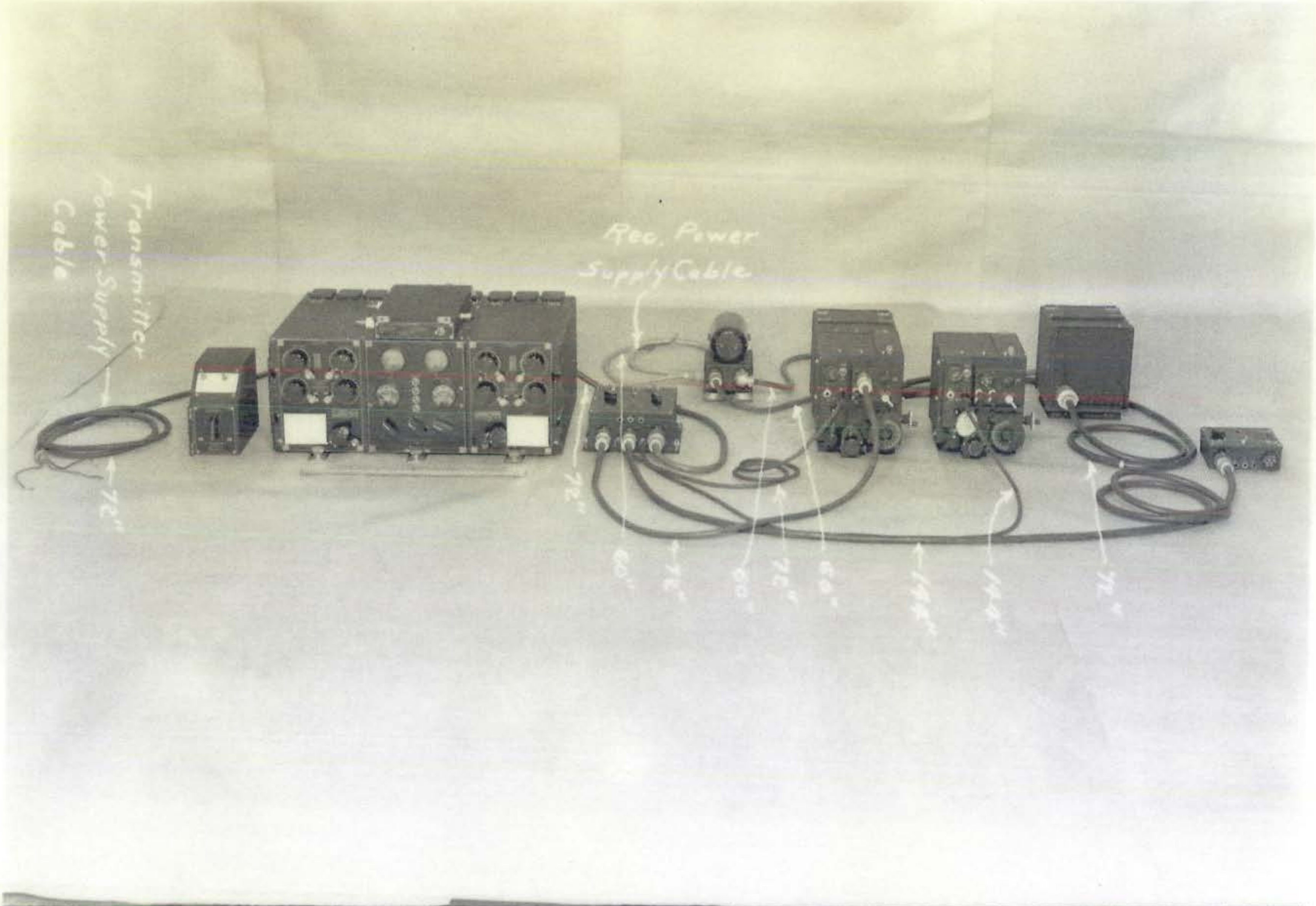
21. It is requested that two copies of the final XGN/XRAM report be furnished this station by the Naval Research Laboratory.

J. D. Price

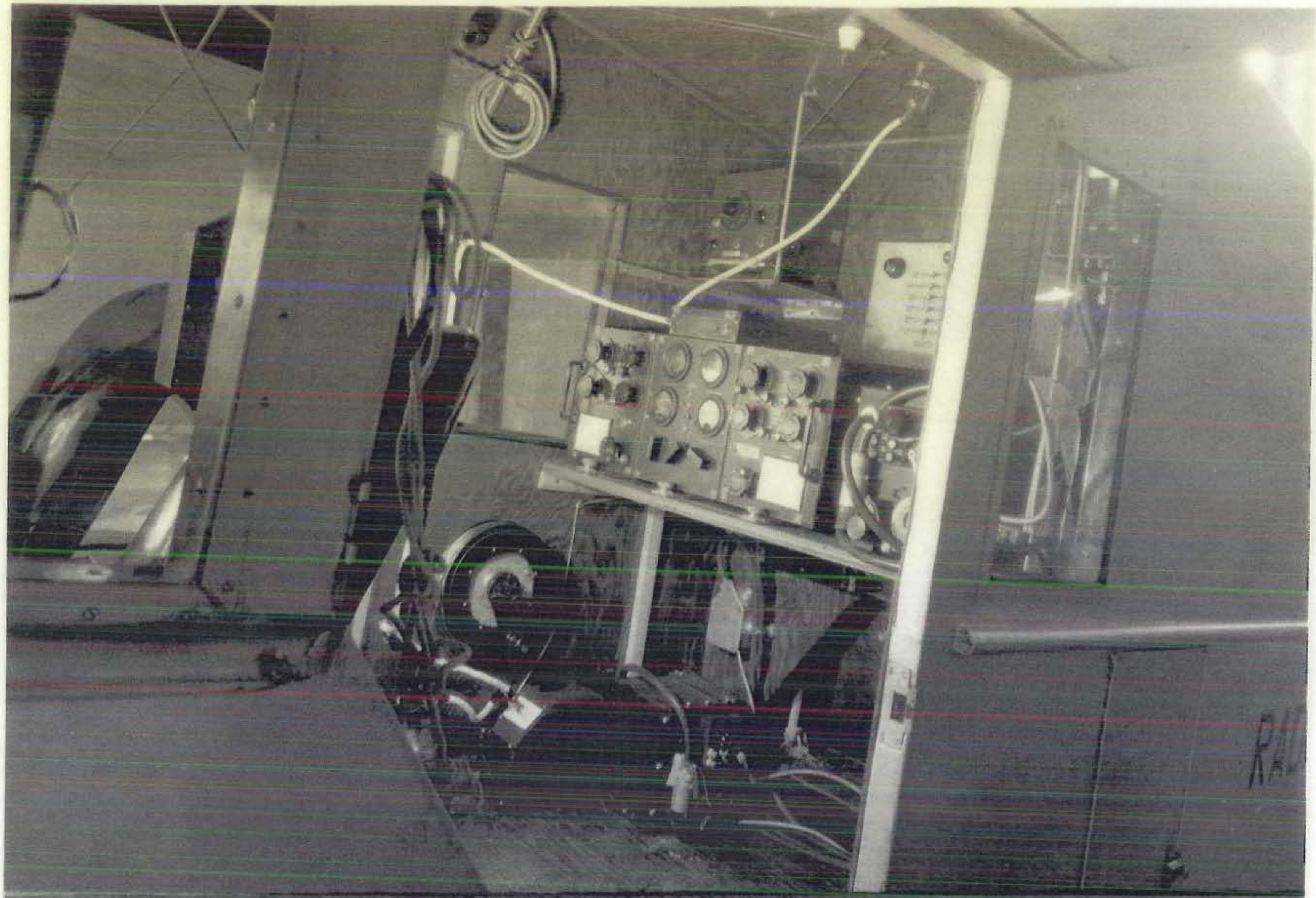
Copy to:
BuAero (2)
BuEng.
NAF Phila.



Model XGN/XRAM Radio Equipment AN-50948 11/23/37 OFFICIAL NAVY PHOTOGRAPH
- Component Parts ENCLOSURE (A) NOT TO BE USED FOR PUBLICATION



Model XGN/XRAM Radio Equipment - with cables connected. AN-50949 11/23/37 ENCLOSURE (B) OFFICIAL NAVY PHOTOGRAPH NOT TO BE USED FOR PUBLICATION



Model XGN/XRAM Radio Equipment
Installation in XRE-2 Airplane
#9207 - View through left door.

AN-50950 3/11/37

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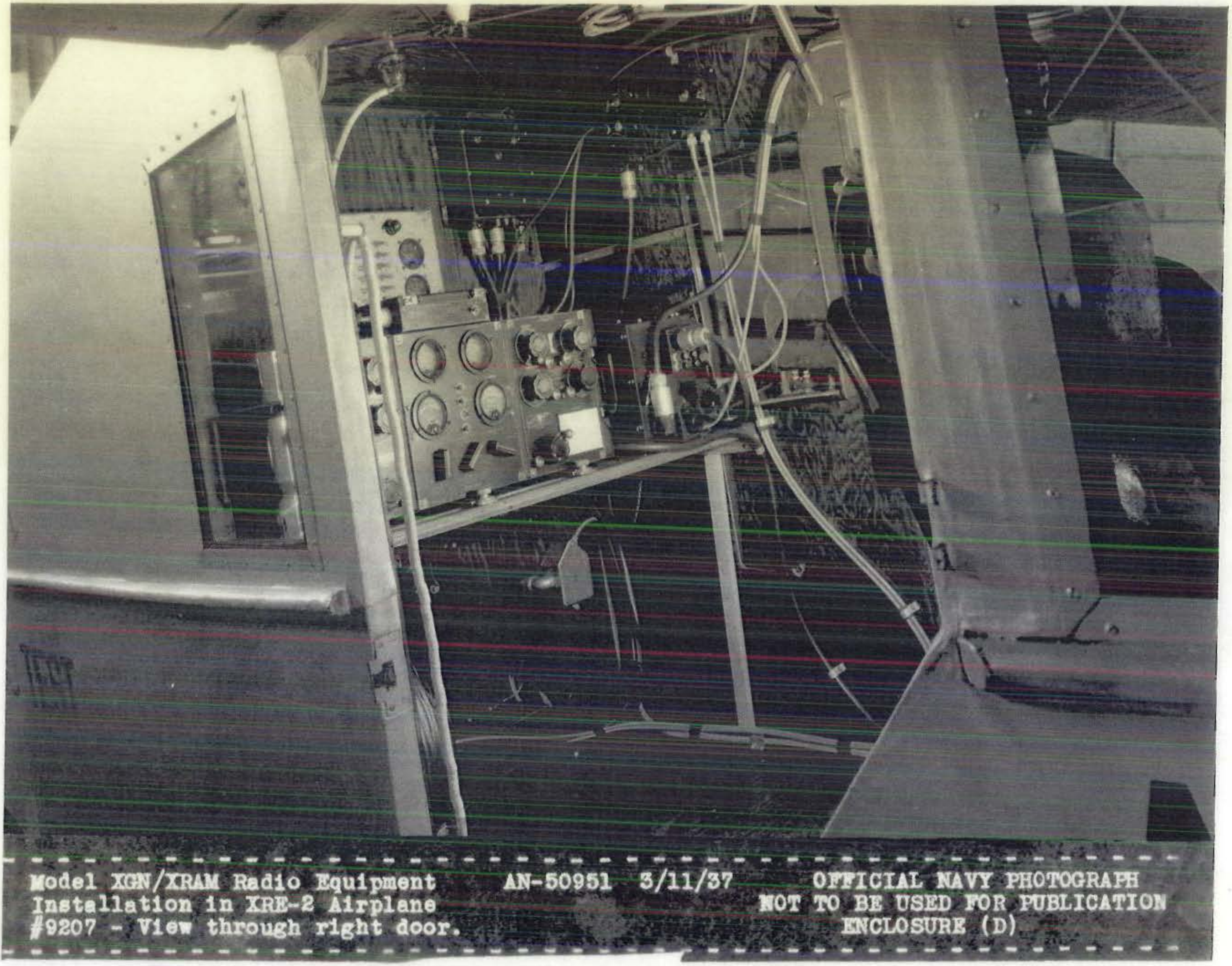
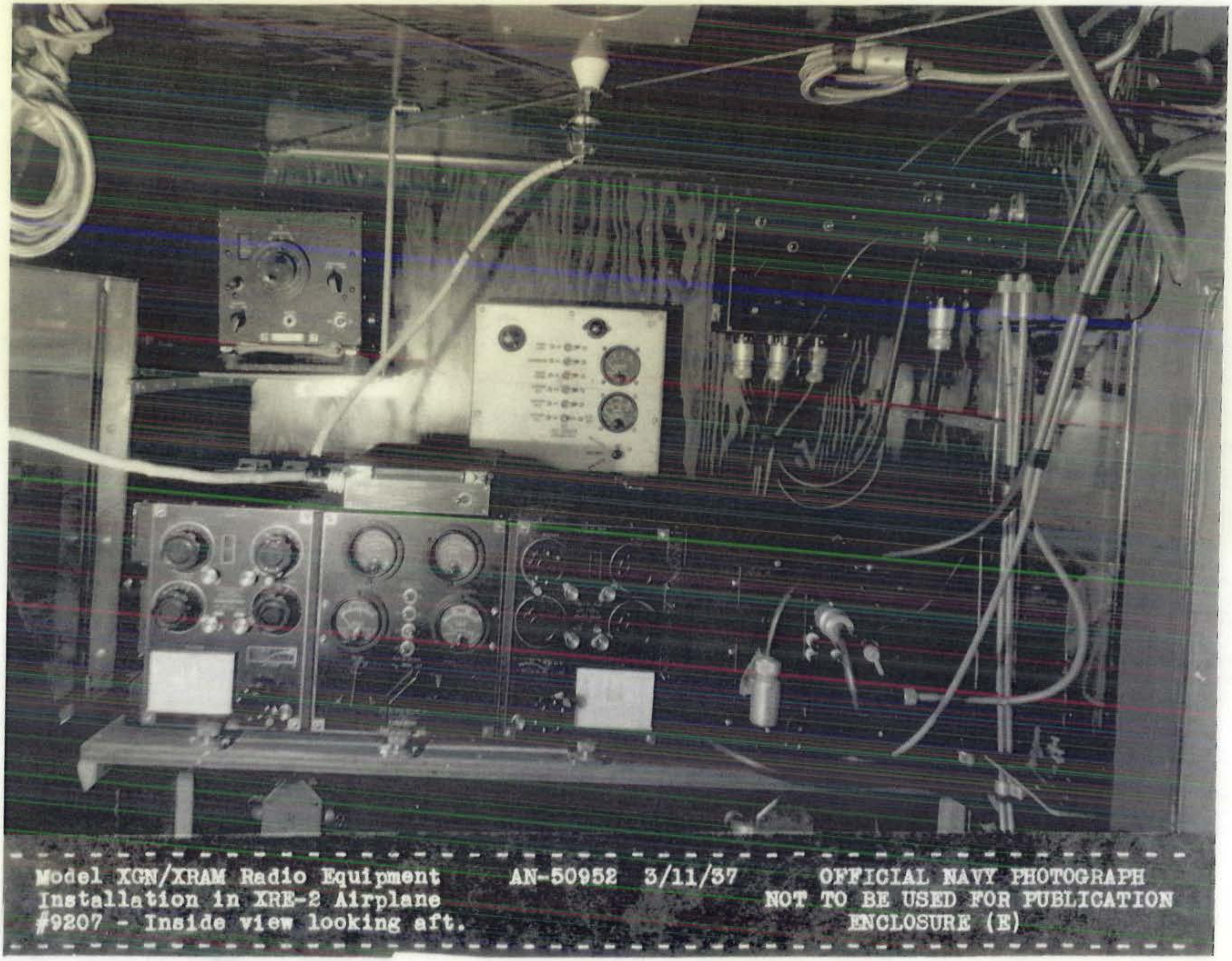
NOT TO BE USED FOR PUBLICATION
ENCLOSURE (C)



Model XGN/XRAM Radio Equipment AN-50951 3/11/37
Installation in XRE-2 Airplane
#9207 - View through right door.

OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION
ENCLOSURE (D)



Model XGN/XRAM Radio Equipment
Installation in XRE-2 Airplane
#9207 - Inside view looking aft.

AN-50952 3/11/37

OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION
ENCLOSURE (E)

Model XGN/XRAM Radio Equipment AN-50953 3/11/37
Installation in XRE-2 Airplane #9207 -
Pilot's radio controls seen through

OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION

ENCLOSURE (F)

Model XGN/XRAM Radio Equipment AN-50954 3/11/37
Installation in XRE-2 Airplane #9207 -
Receiver Dynamotor and Intermediate
Amplifier under cabin seat.

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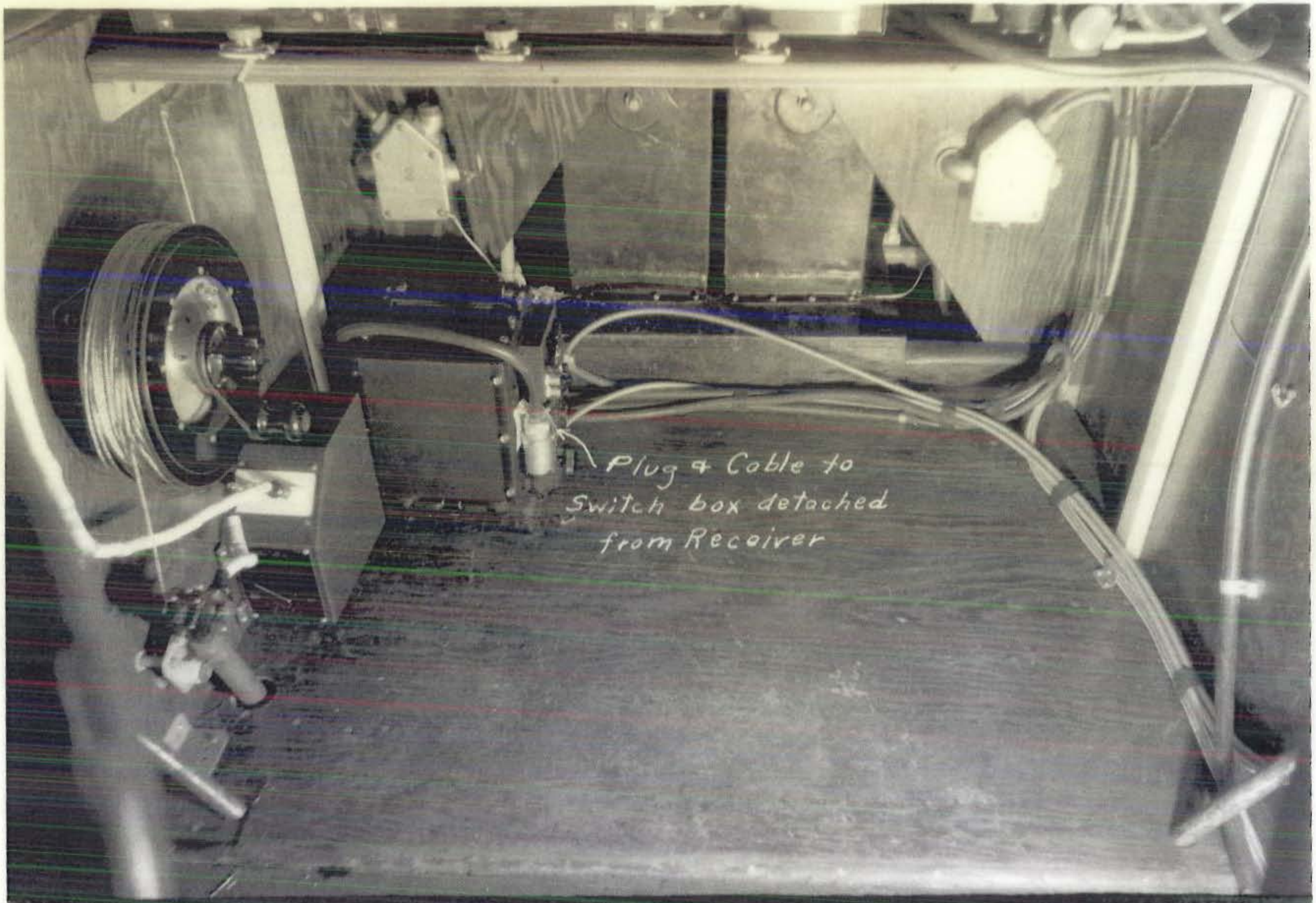
ENCLOSURE (G)



Model XGN/XRAM Radio Equipment AN-50955 3/11/37
Installation in XRE-2 Airplane #9207 -
Antenna Loading Coil and H.F. Receiver
Unit aft on cabin deck.

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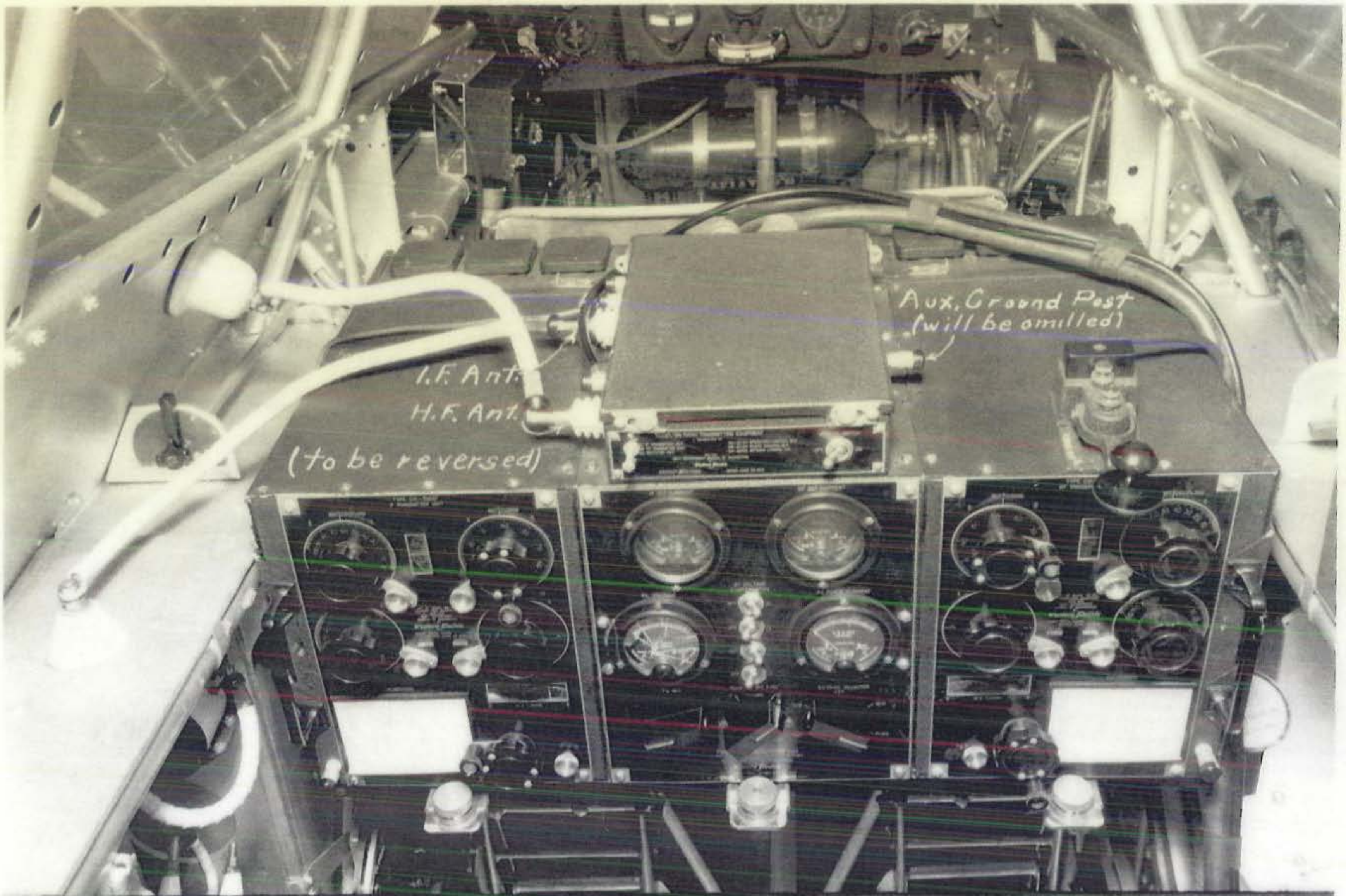
ENCLOSURE (H)



Model XGN Radio Transmitter
Installed in SU-2 Airplane
#9104.

AN-50956 10/13/37

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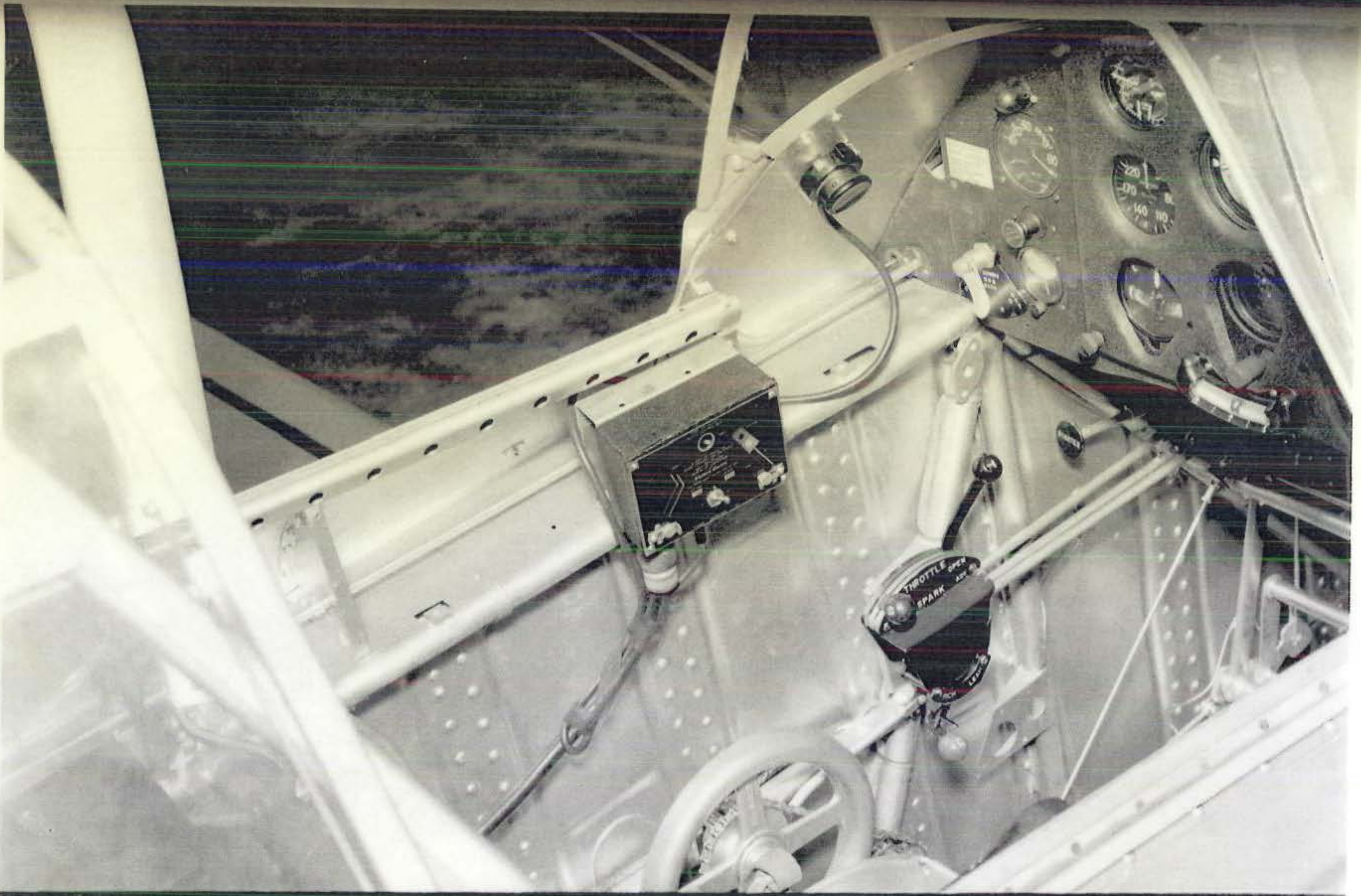
NOT TO BE USED FOR PUBLICATION
ENCLOSURE (I)



Model XGN Radio Installation in SU-2 Airplane #9104 - Pilot's Transmitter Control Box.

AN-50957 10/13/37

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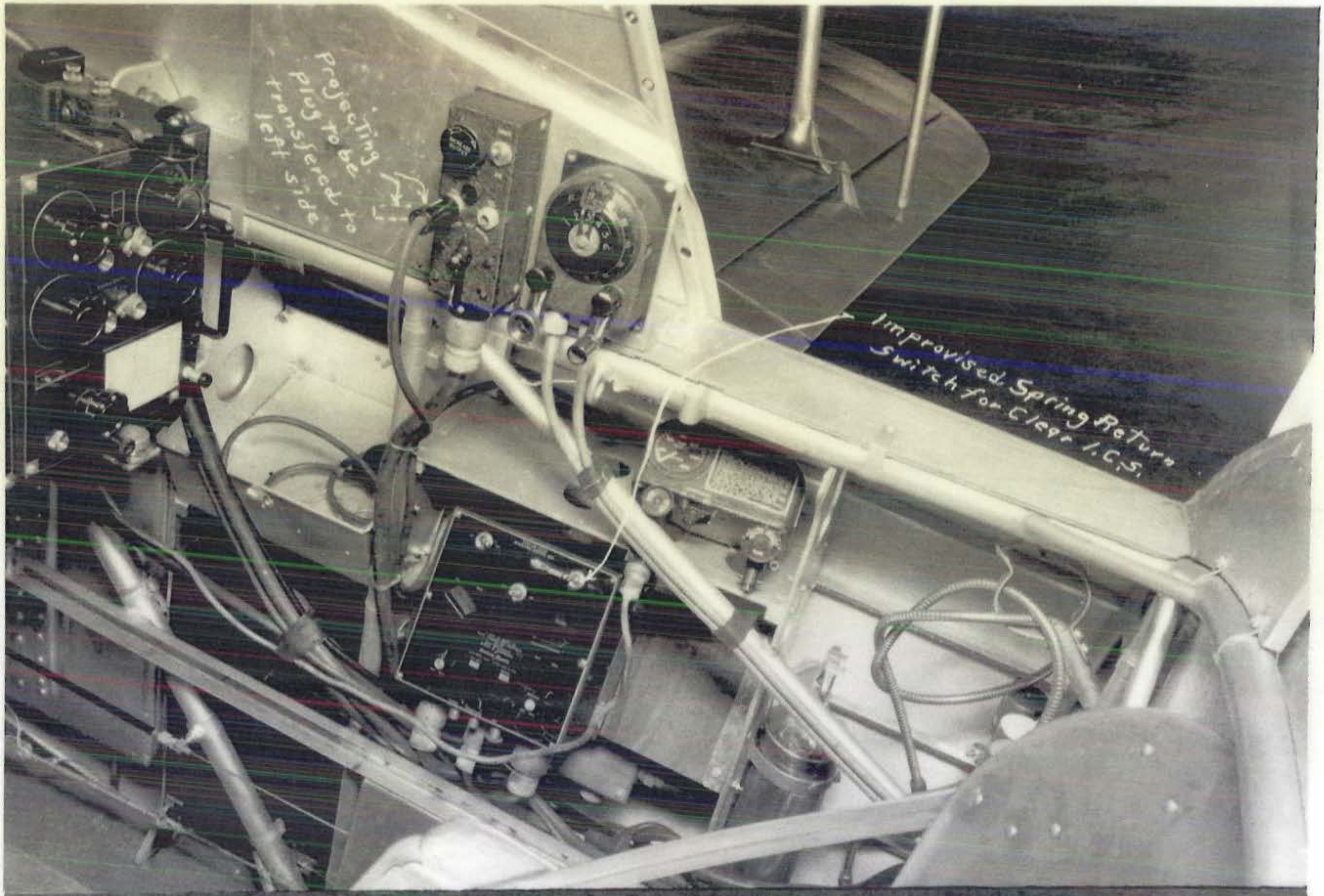
NOT TO BE USED FOR PUBLICATION
ENCLOSURE (J)



Model XGN/XRAM Radio Installation AN-50958 10/13/37
in SU-2 Airplane #9104 - Operator's
controls.

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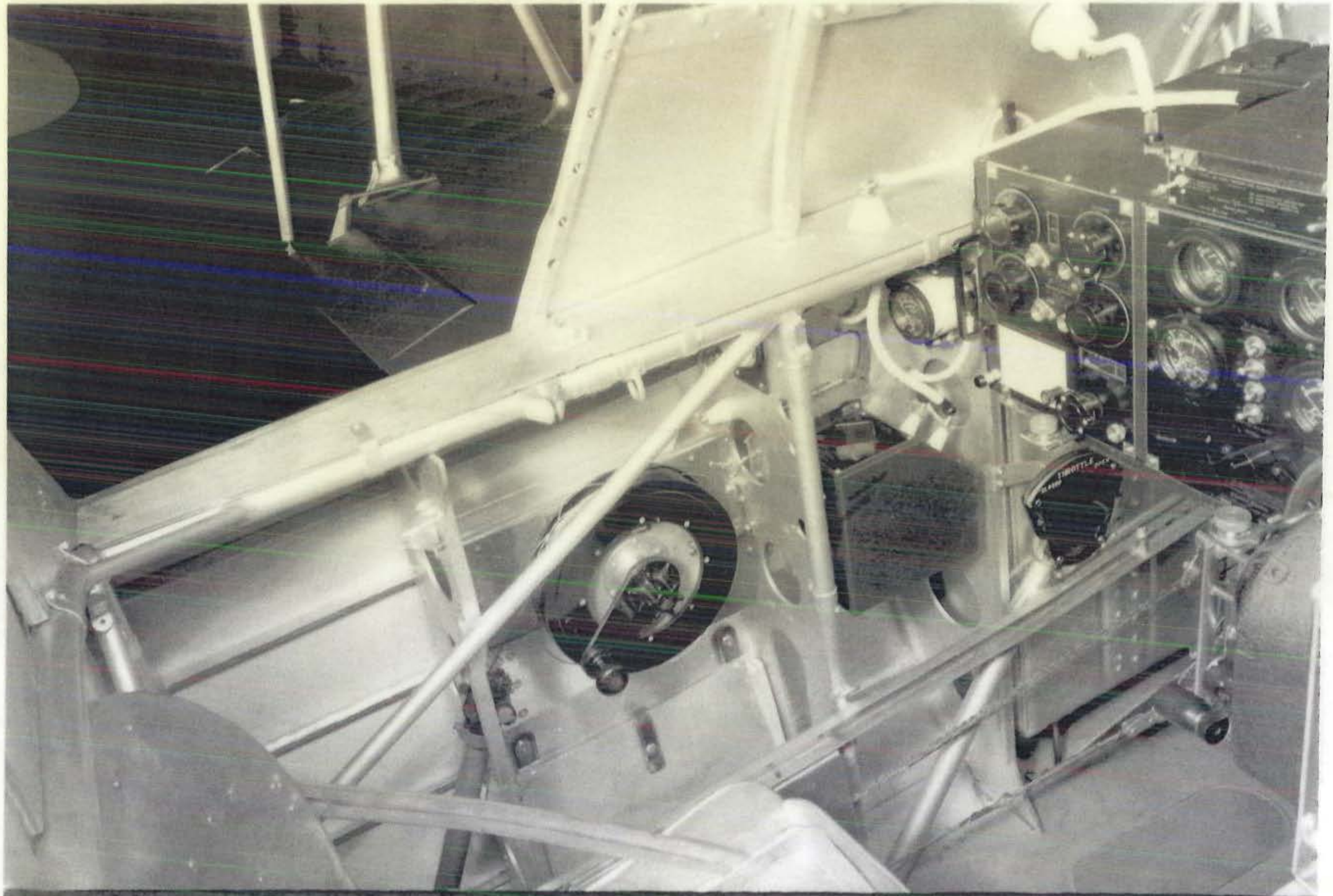
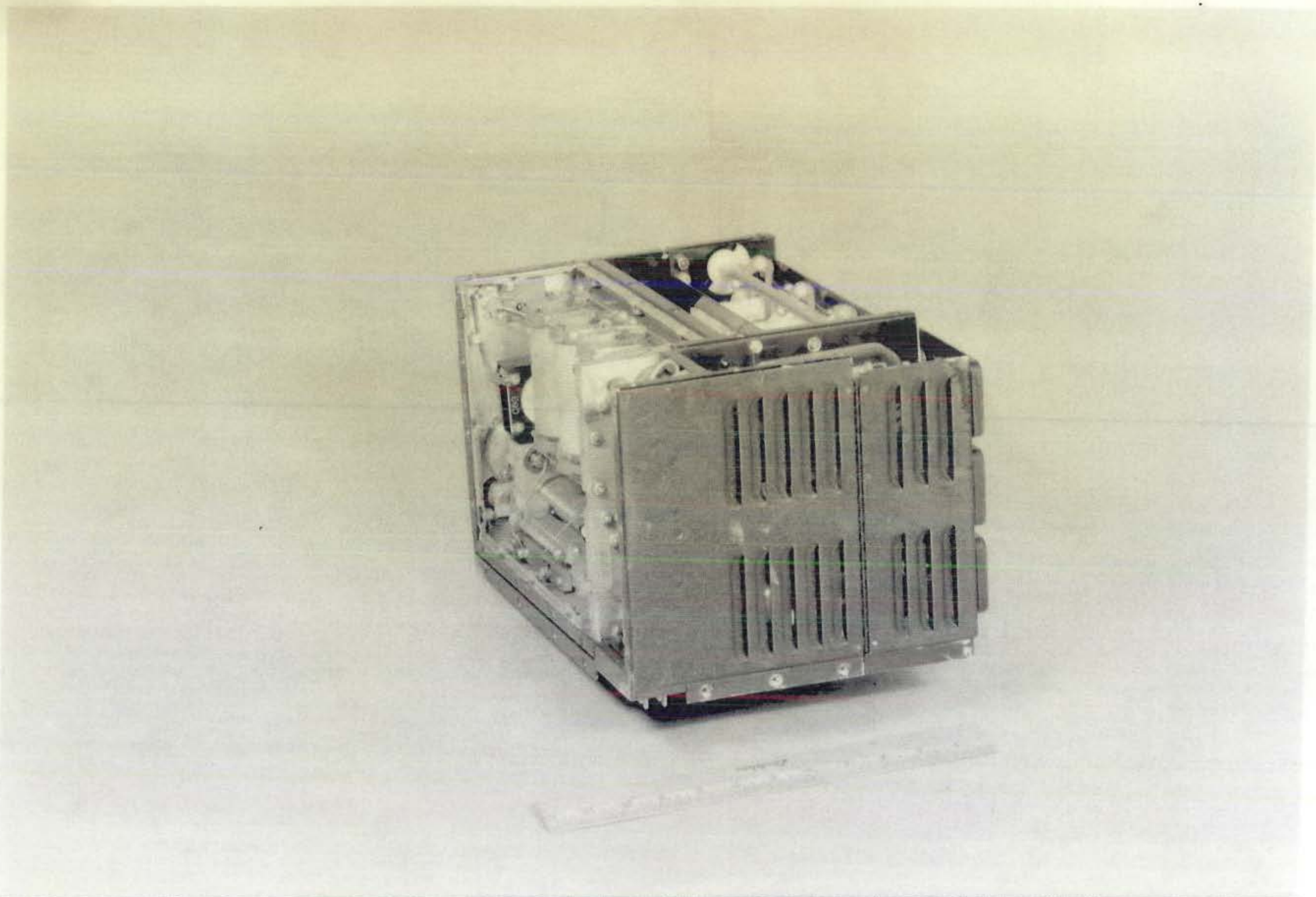
NOT TO BE USED FOR PUBLICATION
ENCLOSURE (K)



Model XGN Radio Installation in SU-2 Airplane #9104 - Antenna connections with added r.f. ammeter.

AN-50959 10/13/37

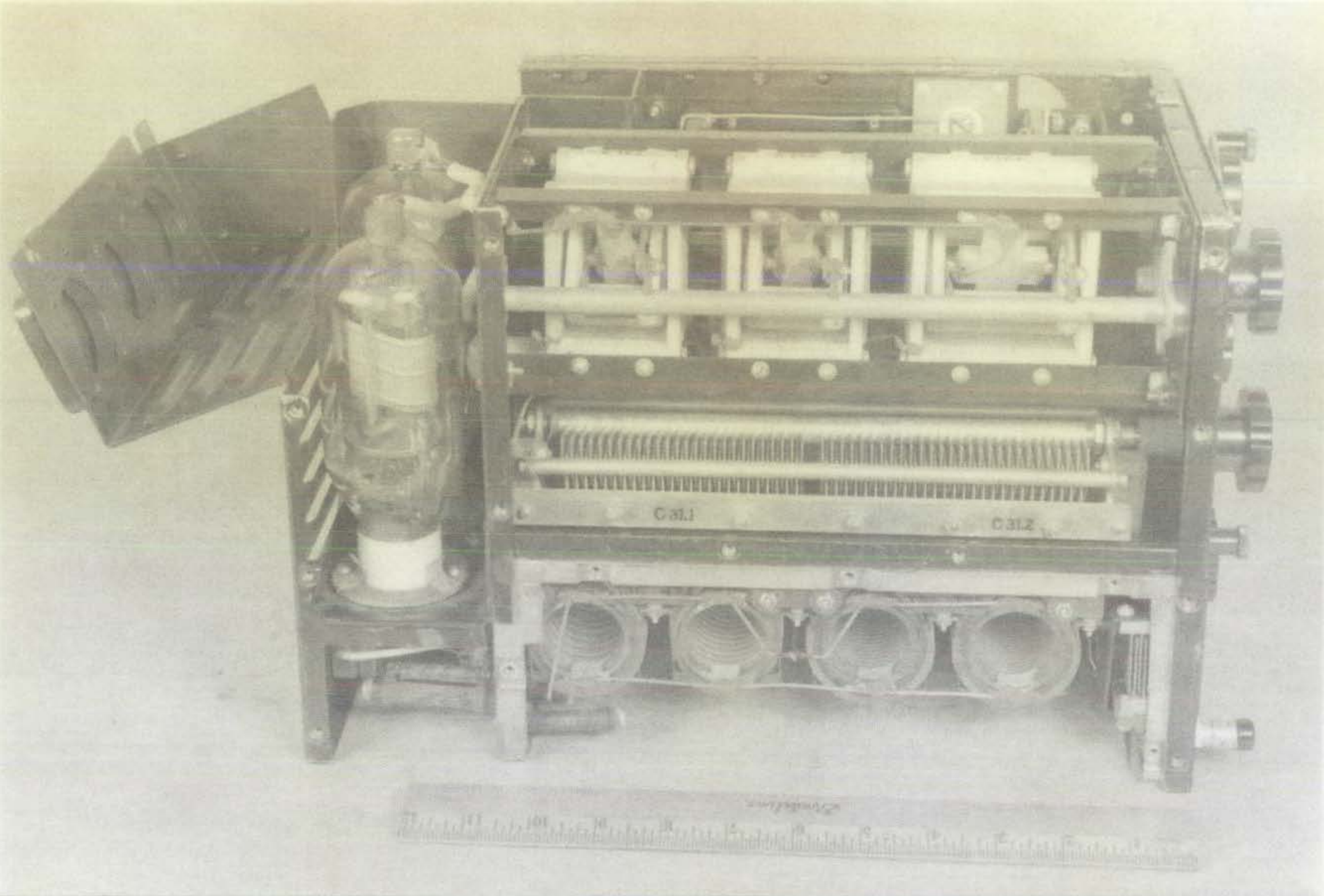
OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION
ENCLOSURE (L)



Model XGN Radio Transmitting
Equipment - CW-52068 H.F. Transmitter Unit - Rear oblique bottom view.

AN-50967 11/23/37

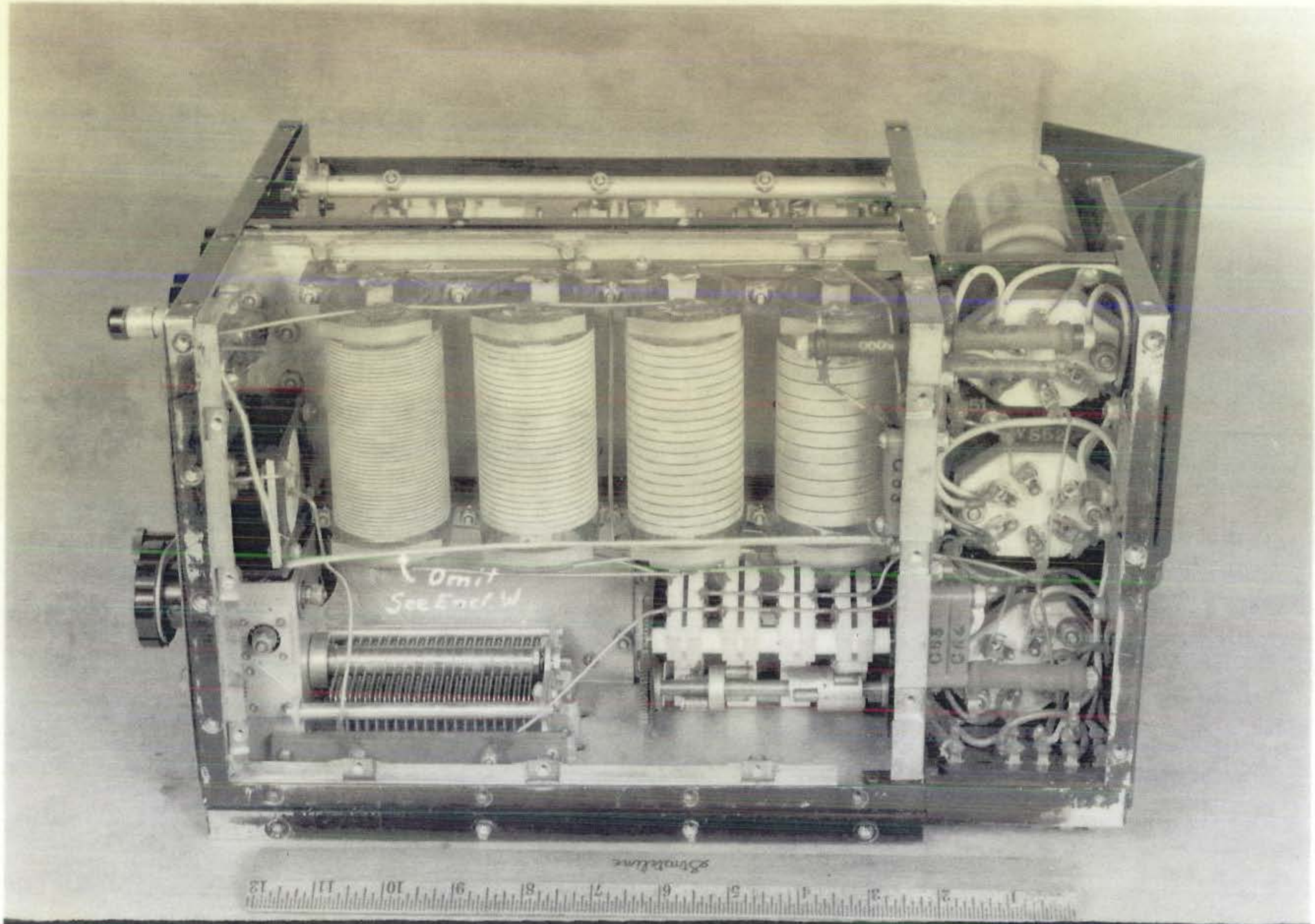
OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION
ENCLOSURE (T)



Model XGN Radio Transmitting Equipment - CW-52068 H.F. Transmitter Unit - Interior from right side.

AN-50968 11/23/37

OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION
ENCLOSURE (U)



Model XGN Radio Transmitting Equipment - CW-52068 H.F. Transmitter Unit - Interior bottom view.

AN-50969 11/23/37

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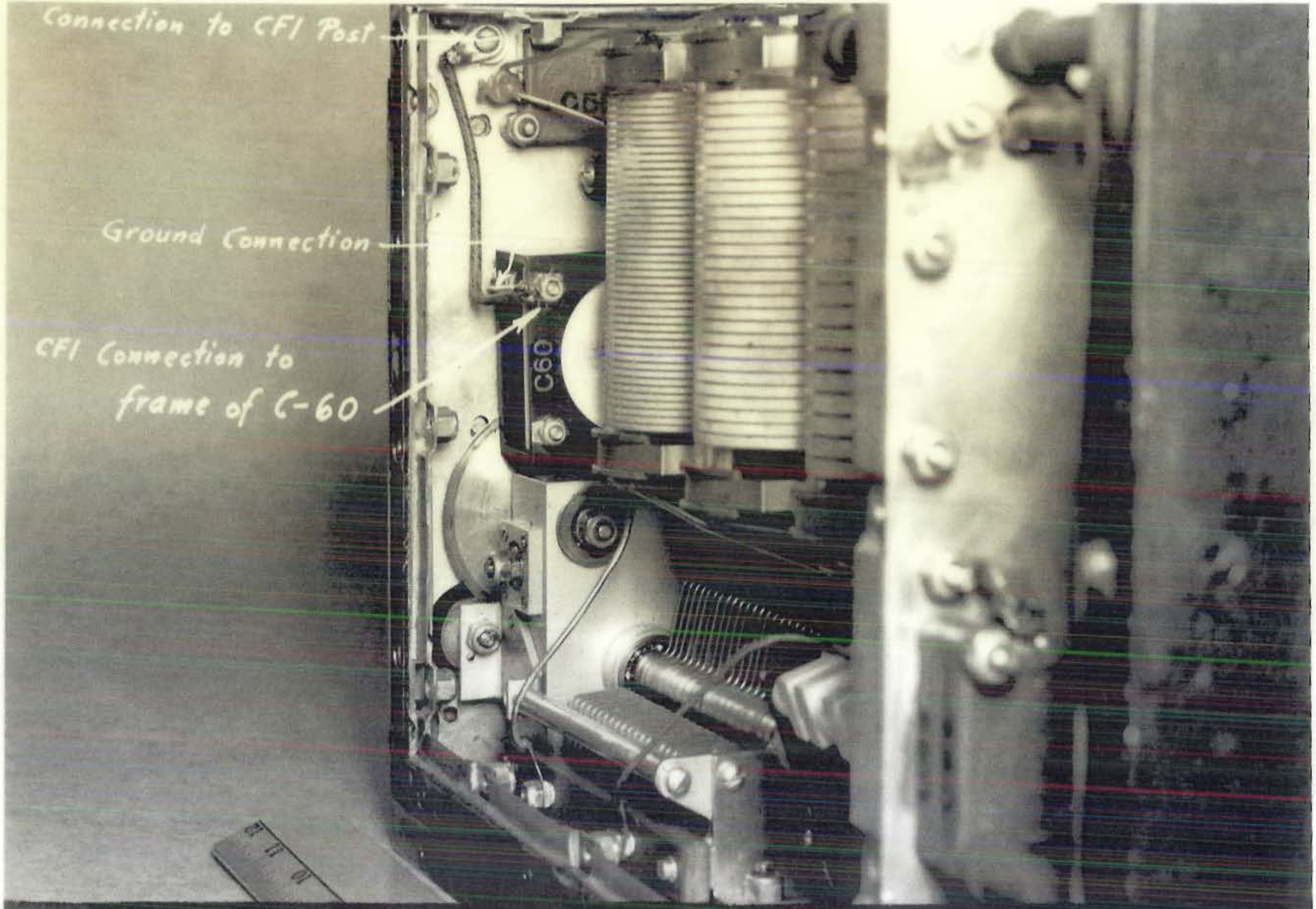
NOT TO BE USED FOR PUBLICATION
ENCLOSURE (V)

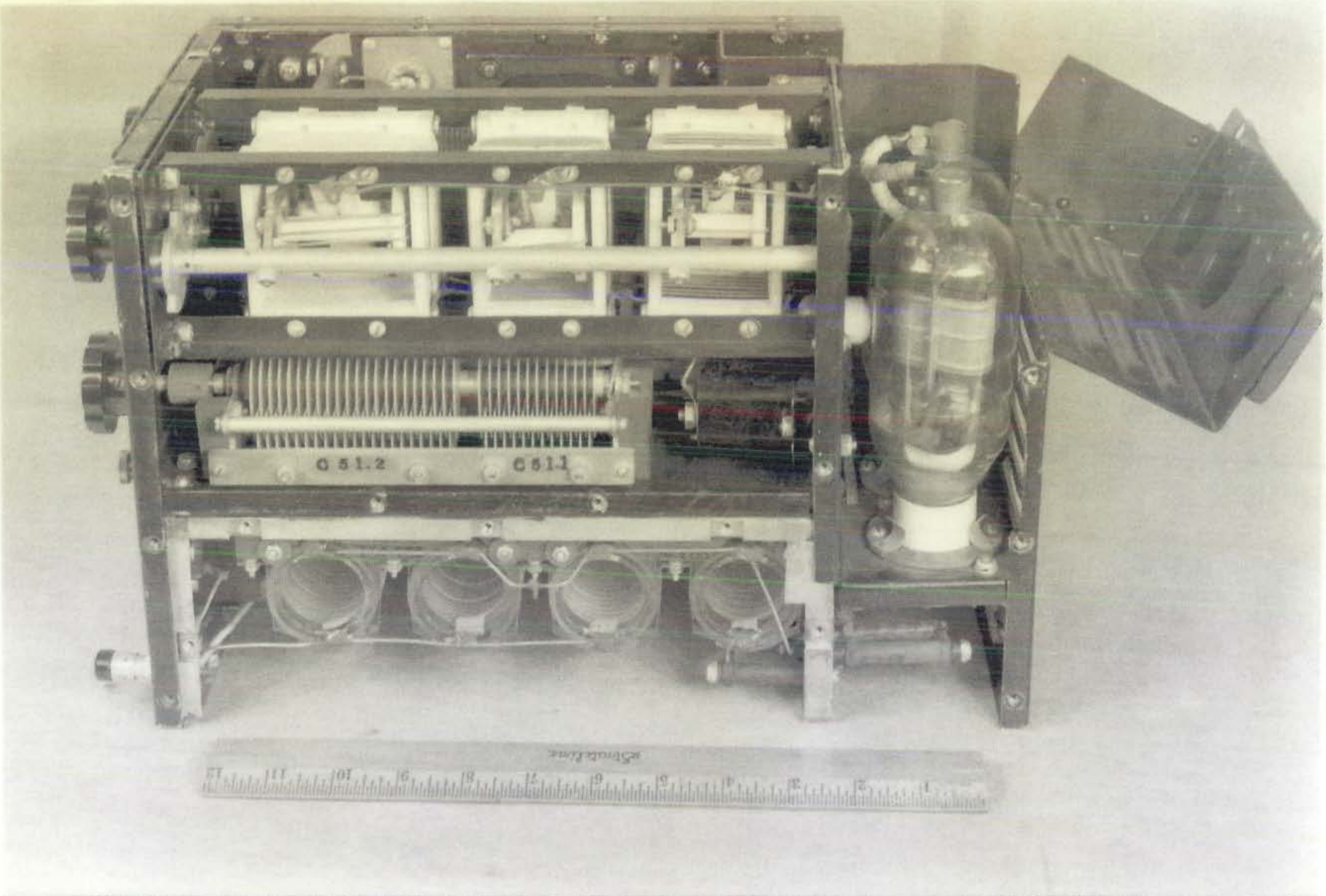


Model XGN Radio Equipment - Connection in H.F. transmitter unit for Crystal Frequency Indicator.

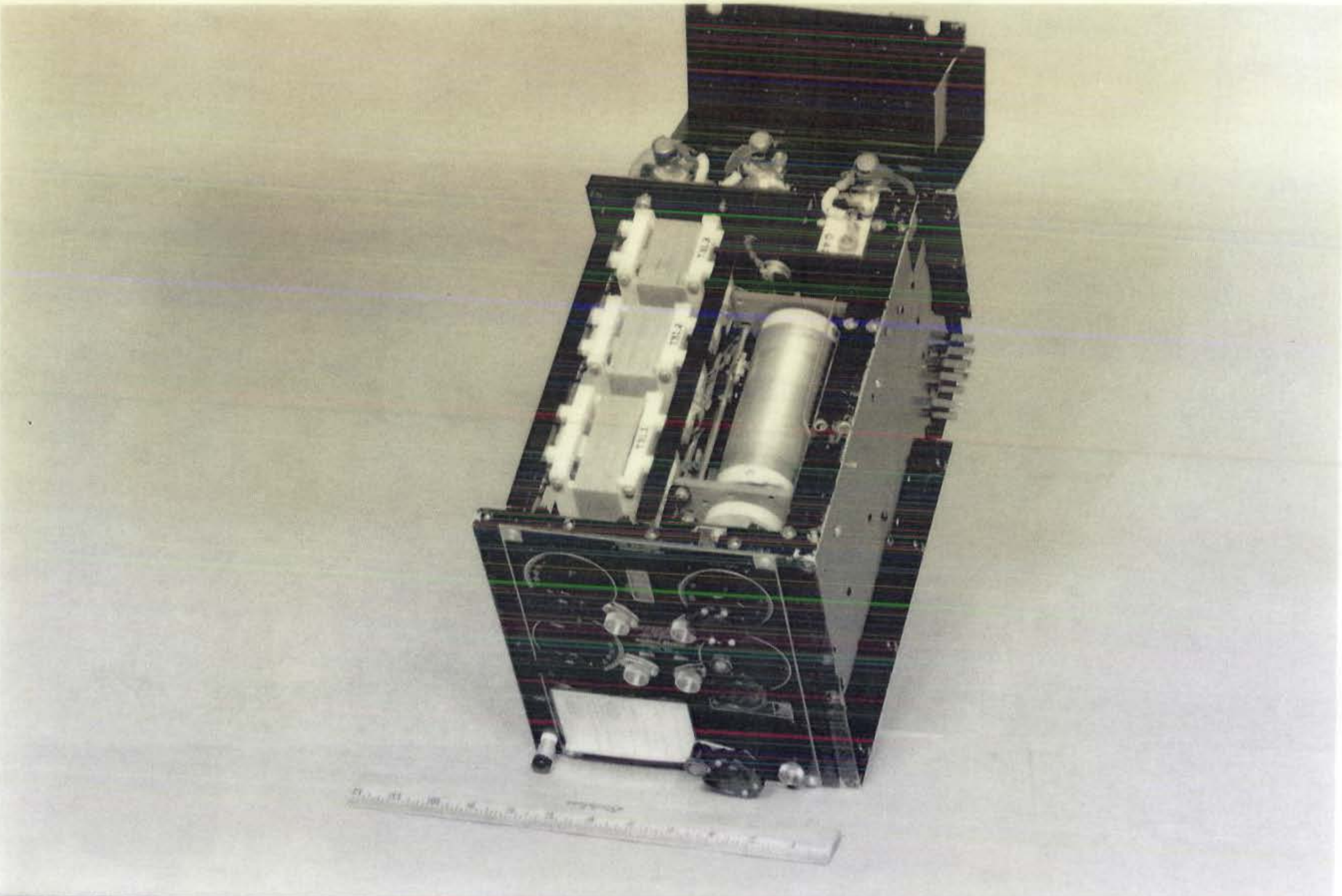
AN-50902 11-10-37

OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION

ENCLOSURE (W)



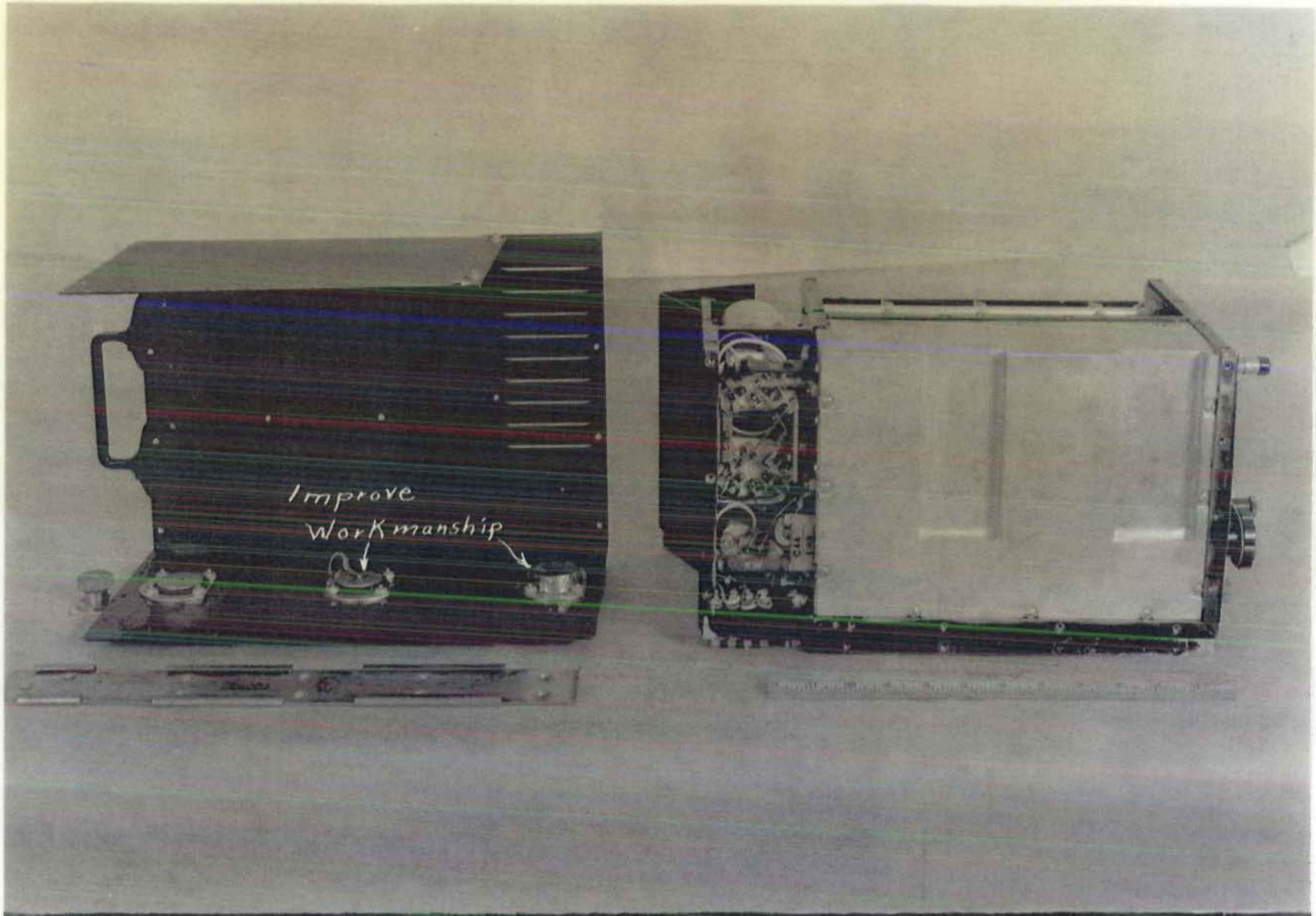
Model XGN Radio Transmitting AN-50970 11/23/37 OFFICIAL NAVY PHOTOGRAPH
Equipment - Type CW-52067 I.F. NOT TO BE USED FOR PUBLICATION
Transmitter Unit - Interior left side view. ENCLOSURE (X)



Model XGN Radio Transmitting Equipment - Type CW-52067 I.F. Transmitter Unit - Interior top view.

AN-50971 11/23/37

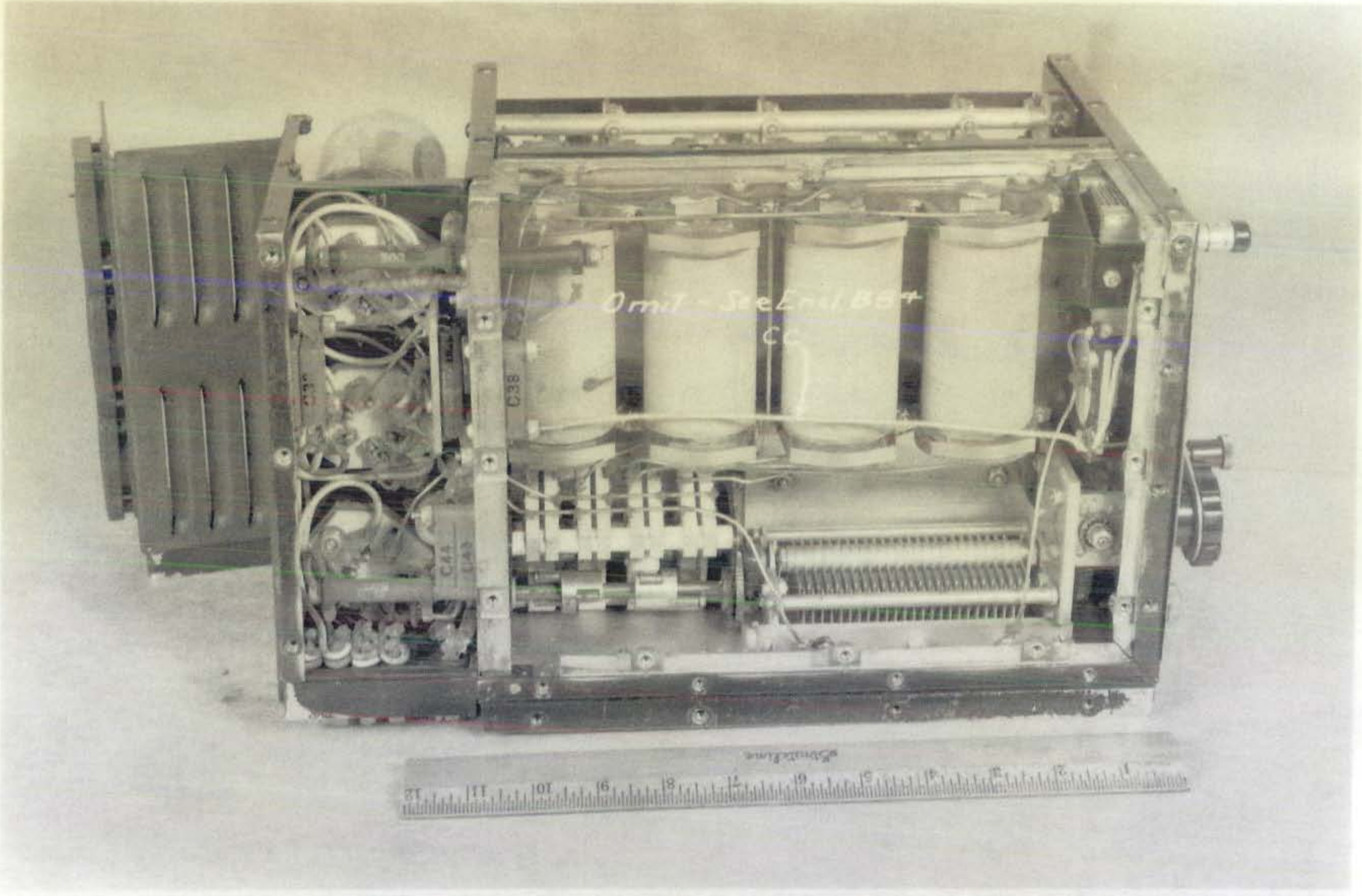
OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION
ENCLOSURE (Y)



Improve Workmanship

Model XGN Radio Transmitting AN-50972 11/23/37
Equipment - Type CW-52067 I.F. Transmitter
Unit - Bottom view with outer shield removed.

OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION
ENCLOSURE (Z)



Omit - See Encl BB + CC

Model XGN Radio Transmitting Equipment - Type CW-52067 I.F. Transmitter Unit - Interior bottom view, with preliminary CFI coupling.

AN-50973 11/23/37

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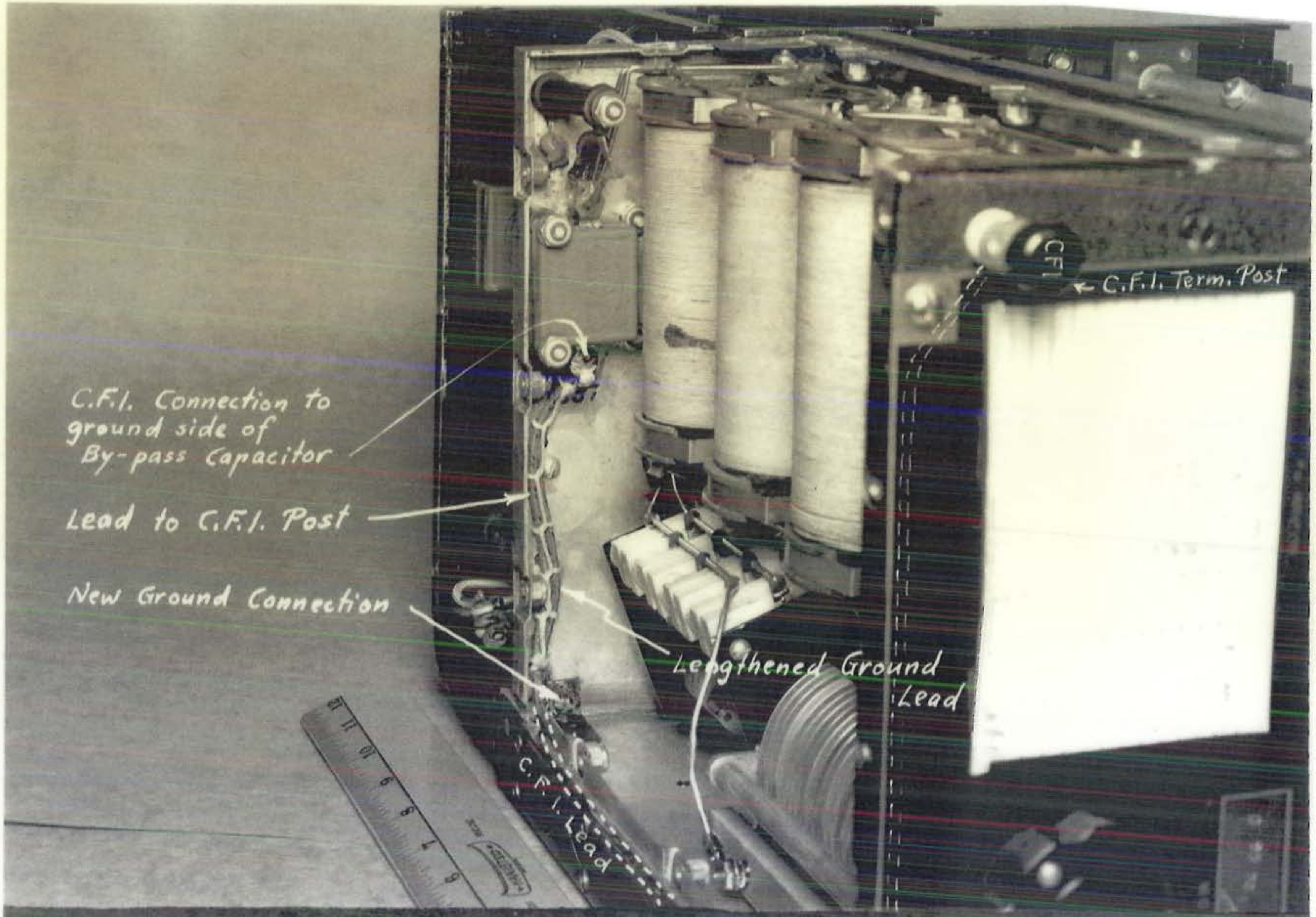
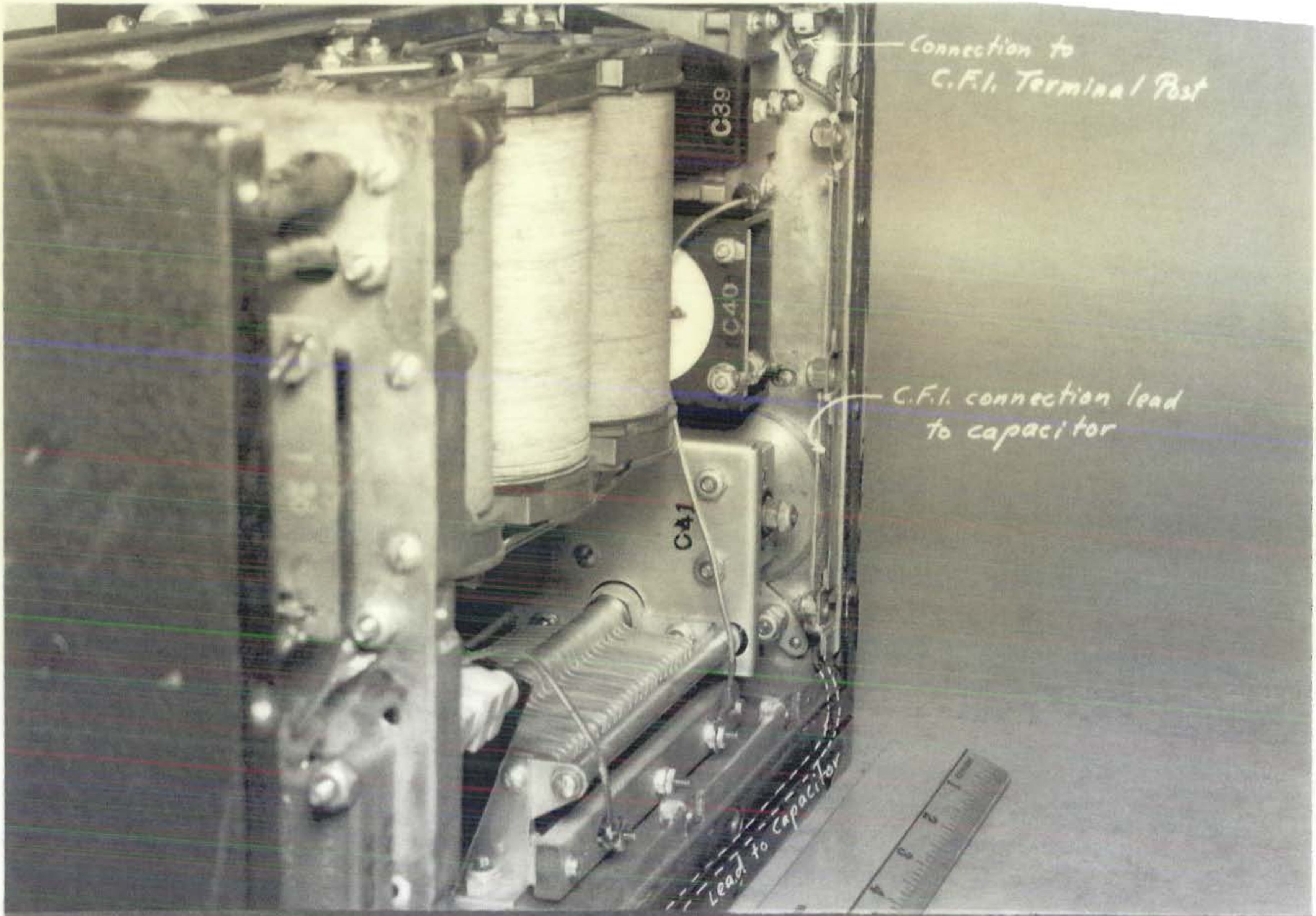
NOT TO BE USED FOR PUBLICATION

ENCLOSURE (AA)

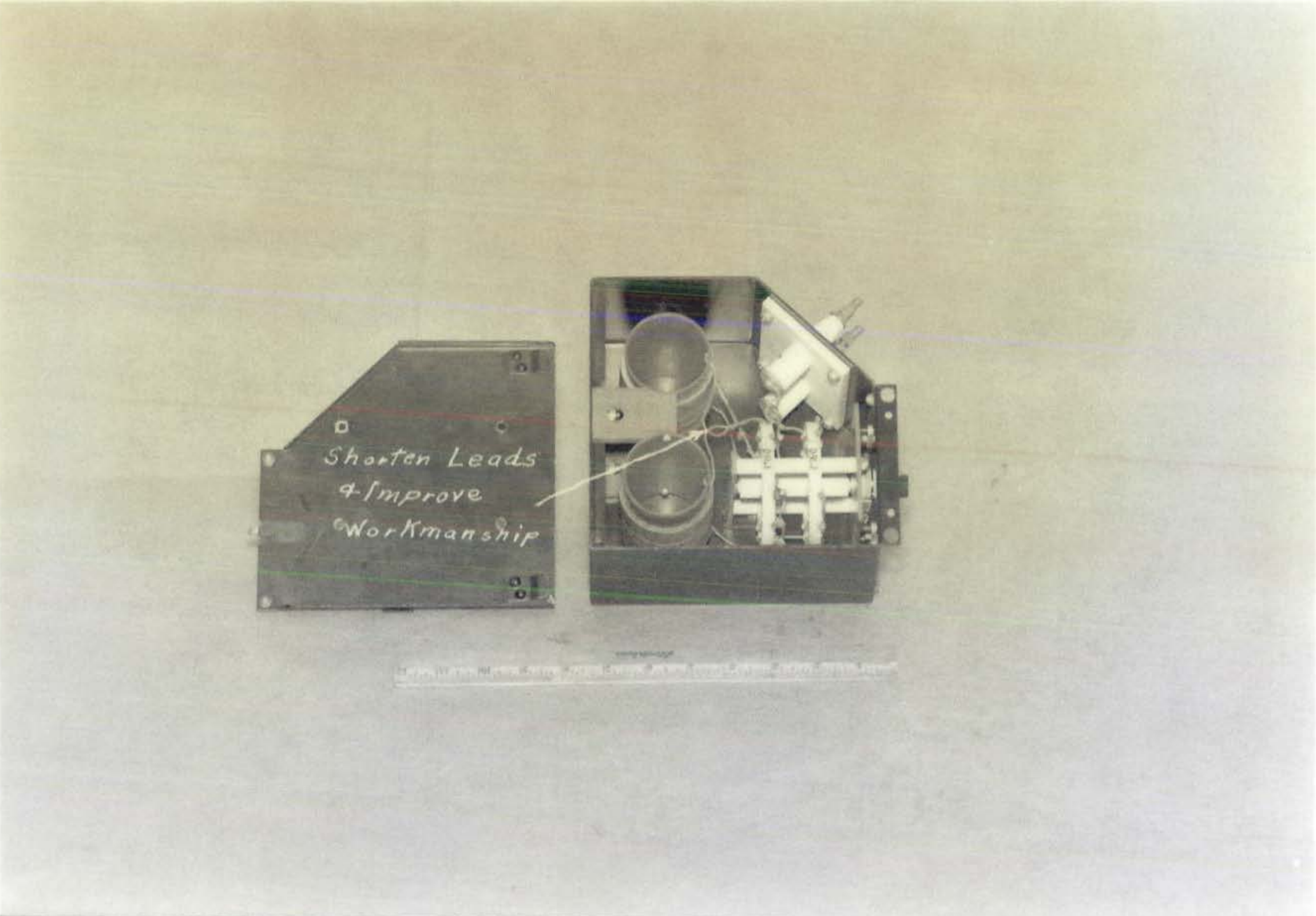


Model XGN Radio Equipment - Connections for C.F.I. in I.F. transmitter unit - Front view through bottom. AN-50903 11-10-37 OFFICIAL NAVY PHOTOGRAPH NOT TO BE USED FOR PUBLICATION

ENCLOSURE (BB)



Model XGN Radio Equipment - Connections for C.F.I. in I.F. transmitter unit - Oblique rear view through bottom.   AN-50904   11-10-37   OFFICIAL NAVY PHOTOGRAPH NOT TO BE USED FOR PUBLICATION



Model XGN Radio Transmitting
Equipment - Interior view of
Antenna Loading Unit.

AN-50974 11/23/37

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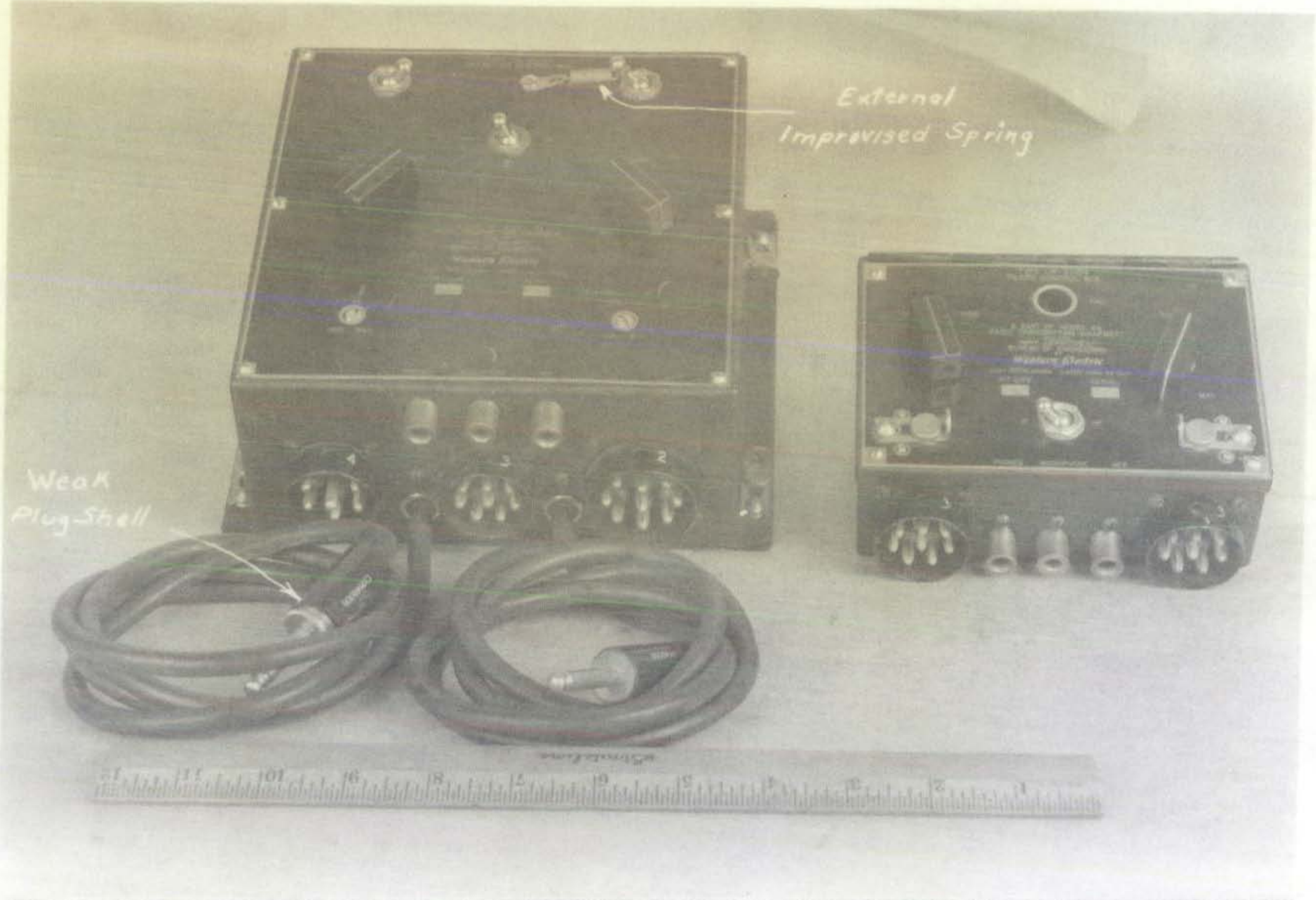
NOT TO BE USED FOR PUBLICATION
ENCLOSURE (DD)



Model XGN Radio Transmitting Equipment - Operator's and Pilot's Control Boxes.

AN-50975 11/23/37

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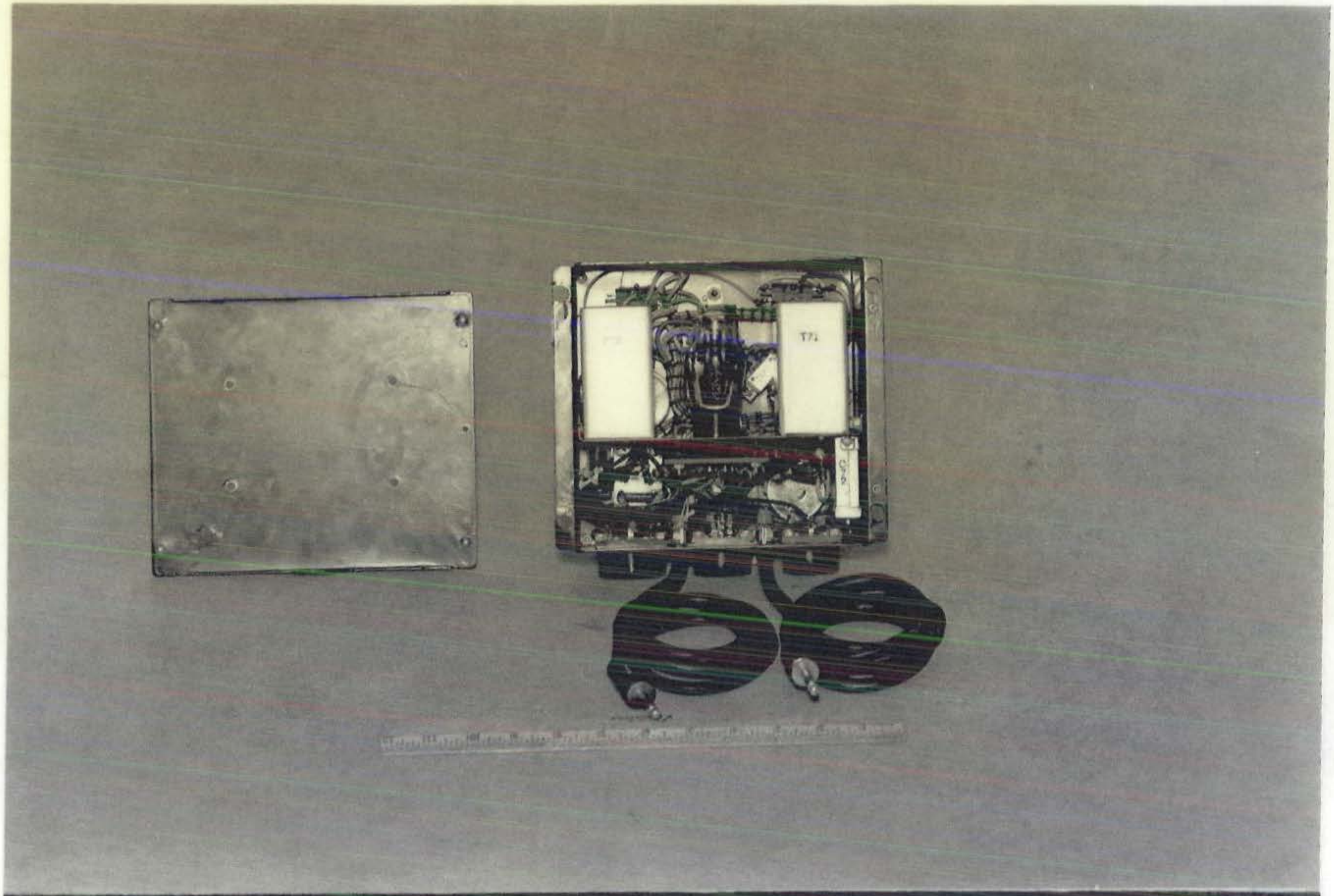
NOT TO BE USED FOR PUBLICATION
ENCLOSURE (EE)



Model XGN Radio Transmitting
Equipment - Rear view into
operator's Control Box.

AN-50976 11/23/37

OFFICIAL NAVY PHOTOGRAPH
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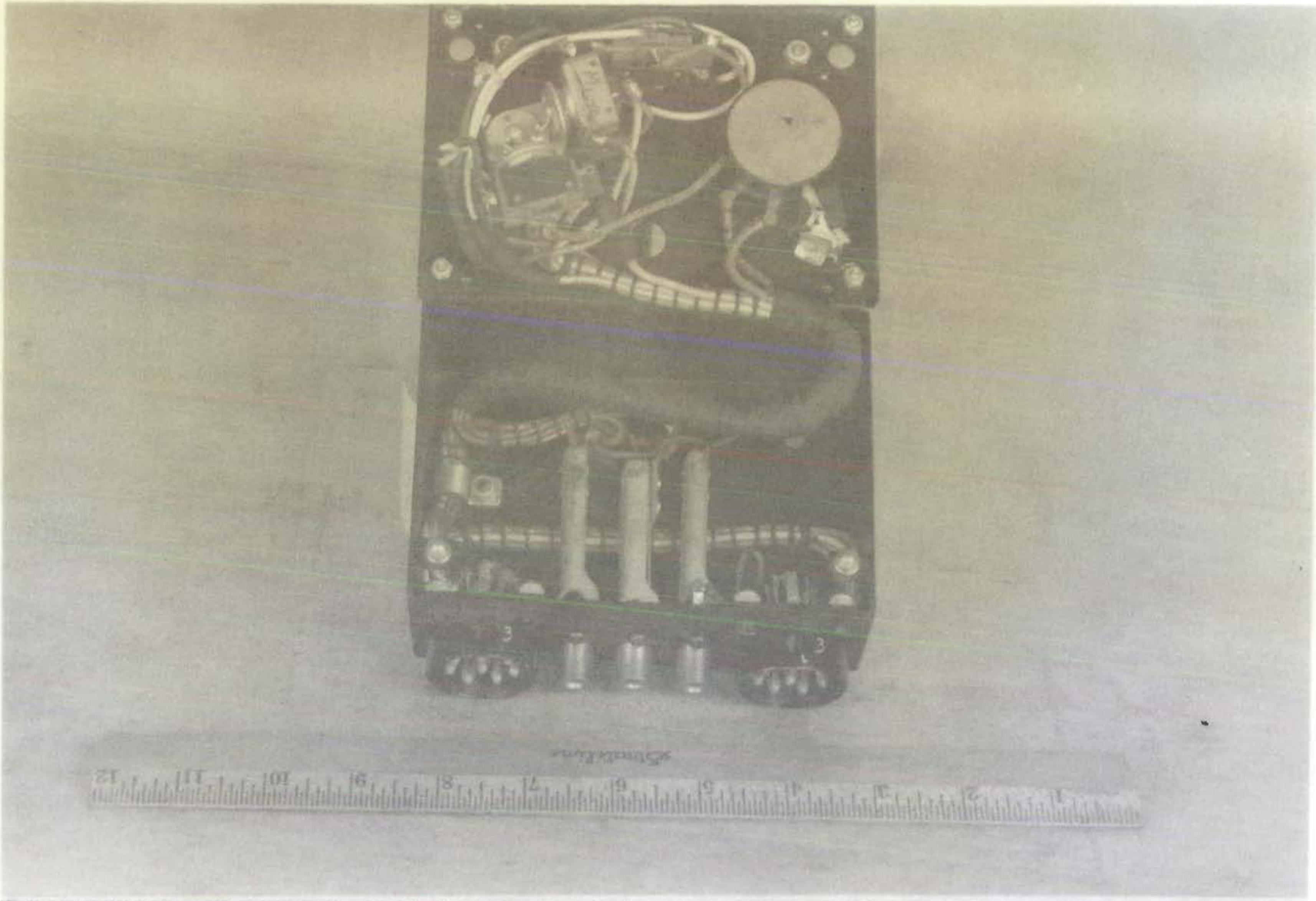
ENCLOSURE (FF)



Model XGN Radio Transmitting
Equipment - View into Pilot's
Control Box with cover open.

AN-50977 11/23/37

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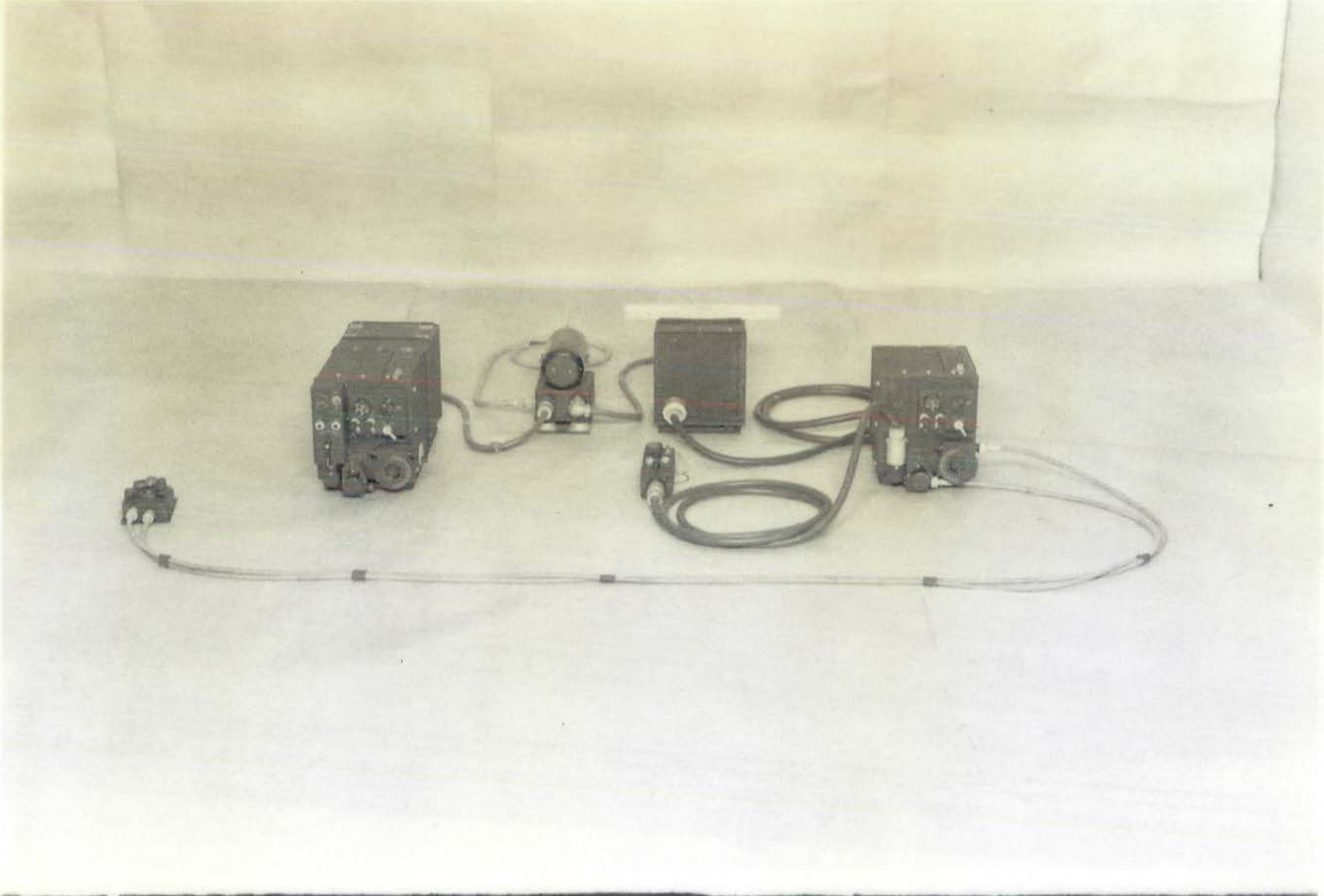
NOT TO BE USED FOR PUBLICATION
ENCLOSURE (GG)



Model XRAM Radio Receiving Equipment - I.F. Receiver combined and locally controlled, H.F. Receiver separated and remotely controlled.

AN-50978 11/23/37

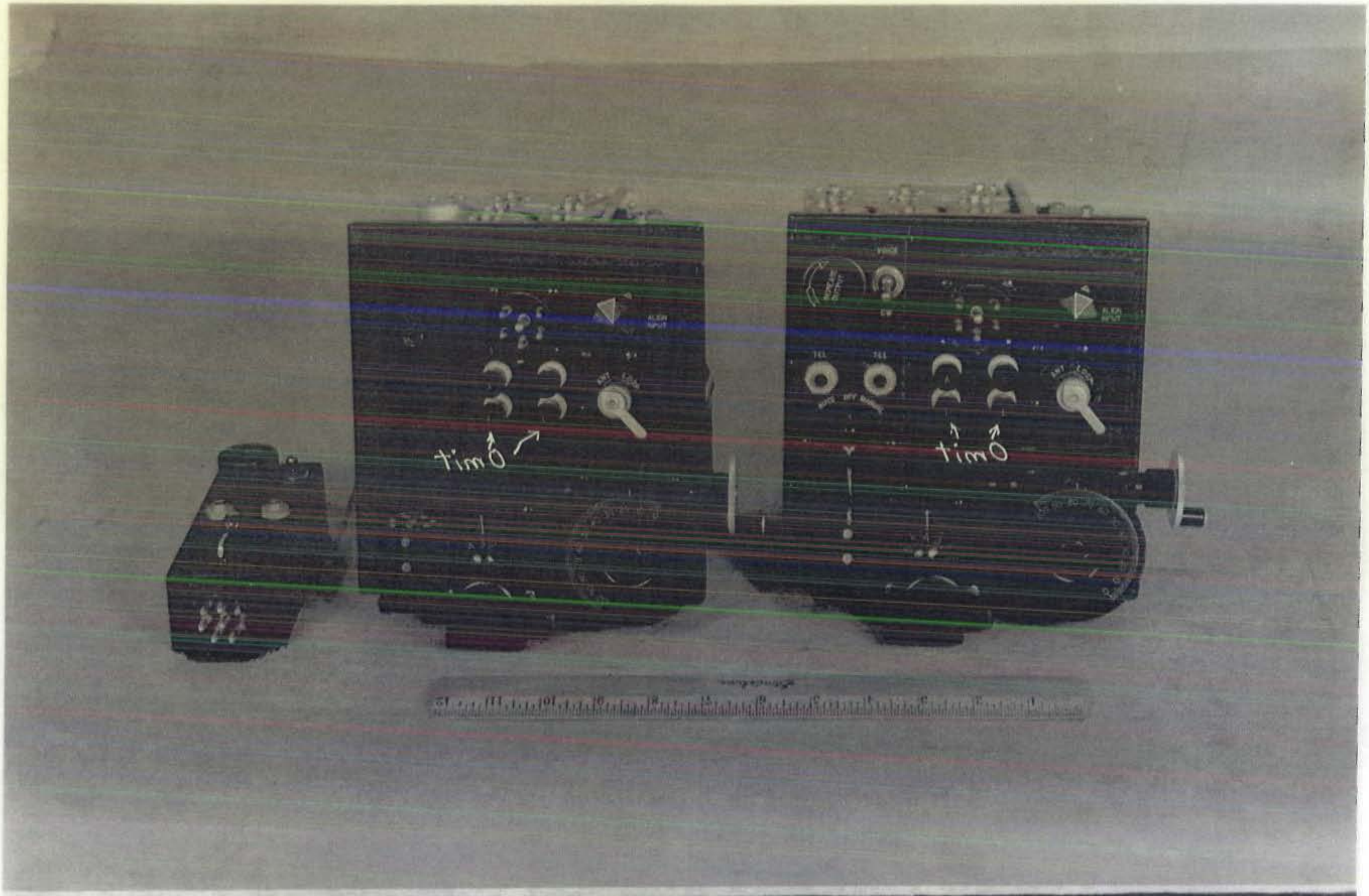
OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION

ENCLOSURE (HH)

Model XRAM Radio Receiving
Equipment - Main Units with
spray-proof covers.

AN-50979 11/23/37

OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION
ENCLOSURE (II)

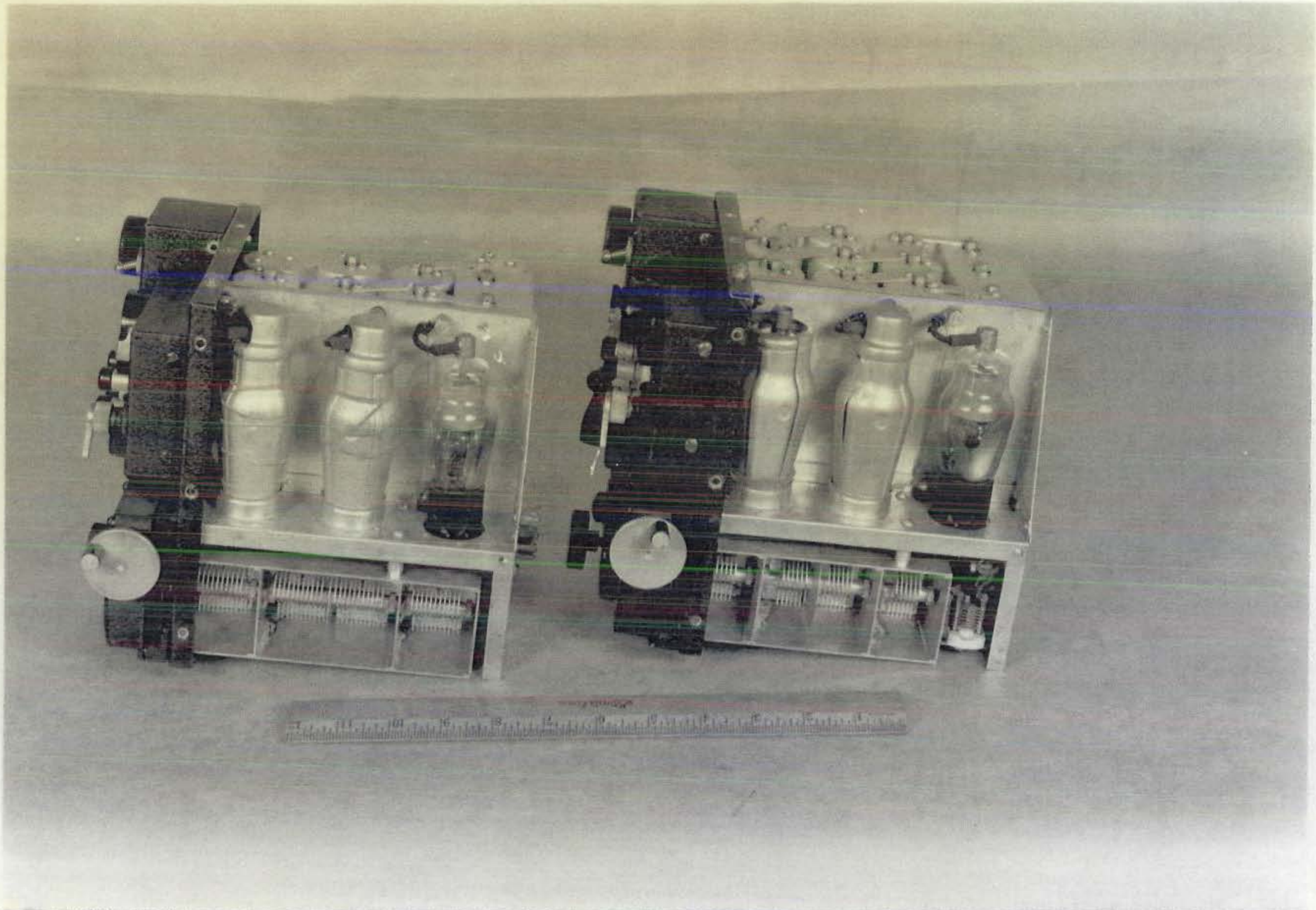


Model XRAM Radio Receiving
Equipment - Front portions of
I.F. and H.F. Receivers, showing
detachable switch box.

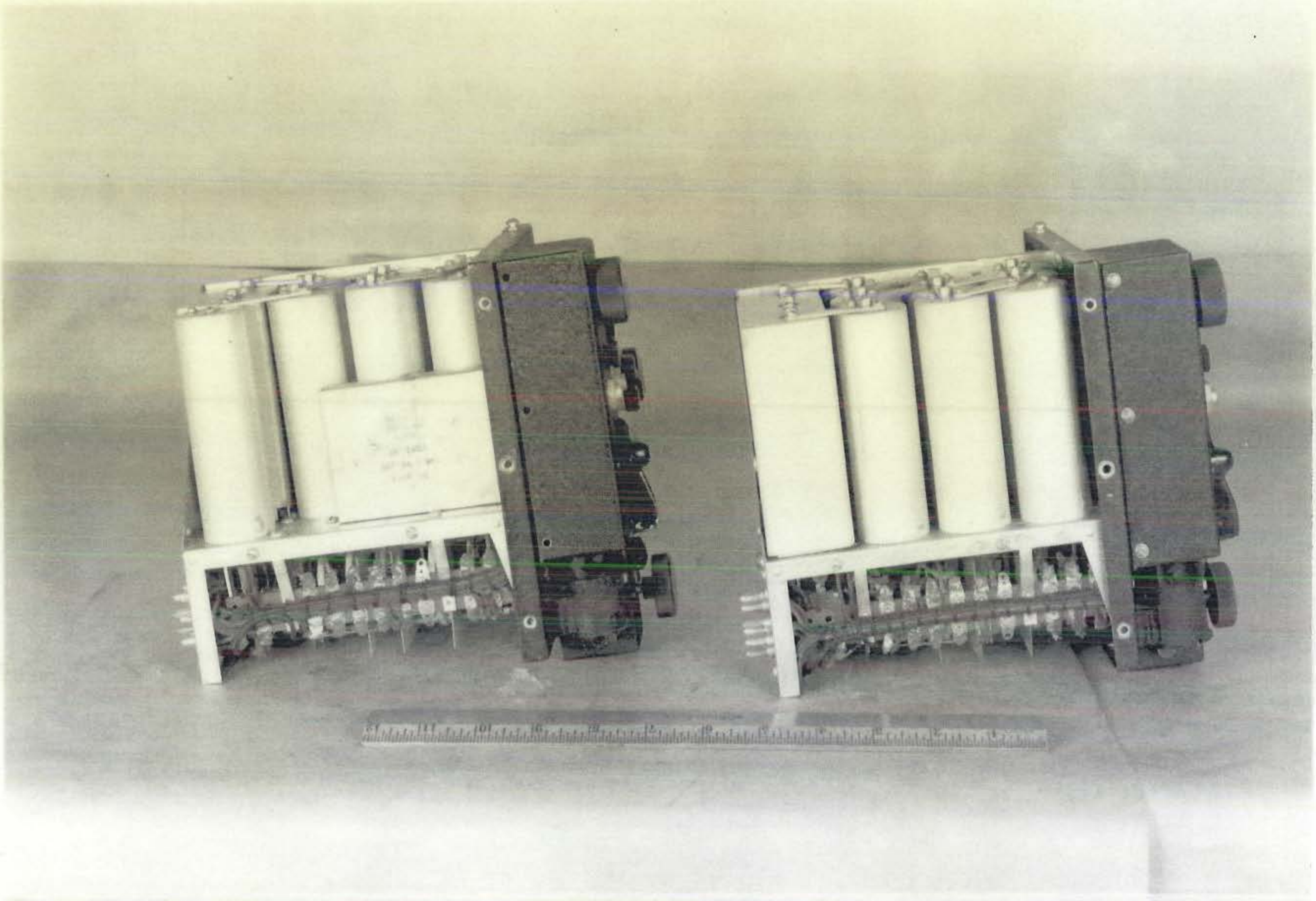
AN-50980 11/23/37

OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION

ENCLOSURE (JJ)



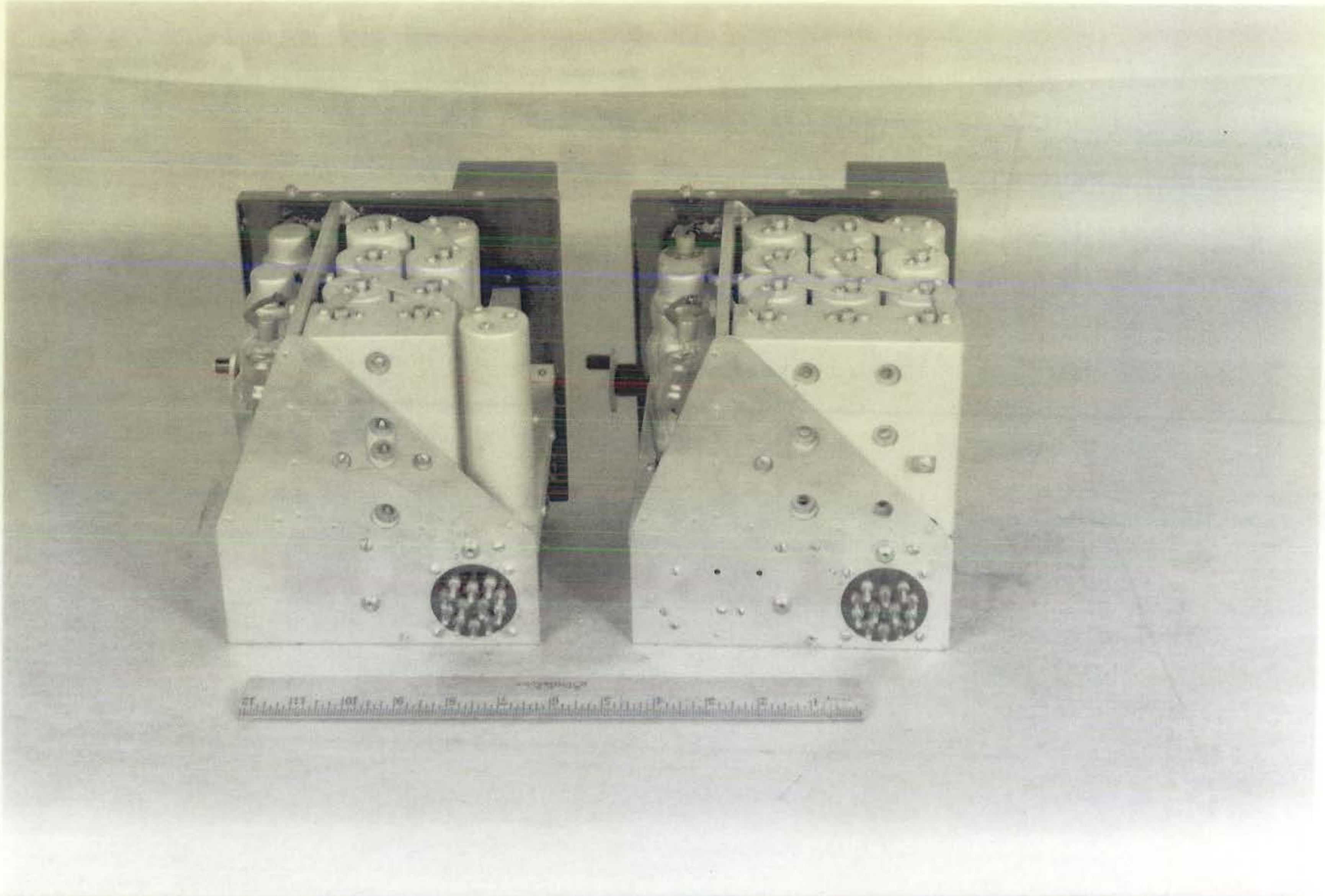
Model XRAM Radio Receiving AN-50981 11/23/37 OFFICIAL NAVY PHOTOGRAPH
Equipment - Interior right side NOT TO BE USED FOR PUBLICATION
views of I.F. and H.F. Receiver Units. ENCLOSURE (KK)



Model XRAM Radio Receiving
Equipment - Interior left side
views of I.F. and H.F. Receiver Units.

AN-50982 11/25/37

OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION
ENCLOSURE (LL)



Model XRAM Radio Receiving Equipment - Interior rear top views of I.F. and H.F. Receiver Units.

AN-50983 11/23/37

OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION
ENCLOSURE (MM)

Model XRAM Radio Receiving Equipment - H.F. Receiver Unit with Amplifier Unit, with shielding cases and mounting plates disassembled.

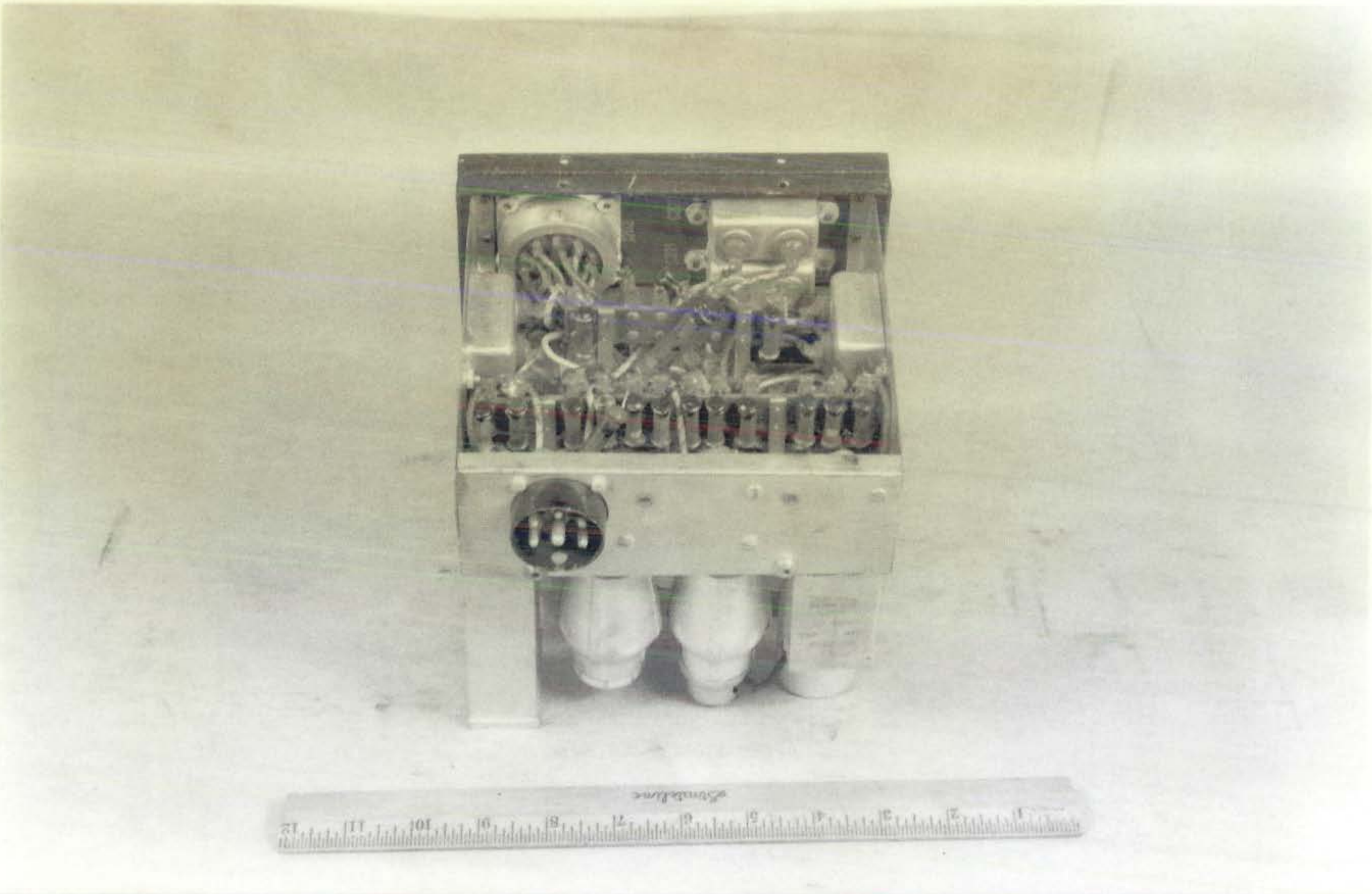
AN-50984 11/23/37

OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION

ENCLOSURE (NN)

Model XRAM Radio Receiving AN-50985 11/23/37
Equipment - Amplifier Unit for
H.F. Receiver - Front end with shield removed.

OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION
ENCLOSURE (OO)



Model XRAM Radio Receiving
Equipment - Amplifier Unit for
H.F. Receiver - Bottom rear view
with shield removed.

AN-50986 11/23/37

OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION

ENCLOSURE (PP)

Model XRAM Radio Receiving AN-50987 11/23/37
Equipment - Amplifier Unit for H.F. Receiver
- Separable shielding cases and mounting
frames for Receiver-Amplifier units.

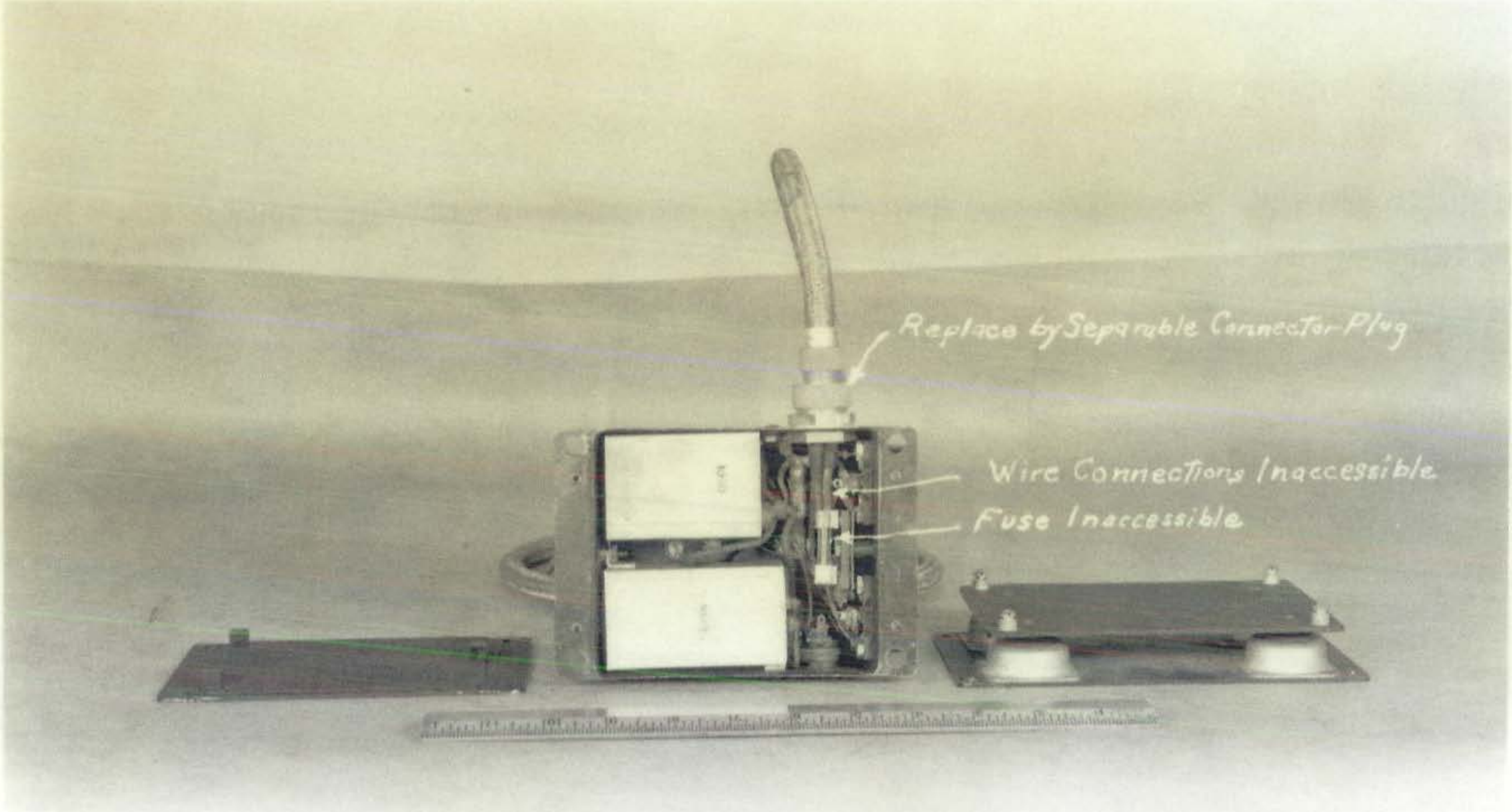
OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION

ENCLOSURE (QQ)

Model XRAM Radio Receiving
Equipment - Dynamotor on
shock-proof mounting.

AN-50988 11/23/37

OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION
ENCLOSURE (RR)



Model XRAM Radio Receiving
Equipment - Bottom view
through dynamotor base.

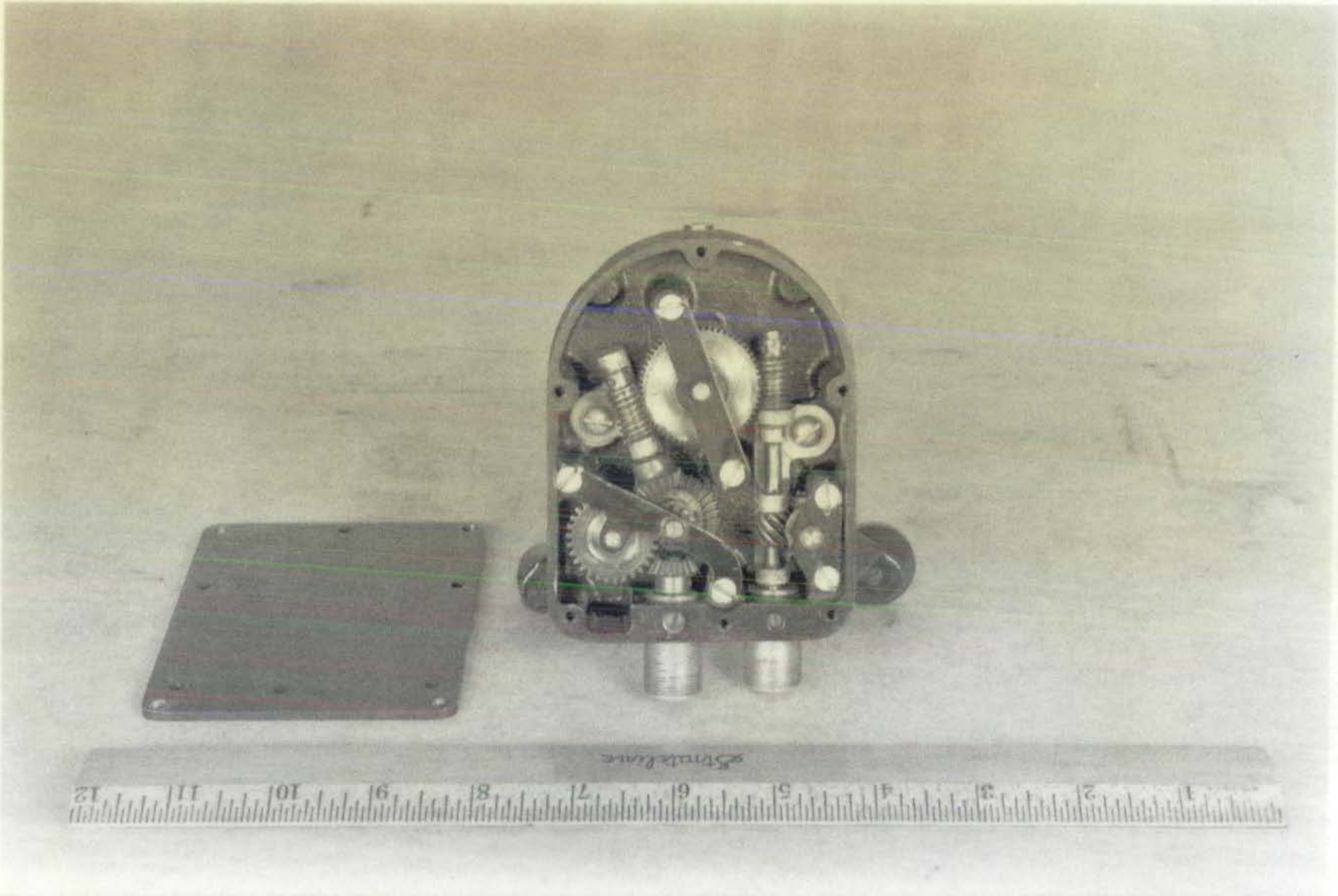
AN-50989 11/23/37

OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION
ENCLOSURE (SS)

Model XRAM Radio Receiving Equipment - Receiver band-change and tuning remote control head.

AN-50990 11/23/37

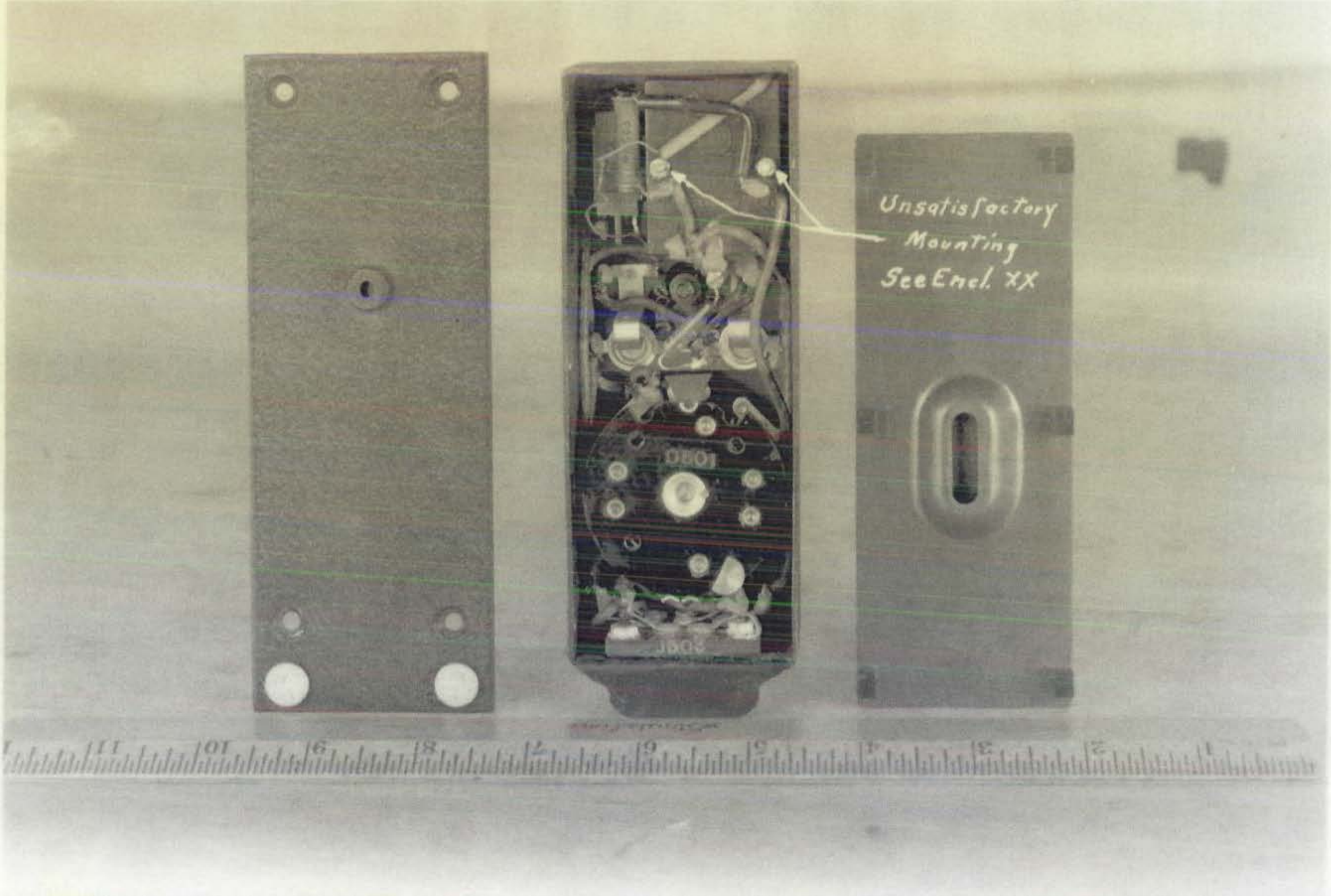
OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION
ENCLOSURE (TT)



Model XRAM Radio Receiving
Equipment - Rear view into remote
receiver control head.

AN-50991 11/23/37

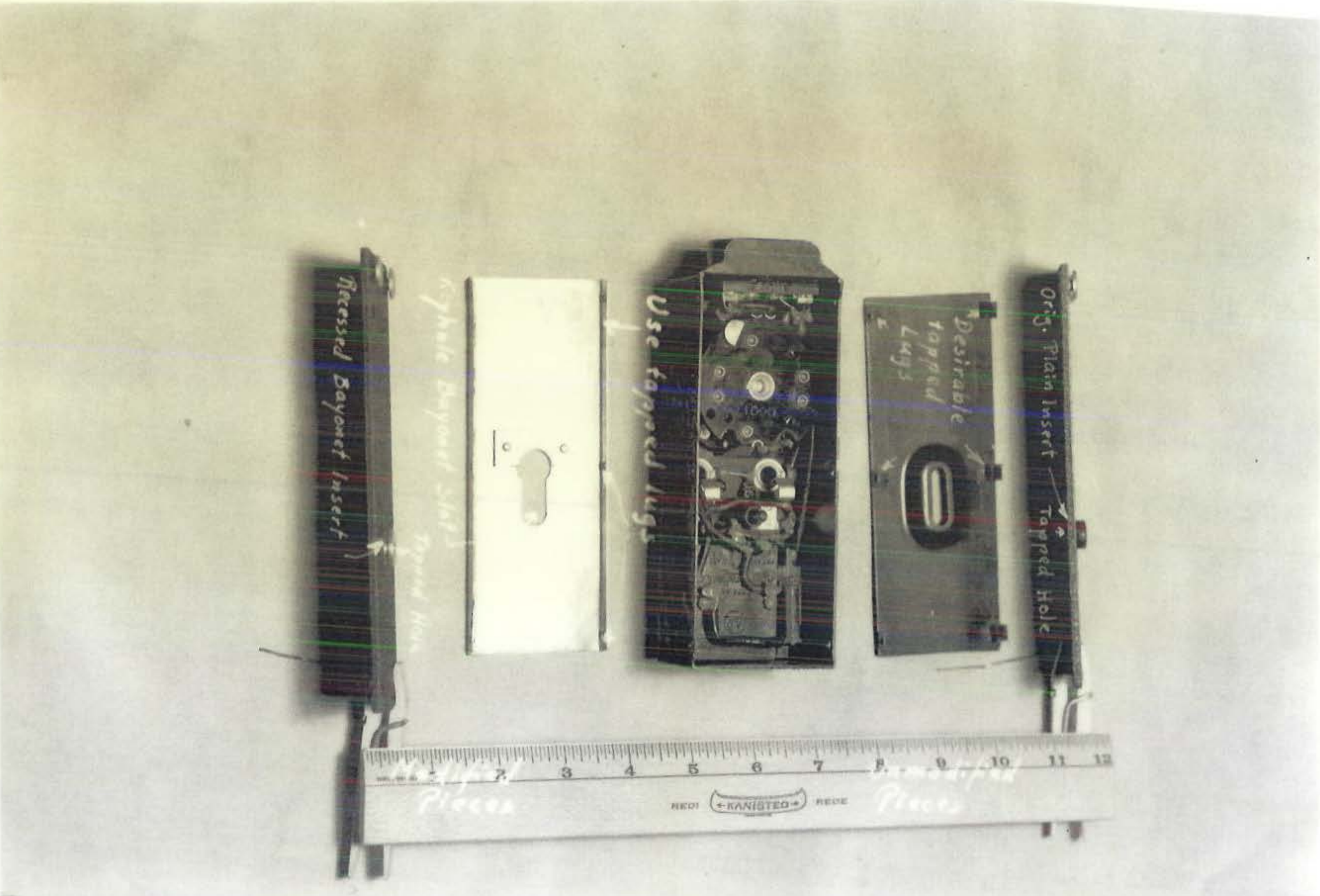
OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION
ENCLOSURE (UU)



Model XRAM Radio Receiving Equipment - Rear view into Receiver Switch Box, with back plate removed.

AN-50992 11/23/37

OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION
ENCLOSURE (VV)

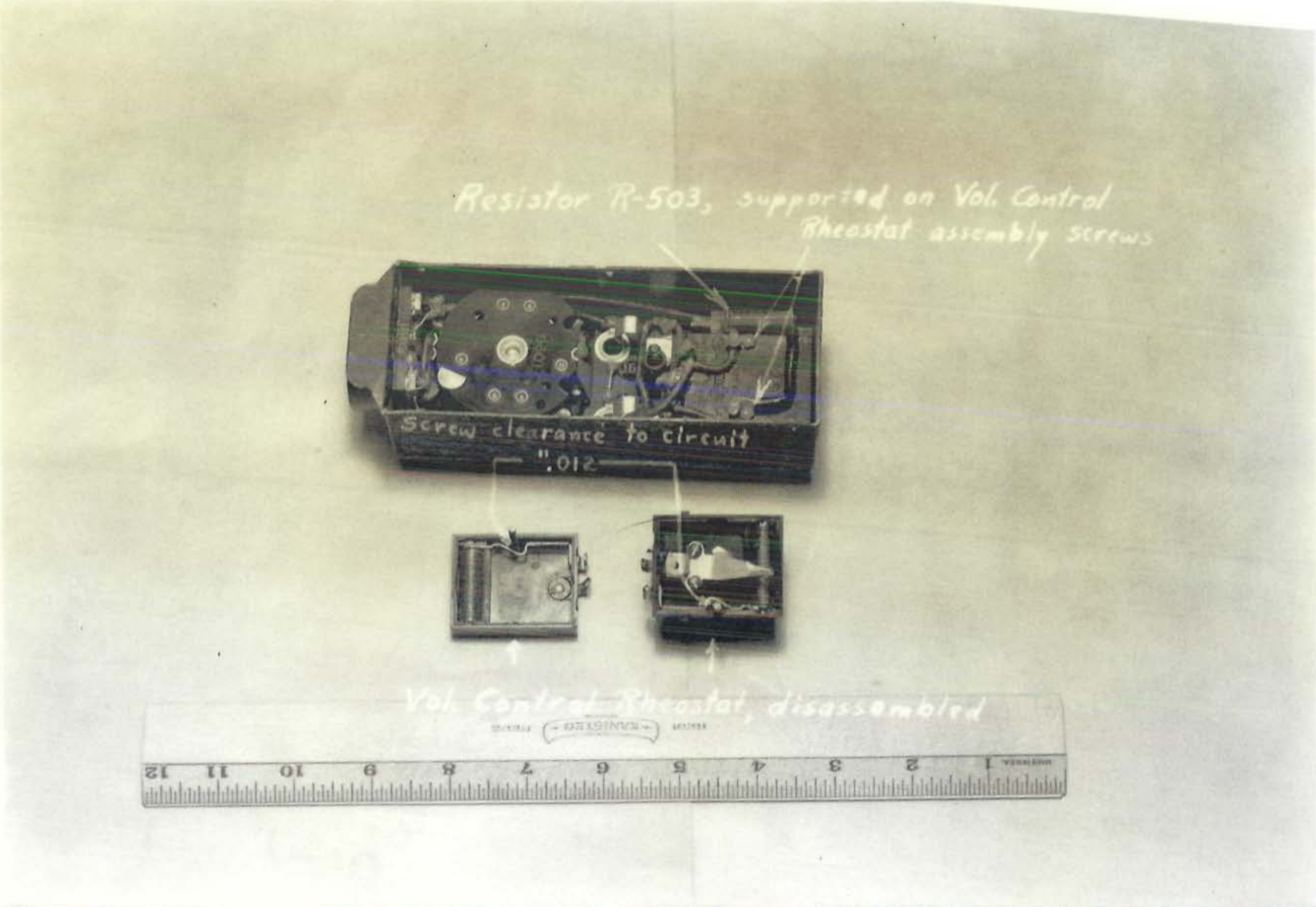


Model XRAM Radio Receiver Switch Box, with Anacostia mounting modifications.

AN-50884

OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION

ENCLOSURE (WW)

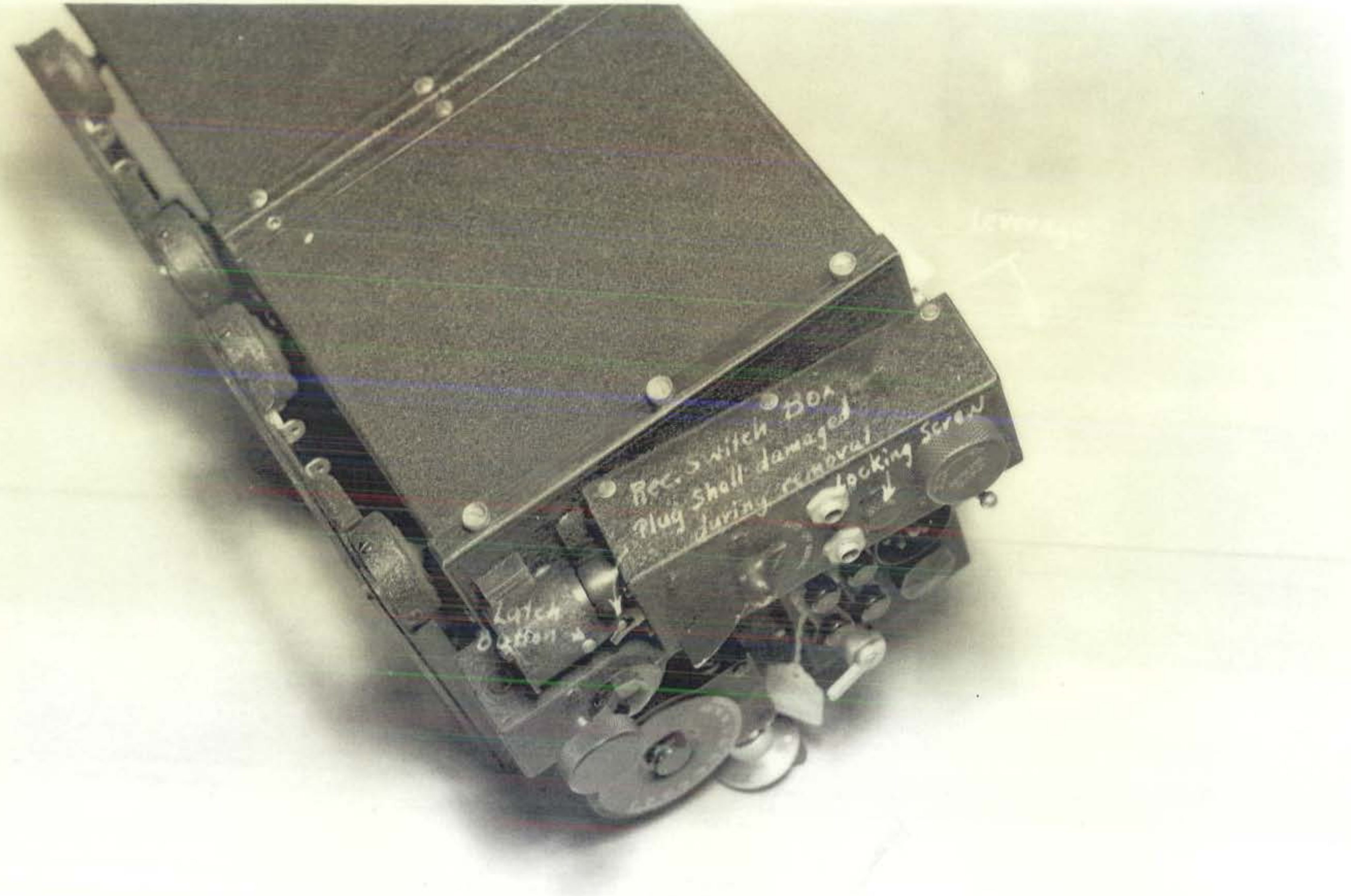


Interior of XRAM Radio Receiver Switch Box, showing inadequate resistor mounting.

AN-50885

OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION

ENCLOSURE (XX)

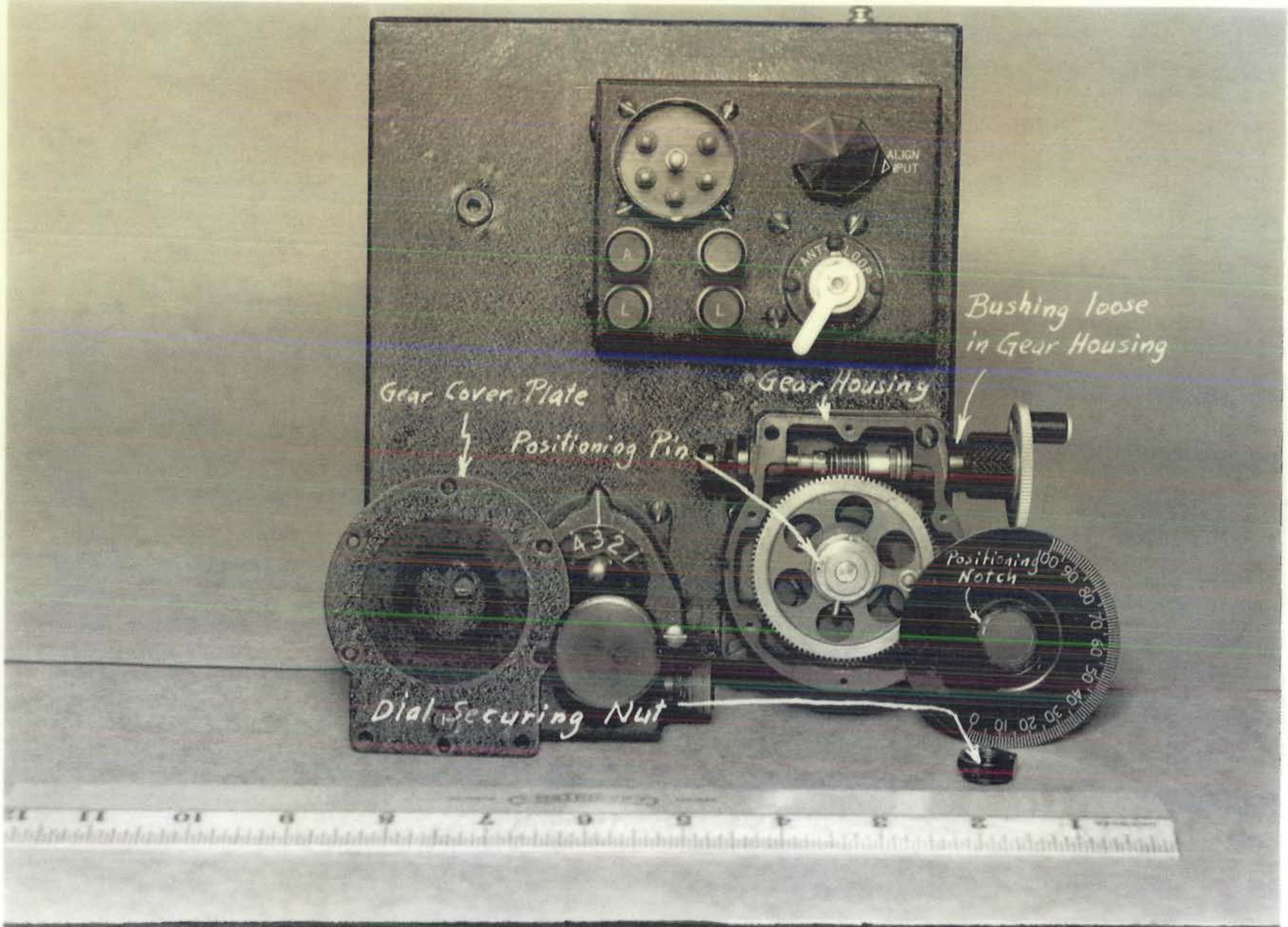


Model XRAM Radio Receiver, showing damage to Switch Box plug shell.

AN-50886

OFFICIAL NAVY PHOTOGRAPH
NOT TO BE USED FOR PUBLICATION

ENCLOSURE (YY)



Model XRAM Radio Receiver - AN-50905 11-10-37 OFFICIAL NAVY PHOTOGRAPH
Dial drive and tuning mechanism. NOT TO BE USED FOR PUBLICATION

ENCLOSURE (ZZ)

COPY

NAVY DEPARTMENT
BUREAU OF ENGINEERING
WASHINGTON, D.C.

MEMORANDUM OF BUREAU OF ENGINEERING CONFERENCE HELD 15 APRIL 1937.

Subject: NOs43068, Test of GN-RAM Models.

1. For the purpose of obtaining information as to status of GN-RAM model test, a conference was held on 15 April 1937. Representatives of Bureau of Engineering, Naval Research Laboratory and Naval Air Station, Anacostia, were present.

2. The following points were brought out:

(a) Tests are not yet complete at Naval Air Station, Anacostia; from 2 to 4 more weeks are required.

(b) <u>Transmitter Deficiencies</u>

(1) Lord Shock Absorber Buttons should be of higher rating and should be distributed to take load at front and back rather than in middle to eliminate excessive rocking.

(2) 38222 Rectifier Tubes are inferior and repeatedly fail. Should be replaced by type 38266A.

(3) Keying Relay furnished is unsatisfactory. A relay similar to the GO-2 relay should be incorporated for test. The auxiliary keying relay is unnecessary.

(4) Keying Relay and Antenna Post location for the two Transmitters should be reversed to provide ease of connection to standard antennas.

(5) Shielding between Keying Relays and of receiver leads should be accomplished to give better duplexability.

(6) Grounding Lug in relay compartment had excessive and variable resistance causing numerous operating troubles.

(7) Overlap between bands should be specified as 1% to 3% in order to avoid excessive overlap in production.

(8) Roller Coil breakdown necessitated mechanical improvement which may have some effect on power outputs previously measured.

(9) Control Designating Symbols should follow GO-2 practice and also be placed on knobs.

COPY

MEMORANDUM OF BUREAU OF ENGINEERING CONFERENCE HELD 15 APRIL 1937.

Subject: NOs43068, Test of GN-RAM Models.

- -

(10) Tube Socket Locations should be designated by tube type numbers at suitable visible locations.

(11) Compensating Condensers C-42 and C-62 should be marked "Do not alter setting" in order to keep inexperienced personnel from throwing out entire frequency stability compensation.

(12) Master Oscillator Drive and Visibility are poor and the torque and back lash exceed requirements. A drive similar to the GO-2 drive should be incorporated for test.

* (13) HF Transmitter Coupling not sufficient to work well in larger fixed antennas. Further data on desired degree of coupling is necessary.

(14) MO Condenser breaks down at altitude.

(15) Binding Posts for CFI connection are desired.

(16) Chromium Insert Switch Knobs should be marked to indicate top and bottom position and these switches also have poor detents.

(c) System Deficiencies.

(1) Power Plugs and Cables should be marked for identification of position and use.

(2) ICS Levels are too low. Approximately 50 milliwatts is needed.

(3) Control System needs further test and study. Too confusing at present. Apparently "transmitter on" indicator lights are needed and an interphone system similar to the GF-3.

(d) Receiver Deficiencies.

(1) Torque, Backlash, Resetability, both remote and local are not satisfactory.

(2) Remote Band Switch Drive not satisfactory but may be improved by a detent on the drive.

(3) Tube Shields (form fitting type) not satisfactory. Straight type is recommended.

(4) 38085 Tube should have dummy grid clip to avoid misconnection.

* Anacostia note: Delete sub-para. 13 above.

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MEMORANDUM OF BUREAU OF ENGINEERING CONFERENCE HELD 15 APRIL 1937

Subject: NOs43068, Test of GN-RAM Models.

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(5) Auxiliary Power Plug and Binding Posts interfere. Rearrangement needed.

(6) Auxiliary Power Plug Wiring is reversed, and two of these plugs for operating other equipment are not available.

(7) Tuning Head not furnished with double outlet.

(8) Flat or Screw Type Plugs desirable for receiver monitoring cables.

(9) Dynamotor Power Plug similar to GO-2 power plug is desired.

(10) Remote Control Cables apparently too light with excessive whip and wind up.

(11) Receiver Units do not line up well as to screw holes and plugs when telescoped together.

(12) Trimmer Condenser Control should be graduated.

(13) Loop Circuit has excessive coupling to antenna circuit.

(14) Bleeder across Series Trimmer Condenser desirable to bleed off static charges.

(15) Selectivity of LF receiver appears satisfactory; on HF receiver selectivity may be too great and may have to be broadened on a "broad-sharp" control provided. Further test on this feature is necessary.

(16) Output Level on AVC position is too low.

3. It is understood that the manufacturer desires to incorporate the improved MO driver and keying relays (GO-2 type) in one GN model and the model at NAS, Anacostia will be released for about one week for this purpose, tests of the RAM to continue in the meantime.

COPY GBHH/adl

F42-1/52/NA6 U.S. NAVAL AIR STATION
ANACOSTIA, D.C.

JUL 21 1937

From: Commanding Officer.
To: The Chief of the Bureau of Engineering.
Via: The Chief of the Bureau of Aeronautics.

SUBJECT: Aircraft Radio - Model GN Transmitting Equipments - Principal deficiencies in, Preliminary Report on.

Reference: (a) Memo. of BuEng conference held 15 April 1937, Enclosure (A) with BuEng ltr. NOs-43068 (4-17-W3) of 23 April 1937.
(b) BuEng Specification RE 13A 504A dated 1 Feb. 1938.

Enclosure: (A) List of GN alterations at contractor's works,
(Herewith) 22 April to 10 June, 1937.

1. The preliminary GN transmitting equipment, in conjunction with the RAM receiving equipment, has been under test at this station since the beginning of March 1937. Major necessary modifications by the contractor listed on Enclosure (A) interrupted these tests during the period from 22 April 1937 to 10 June 1937; additional deficiencies have again interrupted tests since 8 July, 1937.

2. The principal deficiencies which remain in the subject transmitting equipment are the following:

(a) "Roller coil" H.F. and I.F. antenna tuning inductors. Repeated failures of the original construction (roller traveling on circular shaft) both at N.R.L. and this station caused the contractor to change the construction (7 April 1937) to a small roller attached to a spring yoke, traveling on a shaft of square section. Subsequent troubles, including interruption of tests on 1 and 7 July, 1937, due to contact roller failure while in flight, indicate necessity for further redesign before flight tests are resumed.

(b) H.F. and I.F. break-in keying relays. No actual troubles have been experienced with these units since incorporation of the minor modifications described in item 3, Enclosure (A). These relays, however, possess a number of constructional deficiencies which have given troubles on similar relays incorporated in the GP-1 and an early experimental model GO-2 equipment, but which have been improved in the GO-2 production

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models. The outstanding deficiencies in the present GN relay are a weak receiving contact arm, a poor bearing for this arm, inadequate adjustment provisions for contacts, and inferior hold-back coil.

(c) Control and switching system. The ICS level has been increased by the contractor to an apparently satisfactory value; the pilot's and operator's control system, however, continues to prove impracticable for service operation, even though it follows in detail the requirements laid down in section 4-2 of reference (b). See sec. (c) (3) of paragraph 2, Reference (a).

(d) I.F. - H.F. transfer switch. This switch is considered inadequate for service use inasmuch as it transfers only the filament and relay connections, while all plate and screen potentials are applied to both transmitters whenever the keying relay is closed. In case either transmitter develops a high-voltage breakdown path to "ground", the other transmitter channel also becomes inoperative, unless switch sections for transferring the high voltages are added to the switch. Space appears to be available at least for the addition of a 1000 volt transfer section.

(e) Inaccessibility for servicing. While the access to the relay compartment is satisfactory and tubes may be changed in flight if the airplane mock-up leaves sufficient space, the interior of the equipment even for bench servicing or inspection purposes is very inaccessible. To separate either transmitter unit from the rectifier unit requires the complete removal of 15 machine screws, and 22 additional screws must be removed from each unit to separate it from its shielding case before access is gained to the interior.

3. This station recommends that the following action be taken in regard to the above-mentioned deficiencies:

(a) Require re-design of roller coils, and insertion in experimental models of such coils and drive mechanism as contractor proposes to supply in production equipments.

F42-1/52/NA6
(184)

SUBJECT: Aircraft Radio - Model GN Transmitting Equipments - Principal deficiencies in, Preliminary Report on.

(b) Require installation and test in experimental models of actual proposed production relays. It is understood that the present GO-1/GO-2 relay will require some re-design before it will fit the GN equipment.

(c) Make further study of circuits and control system, and authorize equipment's departure from the detail requirements of section 4-2 of reference (c).

(d) Require contractor to incorporate re-designed and more adequate transfer switch in experimental models for flight test.

(e) Require contractor to consider improved accessibility to units through re-design of unit assembly method, and by reducing number of detachable machine screws to a minimum consistent with necessary strength and bonding.

4. It is recommended that the GN transmitter and rectifier units be returned to the contractor's plant for necessary changes; retention of the remainder of the equipment at this station will enable continuation of tests of the receiving and control equipment.

/s/ V.C. GRIFFIN

Copy to:
Director, N.R.L.
NAF Phila.

ALTERATIONS MADE ON GN EQUIPMENT AT CONTRACTOR'S PLANT, BETWEEN 22 APRIL AND 10 JUNE, 1937

1. Installation of two type 836 half-wave rectifier tubes in place of one type RK-22 full-wave rectifier tube.

2. Installation of modified oscillator condenser driving mechanism - H.F. unit only. Both oscillator condensers repaired.

3. Greater R.F. clearance at antenna contacts of both keying relays. Readjustment of relay sequence. Omission of microphone relay, and installation of a 2-mf. condenser to prevent sparking at key contacts. Installation of separate binding post for grounding receivers directly to airplane fuselage.

4. Provisions for greater clearances from switch contacts to ground on external antenna loading coil.

5. Relocation of P.A. plate by-pass condensers to give greater clearances.

6. Remounting of antenna series condenser, H.F. unit, to lessen possibility of breakdown to ground.

7. Modification of terminal on antenna bushings to prevent possibility of R.F. breakdown.

8. Reconnection of variable antenna loading coil on I.F. unit so that the highest H.F. potentials appear where there is little likelihood of breakdown.

9. Reduction of inductance of internal fixed loading coil, used on band 1 and 2 of I.F. unit, from 150 uh. to 100 uh. This will necessitate the use of slightly longer antennas on these bands, but the necessary lengths are within specification limits.

10. Replacement of stop on emission selector switch.

11. Installation of binding post on each transmitter for coupling to the Navy's C.F.I.

12. Installation of heavier shock mountings. 99 lb. rating at 3/32" deflection. Equipment weighs 89 lbs. 5 oz.

13. Installation of new control knobs on rectifier unit.

14. Increase in output on the I.C.S. from 19 mv. to 170 mv. into a 300-ohm load. Microphone voltage 1.30 volts at 1,000 c.p.s. Change effected by removing the 50,000-ohm I.C.S. gain control and replacing it by 0.25-megohm fixed resistor. Gain control is now obtained by a 10,000-ohm rheostat in series with the I.C.S. output transformer secondary.

COPY

NAVY DEPARTMENT
BUREAU OF ENGINEERING
WASHINGTON, D.C.

21 August, 1937

MEMORANDUM FOR FILES.

Subject: Conference with Western Electric Company re GN Transmitting Equipment - Confidential Contract 43068, held on 12 August, 1937 at Navy Department, Washington, D.C.

Present:

For Western Electric Co.	For Bureau of Engineering
Mr. G. A. Merquelin	Lt. Comdr. A. M. Granum
Mr. Phillips	Lieut. Frank Akers
Mr. Whitten	
Mr. Wilson	For NAS, Anacostia
Mr. Nordahl	
	Mr. Malcolm Hanson
	For Naval Research Laboratory
	Mr. Schrenk
	Mr. Hastings

1. A conference was called at the request of Mr. Whitten of Western Electric to discuss the items reported deficient in NAS, Anacostia letter F42-1/52/NA6 (184) dated 21 July, 1937.

2. The Western Electric Co. exhibited the GN transmitting equipment which had been returned to their factory for redesign of the roller coil for HF and IF antenna tuning inductors.

3. The following items were discussed:

(a) Redesign of the control and switching system. The present system leads to confusion between the pilot and radio operator in that the pilot is unable to tell when he hears a signal whether or not it is an incoming signal, his interphone, or an outgoing signal from the radio operator. It was agreed that the Contractor's representative, in conjunction with suggestions from NAS, Anacostia, should install a suitable switching arrangement on the test equipment at Anacostia and that final approval would be taken up at the final conference. This system was to be designed so that when the radio operator or pilot throws the selector switch to ICS, then the output of the two receivers are mixed and placed across the ICS output. Each operator may select the receiver he is listening on.

In case receiving interference is excessive the radio operator is provided with a clear channel switch, with spring return, which may be momentarily pressed to provide a clear channel on the ICS system. The question of providing the pilot with lights to indicate the channel and emission being transmitted was discussed, but due to the complications involved, it was decided to hold this in abeyance awaiting the outcome of tests of the modified control and switching system.

(b) Redesign of the IF-HF transfer switch so that the set could be operated on either IF or HF in case of failure to the other stage. The Contractor opposed this item, stating that a transfer switch of a small size demanded by the available space and designed to carry the high voltages involved would introduce a source of failure to the operation of the equipment which would be greater than the chance of one stage failing. He pointed out the fact that it would be necessary to introduce high voltage leads into various parts of the equipment which would create the possibility of breakdown. The Bureau felt that safety factors demanded the inclusion of some means of operation of the equipment in case of failure to one or the other stage. It was agreed that the Contractor would further study the possibility of placing a switch or other means whereby a stage, if it failed, could be cut out and the equipment continue to operate on the remaining stage. Such an arrangement would be in the nature of an emergency switch not normally operated.

(c) The question of inaccessibility of the set for servicing was discussed and the Contractor was of the opinion that a number of the screws holding the case could be eliminated, thus providing easier disassembly on the bench. The Bureau of Engineering stressed the point that no reduction in the number of screws was desired if there was any possibility of reduction of rigidity of the equipment. It was brought out that the design of the equipment and space limitations were such as to preclude repairs with the equipment installed in an airplane and for this reason all safety features for continued operation must be stressed, and particular attention given to production equipment.

(d) The subject of replacement of break-in keying relays was discussed and certain bad features of the present relay were pointed out to the Contractor by Anacostia.

COPY

Subject: Conference with Western Electric Company re GN Transmitting Equipment - Confidential Contract 43068, held on 12 August, 1937 at Navy Department, Washington, D.C.

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These features included fragility of the "cat whisker" and of the inaccessibility of adjusting screws. The Contractor proposed the use of type relay supplied with GO-1 - GO-2 equipment but stated that none of these would be available for installation in the equipment under test at Anacostia. The Bureau and Anacostia felt that this relay should be tested with the equipment. The Contractor stated that they would prepare detailed drawing and submit these to the Bureau. A study of these drawings would indicate whether test of the relay with the equipment would be necessary.

(e) The modified roller coil in the equipment was inspected and manually operated. It appeared to be materially improved over the original design. The Contractor stated that this had been rotated by machine at the manufacturer's plant for several thousand revolutions without failure. Anacostia stated that they desired to further test the equipment without lubricating the bearings to determine if any binding would result.

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NOTES ON TEST DATA, DEFICIENCIES AND PREFERENCES RE GN/RAM EQUIPMENT BASED ON CONFERENCE OF 21 AND 22 OCTOBER 1937, IN BUREAU OF ENGINEERING.

1. The control features of the original models were found to be not as suitable for Naval use as the system now incorporated in tentative form in the Anacostia model. The inclusion of these features with the addition of a side tone reversing switch and certain minor changes enumerated below in final form in equipments called for by this contract is desired.

2. Redesign of the IF-HF transfer switch to permit operation of set on IF or HF in event of failure of one unit is considered unnecessary.

3. Improvement in accessibility for servicing would be desirable but seems impracticable. Consequently further action appears unnecessary in this connection.

4. Undue noise pick-up is present in transmitter relay compartment. Placing by-pass capacitors on both sides of the 800-cycle line to ground minimized this. Drawing ESXX612425 appears satisfactory except that longer adjusting screws with knurled nuts might be desirable to facilitate adjustment. Windows for micrometer screws should be placed on top instead of at the bottom of the compartment.

5. Roller coil windings were loose. The new design proposed by the contractor which employs silver plated copper wire wound on a ceramic form appears to be satisfactory in view of the contractor tests. Coil mechanism should be lubricated during assembly.

6. Antenna Load Unit.

(a) Antenna load unit control should be labeled "Max. Load" and "Min. Load".

(b) Inductance increases with number of step. The reverse is desired.

(c) Certain connections appear too close to the shielding.

(d) If practicable, taps should be taken off each coil in line with end connections to avoid shorting or chafing.

(e) Unplated detent springs were used in models. Phosphor bronze springs suitably plated would be considered satisfactory.

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(f) One set screw is flush with knob. Correction of this item as in GO-1/GO-2 by countersinking and sealing will be satisfactory.

(g) Double ended metal index line is confusing. Desire single ended index similar in design to those employed generally in the equipment.

(h) It appears to be preferable to omit the ground tab and clean off inside paint around mounting holes. This comment applies to all units.

(i) A separate letter "F" designation on knob is considered desirable. A sample calibration chart should be submitted for Bureau approval.

7. Pilot's Control Box.

(a) Greater clearance between terminals 48 and 51 in left hand internal plug board is desirable if practicable. Facing terminals 48 and 49 out will possibly correct this difficulty.

(b) Nameplate holes on box are in error. This should be corrected.

(c) ICS-Radio Switch and Volume Control are both of the single hole mounting type which is not satisfactory because of the likelihood of rotation. The use of keys on switches and lips on volume controls to prevent turning of unit in mounting is considered satisfactory.

(d) The same objections and corrective measures mentioned in 6(g) and 6(f) above apply here also.

(e) The arrangement of certain controls is somewhat inconvenient. Placing the IF-HF switch at top and turn so that the "H.F. Rec." position is at the top and the "I.F. Rec." at the bottom is considered preferable. The Call switch should be omitted. The question of terminology will be covered later.

(f) Size of lettering on knobs, controls, etc. is considered smaller than necessary. Letters of 1/8" standard type for control designations will be satisfactory on control boxes and other units when feasible. Nameplate drawings should be submitted for approval.

(g) Volume control knob obscures lettering beneath. Omission of designations "Min." and "Max." and placing a circular arrow with wording "Increase Vol." above the knob is considered preferable.

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(h) The designation "Microphone" is very small. It will be satisfactory if "Microphone" is abbreviated by "Mic." and the size of the letters is increased.

(i) A more satisfactory mounting means will be provided for use in Navy airplanes if the vertical spacing between the mounting holes is increased to 2-1/2" and the top holes are located 15/32" from the outside top of box. The lateral spacing is satisfactory. Holes should be 3/16" in diameter.

8. Operator's Control Box.

(a) The double-ended knobs are insufficiently secured. Correction along lines in 6(f) and (g) will be satisfactory.

(b) Same comments and action as indicated in 7(c), (f), (g) and (h) above.

(c) ON-OFF switch should be turned so switch is vertical when in "ON" position.

(d) Present Call Switch should be changed and continually spring loaded to pull left against spring to provide ICS Clear. The control should be marked accordingly.

(e) Arrows marked "Increase" should be placed above both screw adjustments. The labels "Min." and "Max." should be omitted. The marking "ICS" and "Side Tone" should be placed beneath the respective holes.

(f) The upper left switch should be labeled $\overset{\text{IF}}{\text{REC}}$ and $\overset{\text{HF}}{\text{REC}}$.

(g) Clearance of R77 should be improved as practicable.

(h) Instructions covering the sliding shelf disassembly should be included in the instruction book for the equipment.

(i) Sockets have been inadequately marked so far as the identification of the type of tube accommodated is concerned. The Navy tube designation, i.e., type number without prefix letters, should be placed as an aid to tube replacements in service use. The socket designation proper may be placed so as not to confuse an operator though be visible when set is placed on bench for servicing.

(j) Stronger telephone plug shells should be employed if practicable.

(k) A side tone reversing switch with positions marked "Normal" and "Reversed" should be provided. See par. 1 above. This switch should be marked "Side Tone Channel".

(l) Receiver cables are difficult to detach. If practicable, quick detachable lock type plug-in connection devices would facilitate removal of equipment for servicing.

(m) Mounting holes arranged as follows would be preferable: The four upper holes should have the same arrangement as in the pilot's control box. Two additional holes 2-1/2" below the lower of the above holes should be added. Holes should be centered laterally. Paint should be removed around the edges of these holes.

9. H.F. Transmitter Unit.

(a) Celluloid calibration window warped. The use of wider lips and plexiglass appears to be preferable.

(b) Blank calibration charts with suitable spaces for inserting type and serial numbers of the equipment to which they apply would be desirable.

(c) M.O. Dial visibility should be improved for viewing from above. An increase in height of opening by about 1/8" will be satisfactory.

(d) The omission of the lock on Band Switch dial would be desirable.

(e) Dial "Ant. Tune" should be changed so that readings increase with frequency which is the final controlled effect.

(f) Parallax present on Ant. Tune dial. The graduations are finer than necessary. Enlarging the opening and using an index line flush with dial should improve this condition. Marking only every ten divisions appears to be satisfactory.

(g) Plated springs should be used on roller coil.

(h) Bent pin in Ant. Tune Stop latch should be corrected. Slight bends may be necessary as a factory adjustment, however, and are considered satisfactory for this purpose.

(i) Plated springs should be used in Band Selector Switch detent.

(j) Large engraved letters filled in white on five knobs as employed on the GO-1/GO-2 equipment is desirable.

(k) Slide washers were omitted under tube cover latches. This should be corrected.

(l) The beaded pigtail on P.A. tube caps should be shortened to prevent touching shields.

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(m) The rubber covered lead bearing against L-52 (NRL model only) should be changed to avoid this difficulty.

(n) H.F. roller coil and turn loosened. Corrective means as indicated above appears satisfactory.

(o) A C.F.I. coupling post should be incorporated in equipment similar to the one used in the GO-1 transmitter if feasible. It should be marked "C.F.I."

(p) A shorting strap should be provided on the antenna series capacitor and its use covered in the instruction book for the equipment.

(q) Excessive play in P.A. tuning capacitor should be eliminated.

(r) Cover screw nut plates locations should be carefully checked to avoid screw interference.

(s) Cracks in ceramic coupler frames and roller coil forms should be avoided.

(t) Coupling should be properly set after test of first production equipment.

(u) Band switch piece cracked in Model. Correct.

(v) R-31 mounting is weak. It should be strengthened.

(w) Tube connections should be cabled if practicable.

(x) Care should be taken to provide adequate clearance for bus wiring in M.O. and P.A. compartment.

10. I.F. Transmitter Unit.

(a) Similar comments and corrective measures apply to this unit as noted for the H.F. transmitter in 9(a), (b), (c), (d), (e), (f), (g), (i), (j), (k), (l), (o), (r), (t), (v) (R-31) and (w).

(b) Highest frequency coupling frame was cracked. Care should be exercised to avoid this.

(c) M.O. tube touches near bulkhead. It will be satisfactory to correct this difficulty by stamping the louvres outward. This comment applies to both transmitter units and is understood to require 1/4" added depth to such units.

(d) Same comments as in 9(x) above.

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(e) Unsatisfactory drive used for M.O. capacitor. This should be corrected.

(f) An additional column labeled "F" in the calibration chart would be desirable for the external load coil setting.

(g) It appears to be satisfactory to lengthen coil forms T32 and T33 for the two lowest frequency bands by about 1/4" to obtain greater leakage paths.

11. Rectifier Unit.

(a) Single hole mounting of rotatable elements should be avoided.

(b) If practicable a schematic diagram of the input power connections should be placed inside the relay compartment cover together with typical calibration curves for both HF and IF master oscillators.

(c) Receiver antenna terminal posts are of an undesirable type. Terminal posts as used in the GO-1 equipment are preferred.

(d) Jumpers placed on shock mount buttons are desirable to avoid reactance of ground lead as in GO-1 equipment.

(e) Unplated brass studs are used on meters, washers, etc.

(f) Emission selector switch bracket is weak. Strengthening of bracket appears satisfactory as a corrective measure.

(g) Transmitter selector switch stop bent and broken with damage to actuating pins. Index marks are not properly spaced.

(h) The use of non-breakable material such as "plexiglass" for meter glasses, window covers, etc., is desirable. This comment is applicable to all meters.

(i) It will be satisfactory if eyelets are employed instead of bushings in the base.

(j) The use of separate antenna relays for each transmitter is considered to be satisfactory.

(k) An arrow should be placed near filament rheostat control with word increase.

(l) Identifying marks should be placed on plugs and on jacks on transmitter and rectifier units.

(m) Spark gaps appear to be unnecessary.

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12. Cables.

(a) Cables having the following lengths are desired in lieu of lengths specified with proportional reduction in spares if agreeable. The cable lengths desired are given below:

CABLE LENGTHS
GN/RAM

	At Present	Desired
Transmitter to Radio Power Junction Box,	120"	72"
Transmitter to Operator's Control Box,	36"	72"
Operator's Control Box to Ext. Control Box	120"	144"
" " " " ICS Power,	48"	72"
Side Tone (Operator's Control Box to H.F. Rec. switch box,	54"	144"
Cables (" " " " IF " " "	54"	72"
RAM Dynamotor to Radio Power Junction Box	--	60"
" " " I.F. Receiver,	36"	60"
" " " H.F. Receiver,	36"	60"
H.F. Receiver to H.F. Receiver Switch Box,	96"	144"
I.F. " " I.F. " " "	96"	60"
Remote Tuner (Mechanical Linkage)	96"	132"
Remote Band Switch " "	96"	132"
R.F. Units to I.F. Units, Receiver,	96"	72"

(b) Identifying marks should be placed on plugs as covered in par. 11(1) above.

13. Dynamotor Unit.

(a) A socket would be desirable on dynamotor unit instead of present connecting means. Sockets taking power plugs as used in RU-4 equipments are desired.

(b) Fuse should be mounted in small attached box having cover labeled "Fuse".

14. Mechanical Remote Control Drive.

(a) Index notches are 45° apart and index broach has teeth 20° apart. It would be desirable to alter the construction to permit changing index without requiring resetting.

(b) A detent would be desirable on band switch crank.

(c) Excessive torsion and backlash present in H.F. receiver drive which should be eliminated.

(d) Handles have loosened. Staking on both cranks are inadequate and should be improved.

(e) Detachable index should be made more rugged and projecting lip should be omitted.

15. Receiver Switch Box.

(a) The inner top side of the entering terminal panel has very little clearance to the switch. Greater spacing is desirable. Lugs were bent so as to obstruct terminal numbers. Terminal lug No. 50 is too close to unit. These conditions should be improved as practicable.

(b) In the final design and construction signal drain by ICS should be avoided as much as practicable.

(c) Placing left phone jack on left side of box would be preferable to present design.

(d) Box, etc., should be protected as much as practicable against damage while removing. A guide might be feasible.

16. H.F. Receiver.

(a) The operation of the equipment in service would be facilitated and the applying specifications more nearly met if the loop terminals, loop switch and circuit are removed and a second plug socket is provided instead. A smaller knob should be used for the trimmer capacitor control. End stops are not considered necessary on this control. Protective caps for sockets are deemed necessary. Contractor should submit layout for Bureau approval. These comments apply to both receivers.

(b) Plug outlets were wired incorrectly in models.

(c) Receiver dials loose. This condition should be corrected in both the I.F. and H.F. receivers.

(d) Four instead of eight screws are suggested for use in the angle plugs while retaining the 45° adjustability.

(e) Right angle cable plugs are desirable for front as well as for rear of receiver.

(f) Flat head screws on dial drive are not secured by staking, etc. Binding head screws with external type lock washers are suggested for consideration in this connection.

(g) Screw heads should not project over housing of band change frame.

(h) Dummy grid clips should be used where necessary to avoid confusion to operating personnel.

(i) Suitable marks such as letters or numbers should be placed on top of cans to identify trimmer adjustments.

(j) Filter number marking on bottom is not plain. Should be corrected.

(k) Suitable arrangement should be provided for accurate layout of mounting bases. It is suggested that the mounting plate be enlarged to butt against each other.

(l) Terminal board construction and capacitor supports should be improved as practicable. Properly plated switches should be employed.

(m) Chassis and shields are considered to be weak. Rolling lip on bottom chassis edge of I.F. unit appears to be satisfactory method of strengthening.

(n) Edge of shield should be rounded off to clear button.

(o) Protective caps should be furnished for all outlet plug openings. Comment applies generally to complete equipment.

17. I.F. Receiver Unit.

(a) The following terminology is preferred, viz:

(1) Medium Frequency Transmitter.
(2) High Frequency Transmitter.
(3) Radio Frequency Tuner - Medium Frequency.
(4) Radio Frequency Tuner - High Frequency.
(5) Intermediate and Audio Frequency Amplifier, etc.

Nameplates using terminology as above should be submitted for Navy approval.

(b) Comments in paragraphs 16(a) to (o) inclusive above apply to the I.F. Receiver Unit also.

(c) Molded fixed mica capacitors are preferred to the clamp type.

(d) Holes and projecting studs are present in rear compartment. These should be corrected by omitting holes, etc.

(e) Numbers on interconnecting plug panels cannot be discerned. Should be engraved on opposite side. This applies also to the H.F. Receiver.

(f) More extensive use of elastic stop inserts and nuts is desirable throughout equipment when rotary motion is not involved. The use of binding head screws with external type lockwashers are preferred when the use of elastic nuts is not practicable.

(g) Disassembly instructions should be included in instruction book to give method for gaining access to places like bottom of tube sockets.

(h) Identification marks should be placed on separable rear bulkhead to minimize chance of loss.

18. A.F. Unit.

(a) Bonding across shock mount buttons appears to be necessary.

(b) The inclusion of a raised part as a strip riveted around tube access doors, etc., is desirable to stiffen cabinet and minimize possibility of water entering cabinet at such places.

(c) Comments under paragraph 16(i) above apply here also.

(d) Vacuum tube sockets are inadequately marked. Navy tube type numbers without manufacturer's prefix letters should be stamped on chassis. It will be satisfactory to place manufacturer's symbols beneath chassis.

(e) Large brown resistor touches certain terminals. Melted wax is present. It should be corrected.

(f) Plugs should have marked on shells necessary identifying marks to prevent connection to wrong unit. Plugs and sockets should be numbered.

19. Slip Covers.

(a) Identifying marks should be placed on each cover as by stenciling.

(b) Slip covers should be furnished for all units and should fit properly.

20. Performance, Dimensions, Weight, Etc.

(a) Certain units are larger than permitted by specifications of contract. Proposed final sizes should be submitted for approval.

(b) The equipment is heavier than permitted by applying specifications. Consideration is being given this point.

(c) It is believed that production transmitting equipment per paragraphs 1-3 and 2-7 of RE 13A 504A and contract note will be about 112 lbs. Cables and plugs having present specification dimensions weigh about 8 lbs. The external loading unit adds about 3-1/2 lbs, but is not included in the list of units given in par. 1-3 mentioned above.

(d) The receiving equipment, with receiver installed together is understood to weigh about 56-1/2 lbs. for local control and 60 lbs. for remote control under the same conditions, but without cables and linkage which varies with each particular installation. The remote control head will weigh about 3-1/2 lbs. without linkage.

(e) The electrical performance, except reset, sensitivity, etc. appear to be in accordance with the specifications. Reset accuracy should be improved. Sensitivity appears satisfactory and will meet specifications if measured with a signal to noise ratio of 3/1 instead of 5/1. The transmitter power output and frequency drift with temperature appear just to meet the specifications within the limits of accuracy of measurement.

(f) Ripple should not exceed 1/2 per cent rms and be not objectionable so far as transmitter carrier is concerned.

(g) Poor contacts were found in relay compartment.

(h) 100 per cent modulation was not obtainable with 5 per cent distortion but capabilities considered satisfactory for Service use.

21. Miscellaneous.

(a) Small type knobs similar to those on pilot's control box are preferred for use on rectifier unit.

(b) Additional engraved marking of antenna terminals should be placed on top of relay cover.

(c) "Test" switch marking on rectifier unit should be changed to "M.O. Test". There is need for protecting equipment against improperly turning power switch on when test switch is thrown on. Drawing should be submitted for approval.

(d) A nameplate should be placed on top of relay box with warning plate on front of same compartment.

(e) Drawings of proposed calibration chargs should be submitted for approval.

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U.S. NAVAL AIR STATION
ANACOSTIA, D.C.

NOV 24 1937

From: Commanding Officer.
To: The Chief of the Bureau of Engineering.
Via: The Chief of the Bureau of Aeronautics.

SUBJECT: Aircraft Radio - Preliminary Model GN/RAM Equipments - Supplementary Comments.

Reference: (a) BuEng. ltr. NOs-43068 (11-5-W8) of 10 Nov. 1937 to INM, NY.

Enclosure: (Herewith)
(A) Photograph AN-50884. Model XRAM Radio Receiver Switch Box, with Anacostia mounting modifications.
(B) Photograph AN-50885. Interior of XRAM Radio Receiver Switch Box, showing inadequate resistor mounting.
(C) Photograph AN-50886. Model XRAM Radio Receiver, showing damage to Switch Box plug shell.
(D) Photograph AN-50902. Model XGN Radio Equipment - Connection in H.F. transmitter unit for Crystal Frequency Indicator.
(E) Photograph AN-50903. Model XGN Radio Equipment - Connections for C.F.I. in I.F. transmitter unit- Front View through bottom.
(F) Photograph AN-50904. Model XGN Radio Equipment - Connections for C.F.I. in I.F. transmitter unit- Oblique rear view through bottom.
(G) Photograph AN-50905. Model XRAM Radio Receiver - Dial drive and tuning mechanism.
(H) GN/RAM weights.

1. The following comments are submitted in advance of the final report on tests of the subject equipment, and are supplementary to comments by this station's representatives at Bureau of Engineering conferences of 18, 21, and 22 October, 1937.

2. The supplementary observations reported by this letter pertain to the following equipment details:

(a) Receiver and ICS output power, impedance, and mismatching.
(b) Range and smoothness of various volume controls.
(c) Wiring of transmitter key jack through ICS-Radio switch.
(d) Modification of receiver switch box mounting.
(e) Unsuitable resistor mounting in receiver switch box.
(f) Design details of tuning drive and dial.
(g) CFI coupling in transmitter units.

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SUBJECT: Aircraft Radio - Preliminary Model GN/RAM Equipments
- Supplementary Comments.

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3. Laboratory measurements of output impedance confirmed recent flight indications that reception is again unduly impaired when either pilot or radioman switches to ICS, whereas measurements by the contractor's engineer taken at this station 23 August 1937 showed that at that time this trouble had been oversome, by suitable impedance matching obtained with a General Radio type 166 telephone transformer. The statement of the contractor's engineer that, by a change in connection of the contractor's ICS output transformer he had succeeded in duplicating the satisfactory operation demonstrated with the General Radio transformer, is obviously in error as shown by the following comparative data. The measurements were taken on the CW beat note output of the HF receiver on the carrier of a local broadcast station WJSV, 1460 kcs; the receiver volume control was left adjusted where approximately 4.5 volts were delivered to a load of 600 ohms. The ICS power switch was ON, the IF receiver was ON at minimum MVC position; the individual headset volume controls and the ICS screwdriver volume adjustment were at maximum setting. The variable output load, in the measurements of 18 November, was in parallel with one 20,000 ohm headset, one 20,000 ohm and one 4,000 ohm output voltmeter. Slight discrepancies between observed volts and milliwatts are due to instrument errors. Asterisks indicate impedance for greatest output milliwatts.

OUTPUT FROM H.F. RECEIVER

Date	MVC or AVC	Load Resistance Ohms	Switches on RADIO Output Volts		Switch on ICS Output Volts	
			Output Volts	Milliwatts	Output Volts	Milliwatts
23 Aug. 1937	MVC	600	4.5	25	3.5	17
		400	4.25*	36*	3.6*	33*
		300	3.4	28	2.8	23
		200	2.5	24	2.2	21
18 Nov. 1937	MVC	600	4.5	28	0.59	0.50
		400	3.4	24	0.56	0.68
		300	2.7	20	0.52	0.80
		200	1.85	15	0.46	0.95
		100	—	—	0.34*	1.07*
		80	—	—	0.31*	1.07*
		1,000	6.0*	31*	—	—
23 Aug. 1937	AVC	600	4.4	25	3.0	12
		300	3.6	33	2.6	20
		200	3.0	35	2.4	22
		125	2.5*	38*	2.0*	26*

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	MVC	Load	Switches on RADIO		Switch on ICS	
	or	Resistance	Output	Milli-	Output	Milli-
Date	AVC	Ohms	Volts	watts	Volts	watts
18 Nov.	AVC	600	4.25	25	0.4	0.23
		400	3.3	23	0.38	0.31
		300	2.7	21	0.36	0.37
		200	1.9	15	0.33	0.47
		60	–	—	0.22*	0.65*
		1,000	5.6*	26.5*	–	–

The discrepancy between the receiver output resistances (for maximum power) measured on MVC, 23 August compared with 18 November, may be due to possible parallel connection of a low-impedance headset during the measurements by the contractor's engineer; the original low AVC impedance value of 125 ohms was due to the shunting action of the volume control resistor prior to modification of this circuit. The observed present 1,000 ohm output impedance of the receiver, on both MVC and AVC, appears higher than desirable for suitable impedance matching, and in production should be lowered to preferably 250 and not more than 500 ohms. The most serious impairment, however, is the great loss of receiver output when either control switch is on ICS. Whereas the earlier measurements show only a slight signal reduction when the switch is thrown to ICS, the latest measurements now show that this loss has become prohibitive; this apparently is due to a great decrease in the output impedance of the ICS system, which formerly was equal to that of the receiver, but now appears to be less than one tenth of the latter.

OUTPUT FROM I.C.S. SYSTEM
(Volume control settings same as in Receiver Output Measurements, but receivers free from incoming signals)

	IVC	Load	ICS Output		ICS Output	
	or	Resistance	Mixed with Receivers		Clear Channel	
Date	AVC	Ohms	Volts	Milliwatts	Volts	Milliwatts
23 Aug.	MVC	600	6.5	65	9.0	100
1937		400*	6.3*	78*	9.0*	120*
		300	6.0	72	7.0	110
		200	3.2	75	5.0	100
18 Nov.	MVC	600	5.0	40	5.2	42
1937		400	4.5	50	5.0	55
		300	4.3	55	4.5	60
		200	3.8	70	4.1	75
		100*	3.0*	75*	3.2*	80*

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	MVC:	Load	ICS Output		ICS Output	
	or	Resistance	Mixed with Receivers		Clear Channel	
Date	AVC	Ohms	Volts	Milliwatts	Volts	Milliwatts
23 Aug. 1937	AVC	600	4.0	30	9.0	100
		300	3.7	40	6.5*	110*
		200	3.5	45	5.0	100
		125	2.8*	50*	3.5	80
18 Nov. 1937	AVC	(Same as MVC values of this date above)				

ICS output on 18 November is inferior to that observed 23 August 1937; especially the "Clear Channel" position fails to give the formerly observed desirable strength increase, although the second advantage, namely, elimination of noise due to the receiver, is still retained. It is recommended that the ICS output impedance be made approximately 500 ohms, which is high enough to prevent undue by-passing of received signals, yet low enough to give good ICS output into two headsets in parallel. It should be noted that in all above measurements, one headset is represented by a load resistance of 600 ohms, while two headsets result in a 300 ohm load resistance.

4. The peak output obtainable from the H.F. receiver, before saturation, fell from a value of 17.75 volts (into 600 ohms) at full gain MVC, to only 10.0 volts for any other setting; this should be corrected in production, and is probably a result of the temporary modification of the receiver output circuit.

5. The receiver volume control, in the MVC condition, was found to be too abrupt near the high volume end. Thus, an output voltage adjusted to 15 volts at full gain, fell off abruptly to 8.7 volts on the first step of volume reduction; this also may be a result of the improvised switch box circuit modification, as the volume control in another unaltered box, gave less abrupt changes.

6. The ICS volume adjusting rheostat in the operator's transmitter control box was found to give an extremely rapid and critical regulation at its high volume end; when set half-way, an ICS speech signal of 4.3 volts at full volume was reduced to less than one-quarter volt. It is recommended that this action be rendered more linear.

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SUBJECT: Aircraft Radio - Preliminary Model GN/RAM Equipments - Supplementary Comments.

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7. It was noted that the ICS-Radio switches transfer the microphone switch buttons, but not the corresponding circuits of the transmitting key jacks, the latter being left in the radio keying circuit at all times. In order to enable use of a throttle type microphone switch when desired, both for radio and ICS, the key jacks in both operator's and pilot's transmitter control boxes should be wired in parallel with the microphone push-button circuits, through the ICS-Radio switch.

8. Enclosure (C) shows damage to the switch box plug shell which readily occurs during removal of the box from the receiver, inasmuch as release of the knurled screw may be expected to unlatch the box. This damage, likely to occur in service, may be prevented by a simple bayonet slot modification effected at this station and shown on Enclosure (A). This change is recommended for the production equipments.

9. Past experience has shown that no circuit components should be connected to the "Bradleyometer" volume control assembly screws, in view of their very small and undependable clearance to the inner connecting straps as shown on Enclosure (B); it is therefore recommended that the resistor R-503 be electrically insulated from these screws, and be mounted in a more suitable manner.

10. Two defects noted in the dial drive and tuning mechanism are shown in Enclosure (G). The bearing bushing, on the tuning drive end, is apparently merely pressed into the gear case and has worked loose; a more dependable method of securing this should be provided. The tuning dial itself, which worked loose in both receivers tested, is seen to have a small positioning notch on its inner edge, engaging with a pin driven into the gear hub; this pin caused a rough abrasion on the inner face of the dial retaining nut, without however serving as a lock for the latter. It is recommended that standard Navy Practice be followed by providing a positive lock for the dial retaining nut; the standard construction employed on other Navy receivers provides a wider hub surface on the gear, with a small tapped hole in place of the positioning pin. A fillister-head locking screw, located so it bears against a flat side of the dial retaining nut, passes through a suitable hole in the dial into the gear hub, thus properly aligning the dial and locking its retaining nut.

11. Enclosures (D), (E), and (F) show the improved CFI coupling connections incorporated into the transmitter units at this station and found satisfactory for use with the LM and LM-2 CFI equipments. The resistance drop through condenser ground connections is employed as coupling; by lashing the CFI connection alongside

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the ground wire, open loops were avoided, and reaction on the transmitter frequency was eliminated. It should be noted that it was necessary to lengthen the original short ground connection of the by-pass condenser on the rear of the M.O. compartment in the I.F. unit to obtain a suitable degree of CFI coupling, as shown on Enclosure (E). This length of lead should be maintained in production, with ground and CFI lead lashed together; an individually grounded lug should be provided, instead of employing the angle fitting shown.

12. The changes described in this letter have been effected in the subject equipment model which was used at this station for flight tests; this model will be returned to the contractor's plant, in accordance with Bureau instructions.

/s/ V. C. GRIFFIN

Copy to:
NRL Bellevue
NAF Phila.