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Test of Model XRAT Aircraft Receiving Equipment

(Aircraft Radio Corporation)



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NRL Report No. B-1616
Test of Model XRAT Aircraft Receiving Equipment

B
14 May 1940

NRL Report No. R-1616
BuEng. Prob. A5-16C

NAVY DEPARTMENT

Tests on Model X RAT Aircraft Receiving Equipment
manufactured by

Aircraft Radio Corporation


NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D. C.

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Authorization: BuEng let. F42-1(9-18-R6) of 19 Sept. 1939.

Date of Test: 26 December 1939 to 15 April 1940.

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Naval Air Station, Anacostia, let. F42-1/46-52(8),

NA6 (101) (40025) of 15 March 1940 to Naval Research Lab'y - Appendix A

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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 (c) and (c).

Reference: (a) BuEng let. F42-1(9-18-R6) of 19 Sept. 1939
(b) Specifications RE 13A 569A.
(c) BuEng let. C-NOS-61445(9-18-R1) of 20 Sept. 1939.

OBJECT OF TEST

2. The object of these tests was to determine the compliance of the equipment with the requirements of the specifications, reference (b), and to determine its adaptability for use in the Naval Aircraft Service.

ABSTRACT OF TEST

3. The equipment was tested for mechanical construction, electrical performance and its adaptability for installation and operation in Navy planes and suitability for use in the Naval Service.

4. The tests covered the following points:

(a) Mechanical

- (1) Workmanship
- (2) Material used
- (3) Size and weight
- (4) Shock mounting
- (5) Ruggedness

(b) Electrical

- (1) Frequency range, overlap and calibration accuracy
- (2) Sensitivity
- (3) Selectivity
- (4) Audio fidelity
- (5) Audio distortion
- (6) Stability under conditions of vibration and variation of temperature, humidity, and primary voltage supply
- (7) Noise output
- (8) Microphonic tendencies
- (9) Sensitivity control action
- (10) Heterodyne oscillator action
- (11) Overload characteristics
- (12) Current drain
- (13) Interaction between receivers in multiple
- (14) Reset (local and remote control)
- (15) Image response

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Conclusions

(a) The following conclusions were reached as a result of these tests:

1. The material used is of the best known to be suitable for each specific purpose and the workmanship is excellent.
2. The tubes used in the equipment are not on the Navy approved list. They performed satisfactorily and without failure throughout the tests.
3. The controls functioned satisfactorily throughout the temperature range although the tuning control became quite stiff at the lower temperatures.
4. The 20 to 27 megacycle receiver, serial number 1, failed during the test due to an undetermined cause, the effect being of greatly reducing the sensitivity. Sufficient tests were made before this failure to determine that its performance was comparable with other receiver units.
5. The most serious condition wherein the equipment failed to meet the specification requirements was the greatly excessive stray fields of the high frequency heterodyne oscillator.
6. Other points wherein the equipment failed to meet the electrical requirements were of a minor nature and would not seriously detract from satisfactory operation of the equipment.
7. The sensitivity control differs from that employed in other similar equipment in that it does not have a separate position for manual and automatic control but is a single control for both. The automatic feature being a limiter set at a fixed predetermined level by the manufacturer which in this equipment is approximately 650 milliwatts and which prevents the receiver from blocking when receiving signals of an input value in excess of 1 volt. The sensitivity control functions similarly to the manual control in other equipment.
8. The output circuits are so arranged that each receiver has a line selector switch and a neutral position. By this means it is possible to use either receiver separately or mix the signals of both receivers (or more if used) in either line. An undesirable feature of the arrangement is that with an operator receiving signals on one receiver may have impressed on the same line signals of a much higher level by another operator thus interfering with or destroying altogether his reception. The ability to mix the signals is a desirable feature provided the operator has exclusive control of the signal level.

9. The equipment does not meet all of the requirements for weight and dimensions of individual units, but is within the overall requirements.
10. It is practically impossible to remove the vacuum tubes without the use of tools due to congestion of the tubes and associated parts and to gripping of the tube socket contacts. The latter, however, is a highly desirable feature.
11. The dynamotors cannot be removed with more than one receiver in the rack without the aid of a screw driver or by removing the receiver. This is an operation that will seldom if ever be necessary during flight.
12. The method used in marking the parts for identification is not sufficiently permanent and the markings were either omitted entirely or located on an unexposed surface of some units.
13. The crank feature of the tuning controls is not considered essential since in service use changing frequency is not frequent. For test purposes they are decidedly convenient. If retained, they should be a larger diameter.
14. Other mechanical changes that may be desirable but are not necessarily essential are discussed in the recommendations.
15. Subject to correction of those features which contribute to unsatisfactory operation, the equipment is considered suitable for use in the Naval Aircraft Service.

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Recommendations

(a) As a result of the tests, the following recommendations are made:

- (1) That on all points wherein the equipment fails to meet the requirements of the specifications, corrections be made to meet these requirements, particularly and most important that the stray fields of the heterodyne oscillators be reduced.
- (2) That the local control switch panels and switch panel adapters be secured with small snap fasteners similar to those used on the tube compartment cover plate.
- (3) That number of snap fasteners used to secure the tube compartment cover plates be reduced.
- (4) That the identification marking of parts be of a more permanent nature than that on the models.
- (5) That the thickness of the lugs for securing the receivers to the receiver rack be increased to 0.075 inch.
- (6) That the type of detachable mounting for the control box as submitted with the model equipment be provided.

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DESCRIPTION OF EQUIPMENT UNDER TEST

5. The subject equipment, manufactured by the Aircraft Radio Corporation of Boonton, New Jersey, and known as the Model XRAT receiving equipment, consists of two receiver units covering the frequency range of 13.5 to 20 megacycles and 20 to 27 megacycles, respectively, and the necessary equipment for local and/or remote control. The receivers are of the conventional superheterodyne type and designed for the reception of cw, mcw, and voice signals.

6. The equipment is so designed that simultaneous reception from both receivers or individual reception from either or both may be obtained.

7. Each receiver unit is provided with an independent dynamotor for a high voltage supply. The source of power for the entire equipment is the airplane's 12 volt battery.

8. The six tubes used are of the 12 volt heater type and consist of a Type 12SK7 as an r-f amplifier, a Type 12K8 as a mixer, two Type 12SK7's as i-f amplifiers, a Type 12SR7 as a detector and cw oscillator, and a Type 12A6 as an audio amplifier.

METHOD OF TEST

9. A description of the methods used in conducting the tests follows. The units were checked for size, weight, and mechanical construction. It was then assembled and tested for electrical performance.

10. For all tests, except to determine the interaction between receivers, each receiver was tested separately.

11. To determine the frequency range, overlap, and calibration accuracy, measurements were made with the use of a crystal frequency indicator at the extreme ends and the calibration settings of the tuning dial.

12. The sensitivity was determined with the use of a standard signal generator and an output voltmeter. The input in microvolts necessary to obtain standard output at various frequencies through the range was recorded.

13. The selectivity was determined with the use of a standard signal generator and an output voltmeter. The input in microvolts was adjusted to produce standard output with the receiver at full gain. With all receiver controls remaining fixed, the standard signal generator was detuned from resonance, the input increased 10, 100, and 1,000 times and after each increase retuned toward resonance from both above and below until standard output was again obtained. The positions of the standard signal generator were recorded and the selectivity determined as the difference in frequency between these recorded settings and that at resonance.

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14. The audio fidelity was determined with the use of a beat frequency oscillator, a standard signal generator and an output voltmeter. The beat frequency oscillator was coupled to the standard signal generator as an external source of modulation frequency. An input modulated 30 % at 400 cycles was adjusted to produce standard output in the receiver. With all other controls remaining fixed, the modulation frequency was adjusted in progressive steps from 200 to 3,000 cycles and the output recorded at each step. The audio fidelity was determined as the percentage of output at the various modulation frequencies with reference to that of the maximum.

15. The audio distortion was determined with the use of a beat frequency oscillator, output voltmeter, and a wave analyzer. The beat frequency oscillator, coupled to the standard signal generator, provided the desired modulation frequency. The receiver was adjusted for the desired output at the percentage of modulation and modulation frequency to be measured. The output was coupled to the wave analyzer and with all other controls remaining fixed the output was measured at successive harmonics of the modulation frequency. The audio distortion was determined as the r.m.s. of these values.

16. The overload characteristics were determined with the use of a standard signal generator and an output voltmeter. The receiver was adjusted for standard output at maximum gain after which the input was increased in steps to the maximum of the standard signal generator. The output was recorded at each step. This test was conducted on both cw and mcw conditions of the receiver.

17. All frequency stability measurements were made with the use of a crystal frequency indicator and an output voltmeter.

18. For frequency stability at a constant ambient temperature, frequency measurements were made immediately after the receiver was turned on and at five-minute intervals for a period of one hour. The output was recorded at each measurement.

19. For frequency stability with variable temperature, the equipment was installed in a temperature control chamber and the temperature varied over the specified range. Measurements were made at 15-minute intervals and in each case between 1 and 1-1/2 minutes after the receiver was turned on. The receiver was turned off immediately after each measurement. The temperature was maintained at the upper and lower limits for a sufficient length of time for the equipment to assume this temperature.

20. For frequency stability with variable humidity, the equipment was installed as above in a temperature control chamber. The receiver was turned on and the temperature allowed to stabilize at +40° C after which the relative humidity was raised from a low value to approximately 100%. Frequency measurements were made at regular intervals.

21. For frequency stability and sensitivity when subjected to 72 hours of 90% relative humidity at +38° C, the receiver was allowed a 10-minute warm-up period before measurements which were made just prior to and at each 24-hour period of the test.

22. The reset measurements were made with the use of a crystal frequency indicator and an output voltmeter. The receiver was tuned to a frequency as indicated by the calibration of the tuning dial. The actual frequency was measured then the receiver was detuned and reset to the original setting by eye. The input was readjusted to again obtain maximum output and the frequency at this setting recorded. This procedure was repeated three times approaching resonance from both a clockwise and counterclockwise position. The accuracy of reset was determined as the frequency difference between the most greatly removed positions of the clockwise and counterclockwise resets. These measurements were made with both local and remote control.

23. The image response measurements were made with the use of a standard signal generator and an output voltmeter. The input was adjusted to produce standard output from the receiver at resonance with full gain. With the receiver controls remaining fixed, an input at the image frequency was introduced. The input in microvolts was adjusted to again obtain standard output. The image response was determined as the ratio of the image input with reference to the input at resonance.

24. The overload selectivity was determined with the use of two standard signal generators and an output voltmeter. Both standard signals were coupled to the input of the receiver and to establish a reference point adjusted, separately, to produce standard output from the receiver. With the receiver and one standard signal generator remaining fixed, the other signal generator was detuned and with the input increased respectively to 0.1 and 1 volt, was retuned toward resonance until a change of output of 3 decibels was obtained. The dial settings of these positions were recorded and the overload selectivity determined as the difference in frequency between these settings and that at resonance.

25. The acceleration test was made by installing the equipment on an accelerometer calibrator and subjecting to a maximum acceleration of approximately 8 g. This test was made at three different mounting positions of the equipment; one in a horizontal position with respect to the normal position of the mounting base, one in a vertical position with the panel down and one position at 90° from the latter.

DATA RECORDED DURING TEST

26. Data recorded during the tests in the form of tables, plates, and photographs are appended to this report. These and other data pertinent to the tests are discussed in RESULTS OF TESTS.

DISCUSSION OF PROBABLE ERRORS

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

				<u>Accuracy</u>
General Radio Output Voltmeter	Type 483-F	Ser.# 552		$\pm 5.0\%$
General Radio Standard Signal Generator	" 605-B	" 814		$\pm 10.0\%$
General Radio Standard Signal Generator	" 605-B	" 1137		$\pm 10.0\%$
General Radio Beat Frequency Oscillator	" 713-B	" 499		$\pm 2.0\%$
General Radio Wave Analyzer	" 736-A	" 118		$\pm 5.0\%$
Weston D-C Voltmeter	Model 45	" 41660		$\pm 0.5\%$
Weston D-C Ammeter	" 45	" 30006		$\pm 0.5\%$
Radio Research Company Crystal Frequency Indicator	Type LM-2	" 1		$\pm 0.001\%$
Hygrometer	G. Luff			15.0%
Refrigerator	Frigidaire			$\pm 1^{\circ} \text{C}$
Vibration Table	N.R. L.			
Accelerometer	N.A.F.	Ser.# 1		$\pm 10\%$

RESULTS OF TESTS

28. The results of the tests of the subject equipment will be discussed with regard to its compliance with the specifications, reference (b). 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.

I. INTRODUCTION

29. Requirements of this section, except those parts with reference to the manufacturer's guarantee, are for conditions met with in actual flight installation and are discussed in the flight test report appended to this report.

II. GENERAL

30. Par. 2-1 to 2-3. The material used in the equipment appears to be of the best and most suitable for its specific purpose.

31. Par. 2-4. The workmanship is of a very high order.

32. Par. 2-7. The equipment was tested over a temperature range of -30 to $+50^{\circ} \text{C}$. All controls functioned over this range although the tuning control was very stiff at -30°C .

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33. Par. 2-8. A 2 kilowatt signal was not available to conduct this test; however, the equipment is provided with protective devices to prevent damage due to overload.

34. Par. 2-9. No provision has been made for ventilation, but throughout the tests there was no evidence of overheating.

35. Par. 2-10. All of the equipment with one exception has withstood continuous operation over long periods of time during the tests. The exception was failure, of an undetermined nature, of the 20 to 27 megacycle receiver, Ser. No. 1, wherein the sensitivity decreased by a ratio of approximately 4 to 1.

36. Par. 2-11. The equipment successfully withstood an acceleration of 8 g in all directions electrically. Mechanically the metal links used to secure the receiver unit in place in the rack showed a definite bend allowing the receiver unit to slide forward although not enough to cause the equipment to become inoperative. The results of this test are shown in Plate 24.

37. Par. 2-13. The equipment is designed to permit interchangeability of physically and electrically similar parts. Some parts are not marked for identification and on those parts which are marked, the method used is not of a sufficiently permanent nature.

38. Par. 2-18. Condenser unit, part 5413, showed evidence of leakage of the impregnating compound.

39. Par. 2-41, 2-42, 2-43, 2-44. Six vacuum tubes are employed in the equipment involving four types which is the least number for compatibility with the requirements of the specifications. The tubes employed are not included in the Navy's approved list. However, they performed without failure throughout the test.

40. Par. 2-47. The results of this humidity test are shown on Table 31. It will be noted that in the first portion of this test the temperature is increased from +23°C to +40°C. The change over this period is comparable to similar conditions as shown on Tables 11, 13, and 15. During the remainder of the test there was little change in sensitivity and frequency. It is therefore determined that the humidity had little effect on the equipment.

41. Par. 2-51. The effect of variable humidity conditions is shown on Table 30 and Plates 22 and 23.

III. MECHANICAL REQUIREMENTS

42. Par. 3-2. Two complete sets of equipment were supplied by the contractor each consisting of the units listed in this paragraph less waterproof slip covers and spare parts except tubes.

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43. Par. 3-3 to 3-7 incl. The equipment does not meet the requirements for weight and dimensions in all instances as shown on Table 1. The receiver unit rack is overweight .788 pound and the battery cable overweight .212 pound; however, the total weight of the individual units is .558 pound under specification requirements and the complete equipment for local control 1.5 pounds and for remote control 2.13 pounds under the specification allowance. The total height of the receiver unit, receiver rack, and mounting base is 12 inches; but due to overhanging features when assembled, the overall height is 7-1/8 inches.

44. Par. 3-8. The equipment meets the backlash requirements of this paragraph.

45. Par. 3-19. Actual operation under service conditions is necessary to determine the compliance of the dynamotors with the requirements of this paragraph. However, they performed satisfactorily throughout the tests which constituted a total operation period in excess of 100 hours.

46. Par. 3-27. The mechanical linkage performed satisfactorily with at least two bends of approximately 5 inch radius.

47. Par. 3-31. The receiver units and receiver racks are quickly detachable from their mountings without the use of tools, but the dynamotors are not removable without the aid of a screw driver when more than one receiver is mounted in the rack unless the receiver is removed.

48. Par. 3-33. All the controls can be operated while wearing heavy gloves, although some with difficulty, particularly the antenna trimming condenser. It would be difficult to increase the size of the controls without increasing the size of the receiver.

IV. DEFINITIONS

49. This section deals with information for guidance in conducting the tests.

V. OPERATING CHARACTERISTICS

50. Par. 5-1 to 5-12 incl. The equipment meets the requirements of these paragraphs except for the manual and automatic control of sensitivity. The equipment has a single manual sensitivity control and features a limiting arrangement which prevents blocking of the receiver with signals of a high level but having no automatic sensitivity control features at low levels.

51. Par. 5-13 to 5-15 incl. The compliance with these paragraphs requires flight tests, the report on which is appended to this report.

VI. ELECTRICAL REQUIREMENTS

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52. Par. 6-3. The equipment consists of two receiver units covering the frequency range of 13.5 to 20 megacycles and 20 to 27 megacycles,

respectively, the frequency of 20 megacycles being included in both units. Frequency range, overlap, and calibration accuracy are shown on Table 2.

53. Par. 6-5. The radio amplifier coil assemblies employ a plug-in feature, but are held permanently in place with machine screws. No difficulty was encountered during the tests and this feature appears to be satisfactory.

54. Par. 6-6. There is one tuned circuit interposed between the antenna and the grid of the first tube of each receiver.

55. Par. 6-7. The tubes employed in the equipment are not included in the Navy approved list but performed satisfactorily and without failure throughout the tests.

56. Par. 6-8. The equipment includes a heterodyne oscillator for the reception of cw signals.

57. Par. 6-9. Automatic alignment of the antenna and amplifier circuits is such that with the same antenna no adjustment of the antenna trimming condensers is necessary after the initial adjustment.

58. Par. 6-13. All measurements were made on each receiver separately except those to determine interaction between receivers.

59. Par. 6-14. The equipment meets the sensitivity requirements of this paragraph. The results are shown on Table 3 and Plates 1 and 2.

60. Par. 6-15. The equipment meets the off resonance frequency sensitivity requirements of this paragraph.

61. Par. 6-16 and 6-17. The selectivity is slightly outside the requirements of this paragraph at the lower frequencies. The results are shown on Table 4 and Plates 3 to 8 inclusive.

62. Par. 6-19. The equipment meets the audio fidelity requirements of this paragraph as shown on Table 5.

63. Par. 6-20. The equipment does not meet the undistorted output requirements operating on a carrier modulated 30 per cent at 400 cycles. The results of this test are shown on Table 6.

64. Par. 6-21. The equipment meets the noise output requirements of this paragraph.

65. Par. 6-22. Under conditions of vibration when tuned to a cw signal, a rough note was observed but of such a degree as not to seriously affect reliable communication. By lightly tapping the 12K8 mixer tube, when the equipment was not subjected to vibration, the same condition was observed. In the mcw position, there was no effect on the signal.

66. Par. 6-23. The equipment meets the requirements for beat frequency shift at 15 megacycles over a period of 10 minutes. The results of this test are shown on Table 7.

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67. Par. 6-24. The sensitivity control of each receiver is such that with an input signal of one volt, the output may be reduced to zero.

68. Par. 6-25. The equipment is not provided with an automatic sensitivity control position. A manual control is provided and arranged so that blocking does not occur with an input in excess of 1 volt.

69. Par. 6-26. The cw heterodyne oscillator is so designed that an audible signal is produced at one frequency (the fourth harmonic) in the low frequency receiver and on two frequencies (the fifth and sixth harmonics) in the high frequency receiver. The measurements were made with the receivers at full gain and no connection to the antenna posts. The magnitude of the output was 30 milliwatts in the low frequency receiver and 1.2 milliwatts in the high frequency receiver. In the latter case there would be no serious interference with reliable communication.

70. Par. 6-28 and 6-29. The equipment does not block with input signals up to 1 volt. The results of these tests are shown on Tables 8 and 9 and Plates 9 and 10.

71. Par. 6-30. An input signal of 5 volts was not available to conduct this test; however, the equipment is provided for protection against excessive overload.

72. Par. 6-31. The frequency spread per division over the range of the tuning dial is substantially uniform.

73. Par. 6-32. The equipment meets the calibration requirements of this paragraph. The calibrated portion of dials extends over 287° with a frequency spread of approximately 24 kilocycles per degree.

74. Par. 6-33. All controls functioned throughout the tests. The tuning control became stiff at -30°C but not sufficiently so to prevent tuning of the equipment.

75. Par. 6-34. All parts of the equipment performed satisfactorily throughout the tests with the exception of the 20 to 27 megacycle receiver, Ser.No. 1, which developed a reduction of sensitivity of approximately 4 to 1 (or down 12.2 decibels) due to an undetermined cause.

76. Par. 6-35. The automatic sensitivity control feature of the equipment is in the form of a limiter, set at a predetermined level during manufacture. This level is approximately 600 milliwatts. There is no provision for the operator to adjust this level except by manual reduction of sensitivity.

77. Par. 6-37. The equipment performs satisfactorily with variation of the primary voltage supply between the limits of 11 to 15 volts. Further discussion of this condition follows.

78. Par. 6-38. The frequency stability of the equipment at a constant ambient temperature for one hour from a cold start is well within the requirements of this paragraph. The results of these tests

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are shown on Tables 11 and 12, and Plates 11 to 14 inclusive. Referring to the tables it will be noted that the output drops during this run to a maximum of -4.8 decibels, leveling off toward the last. The sensitivity measurements were made after this stabilization period and were found to be within the specification requirements.

79. Par. 6-39. The frequency stability with change of the primary power supply meets the requirements of this paragraph. The results of this test are shown on Table 10.

80. Par. 6-40. The overall frequency stability with variable ambient temperature meets the requirements of this paragraph, but the stability of the cw heterodyne oscillator is outside of these requirements. The results of these tests are shown on Tables 13 to 15 and Plates 15 to 20 inclusive. It will be noted that an apparent condition of automatic compensation exists.

81. Par. 6-41. Except for the 13.5 to 20 megacycle receiver, which is slightly outside, the equipment meets the requirements for frequency stability for the cw heterodyne oscillator. There was practically no frequency change with variation of the primary voltage from 11 to 15 volts. Actual measurement indicated a change of approximately 100 cycles. The result of this test is shown on Table 21.

82. Par. 6-42. The equipment meets the calibration requirements of this paragraph. The results are shown on Table 2.

83. Par. 6-43. With the equipment adjusted to the condition specified in this paragraph, the output with the modulation removed was so low as to be unmeasurable on the 13.5 to 20 megacycle receiver. On the 20 to 27 megacycle receiver the output was 1.2 milliwatts which is .7 milliwatts over the specification requirement.

84. Par. 6-44. The equipment meets the current drain requirement, the total being 6 amperes at 14 volts for both receivers in simultaneous operation.

85. Par. 6-45. When tuning one receiver through the same frequency on which another is receiving pure cw signals, the output change is 20% which is within the requirements of this paragraph. There was no change in the audio beat note.

86. Par. 6-46. The equipment does not meet the requirements of this paragraph with respect to stray fields of the heterodyne oscillator. With both receivers in operation and both antenna posts grounded, one receiver was tuned to the heterodyne frequency of the other resulting in an output of 563 milliwatts.

87. Par. 6-47. The equipment meets the sensitivity reduction requirement when both receivers are connected for simultaneous operation.

88. Par. 6-48. The shielding of the r-f oscillators does not meet the requirements of this paragraph. One receiving unit was put in operation with no connection to the antenna binding post. Another similar unit was put in operation adjacent to and tuned to the r-f heterodyne oscillator frequency of the first with a resulting output of 650 milliwatts.

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89. Par. 6-49. The equipment does not meet the audio distortion requirements of this paragraph in its entirety. The results are shown in Tables 17 to 22 inclusive.

90. Par. 6-50. The equipment meets the requirements for reset on both local and remote control when a calibration mark of the dial is used for a reference point. In making reset adjustments between marks with local control, the equipment was slightly outside the requirements. The results are shown on Table 23.

91. Par. 6-51. The sensitivity control meets the requirements of this paragraph.

92. Par. 6-52. The design of the equipment is such that it is possible to change from one frequency to any other within the range in one minute.

93. Par. 6-53. The equipment is slightly outside the overlap requirements as shown on Table 2.

94. Par. 6-54. The equipment meets the cw sensitivity requirements of this paragraph. The results are shown on Table 3.

95. Par. 6-55. The equipment does not fully meet the image rejection requirements of this paragraph. The results of this test are shown on Tables 24 to 28 inclusive.

96. Par. 6-56. The equipment meets the requirement of output change due to primary voltage change. The result of this test is shown on Table 10.

97. Par. 6-57. Throughout the tests there was no evidence of overheating of the equipment.

98. Par. 6-58. The equipment operated satisfactorily with interchange of dynamotors.

99. Par. 6-59. The equipment does not meet the power output requirement of this paragraph. The result of this test is shown on Tables 11 and 12. An additional test of overload selectivity was made. The results of this test are shown on Table 29.

CONCLUSIONS

100. The following conclusions were reached as a result of these tests:

- (a) The material used is of the best known to be suitable for each specific purpose and the workmanship is excellent.
- (b) The tubes used in the equipment are not on the Navy approved list. They performed satisfactorily and without failure throughout the tests.

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- (c) The controls functioned satisfactorily throughout the temperature range although the tuning control became quite stiff at the lower temperatures.
- (d) The 20 to 27 megacycle receiver, serial number 1, failed during the test due to an undetermined cause, the effect being of greatly reducing the sensitivity. Sufficient tests were made before this failure to determine that its performance was comparable with other receiver units.
- (e) The most serious condition wherein the equipment failed to meet the specification requirements was the greatly excessive stray fields of the high frequency heterodyne oscillator.
- (f) Other points wherein the equipment failed to meet the electrical requirements were of a minor nature and would not seriously detract from satisfactory operation of the equipment.
- (g) The sensitivity control differs from that employed in other similar equipment in that it does not have a separate position for manual and automatic control, but is a single control for both. The automatic feature being a limiter set at a fixed predetermined level by the manufacturer which in this equipment is approximately 650 milliwatts and which prevents the receiver from blocking when receiving signals of an input value in excess of 1 volt. The sensitivity control functions similarly to the manual control in other equipment.
- (h) The output circuits are so arranged that each receiver has a line selector switch and a neutral position. By this means it is possible to use either receiver separately or mix the signals of both receivers (or more if used) in either line. An undesirable feature of the arrangement is that with an operator receiving signals on one receiver may have impressed on the same line signals of a much higher level by another operator, thus interfering with or destroying altogether his reception. The ability to mix the signals is a desirable feature provided the operator has exclusive control of the signal level.
- (i) The equipment does not meet all of the requirements for weight and dimensions of individual units, but is within the overall requirements.
- (j) It is practically impossible to remove the vacuum tubes without the use of tools due to congestion of the tubes and associated parts and to gripping of the tube socket contacts. The latter, however, is a highly desirable feature.

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- (k) The dynamotors cannot be removed with more than one receiver in the rack without the aid of a screw driver or by removing the receiver. This is an operation that will seldom if ever be necessary during flight.
- (l) The method used in marking the parts for identification are not sufficiently permanent and were either omitted entirely or located on an unexposed surface of some units.
- (m) The crank feature of the tuning controls is not considered essential since in service use changing frequency is not frequent. For test purposes they are decidedly convenient. If retained, they should be a larger diameter.
- (n) Other mechanical changes that may be desirable but are not necessarily essential are discussed in the recommendations.
- (o) Subject to correction of those features which contribute to unsatisfactory operation, the equipment is considered suitable for use in the Naval Aircraft Service.

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TABLE 1

MODEL XRAT RECEIVING EQUIPMENT SER. NO. 1.

WEIGHT AND DIMENSIONS

	WEIGHT			
	Actual	Spec. Allowance	Over	Under
Receiver Unit	9.125 Lb	10.0 lbs		.875 lbs
Rec. Unit Rack	2.688 "	1.9 "	.788 lbs	
Rack Mounting Base	.75 "	.8 "		.05 "
Control Box	1.5 "	2.0 "		.5 "
Batt. Cable	1.812 "	1.6 "	.212 "	
Control Box Cable	.875 "	.9 "		.025 "
Mechanical Linkage	.562 "	.7 "		.138 "
Total	17.312 "	17.9 "	1.0 "	1.588 "
Under Weight	.588 "			
Complete Equipment for Local Control	23.5 lbs	Allowed 25 lbs.		
Complete Equipment for Remote Control	27.874 "	Allowed 30 lbs.		

	Width			Length			Height		
	Act.	Spec.	Diff.	Act.	Spec.	Diff.	Act.	Spec.	Diff.
Receiver Unit	4 7/8 In.	5 in.	-1/8 in	11 3/8 in.	11 1/4 in	+1/8 in.	5 5/8 in.	5 1/2 in.	+1/8 in
Rec. Unit Rack	11 "	12 1/2"	-1 1/2 "	13 1/4 "	12 1/2 "	+3/4 "	4 5/8"	4 "	+5/8 "
Rack Mounting Base	11 11/16"	11 3/4"	-1/16"	10 3/4 "	10 3/4 "	0	1 3/4 "	1 5/8 "	+1/8 "
Control Box	6 3/8 "	6 "	+3/8 "	5 1/8 "	3 3/4 "	+1 3/8"	2 1/2 "	2 5/8 "	-1/8 "
Batt. Cable				10 Ft.	10 Ft	0			
Control Box Cable				5 "	5 "	0			
Mechanical Linkage				5 "	5 "	0			

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MODEL XRAT RECEIVING EQUIPMENT SER. NO. 1

TABLE 2.

FREQUENCY RANGE - OVERLAP - CALIBRATION ACCURACY
13.5 to 20 MC RECEIVER.

Receiver Calibration Setting KC	Measured Frequency KC	KC Off Calibration	PCT Calibration	Overlap	
				KC	Pct
Min	13,183.4			316.6	2.35
13,500	13,499.6	- 0.4	- 0.002		
14,000	14,001.6	+ 1.6	+ 0.011		
15,000	15,014.0	+14.0	+ 0.093		
16,000	16,009.5	+ 9.5	+ 0.06		
17,000	17,010.75	+10.75	+ 0.063		
18,000	18,006.0	+ 6.0	+ 0.033		
19,000	19,008.5	+ 8.5	+ 0.045		
20,000	19,997.3	- 2.7	- 0.013		
Max.	20,375.6			375.6	1.88

20 to 27 MC RECEIVER

Min.	19,226.25			773.75	3.8
20,000	20,005.2	+ 5.2	+ 0.026		
21,000	21,024.4	+24.4	+ 0.116		
22,000	22,018.4	+18.4	+0.084		
23,000	23,014.8	+14.8	+0.065		
24,000	24,016.0	+16.0	+ 0.067		
25,000	25,018.8	+18.8	+ 0.075		
26,000	26,015.2	+15.2	+ 0.059		
27,000	26,993.2	- 6.8	- 0.025		
Max	27,507.2			507.2	1.88

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TABLE 3

SENSITIVITY
13.5 to 20 MC RECEIVER

<u>Frequency</u> <u>MC</u>	<u>Microvolts Input Necessary to Produce</u> <u>Standard Output (10 MW)</u>	
	<u>MCW</u>	<u>CW</u>
13.5	21.0	5.8
14.0	20.0	5.3
15.0	19.5	5.1
16.0	19.5	4.9
17.0	19.5	4.9
18.0	20.5	5.2
19.0	27.0	7.3
20.0	26.5	6.7

20 to 27 MC RECEIVER

20.0	23.0	6.5
21.0	23.5	6.5
22.0	24.5	6.8
23.0	24.5	6.8
24.0	24.0	7.1
25.0	24.0	7.4
26.0	23.5	7.3
27.0	21.0	7.0

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TABLE 4

SELECTIVITY
MCW - FULL GAIN

Res. Freq.	<u>ABOVE RESONANCE</u>			<u>BELOW RESONANCE</u>		
	X10	X100	X1000	X10	X100	X1000
13.5 MC	20.25kc	60.75kc	101.25 Kc	27.0 kc	60.75 kc	108.0 kc
17.0 "	25.5 "	59.5 "	110.5 "	28.9 "	59.5 "	110.5 "
20.0 "	30.0 "	70.0"	110.0 "	30.0 "	70.0 "	110.0 "
20 "	24.0 "	60.0 "	110.0 "	20.0 "	60.0 "	110.0 "
24 "	30.0 "	72.0 "	120.0 "	24.0 "	66.0 "	132.0 "
27 "	27.0 "	81.0 "	121.5 "	27.0 "	67.5 "	121.5 "

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TABLE 5.

AUDIO FIDELITY.

Audio Freq. ~	13.5 MC		17 MC		20 MC		20 MC		23.5 MC		27 MC	
	Output Volts	Pct. of Max	Output Volts	Pct. of Max.	Output Volts	Pct. of Max.	Output Volts	Pct. of Max.	Output Volts	Pct. of Max.	Output Volts	Pct. of Max.
100	1.18	66.0	1.18	65.6	1.17	65.0	1.15	64.0	1.15	64.0	1.15	64.0
200	1.58	88.0	1.57	87.0	1.58	87.8	1.55	80.0	1.56	87.7	1.56	86.7
300	1.67	93.0	1.67	92.8	1.67	92.8	1.68	93.4	1.68	94.4	1.67	92.8
400	1.73	96.6	1.73	96.0	1.73	96.0	1.73	96.1	1.73	97.2	1.73	96.1
500	1.75	97.8	1.74	96.7	1.74	96.7	1.75	97.2	1.75	98.3	1.74	96.8
600	1.76	98.4	1.75	97.2	1.75	97.2	1.76	97.8	1.76	98.9	1.76	97.8
700	1.77	99.0	1.76	97.8	1.78	99.0	1.78	98.8	1.78	100.0	1.77	98.3
800	1.78	99.6	1.78	99.0	1.79	99.5	1.8	100.0	1.78	100.0	1.78	98.8
900	1.78	99.6	1.8	100.0	1.79	99.5	1.8	100.0	1.78	100.0	1.8	100.0
1000	1.79	100.0	1.8	100.0	1.8	100.0	1.8	100.0	1.78	100.0	1.8	100.0
1500	1.79	100.0	1.8	100.0	1.8	100.0	1.78	98.8	1.76	98.9	1.78	98.8
2000	1.77	99.0	1.78	99.0	1.75	97.2	1.76	97.8	1.73	97.2	1.73	96.1
2500	1.73	96.6	1.74	96.7	1.7	94.4	1.7	94.5	1.68	94.4	1.63	90.6
3000	1.64	91.6	1.65	91.7	1.63	90.6	1.6	88.9	1.55	86.0	1.5	83.4
4000	1.4	78.2	1.4	78.0	1.38	76.7	1.25	69.4	1.22	68.0	1.15	64.0
5000	1.0	56.0	1.0	55.6	0.98	54.4	0.9	50.0	0.8	45.0	0.8	44.4

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TABLE 6

AUDIO DISTORTION

RECEIVER ADJUSTED FOR 300 MW OUTPUT AT FULL GAIN. 30% MODULATION at 400 ~

MCW

13.5 to 20 MC RECEIVER

PCT. OF FUND OUTPUT AT FOLLOWING HARMONICS

Freq. Mc.	2	3	4	5	6	7	RMS
13.5	7.6	4.5	0.32	0.62	0.34	0.3	8.86%
17.0	7.0	4.3	0.34	0.6	0.35	0.32	8.24
20.0	6.6	4.5	0.46	0.64	0.36	0.35	8.04

20 to 27 MC RECEIVER

20.0	7.5	6.0	1.0	1.3	0.2	0.4	9.75
23.5	6.0	6.0	1.0	1.2	0.2	0.4	8.64
27.0	6.2	6.0	0.95	1.2	0.2	0.4	8.78

ACCURATE MEASUREMENTS OF CW WERE IMPOSSIBLE BUT THE DISTORTION APPEARED TO BE LESS THAN FOR MCW.

TABLE 7

BEAT FREQUENCY SHIFT AT 15 MC AFTER WARM-UP.

CW

Time Min.	Freq. ~
0	1750
2	1790
4	1850
6	1875
8	1910
10	1950

TOTAL SHIFT 200 ~

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MODEL XPRAT RECEIVING EQUIPMENT SER. NO. 1

TABLE 8

OVERLOAD

CW

Input MCV	13.5 to 20 MC REC.			20 to 27 MC REC.		
	13.5 MC Output Volts	17 MC Output Volts	20 MC Output Volts	20 MC Output Volts	23.5 V Output Volts	27 MC. Output Volts
10	3.1	3.0	2.2	2.6	2.5	2.5
20	5.75	5.2	4.2	5.0	4.5	4.5
30	7.5	7.0	5.8	7.0	6.25	6.25
40	9.5	8.6	7.1	8.5	8.0	8.0
50	11.5	10.5	8.3	10.0	9.25	9.25
60	13.3	11.2	9.8	11.0	10.0	10.0
70	14.4	12.6	11.2	12.0	11.5	11.5
80	15.0	12.6	11.4	12.5	12.5	12.5
90	15.25	12.6	11.8	13.0	13.5	12.5
100	15.5	12.6	12.0	13.5	13.7	12.75
150	15.25	12.8	13.0	14.5	15.0	13.7
200	15.0	13.0	13.2	14.5	14.75	13.9
300	14.0	13.0	13.75	14.5	15.0	13.9
400	13.5	13.0	13.5	14.0	14.5	13.6
500	12.5	13.0	13.75	13.5	14.25	13.4
600	12.5	13.0	13.0	13.0	14.25	13.0
700	12.5	12.75	12.75	12.75	14.0	13.0
800	12.25	12.75	12.75	12.5	13.5	13.0
900	12.0	12.5	12.25	12.5	13.5	13.0
1000	12.0	12.25	12.25	12.0	13.25	13.0
1.0 Volt	11.5	11.5	12.25	11.0	12.5	12.0

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TABLE 9

OVERLOAD

Input MCV	MCW 13.5 to 20 MC REC.			20 to 27 MC REC.		
	13.5 Mc Output Volts	17 MC Output Volts	20 MC Output Volts	20 MC Output Volts	23.5 MC Output Volts	27 MC Output Volts
40	3.0	3.0	2.7	2.4	2.4	2.2
50	3.8	3.8	3.2	3.0	3.0	3.0
60	4.5	4.5	3.8	3.5	3.5	3.8
70	5.0	5.2	4.5	4.0	4.0	4.25
80	5.8	5.8	5.0	4.5	4.5	5.0
90	6.2	6.3	5.5	5.0	5.0	5.5
100	6.8	6.9	6.3	5.5	5.5	6.25
150	10.0	10.0	8.5	8.2	8.5	8.0
200	12.25	12.3	10.7	10.0	10.0	10.0
300	15.0	15.3	14.5	13.0	13.5	12.0
400	15.75	16.0	15.7	15.0	15.0	15.0
500	15.75	16.0	16.0	16.0	16.0	16.0
600	15.5	15.8	16.0	16.0	16.0	16.5
700	15.25	15.6	16.0	16.0	16.0	16.5
800	15.25	15.5	15.9	16.0	16.0	16.5
900	15.0	15.4	15.8	16.0	16.0	16.5
1000	15.0	15.3	15.7	16.0	16.0	16.5
To 1.0V	15.0	15.3	15.7	16.0	16.0	16.5

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MODEL XRAT RECEIVING EQUIPMENT SER. NO. 1.

TABLE 10

FREQUENCY AND OUTPUT CHANGE DUE TO VARIATION OF PRIMARY SUPPLY VOLTAGE

17.5 MC

Pri. Volts	Freq. KC	Output Volts	
11	17,492.5	1.2	Max. Freq. Change 1.25 KC = 0.007%
14	17,493.25	1.73	Output change ratio 1.5 to 1
15	17,493.75	1.8	

24 MC

11	23,980.0	1.19	Max. Freq. Change 4.25 KC = 0.017%
14	23,984.0	1.73	Output change ratio 1.55 to 1
15	23,984.25	1.84	

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TABLE 11.

MODEL XRAT RECEIVING EQUIPMENT SER. NO. 1

OUTPUT AND FREQUENCY STABILITY FOR ONE HOUR FROM COLD START
AT CONSTANT AMBIENT TEMPERATURE OF + 27° C.

MCW

17.5 MC				24 MC		
Time Min.	Freq. Kc	Output		Freq. KC	Output	
		Volts	MW		Volts	MW
0	17,500.0	1.73	10.0	24,000.0	1.73	10.0
5	17,496.5	1.55	8.0	23,996.0	1.68	9.5
10	17,496.75	1.5	7.5	23,994.8	1.63	8.9
15	17,497.25	1.3	5.7	23,992.4	1.55	8.0
20	17,497.25	1.15	4.4	23,991.6	1.4	6.5
25	17,496.25	1.1	4.04	23,990.0	1.28	5.5
30	17,495.75	1.05	3.7	23,988.0	1.25	5.2
35	17,495.25	1.05	3.7	23,987.6	1.25	5.2
40	17,494.75	1.02	3.4	23,986.8	1.25	5.2
45	17,494.25	1.0	3.3	23,985.6	1.25	5.2
50	17,493.75	1.0	3.3	23,984.8	1.25	5.2
55	17,493.5	1.0	3.3	23,984.4	1.25	5.2
60	17,493.25	1.0	3.3	23,984.0	1.25	5.2

Output Ratio 1.73 to 1
(Voltage)

-4.8 DB

1.38 to 1

-2.8 DB

Freq. Drift

First 10 min. 3.5 Kc = 0.02%

5.2 KC = 0.02%

Next 50 Min. 4.0 Kc = 0.023%

10.8 KC = 0.045%

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MODEL XRAT RECEIVING EQUIPMENT SER. NO. 1

TABLE 12

OUTPUT AND FREQUENCY STABILITY FOR ONE HOUR FROM COLD START AT
CONSTANT AMBIENT TEMPERATURE OF +26°C.

CW

17.5 MC				24 MC		
Time Min.	Freq. KC	Output		Freq. KC	Output	
		Volts	MW		Volts	MW
0	17,504.00	1.73	10.0	23,991.2	1.73	10.0
5	17,502.00	1.68	9.5	23,989.2	1.65	9.1
10	17,501.75	1.6	8.5	23,987.6	1.6	8.5
15	17,502.5	1.5	7.5	23,986.8	1.5	7.6
20	17,502.25	1.32	5.8	23,984.8	1.4	6.5
25	17,502.00	1.25	5.2	23,983.2	1.35	6.1
30	17,501.50	1.16	4.5	23,981.6	1.32	5.8
35	17,501.00	1.1	4.05	23,980.2	1.3	5.6
40	17,500.75	1.05	3.7	23,980.0	1.27	5.4
45	17,500.75	1.03	3.5	23,979.6	1.27	5.4
50	17,500.75	1.0	3.3	23,978.4	1.27	5.4
55	17,500.75	1.0	3.3	23,978.4	1.27	5.4
60	17,500.75	1.0	3.3	23,978.4	1.27	5.4

Output ratio 1.73 to 1
(Voltage)

-4.8 DB

1.36 to 1

-2.7 DB

Freq. Drift

First 10 min. 2.25 KC = 0.013%

3.6 KC = 0.015%

Next 50 min. 1.75 KC = 0.01%

9.2 KC = 0.038%

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MODEL XRAT RECEIVING EQUIPMENT SER. NO. 1.

TABLE 13

FREQUENCY DRIFT DUE TO VARIABLE TEMPERATURE.

17.5 MC - MCW

<u>Time</u> <u>Min</u>	<u>Temp.</u> <u>°C</u>	<u>Freq.</u> <u>KC</u>	<u>Time</u> <u>Min</u>	<u>Temp.</u> <u>°C</u>	<u>Freq.</u> <u>KC</u>
0	+23.0	17,494.25	75	+40.0	17,489.5
15	36.0	17,492.75	90	30.0	17,490.5
30	40.0	17,491.5	105	23.0	17,492.0
45	40.0	17,490.0	120	23.0	17,493.5
60	+40.0	17,489.0	135	+23.0	17,494.25

Max. Change +23° to +40° = 5.25 KC = 0.03%

0	+23.0	17,500.00	225	-30.0	17,497.84
15	15.0	17,498.00	240	31.0	17,498.8
30	+ 4.0	17,501.20	255	30.5	17,499.28
45	- 1.0	17,502.40	270	30.0	17,499.76
60	4.5	17,503.12	285	30.0	17,498.8
75	8.5	17,503.36	300	23.0	17,499.76
90	11.0	17,503.60	315	16.0	17,500.96
105	14.0	17,504.08	330	12.0	17,501.92
120	16.0	17,503.60	345	- 5.0	17,501.20
135	18.0	17,503.36	360	+ 3.0	17,501.68
150	21.0	17,502.88	375	13.0	17,503.36
165	24.0	17,501.68	390	18.0	17,504.08
180	27.0	17,500.72	405	21.0	17,500.96
195	28.0	17,499.76	420	23.0	17,500.72
210	-29.0	17,498.80			

Max. Change +23° to -30° = 6.24 KC = 0.035%

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TABLE 14

FREQUENCY DRIFT DUE TO VARIABLE TEMPERATURE

13.5 to 20 MC RECEIVER

CW OSCILLATOR

<u>Time</u> <u>Min.</u>	<u>Temp</u> <u>°C</u>	<u>Freq.</u> <u>KC</u>	<u>Time</u> <u>Min.</u>	<u>Temp.</u> <u>°C</u>	<u>Freq.</u> <u>KC</u>
0	+23	4201.4	90	+40	4199.2
15	32	4201.0	105	25	4200.1
30	38	4200.2	120	23	4201.0
45	40	4199.7	135	23	4201.4
60	40	4199.5	150	23	4201.8
75	+40	4199.2	165	+23	4202.2
Max. Change +23° to +40° = 2.2 KC = 0.05%					
0	+23	4198.2	195	-29	4213.6
15	15	4198.6	210	29.5	4213.7
30	+ 4	4202.8	225	30	4213.8
45	- 7	4204.5	240	30	4213.9
60	10	4207.0	255	23	4213.2
75	13	4208.9	270	13	4210.8
90	15	4209.7	285	- 7	4207.9
105	20	4210.8	300	0	4206.0
120	23	4211.3	315	+10	4203.0
135	25	4211.8	330	20	4201.1
150	26	4212.2	345	23	4199.7
165	27	4212.5	360	23	4199.5
180	-28	4213.1			

Max. Change +23° to -30° = 15.7 KC = 0.374%

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MODEL XRAT RECEIVING EQUIPMENT SER. NO. 1

TABLE 15

FREQUENCY DRIFT DUE TO VARIABLE TEMPERATURE

20 to 27 MC RECEIVER

24 MC - MCW

<u>Time</u> <u>Min.</u>	<u>Temp.</u> <u>°C</u>	<u>Freq.</u> <u>KC</u>	<u>Time</u> <u>Min.</u>	<u>Temp.</u> <u>°C</u>	<u>Freq.</u> <u>KC</u>
0	+23	24,001.2	90	+40	23,988.8
15	+34	23,998.8	105	+26	23,994.8
30	+40	23,995.2	120	+23	23,999.6
45	+40	23,992.0	135	+23	14,001.2
60	+40	23,990.0	150	+23	24,002.0
75	+40	23,989.2			

Freq. Change +23° to +40° = 12.4 KC = 0.05%

CW OSCILLATOR

0	+23	4197.4	75	+40	4200.7
15	+38	4198.8	90	+24	4199.7
30	+40	4199.8	105	+23	4199.1
45	+40	4200.2	120	+23	4198.6
60	+40	4200.4	135	+23	4197.8

Freq. Change +23° to +40° = 3.3 KC = 0.08%

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TABLE 16

FREQUENCY STABILITY OF CW OSCILLATOR FOR ONE HOUR FROM
A COLD START AT A CONSTANT AMBIENT TEMPERATURE OF $\pm 26^{\circ}\text{C}$.

	13.5 to 20 MC Receiver	20 to 27 MC Receiver
<u>Time</u> <u>Min.</u>	<u>Freq.</u> <u>KC</u>	<u>Freq.</u> <u>KC</u>
0	4202.6	4202.4
5	4201.8	4201.2
10	4201.0	4200.8
15	4200.1	4200.3
20	4199.7	4200.1
25	4199.3	4200.0
30	4199.2	4199.9
35	4199.0	4199.8
40	4198.9	4199.7
45	4198.8	4199.6
50	4198.7	4199.6
55	4198.7	4199.6
60	4198.7	4199.6

Freq. Drift

First 10 min. 1.6 KC = 0.038%

Next 50 min. 2.3 KC = 0.054%

1.6 KC = 0.038%

1.2 KC = 0.028%

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MODEL XRAT RECEIVING EQUIPMENT SER. NO. 1

TABLE 17

AUDIO DISTORTION
13.5 to 20 MC RECEIVER.
MCW.

RECEIVER OUTPUT ADJUSTED FOR 200 MW AT FULL GAIN

13.5 MC

PCT. OF FUND. OUTPUT AT FOLLOWING HARMONICS

Mod. Freq. ~	Pct. Mod.	2	3	4	5	6	7	RMS
200	10	8.6	4.1	0.3	0.56	0.2	0.1	9.53%
"	30	8.2	4.2	0.34	0.6	0.36	0.1	9.24
"	80	6.8	5.2	1.2	0.68	0.11	0	8.66
400	10	4.8	3.6	0.1	0.64	0.26	0.1	6.04
"	30	5.0	3.7	0.14	0.65	0.25	0.1	6.26
"	80	5.2	5.6	0.78	0.8	0.2	0.18	7.72
3000	10	5.2	0.65	0.44	0			5.25
"	30	5.3	0.5	0.42	0			5.33
"	80	17.0	0.66	0				17.0

TABLE 18

17 MC

200	10	8.2	4.0	0.32	0.56	0.34	0	9.14%
"	30	7.3	4.0	0.3	0.58	0.3	0	8.36
"	80	6.5	5.6	1.2	0.7	0.12	0.1	8.6
400	10	4.5	3.6	0	0.65	0.26	0.1	5.8
"	30	4.4	3.6	0.12	0.6	0.24	0.1	5.74
"	80	5.5	5.8	0.68	0.8	0.1	0.18	8.06
3000	10	5.2	0.64	0.44	0			5.25
"	30	5.6	0.48	0.4	0			5.63
"	80	18.0	0.64	0.05	0			18.0

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MODEL XRAT RECEIVING EQUIPMENT SER. NO. 1

TABLE 19

AUDIO DISTORTION
13.5 to 20 MC RECEIVER
MCW

RECEIVER OUTPUT ADJUSTED FOR 200 MW AT FULL GAIN

20 MC

PCT. OF FUND. OUTPUT AT FOLLOWING HARMONICS

Mod. Freq. ~	Pct Mod.	2	3	4	5	6	7	RMS
200	10	8.5	4.0	0.25	0.6	0.35	0	9.43%
"	30	7.8	4.0	0.3	0.6	0.28	0	8.7
"	80	6.4	5.8	1.2	0.7	0		8.74
400	10	4.8	3.5	0.1	0.65	0.24		5.98
"	30	4.1	3.2	0.2	0.66	0.2		5.2
"	80	5.8	6.0	0.6	0.8	0.15		8.4
3000	10	5.2	0.64	0.42	0			5.25
"	30	5.8	0.5	0.4	0			5.8
"	80	18.0	0.65	0.1	0.1			18.0

TABLE 20

AUDIO DISTORTION
20 to 27 MC RECEIVER
MCW

RECEIVER OUTPUT ADJUSTED FOR 200 MW AT FULL GAIN.

20 MC

PCT. OF FUND. OUTPUT AT FOLLOWING HARMONICS.

Mod. Freq. ~	Pct. Mod.	2	3	4	5	6	RMS
200	10	8.3	4.4	0.5	0.7	0.15	9.44%
"	30	8.0	4.2	0.5	0.65	0.1	9.07
"	80	7.7	6.2	1.3	0.8	0.1	10.0
400	10	4.6	4.0	0.4	0.8	0	6.1
"	30	4.8	4.3	0.5	0.8	0	6.46
"	80	5.7	6.2	0.8	0.9	0.15	8.43
3000	10	5.3	0.8	0.3	0		5.37
"	30	5.4	0.65	0.3	0		5.45
"	80	10.3	1.5	0.1	0		10.4

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MODEL XRAT RECEIVING EQUIPMENT SER. NO. 1

TABLE 21

AUDIO DISTORTION
20 to 27 MC RECEIVER
MCW

RECEIVER OUTPUT ADJUSTED FOR 200 MW AT FULL GAIN.

23.5 MC

PCT. OF FUND. OUTPUT AT FOLLOWING HARMONICS.

Mod. Freq. ~	Pct. Mod.	2	3	4	5	6	RMS
200	10	8.0	4.2	0.5	0.68	0.15	9.08%
"	30	9.0	4.4	0.65	0.7	0.2	10.0
"	80	7.4	7.0	1.1	0.7	0.2	10.2
400	10	4.6	4.0	0.4	0.76	0	6.15
"	30	4.4	4.0	0.46	0.78	0.2	6.0
"	80	6.8	7.4	0.92	1.0	0.2	10.1
3000	10	5.4	0.88	0.38	0.12		5.48
"	30	6.5	0.52	0.37	0.12		6.48
"	80	10.2	2.8	0.15	0		10.5

TABLE 22

27 MC

200	10	8.6	4.4	0.55	0.7	0.15	9.7
"	30	8.4	3.8	0.4	0.52	0	9.24
"	80	7.4	8.5	1.1	0.85	0.3	11.35
400	10	4.3	4.0	0.45	0.7	0	5.92
"	30	4.4	4.2	0.6	0.72	0	6.15
"	80	9.6	9.0	1.8	1.0	0.3	13.7
3000	10	5.5	0.88	0.3	0.1		5.56
"	30	9.0	0.7	0.42	0.1		9.0
"	80	20.0	1.0	0.12	0		20.0

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MODEL XRAT RECEIVING EQUIPMENT SER. NO. 1

TABLE 23

RESET
LOCAL CONTROL

	<u>CLOCKWISE</u> MAX. DIFFERENCE BETWEEN SETTINGS		<u>COUNTER CLOCKWISE</u> MAX. DIFFERENCE BETWEEN SETTINGS		MAX. DIFFERENCE BETWEEN MOST WIDELY SEPARATED CLOCKWISE AND COUNTER CLOCKWISE SETTINGS	
	<u>KC</u>	<u>PCT</u>	<u>KC</u>	<u>PCT</u>	<u>KC</u>	<u>PCT.</u>
14 MC	1.0	.007	1.4	.01	2.0	.014
17 "	1.5	.0088	1.25	.0073	2.0	.0117
20 "	1.8	.009	1.7	.0085	2.6	.013
21 "	2.0	.0095	2.0	.0095	6.0	.0285
*21.075 MC	3.2	.0152	5.6	.0266	8.0	.038
*21.45 "	3.6	.0168	5.2	.0242	8.0	.037
23.5 "	3.6	.0153	3.2	.0136	6.4	.0272
26.0 "	3.6	.0138	3.6	.0138	4.8	.0185

REMOTE CONTROL

14 MC	2.2	.0157	2.8	.02	9.0	.064
17 "	2.75	.0157	3.25	.0186	8.75	.05
20 "	2.6	.013	2.4	.012	8.6	.043
21 "	5.2	.0248	4.8	.0228	11.6	.055
*21.45 MC	4.8	.0225	6.8	.0315	20.8	.097
23.5 "	5.2	.022	4.4	.0187	8.8	.0375
26.0 "	4.4	.017	4.8	.0185	12.0	.046

* MEASUREMENTS MADE BETWEEN CALIBRATION MARKING OF TUNING DIAL.

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MODEL XRAT RECEIVING EQUIPMENT SER. NO. 1.

TABLE 24

IMAGE RESPONSE
13.5 to 20 MC RECEIVER

CW

<u>Freq.</u> <u>Mc</u>	MCV Input at <u>Image Freq.</u>	<u>Output</u> <u>Volts</u>	MCV Input at Resonance for <u>Same Output</u>	<u>Ratio</u>
13.5	100,000	1.0	3.1	32,000
14.0	100,000	1.2	3.6	28,000
15.0	100,000	1.62	5.3	19,000
16.0	82,000	1.73	5.35	15,400
17.0	69,000	1.73	5.5	12,500
18.0	60,000	1.73	5.6	10,700
19.0	56,000	1.73	7.4	7,600
20.0	51,000	1.73	7.0	7,300
13.5	10 ⁶	3.2	10.0	100,000
14.0	"	3.6	11.5	87,000
15.0	"	4.5	16.0	62,000
16.0	"	5.5	21.0	47,500
17.0	"	6.5	26.0	38,000
18.0	"	7.15	29.0	34,500
19.0	"	7.15	37.0	27,000
20.0	"	8.0	43.5	23,100

TABLE 25

MCW

13.5	100,000	0.2	3.5	28,500
14.0	100,000	0.25	4.0	25,000
15.0	100,000	0.35	5.7	17,500
16.0	100,000	0.5	7.2	13,900
17.0	100,000	0.6	8.8	11,400
18.0	100,000	0.7	10.0	10,000
19.0	100,000	0.75	13.0	7,700
20.0	100,000	0.95	17.0	5,900
13.5	10 ⁶	0.8	11.0	91,000
14.0	"	1.0	13.0	77,000
15.0	"	1.25	17.0	58,000
16.0	"	1.5	22.0	45,400
17.0	"	1.8	26.0	38,500
18.0	"	2.1	30.0	33,300
19.0	"	2.15	37.0	27,000
20.0	"	2.5	45.0	22,200

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MODEL XRAT RECEIVING EQUIPMENT SER. NO. 1.

TABLE 26

IMAGE RESPONSE
20 to 27 MC RECEIVER

<u>Freq.</u> <u>MC</u>	<u>MCV Input</u> <u>at</u> <u>Image Freq.</u>	<u>CW</u> <u>Output</u> <u>Volts</u>	<u>MCV Input at</u> <u>Resonance for</u> <u>Same Output</u>	<u>Ratio</u>
20	80,000	1.73	6.5	12,300
21	62,000	1.73	6.4	9,700
22	55,000	1.73	6.5	8,500
23	45,000	1.73	6.5	6,900
24	38,000	1.73	7.3	5,200
25	33,000	1.73	7.6	4,350
26	30,000	1.73	7.0	4,280
27	28,000	1.73	6.7	3,900
20	100,000	2.0	7.7	13,000
21	100,000	2.6	10.0	10,000
22	100,000	2.92	11.0	9,100
23	100,000	3.52	13.5	7,400
24	100,000	3.8	17.0	5,900
25	100,000	4.25	21.0	4,750
26	100,000	4.5	22.0	4,550
27	100,000	5.0	22.0	4,550

TABLE 27

		<u>CW</u>		
20	10 ⁶	5.0	22	45,500
21	"	5.9	26	38,500
22	"	6.5	30	33,300
23	"	7.75	37	27,000
24	"	8.4	44	22,700
25	"	9.0	51	19,600
26	"	9.5	50	20,000
27	"	10.0	55	18,200
		<u>MCW</u>		
20	100,000	0.65	9.3	10,750
21	100,000	0.8	11.0	9,100
22	100,000	0.8	11.0	9,100
23	100,000	1.05	13.5	7,400
24	100,000	1.25	17.0	5,900
25	100,000	1.42	19.0	5,260
26	100,000	1.57	18.7	5,350
27	100,000	1.73	18.2	5,500

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MODEL XRAT RECEIVING EQUIPMENT SER. NO. 1

TABLE 28

IMAGE RESPONSE
20 to 27 MC RECEIVER.

Freq. Mc	MCV Input at Image Freq.	MCW Output Volts	MCV Input at Reso- nance for same Output	Ratio
20	10 ⁶	1.9	26.0	38,500
21	"	2.25	30.5	32,800
22	"	2.1	29.5	33,900
23	"	2.6	35.7	28,000
24	"	2.95	40.0	25,000
25	"	3.3	45.0	22,200
26	"	3.6	44.0	22,700
27	"	4.0	50.0	20,000

REC. ADJUSTED FOR STANDARD OUTPUT AT RESONANCE WITH REDUCED GAIN.

20	10 ⁶	1.73	25.0	40,000
21	"	1.73	30.0	33,300
22	"	1.73	29.0	34,500
23	"	1.73	35.5	28,200
24	"	1.73	40.0	25,000
25	"	1.73	44.5	24,400
26	"	1.73	44.0	22,700
27	"	1.73	45.0	22,200

TABLE 29

OVERLOAD SELECTIVITY

14 MC

KC DISPLACEMENT FOR 3 KB CHANGE OF OUTPUT

Input MCV		Above Resonance	Below Resonance
100,000	MCW	91.0 KC	105.0 KC
100,000	CW	84.0 KC	91.0 KC
10 ⁶	MCW	126.0 KC	140.0 KC
10 ⁶	CW	105.0 KC	126.0 KC

17 MC

100,000	MCW	102.0 KC	119.0 KC
100,000	CW	93.5 KC	110.5 KC
10 ⁶	MCW	161.5 KC	170.0 KC
10 ⁶	CW	127.5 KC	144.5 KC

20 MC

100,000	MCW	130.0 KC	110.0 KC
100,000	CW	110.0 KC	110.0 KC
10 ⁶	MCW	220.0 KC	190.0 KC
10 ⁶	CW	170.0 KC	150.0 KC

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MODEL XRAT RECEIVING EQUIPMENT SER. NO. 1.

TABLE 30

FREQUENCY DRIFT DUE TO HUMIDITY VARIATION
TEMPERATURE CONSTANT AT +40° C.

MCW

13.5 to 20 MC Rec.

20 to 27 MC Rec.

17.5 MC

20 MC

Time Min	Pct. Humidity	Freq. KC	Pct. Humidity.	Freq. KC
0	50	17,480.75	46	19,995.6
5	52	17,481.25	47	19,996.8
10	62	17,481.25	50	19,997.2
15	85	17,481.50	54	19,998.0
20	90	17,481.75	62	19,998.4
25	94	17,482.25	70	19,998.8
30	98	17,481.75	83	19,998.8
40	96	17,480.00	85	19,996.4
50	93	17,478.75	88	19,998.0
60	98	17,478.25	85	19,996.8
75	96	17,478.00	88	19,997.6
90	100	17,478.00	84	19,997.2
105	97	17,478.00	91	19,996.8
120	96	17,477.75	98	19,997.6
135	96	17,477.75		

Max. Change 4.5 KC = 0.025%

Max. Change 3.2 KC = 0.016%

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MODEL X RAT RECEIVING EQUIPMENT SER. NO. 1

TABLE 31

EFFECT OF 72 HOURS SUBJECTION TO 90 PERCENT RELATIVE HUMIDITY
AT +40 DEGREES CENTIGRADE.

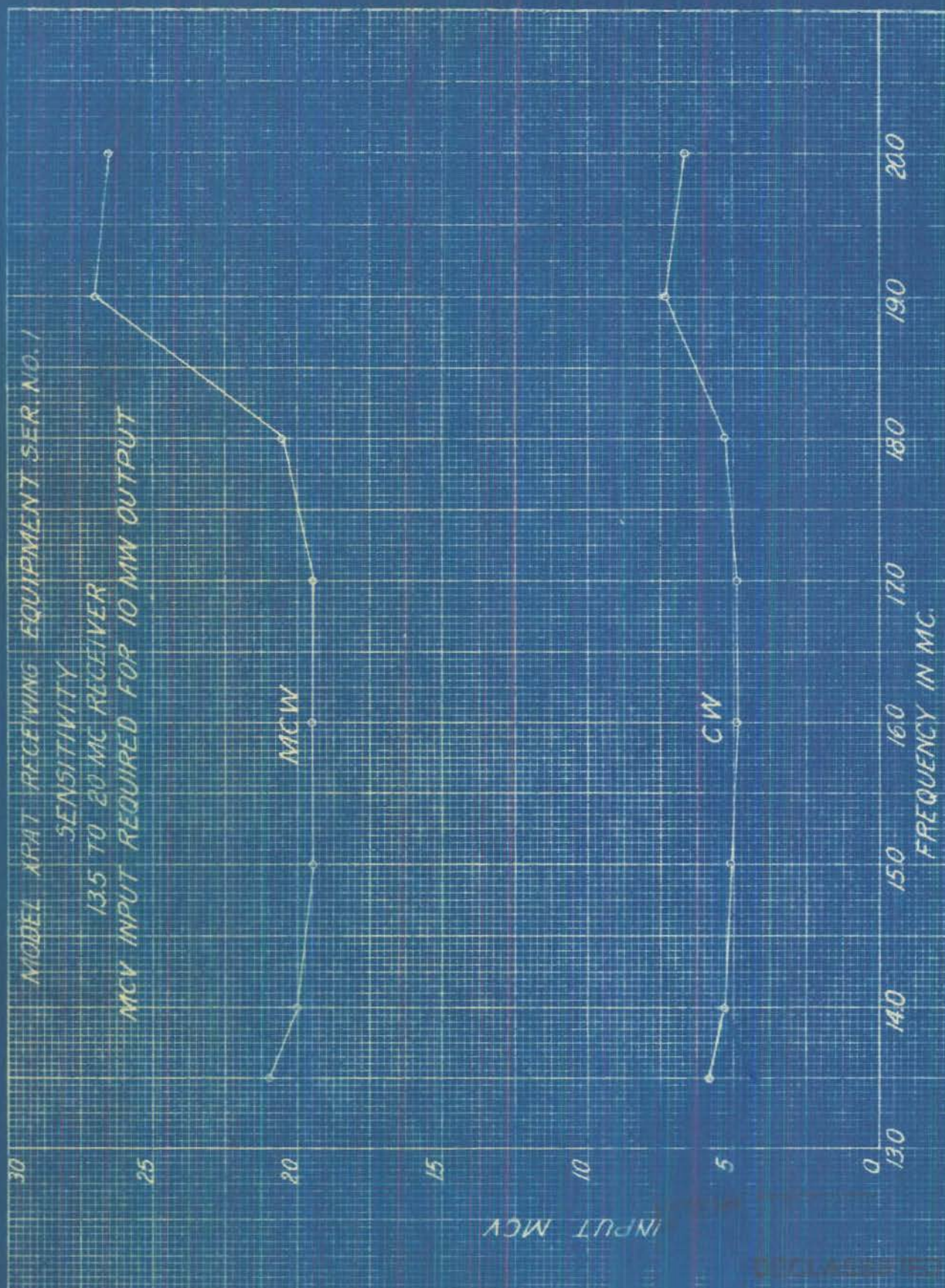
17.5 MC

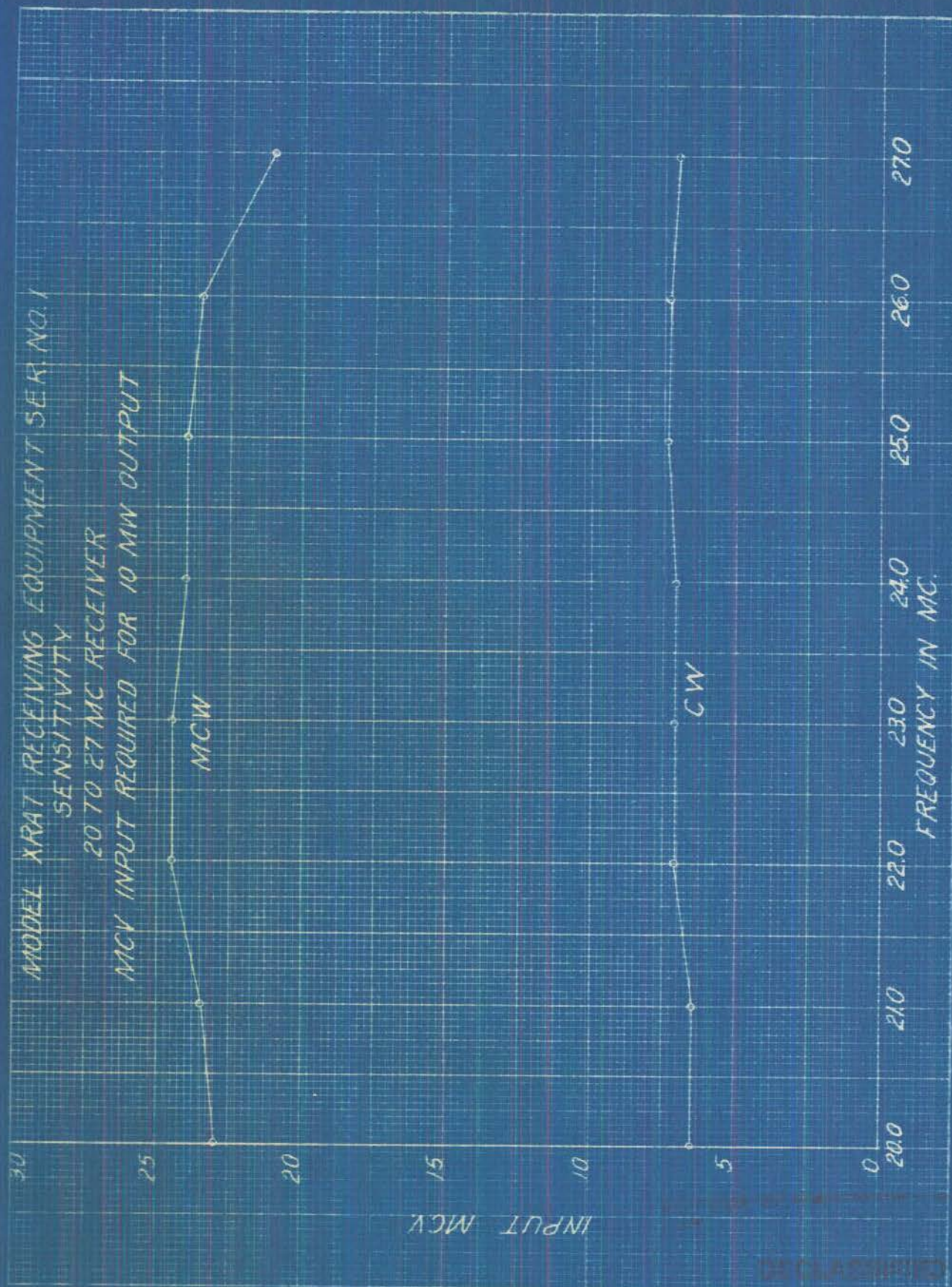
Time	Temp.	Hum.	MCV Input for 10 MW Output		Sensitivity Reduction		Freq. KC	Freq. Change
			CW	MCW	CW	MCW		
Start	+23°C	27%	3.5	17			17,500	
24 Hrs.	+40°C	90%	5.9	26	41%	35%	17,494	
48 Hrs.	+40°C	90%	5.9	26	41%	35%	17,494	
72 Hrs.	+40°C	90%	6.3	30	45%	44%	17,494	6 kc=0.034%

23 MC

Start	+23°C	27%	6.4	39			22,961	
24 Hrs.	+40°C	90%	12.0	58	47%	33%	22,950	
48 Hrs.	+40°C	90%	13.0	57	51%	32%	22,950	
72 Hrs.	+40°C	90%	14.0	61	54%	36%	22,950	11 kc=0.048%

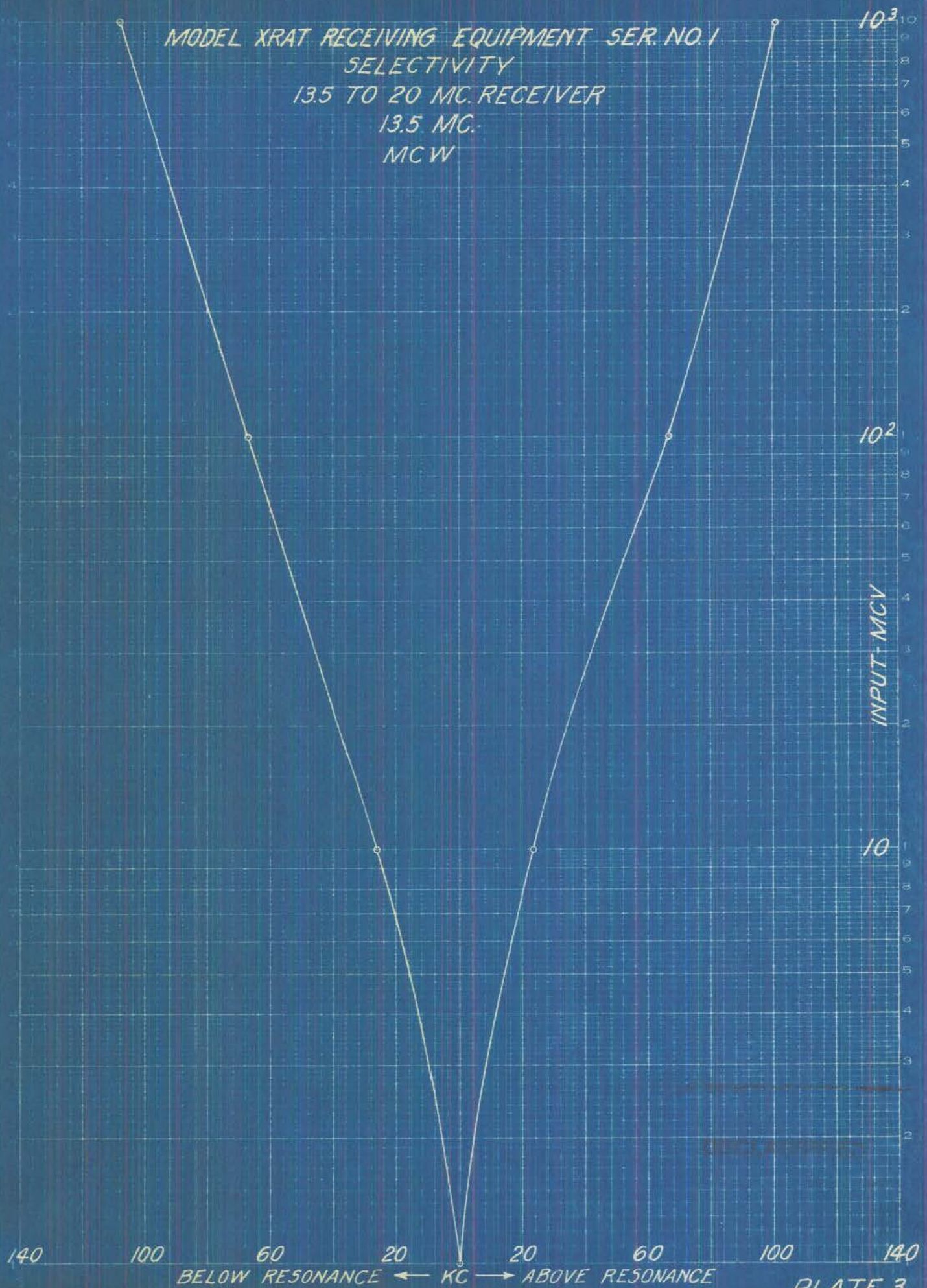
DECLASSIFIED



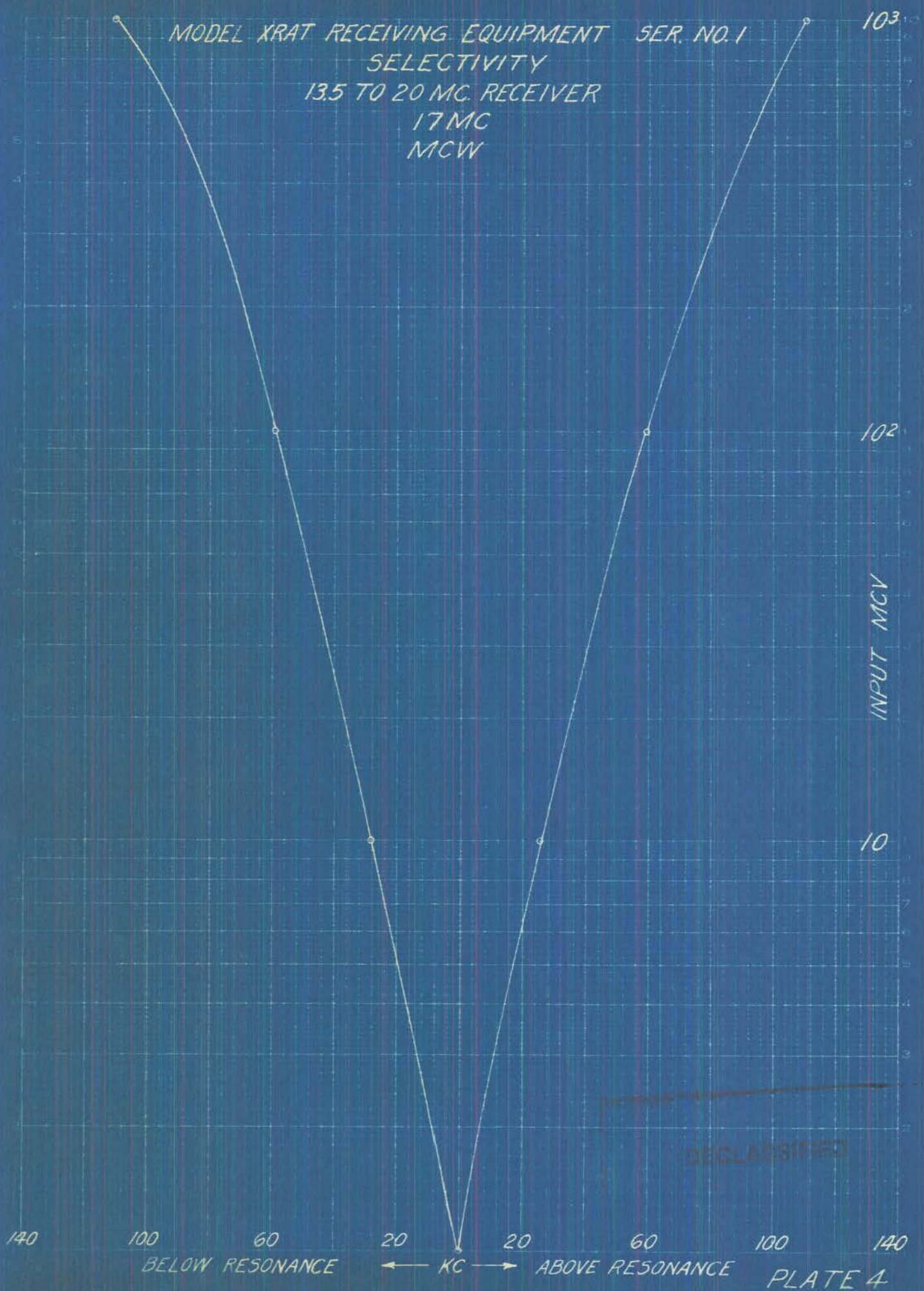


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MODEL XRAT RECEIVING EQUIPMENT SER. NO. 1
SELECTIVITY
13.5 TO 20 MC. RECEIVER
13.5 MC.
MCW

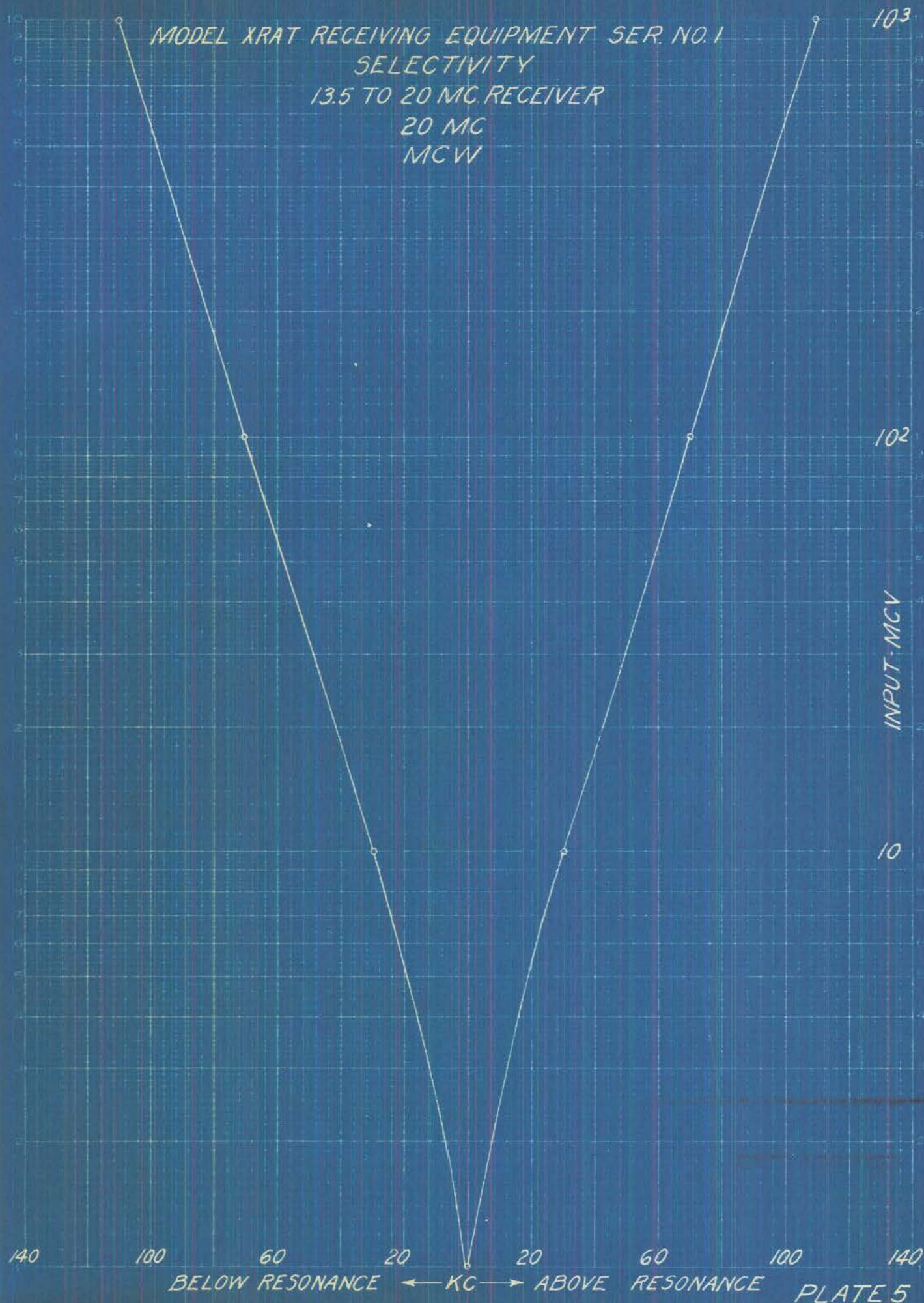


MODEL XRAT RECEIVING EQUIPMENT SER. NO. 1
SELECTIVITY
13.5 TO 20 MC. RECEIVER
17 MC
MCW

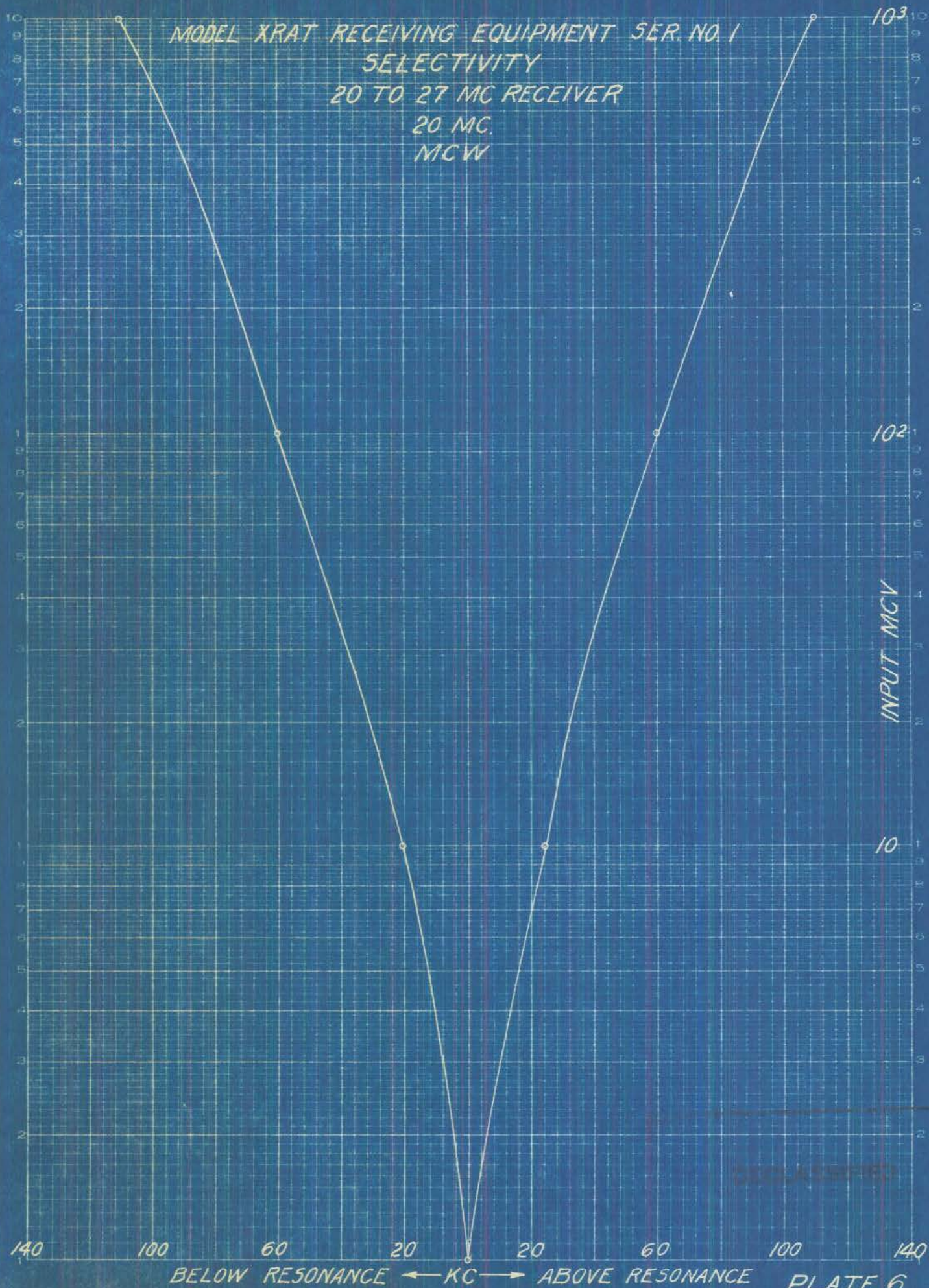


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MODEL XRAT RECEIVING EQUIPMENT SER. NO. 1
SELECTIVITY
13.5 TO 20 MC RECEIVER
20 MC
MCW

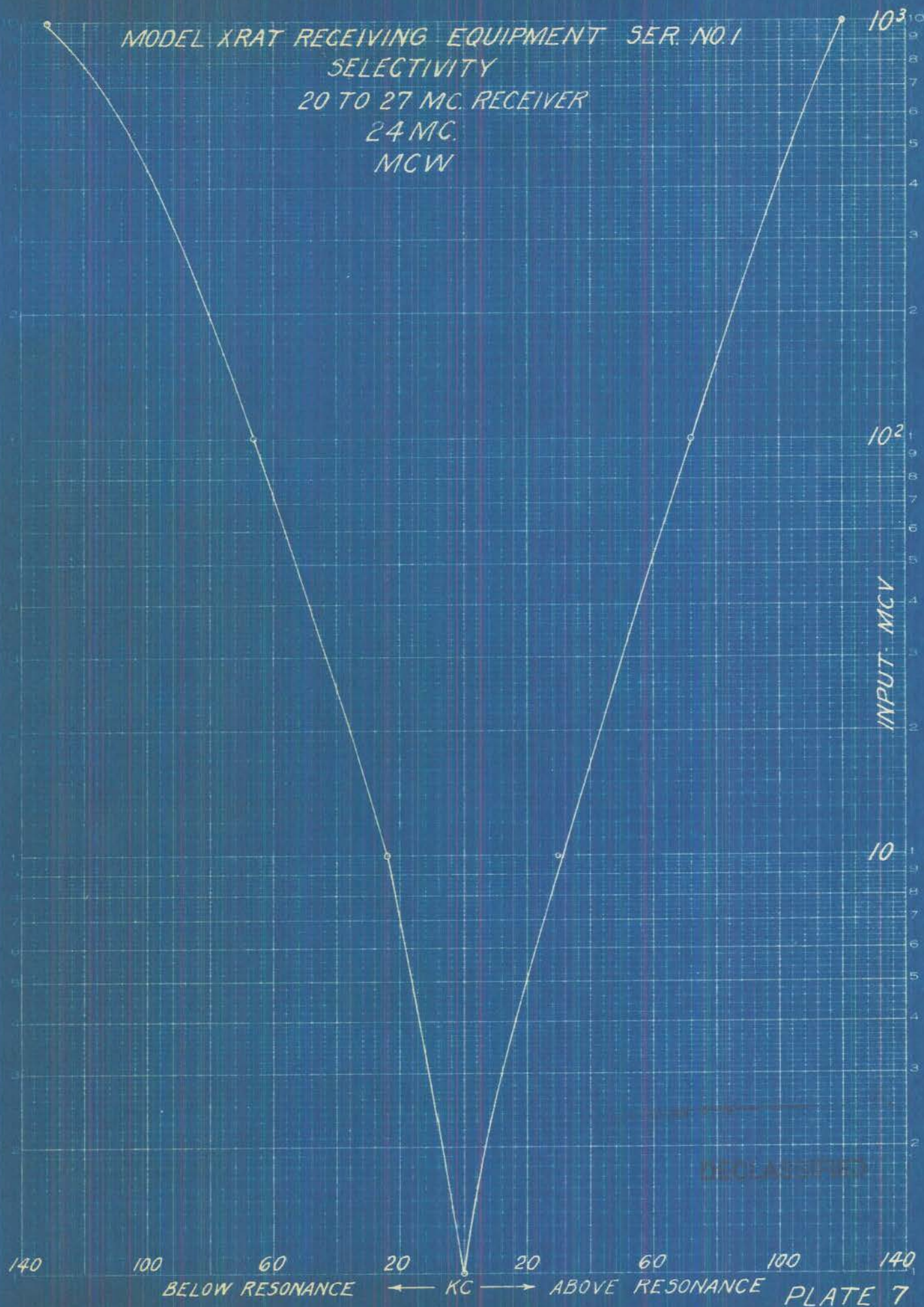


MODEL XRAT RECEIVING EQUIPMENT SER. NO. 1
 SELECTIVITY
 20 TO 27 MC RECEIVER
 20 MC.
 MCW

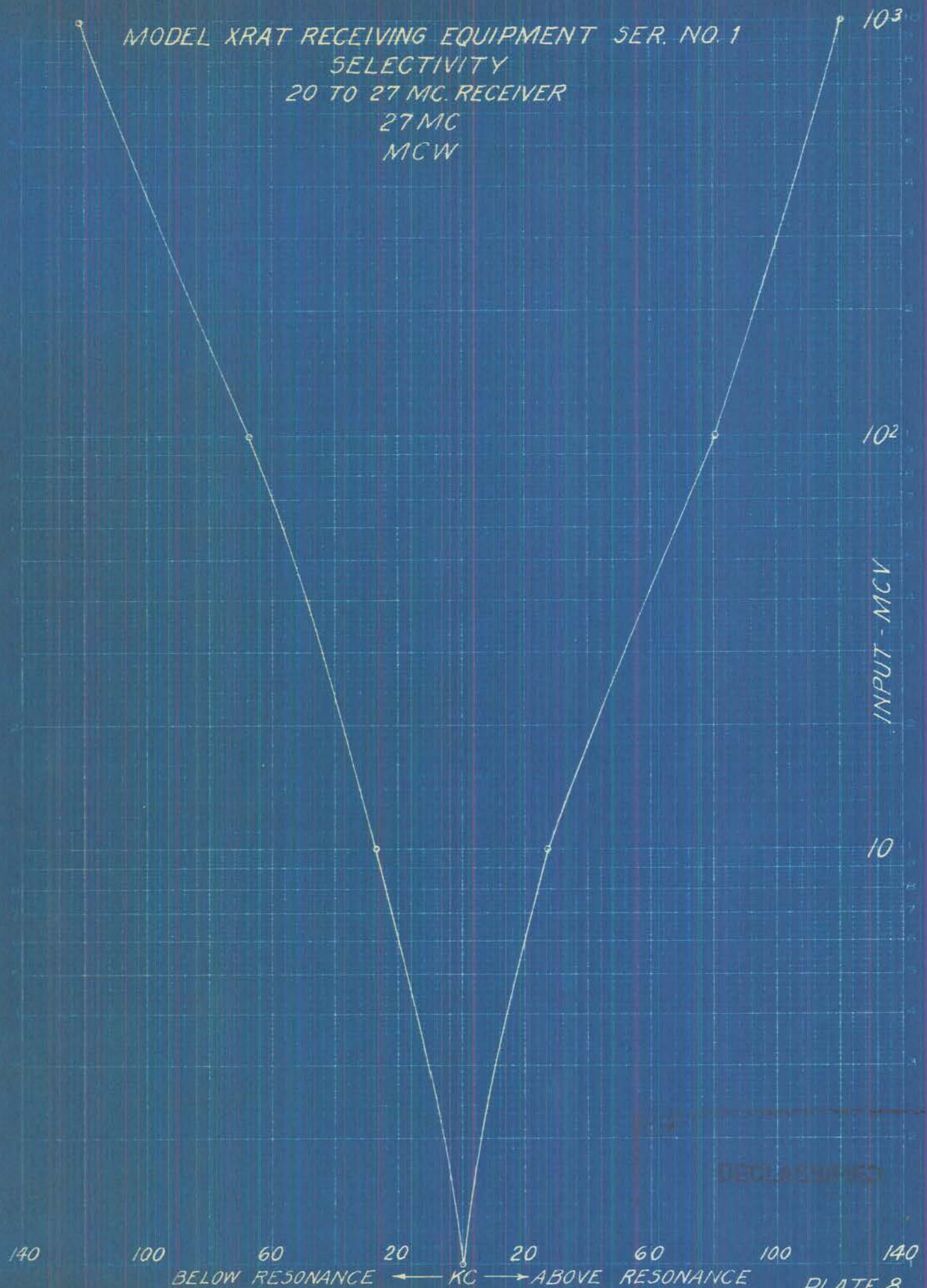


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MODEL XRAT RECEIVING EQUIPMENT SER. NO. 1
SELECTIVITY
20 TO 27 MC. RECEIVER
24 MC.
MCW



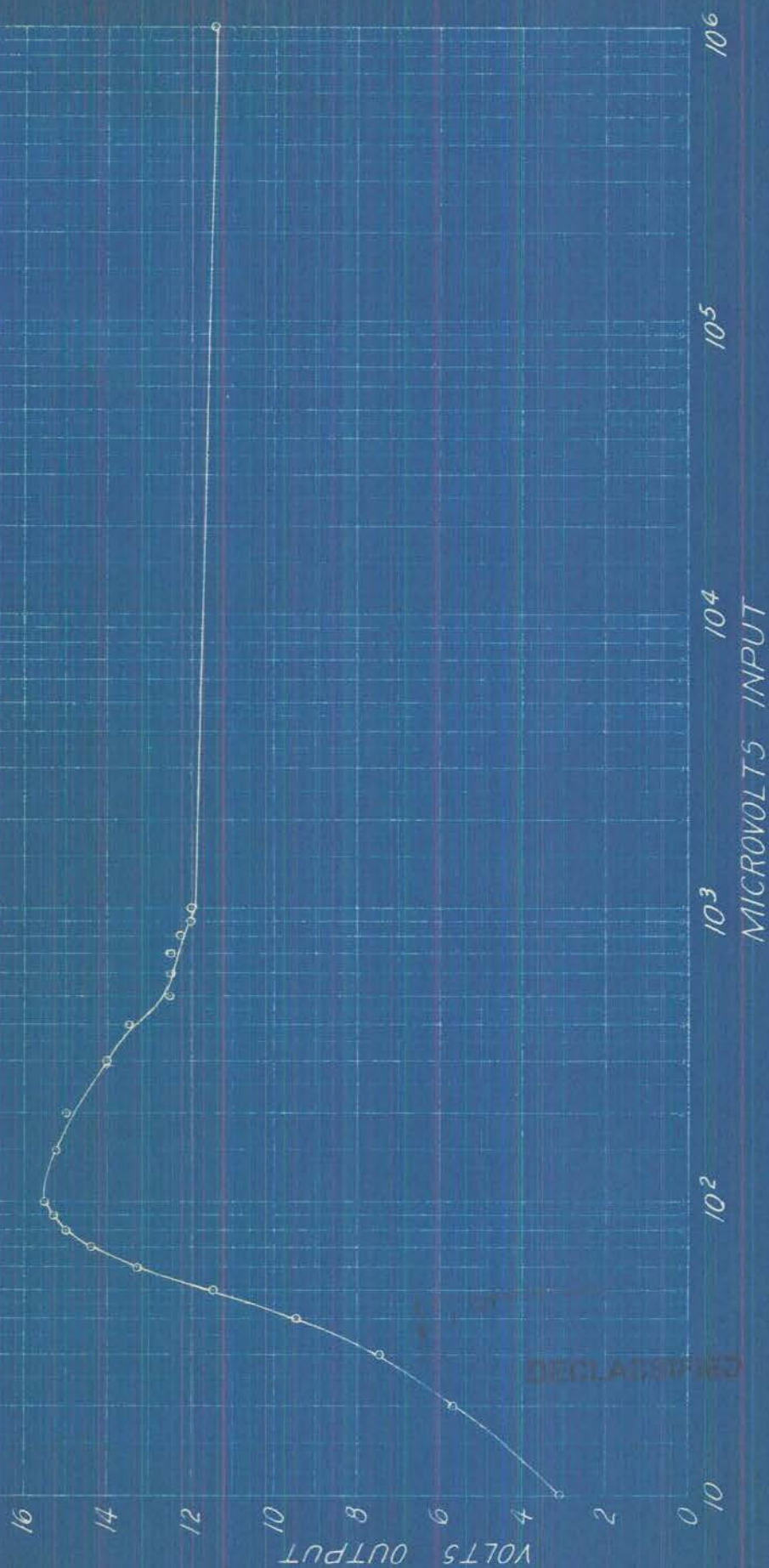
MODEL XRAT RECEIVING EQUIPMENT SER. NO. 1
SELECTIVITY
20 TO 27 MC. RECEIVER
27 MC
MCW



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MODEL XRAT RECEIVING EQUIPMENT SER. NO. 1
OVERLOAD CHARACTERISTIC
CW

TYPICAL CURVE FOR ALL FREQUENCIES



MODEL X RAT RECEIVING EQUIPMENT SER. NO. 1
OVERLOAD CHARACTERISTIC

MCW

TYPICAL CURVE FOR ALL FREQUENCIES

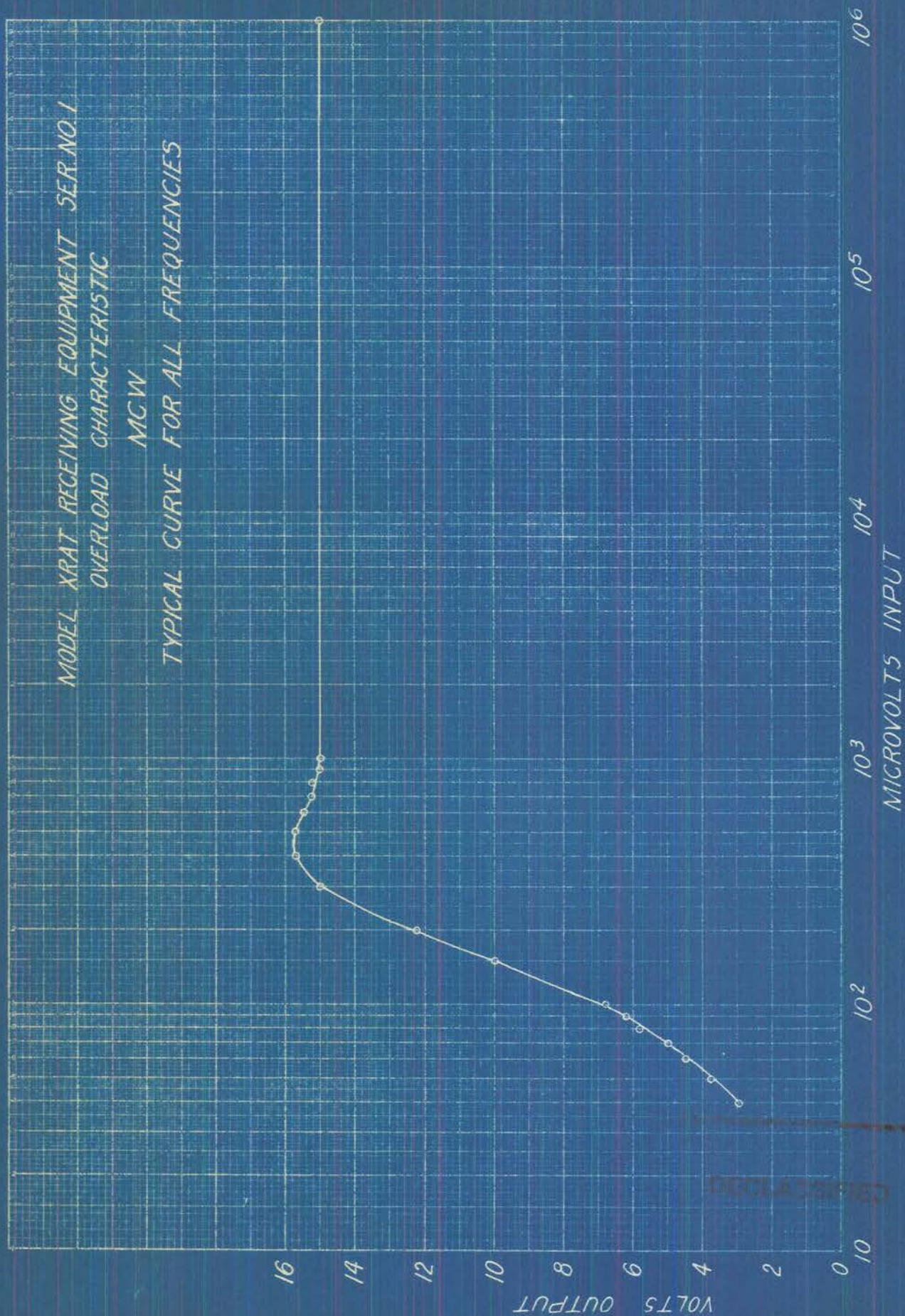
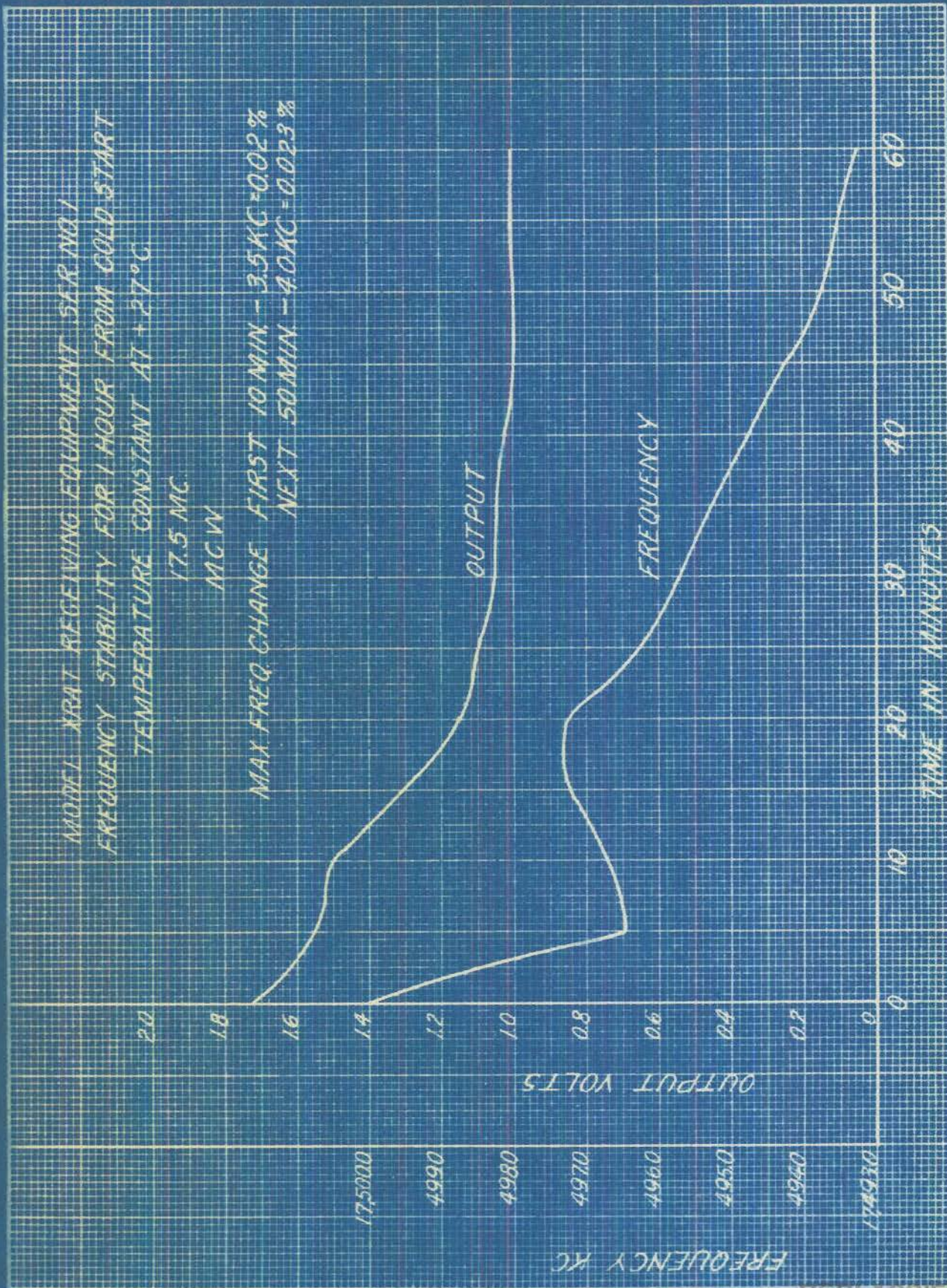
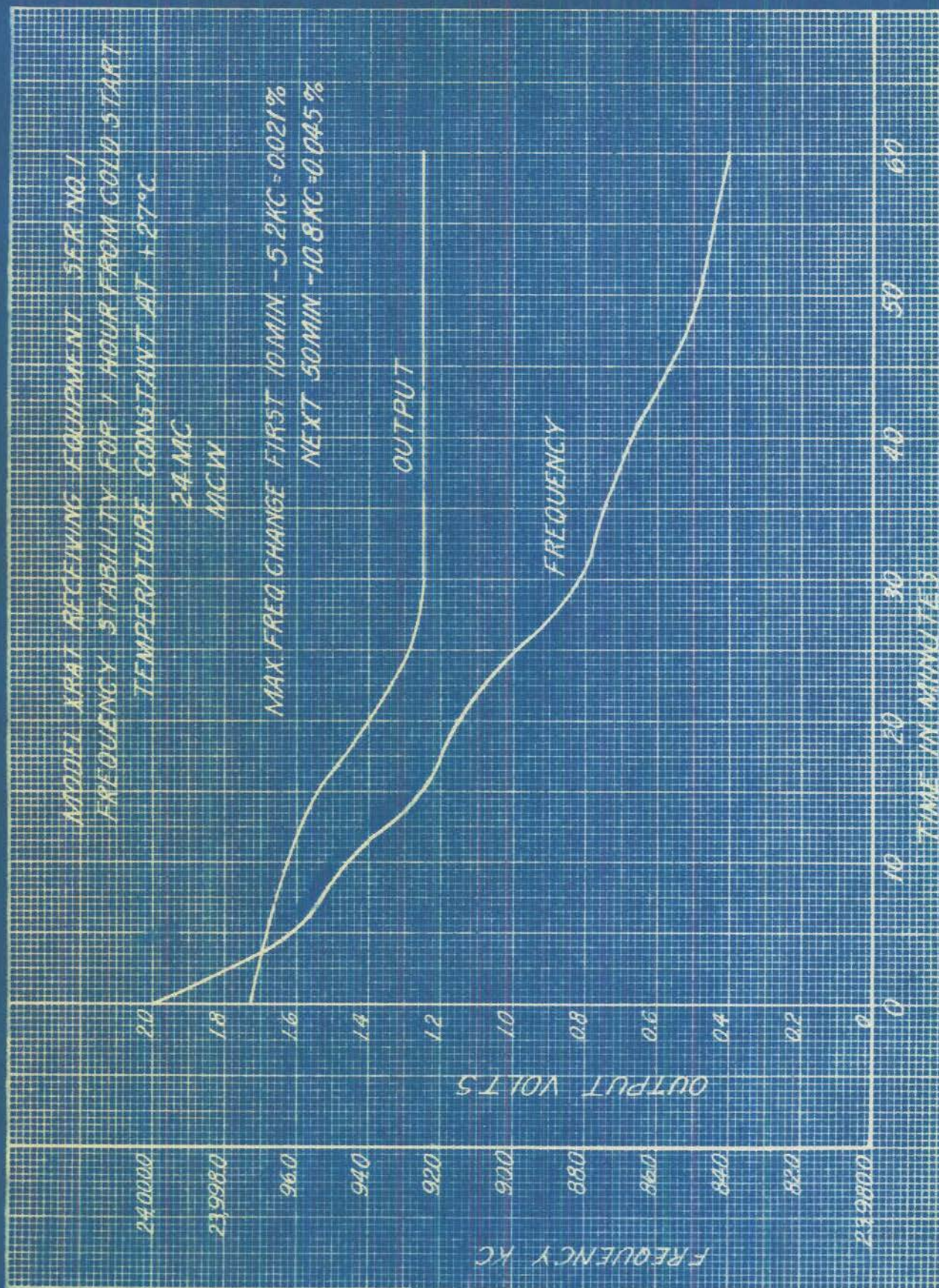


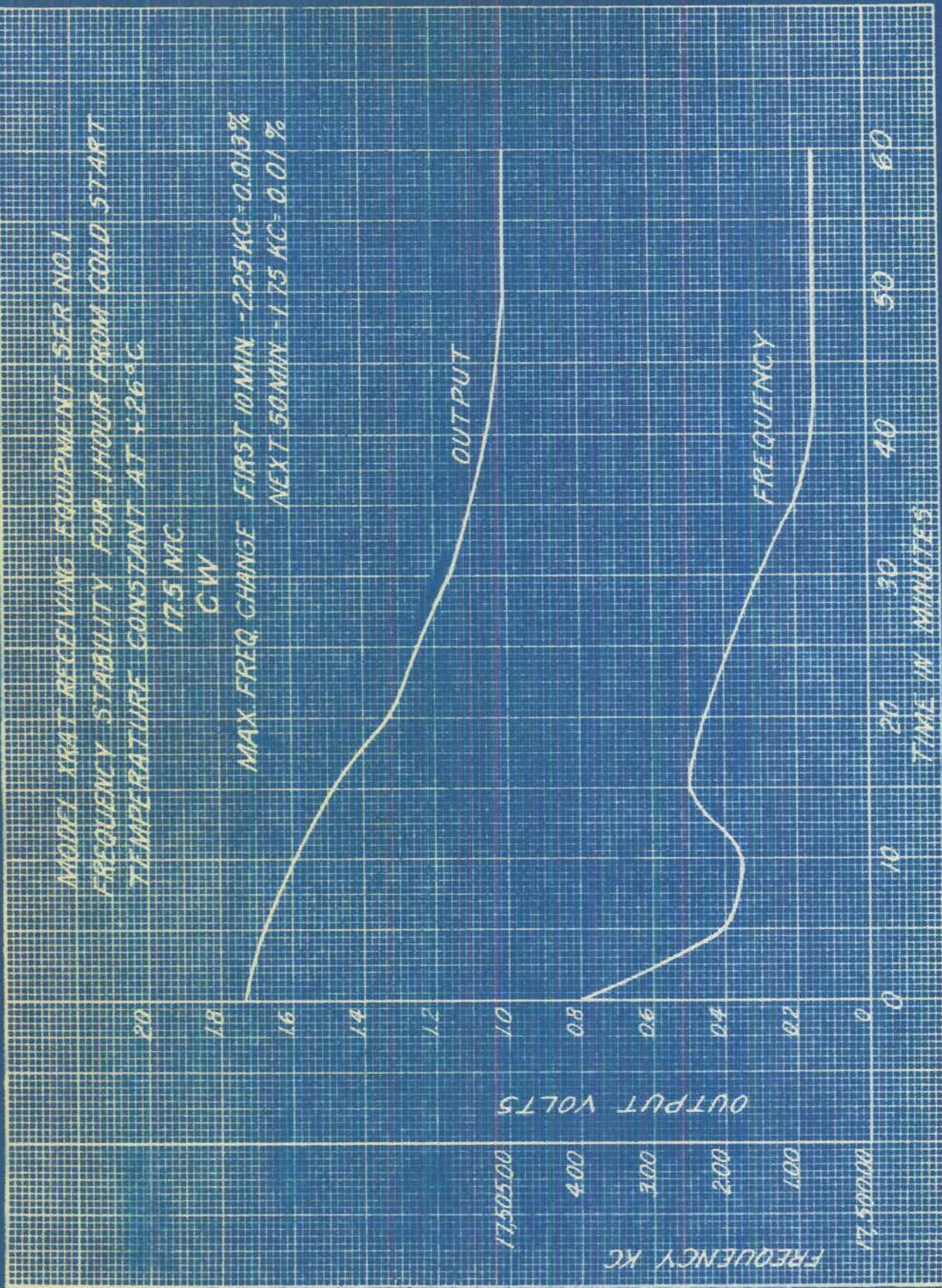
PLATE 10





MODEL 1001 RECEIVING EQUIPMENT SER NO. 1
 FREQUENCY STABILITY FOR 1 HOUR FROM COLD START
 TEMPERATURE CONSTANT AT +26°C

17.5 MC
 CW
 MAX FREQ. CHANGE FIRST 10 MIN - 225 KC = 0.013%
 NEXT 50 MIN - 175 KC = 0.01%



MODEL XEAT RECEIVING EQUIPMENT SER NO. 1
 FREQUENCY STABILITY FOR 1 HOUR FROM COLD START
 TEMPERATURE CONSTANT AT $+26^{\circ}\text{C}$.

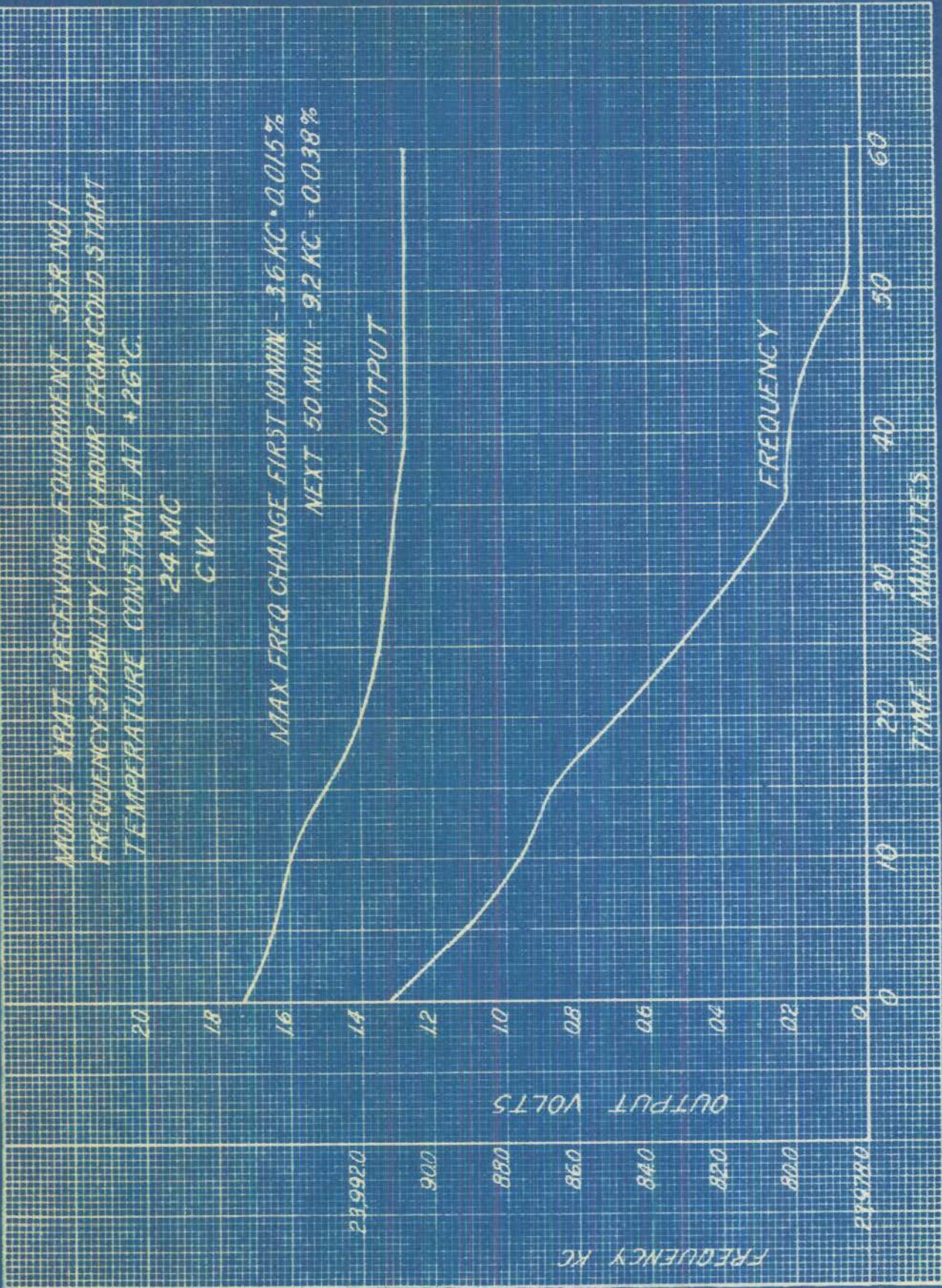
24 MC
 CW

MAX FREQ CHANGE FIRST 10 MIN - $3.6 \text{ KC} \cdot 0.015\%$
 NEXT 50 MIN - $9.2 \text{ KC} \cdot 0.038\%$

OUTPUT

FREQUENCY

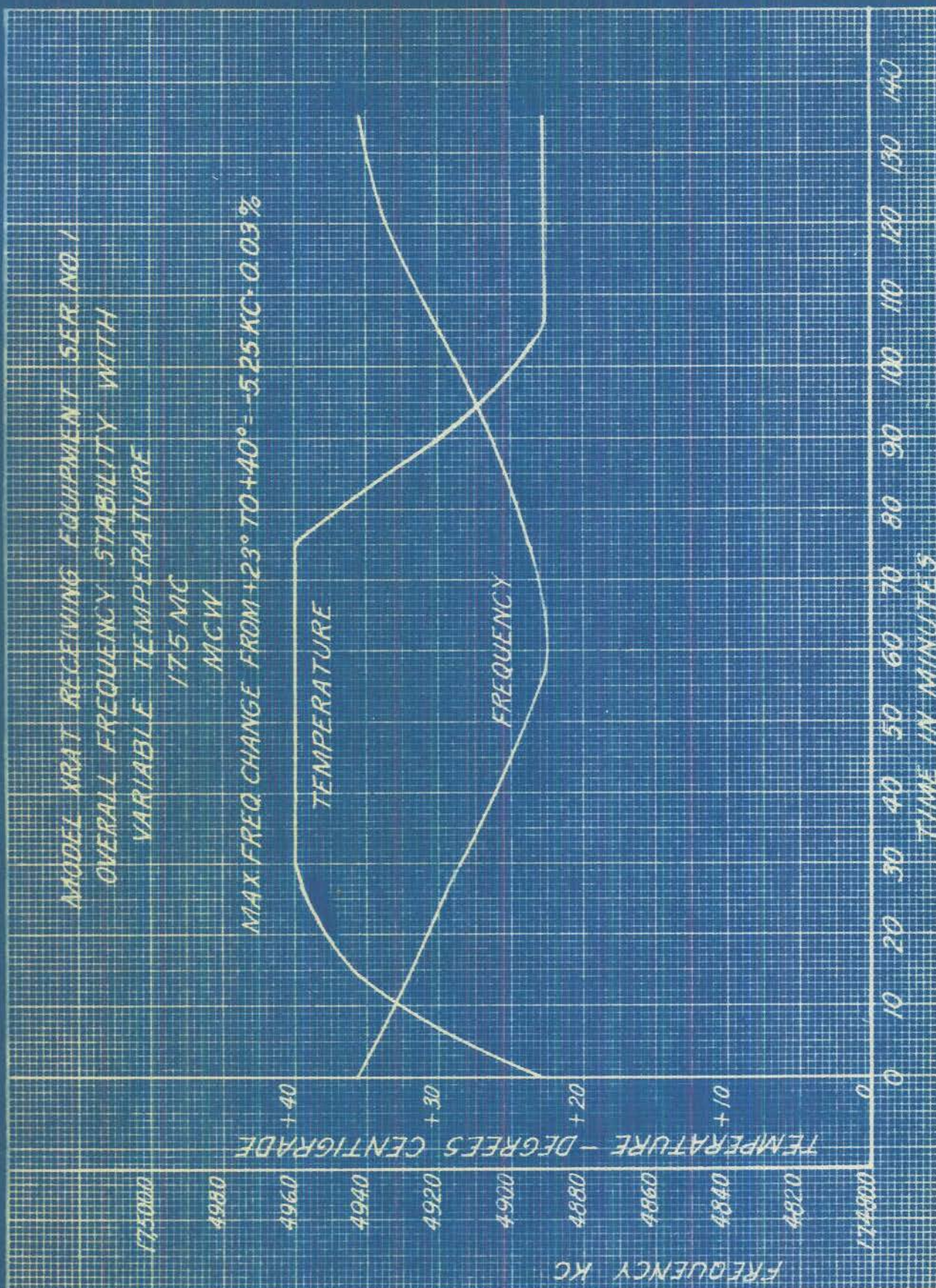
TIME IN MINUTES

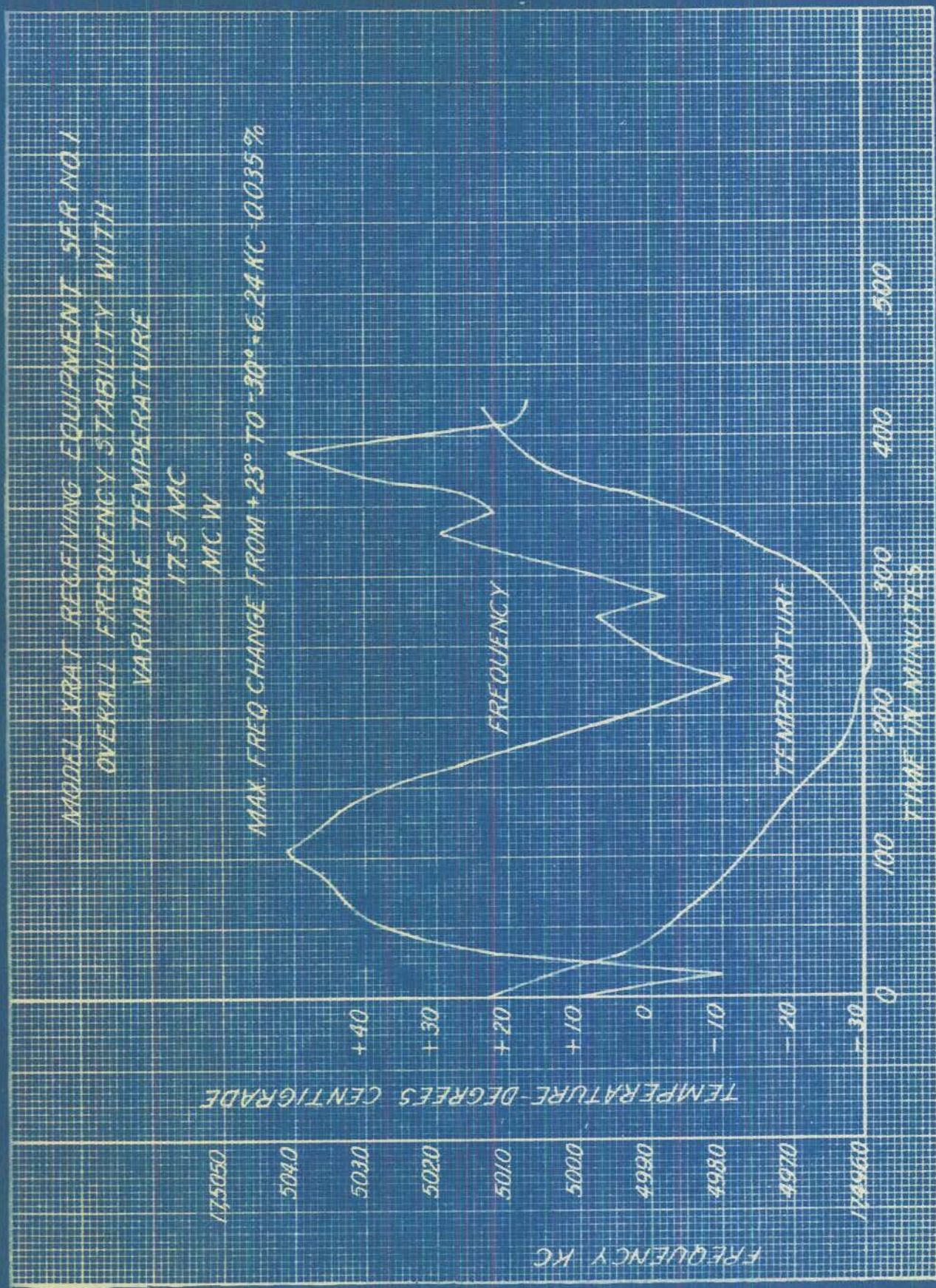


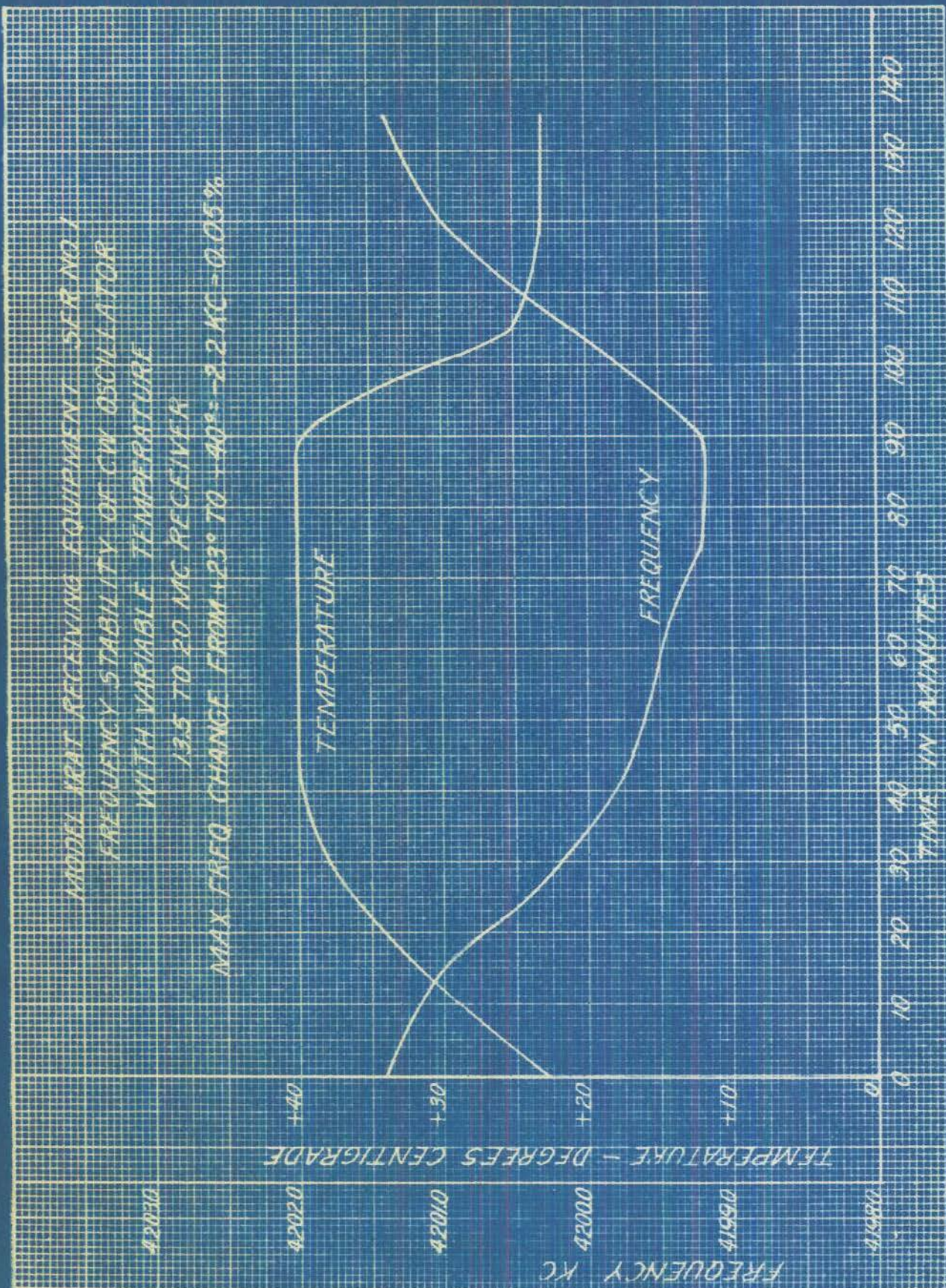
MODEL XRAY RECEIVING EQUIPMENT SER NO 1
OVERALL FREQUENCY STABILITY WITH
VARIABLE TEMPERATURE

175 MC
MCW

MAX. FREQ. CHANGE FROM $+23^{\circ}$ TO $+40^{\circ} = -5.25 \text{ KC} \cdot 0.03\%$



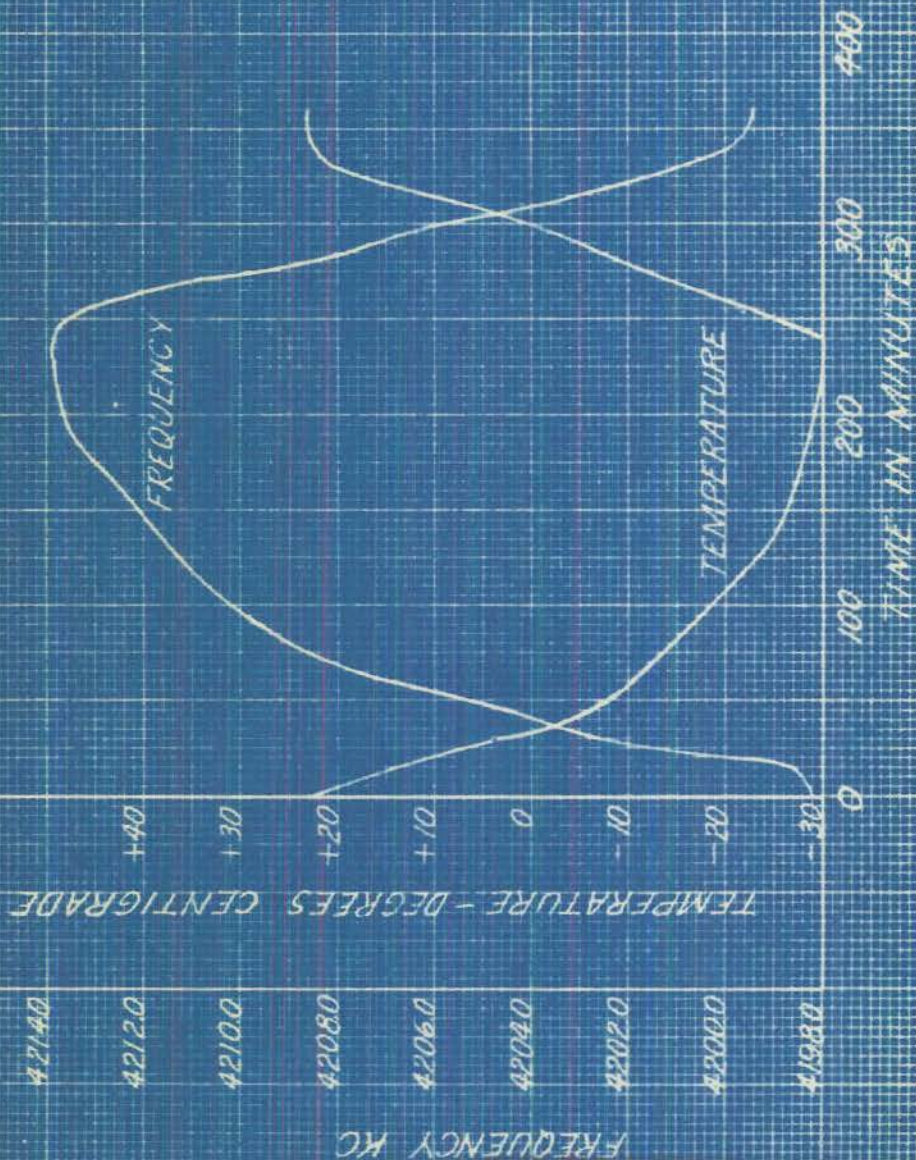




MODEL KRAT RECEIVING EQUIPMENT SER NO. 1
 FREQUENCY STABILITY OF CW OSCILLATOR
 WITH VARIABLE TEMPERATURE

13.5 TO 20 MC RECEIVER

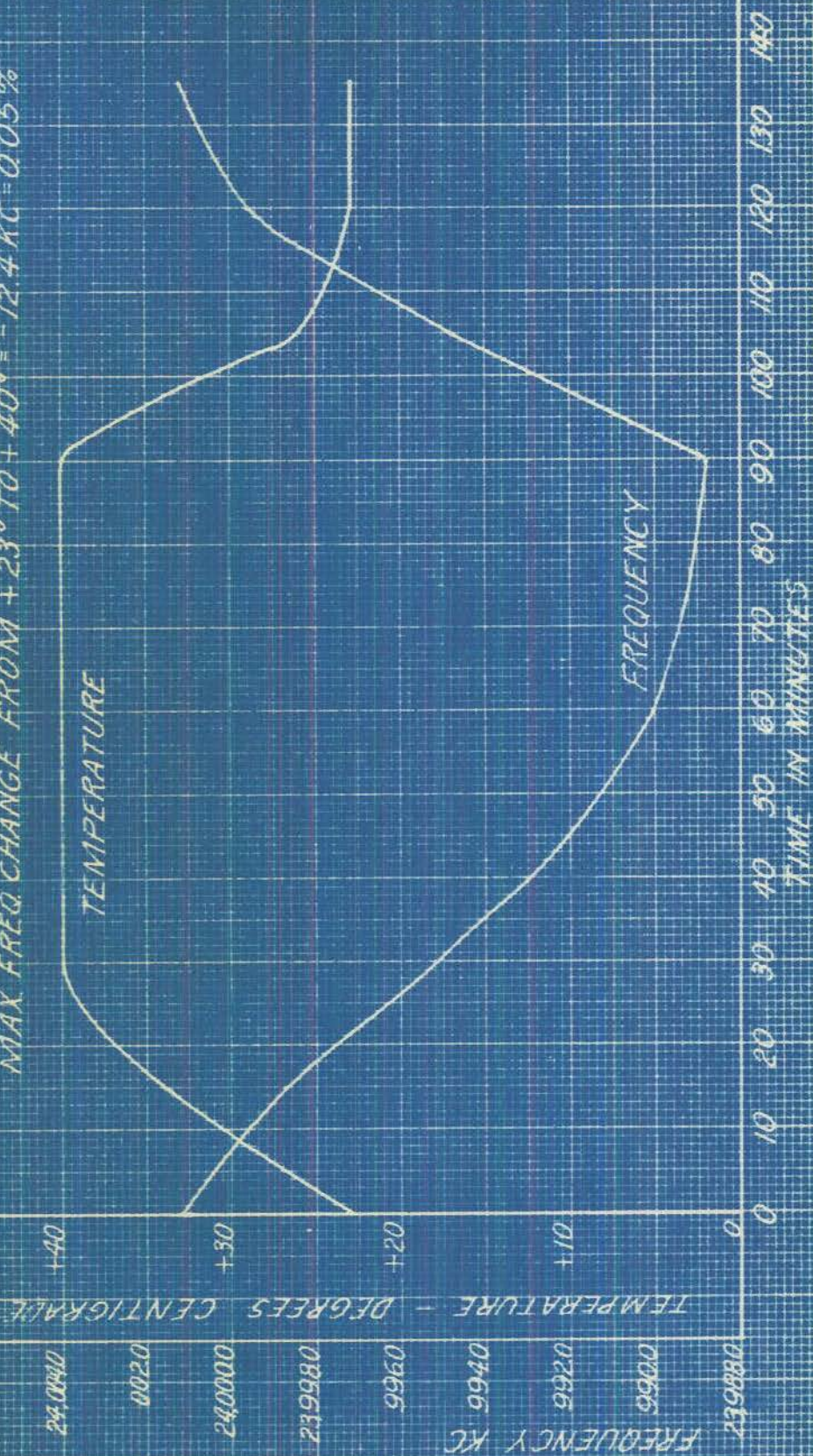
MAX FREQ CHANGE FROM $+23^{\circ}$ TO $-30^{\circ} = +15.7 \text{ KC} = 0.374 \%$



MODEL XRAY RECEIVING EQUIPMENT SER NO 1
OVERALL FREQUENCY STABILITY WITH
VARIABLE TEMPERATURE

24 MC
MCW

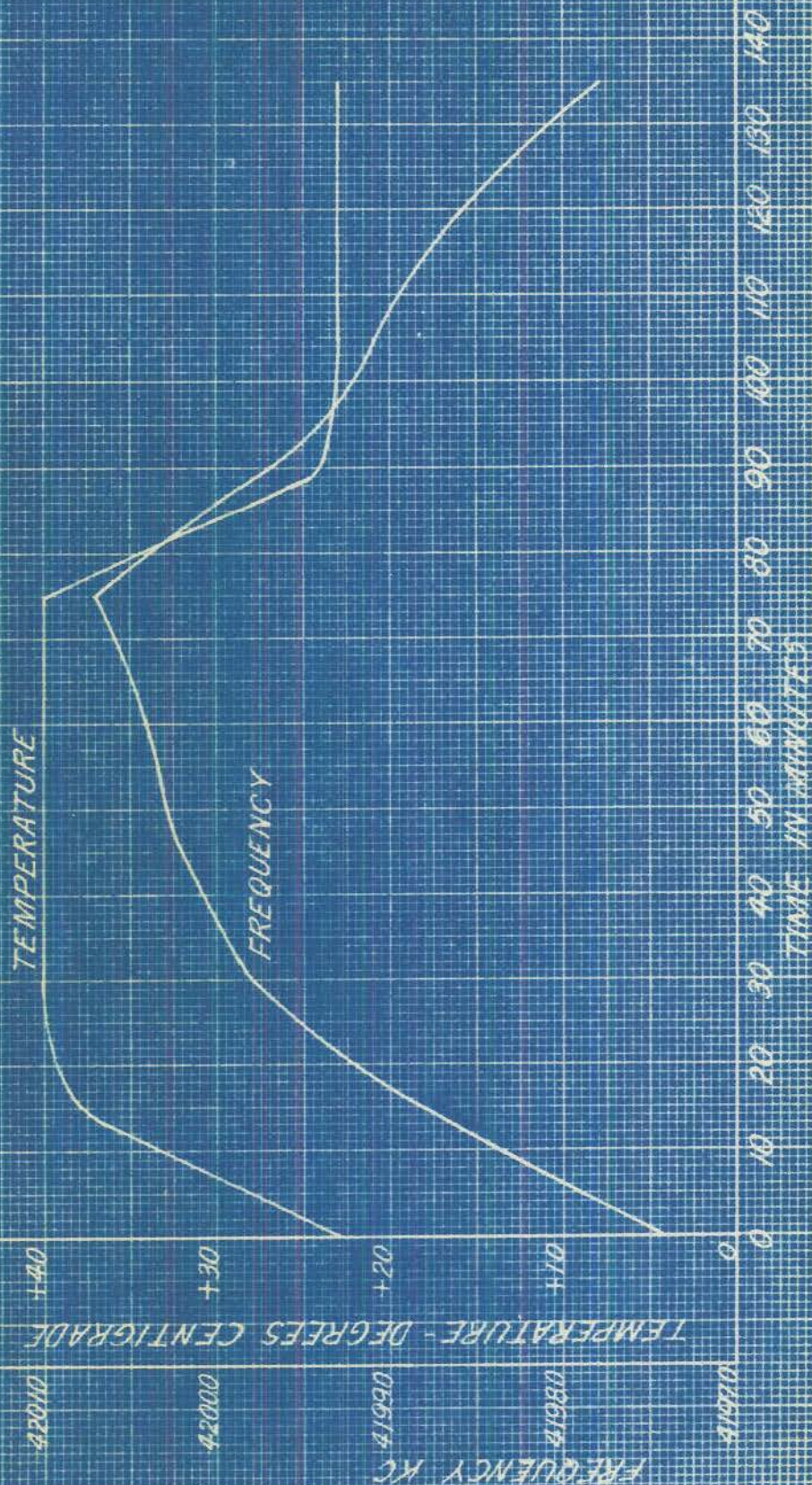
MAX FREQ CHANGE FROM $+23^{\circ}\text{TO} +40^{\circ} = -12.4 \text{ KC} = 0.05\%$



MODEL KRAT RECEIVING EQUIPMENT SER NO. 1
 FREQUENCY STABILITY OF CW OSCILLATOR
 WITH VARIABLE TEMPERATURE

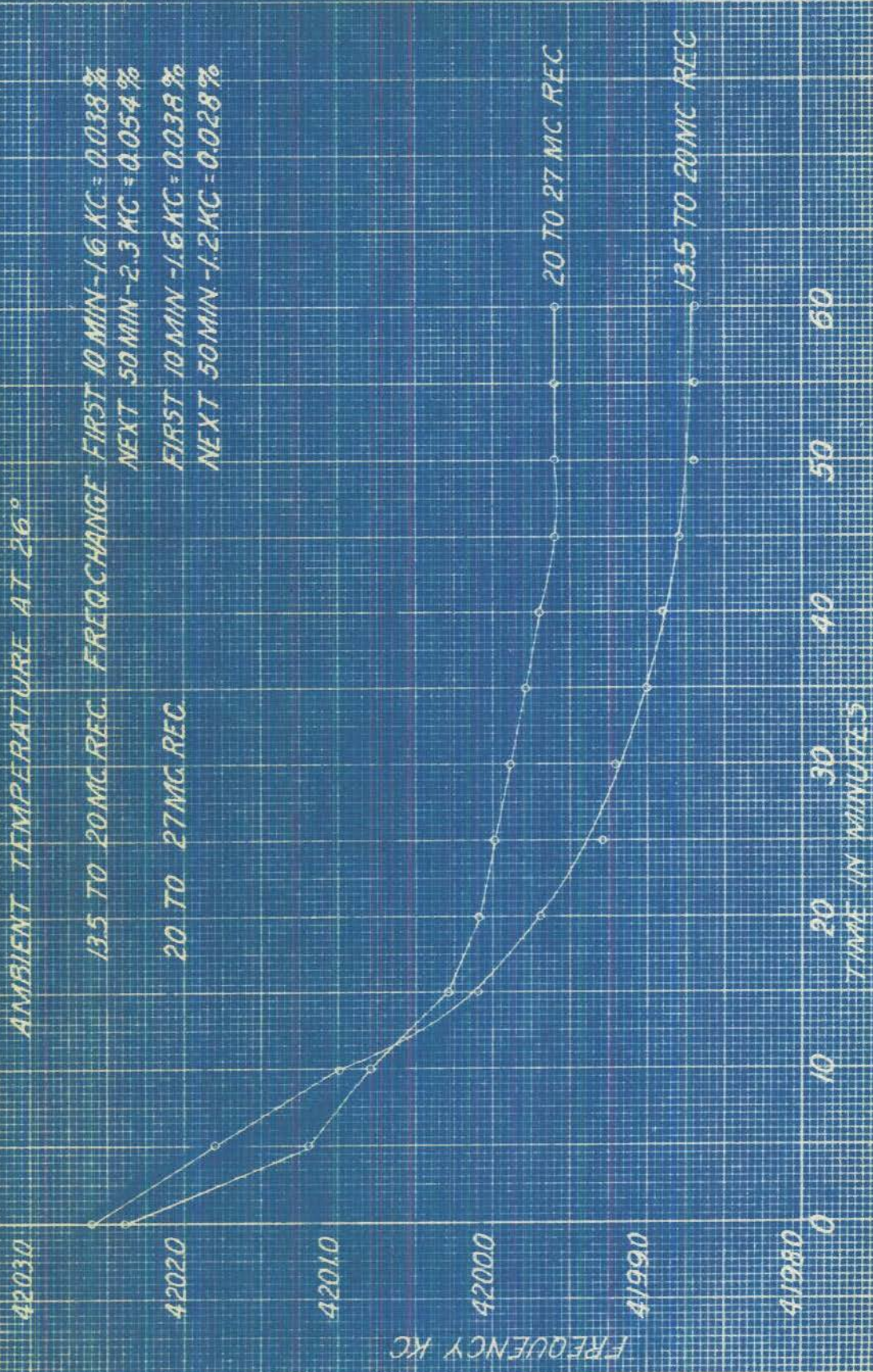
20 TO 27 MC RECEIVER

MAX FREQ CHANGE FROM $+23^{\circ}$ TO $+40^{\circ} = +3.3 \text{ KC} \pm 0.08\%$



MODEL NRAT RECEIVING EQUIPMENT SER NO 1
 FREQUENCY STABILITY OF CW OSCILLATOR FOR
 ONE HOUR FROM A COLD START CONSTANT
 AMBIENT TEMPERATURE AT 26°

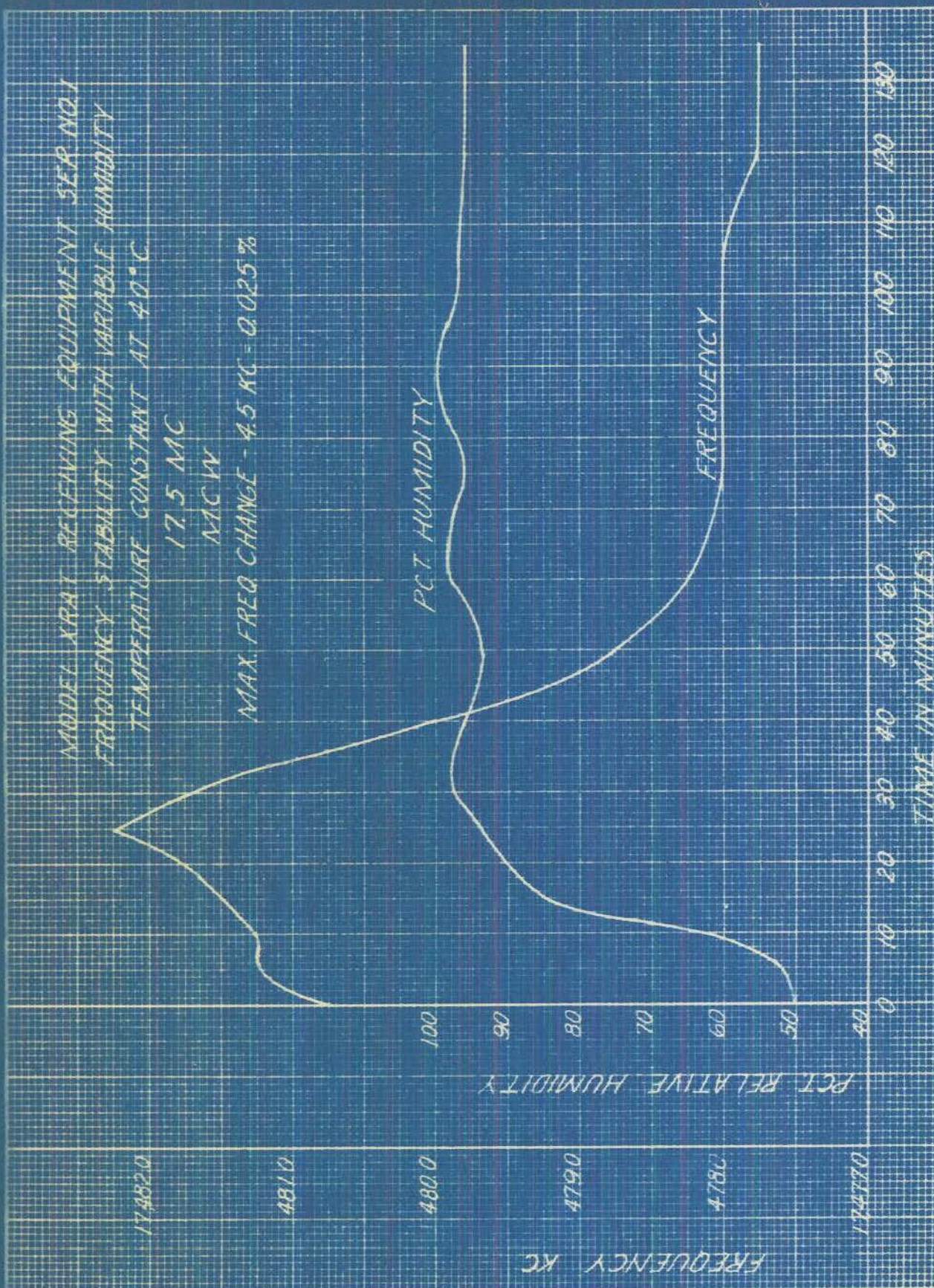
13.5 TO 20 MC REC. FREQ. CHANGE FIRST 10 MIN - 1.6 KC = 0.038 %
 NEXT 50 MIN - 2.3 KC = 0.054 %
 20 TO 27 MC REC. FIRST 10 MIN - 1.6 KC = 0.038 %
 NEXT 50 MIN - 1.2 KC = 0.028 %



MODEL XRAY RECEIVING EQUIPMENT SER NO. 1
 FREQUENCY STABILITY WITH VARIABLE HUMIDITY
 TEMPERATURE CONSTANT AT 40°C

17.5 MC
 MICW

MAX. FREQ. CHANGE - 4.5 KC = 0.025 %



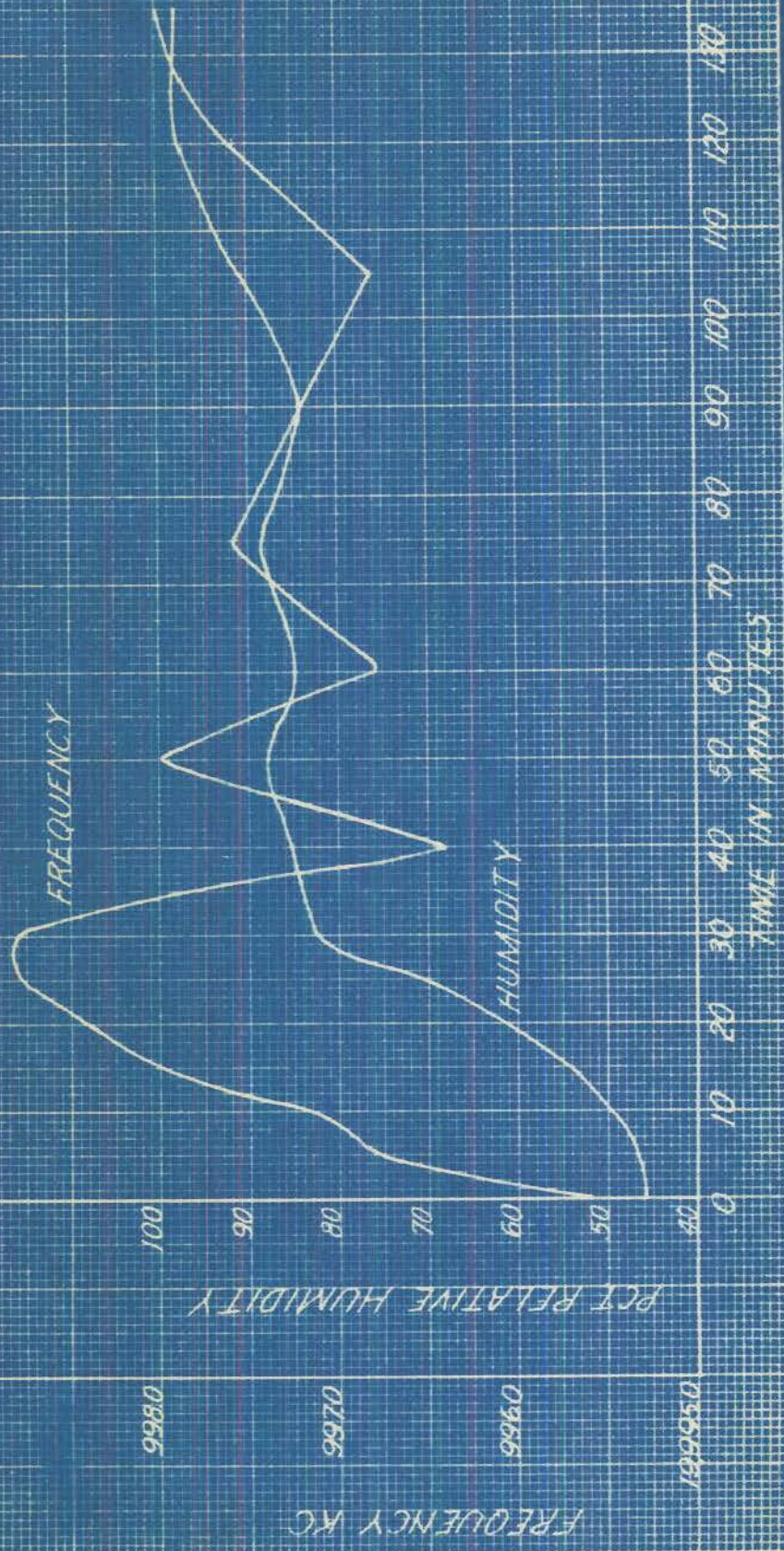
MODEL XRA1 RECEIVING EQUIPMENT SER NO 1
 FREQUENCY STABILITY WITH VARIABLE HUMIDITY
 TEMPERATURE CONSTANT AT 40°C

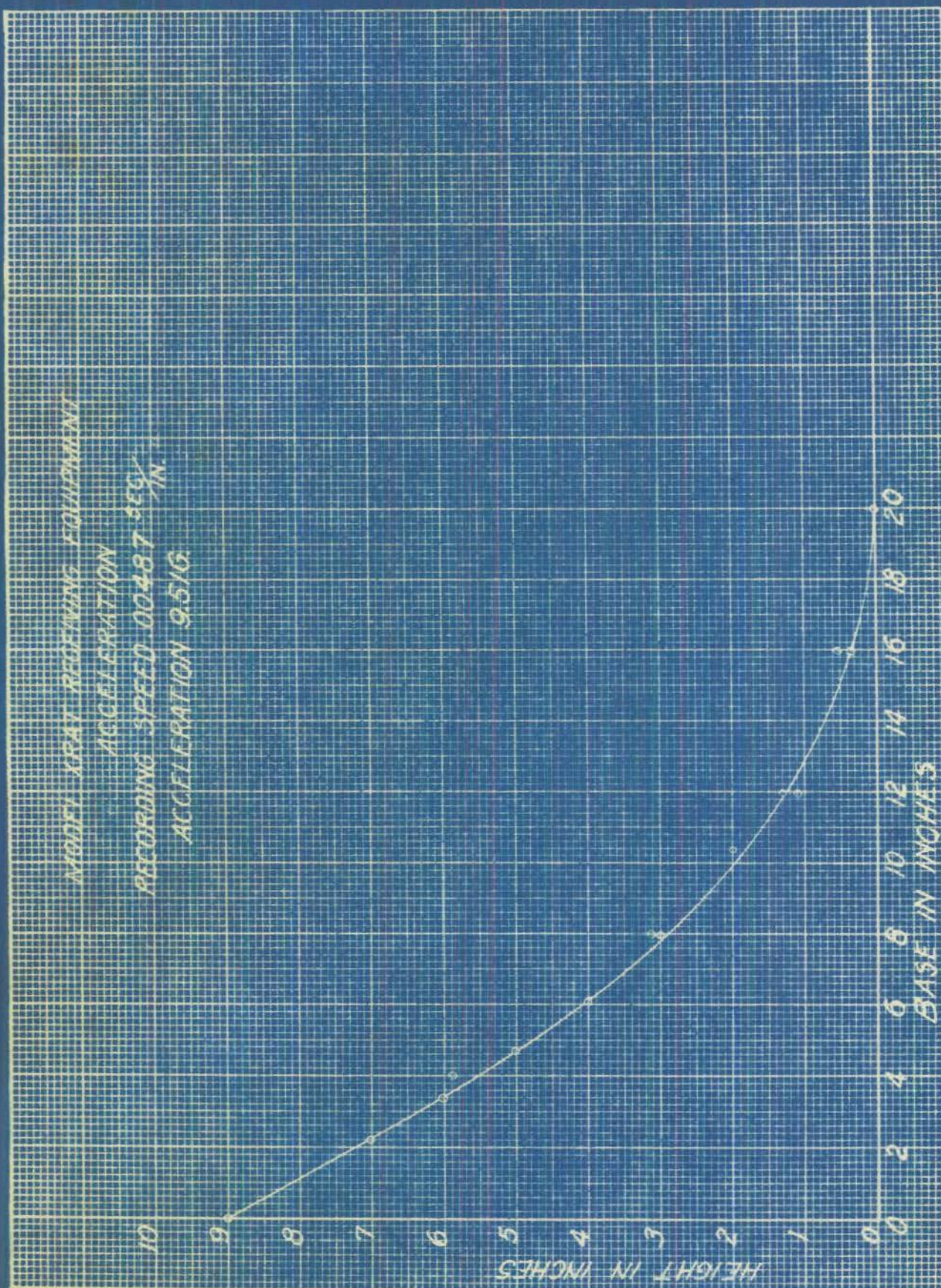
20 TO 27 MC REC

20 MC

MC W

MAX FREQ CHANGE +3.2 KC +0.016%





Refer to No.
F42-1/46-52(8)
NA6 (101)
(40025)

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

NDC/hjf

15 March 1940

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

SUBJECT; Aircraft Radio Tests - Model XRAT Equipment -
Confidential Contract No.s67258 with Aircraft
Radio Corporation - Report of.

Reference: (a) Bu.Eng. Confidential Letter C-NOS61445
(9-18-R1) of 20 September 1939
(b) Bu.Eng. Confidential Letter F42-1(9-18-R6)
of 19 September, 1939.
(c) Enclosure (A) of Bu.Eng. Confidential Letter
C-F 42-1(11-22-DRL) of 12 December, 1939.
(d) CO NAS Anacostia Confidential Letter F42-1/
46-52(7)/NA6(203) Serial #39089 of 15 June,
1939.

Enclosure: (A) Photograph AN-54353 XRAT Receiving Equipment
with remote control box and cables.
(B) Photograph AN-54354 XRAT Receiver disassembled.
(C) Photograph AN-54355 Three quarter view of 2 re-
ceivers, and mounting model XRAT.
(D) Photograph AN-54356 Model XRAT two receiver re-
mote control unit with 90° mechanical linkage unit.
(E) Photograph AN-54357 Model XRAT Receiver with dyna-
motor and switch panel removed.
(F) Photograph AN-54358 XRAT Receiver mounting rack
assembly.
(G) Photograph AN-54460 Model XRAT Receiving equip-
ment schematic circuit diagram.

1. General Information.

The XRAT receiving equipment designed by the Air-
craft Radio Corporation is shown by enclosures (A) to (G) in-
clusive.

This letter reports the findings in conformity with
references (a) and (b).

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SUBJECT: Aircraft Radio Tests - Model XRAT Equipment -
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2. Description of Equipment.

The receiving equipment has been designed along lines similar to the Type K receivers reported in reference (d). One complete equipment consists of two super-heterodyne receivers mounted on a single rack and mounting, a local control unit, and the necessary cables and mechanical linkages. The receivers are designed for the simultaneous reception of CW or MCW signals in two adjacent bands, 13.5 - 20 mc and 20 - 27 mc. The major differences between the subject receivers and the Type K receivers are:

- (a) 12 volt heater vacuum tubes.
- (b) Output switching circuit.
- (c) A.V.C. eliminated and limiter type control installed.
- (d) Side tone relays employed.
- (e) New type of rack and mounting.
- (f) New type of remote control unit.
- (g) Provision for operation with associated transmitter.

3. Vacuum tube lineup.

All vacuum tubes used in the receivers are the all-metal type with heaters for 12 volt d-c power supply.

They are:

Radio Frequency Amplifier - - - - -	one	12SK7
Mixer - - - - -	one	12K8
Intermediate Frequency Amplifier - -	two	12SK7
Detector and CW Oscillator - - - - -	one	12SR7
Audio Amplifier . - - - -	one	12A6

Total number of vacuum tubes - - 6 per receiver.

4. Test Objects.

The equipment was examined and tested to determine the following characteristics:

- (a) Dimensions and weights.
- (b) Vacuum tube line-up.
- (c) Mechanical ruggedness.

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SUBJECT: Aircraft Radio Tests - Model XRAT Equipment -
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- (d) Installation facilities
- (e) Performance at altitude at 25000 feet.
- (f) Break-in operations.
- (g) Selectivity Checks in flight.
- (h) Reset checks in flight.
- (i) Flight distance test.
- (j) Local conversion oscillator interference between receivers.
- (k) Cross-modulation in flight.
- (l) Image frequency in flight.
- (m) Accessibility.
- (n) Operation with GO-3 transmitting equipment.
- (o) Volume control operation.
- (p) Overload characteristics.
- (q) Key click and sidetone operation.
- (r) Random noise level.
- (s) Output limiter action.
- (t) Antenna alignment.
- (u) Output switching arrangement.
- (v) Vibration effects in flight.

5. History of Tests.

The equipment was received on 12 December, 1939. Bench tests were started immediately and upon completion the flight tests were conducted. All flight tests involving thirteen flights and 20.1 hours were made with Model GO-3 transmitter equipment in the JE-1 airplane, #0795. The tests have been itemized in paragraph 4. No mention is made herein about any of the tests where the equipment functioned satisfactorily.

6. Weights and Dimensions.

The maximum overall weights and dimensions for the equipment are: as shown in Table One.

TABLE NO. ONE.

XRAT Receivers Weights & Dimensions.

<u>Equipments</u>	<u>Weight-lbs</u>	<u>Dimensions - Inches</u>		
		<u>Height</u>	<u>Depth</u>	<u>Width</u>
Receiver Unit (13.5 - 20 mc) with vacuum tubes (*1)	6.05	5-5/8	11-1/2	4-7/8
Receiver Unit (20-27 mc) " " " (*1)	6	5-5/8	11-1/2	4-7/8
Receiver rack for 2 receivers (*5)	2.9	4-5/8	13-1/8	11
Receiver mounting for a 2 receiver rack	0.8	1-11/16	11-11/16	10-3/4
Receivers, Rack and mounting complete (*2)	21.8	7-1/8	13-3/4	11-11/16
Switch panel unit	0.2	2	2-1/8	3-1/16
Dynamotor Unit	2.9	3-5/16	4-7/8	2-3/4
Local Tuner (Crank Type)	0.04	1	1-1/4	1
Local Tuner (Knob Type)	0.03	7/8	3/4	7/8
Right Angle Linkage Coupling	0.08	1-3/8	1-5/8	11/16
Control Box (2 receiver unit) with crank type tuner (*3)	1.7	5-1/2	2-7/8	6-1/2
Control Box (2 receiver unit) with crank type tuner (*4)	1.7	5-1/8	2-7/8	6-3/8
Switch Panel Adapter	0.1	2	2-1/16	3-1/16
Cable (Receiver rack to battery) (*6)	1.9	10' lg.	7/16 in diameter	
2 Cables (Receiver rack to control box)	1.8 each	5' lg	7/16 in diameter	
2 Linkages (Receiver unit to control box)	1.2 each	5' lg	5/16 in diameter	
Cable (Receiver Rack to Associated Transmitter (*6)	0.9	5'	5/16 in diameter	

NOTE:

- *1 - Receiver less dynamotor, tuner and switch panel adapter.
- *2 - Two receivers, 2 local controls, 2 tuners with crank type knobs and 2 dynamotors.
- *3 - Control box with snap-on mounting plate.
- *4 - Control box with mounting plate secured with screws.
- *5 - With local control adapter plug. Without plug, for remote operations, height is 4-3/8".
- *6 - Add 6" for leads.

F42-1/46-52(8)
NA6 (101)
(40025)

F42-1/46-52(8)
NA6 (101)
(40025)

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

NDC/hjf

SUBJECT: Aircraft Radio Tests - Model XRAT Equipment -
Confidential Contract No. s67258 with Aircraft Radio
Corporation - Report Of. - - - - -

7. Mechanical Comments.

A. General

1. Bristo type wrenches and Phillips head screwdrivers should be provided with this equipment in the "servicing kit". Paragraph 10-A-6(a) of reference (c).
2. Single set screws are used to secure all knobs to the shafts in the manner similar to that suggested by Bureau of Engineering, Paragraph 10-A-6(b) of reference (c) except the shafts that are spotted do not have the retaining feature to retain the knob when the set screws are moderately loosened, or vice versa. Both the slots and the retainer feature should be incorporated on the shafts.
3. All jack, cable and switch nuts are locked by lacquer. Paragraph 10-E-1 of reference (c). It is believed a more positive and lasting method is to either use a lock washer or to stake.
4. Lacquer on soldered joints should be more transparent.
5. All shielded connecting cables and mechanical linkages should be rubber covered. Paragraph 10-A-5 of reference (c) and (d). Enclosure (A).
6. All cable plugs and receptacles should conform with Paragraph 10-A-8 of reference (c) and (d).
7. The dynamotors should be marked with arrow (direction of rotation indicator). Paragraph 10-A-13(a) of reference (c) and (d).

B. Receiver

1. Secure dial with lockwasher or equivalent. Paragraph 10-D-2 of reference (d).


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2. Wires connecting parts within the chassis should be secured to eliminate excessive movement.
3. Excessive wax should be removed from all contact plugs. Paragraph 10-A-10 of reference (c).
4. Vacuum tubes cannot be removed, especially the 12K8 type, without the aid of a pair of pliers. Redesign to meet the requirements of Paragraph 10-A-31 of reference (d) without the aid of grease. Enclosure (C).
5. Increase clearance between chassis and coil case for the bare antenna lead connecting "align input" condenser to "antenna" coil socket. Paragraph 10-D-10 of reference (d).
6. The tube sockets should have a positive mechanical lock to prevent turning. Paragraph 10-A-21 of reference (e) and (d).
7. Type number nameplate for dynamotor should be placed on dynamotor and visible when the dynamotor is installed. Present method is to stamp with lacquer paint the type number on the bottom of the mount.
8. Remove knurl from the caps of the i-f transformers. Enclosure (B).
9. Provide a cover plate for the oscillator transformer adjusting screw which is located on the right side.
10. The lock designed to eliminate the antenna terminal post against turning is not satisfactory and should be improved.
11. Holes should be placed in the dynamotor mounting studs which are easily accessible for safety wiring dynamotor in place. Paragraph 10-A-11a of reference (c) and (d).
12. The present access plate to the vacuum tubes requires the use of five snap locks. A redesign of the cover is recommended employing the same system as used on the recommended mounting plate of the control box. Such a design would require only one snap lock. Enclosure (B).

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13. The radius of control knobs should be increased as recommended in Paragraph 10-D-5 of reference (d).

14. It is this station's belief that the r.f. and i.f. coils plug-in socket features should be eliminated and all leads adequately soldered. Paragraph 10-D-12 of reference (d). Reference (c) states the contractor's willingness to guarantee dependability of the plug-in transformer feature. It is not understood why the plug-in feature is necessary unless such coils will give trouble under service conditions. If such is the case then the plug-in feature should be retained, but there is no reason to expect that the coils will require servicing or replacing in any large quantity. The contractor's willingness to guarantee dependability does not cover the point of loss of selectivity and sensitivity due to increase in circuit resistance attendant with the plug-in feature.

C. Control Box.

1. The dials are secured to the shaft by a hand screw making approximately 1-1/2 turns. This form of friction locking, although it appeared satisfactory on the Type K equipment should be modified by a more positive type of locking as airplane vibration will shake the dial loose.

2. Screws #2-56 are used to secure the bottom plate. In line with the recommendation for standardization of screw sizes, Paragraph 10-A-29 of reference (c) and (d), the 2-56 screws should not be used.

3. Use larger engraved letters for the nomenclature above switches as present size is too small to be read with ease. Enclosure (F).

4. Flight tests indicated that remote tuning of the receivers was too difficult to be satisfactory due to the number of frequencies per division required to cover the radio frequency spectrum per band, where back lash is involved and high torque is present. The actual force required to tune, due to handle being located on the remote tuner knob at a radius of 3/8", will average approximately three and one half pounds. Improvement can be made by increasing the radius of the tuning

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knob and providing the knob with a handle similar to submitted design. Increasing the tuning radius will require reducing the volume control knob radius, which can be accomplished without too great a complication. The 90° mechanical linkage elbow, Enclosure (F), submitted with the equipment is not recommended unless the torque is reduced considerably. The results of the torque tests when tuning the receivers from the remote control box in the following table were obtained using the mechanical linkages as submitted. Increase in the torque values can be expected when the mechanical linkages are operated with a reduction in the lubrication.

Torque Table.

<u>No. of 90° bends</u> <u>with 6" radius.</u>	<u>90° Elbow.</u>	<u>Torque *</u> <u>in oz.</u>
2	no	7.5
2	one at remote position	16
2	one at receiver	12.5
3	no	32

* Note: Tuning cable, 60 inches long, connected to receiver. Torque measured at remote end.

5. The volume control knob radius should be reduced to give greater clearance to the tuning knob. See paragraph above. Enclosure (F).

6. Two types of control box mountings were submitted for approval. The quick detachable type, Enclosure (F), is recommended. The slot holding feature at the top should be improved in order to reduce the possibility of a misfit due to the close tolerance required to keep the control box tight in the mounting plate.

7. The dial index mark is "Vee" shaped, Paragraph 10-A-4 of reference (d); however, the apex of the "vee" should be placed just below the edge of the dial rather than just above the edge.

8. The use of right angle plug for the cables may be required at some future date if the remote control box is retained. If such a step is contemplated the snap-on lock should be redesigned to permit the insertion of a right angle plug.

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8. Electrical Comments.

A. General

1. To assist in installation the transmitter connecting cable, shown in schematic drawing 6421-3-B, should have conductor numbers at both ends of the cable.

2. The output circuit working into a network composed of lines "A" and "B", Enclosure (B) and (G) is not desirable. The system is too complicated and only split-phone operation is possible when using the switches that are provided. It should be possible with the output circuit to mix the received signals in the telephones by the proper selection of the output switches. The elimination of two of the four telephone jacks on the remote control box and the telephone jack that cannot be switched on the receiver is desirable. The system proposed by the contractor at the conference held in the Bureau of Engineering office on 20 February 1940 should be capable of obtaining the desired results, which consists of using only one jack per each receiver and control box. The present "A" "B" switch can then be used to switch the receiver output to the output plug desired. The desired results are, "Output from each receiver should be impressed across each telephone jack in the system individually or collectively by suitable switches."

3. There has been provided only A.V.C. in the form of a limiter control for receiver blocking. The limiter is set at a predetermined value when the equipment is manufactured, and is not controlled by the operator. The general operation has been successful for the Model XRAT receivers in eliminating the possibility of blocking but the received audio frequency is distorted; however, this distortion did not decrease the transmission of reliable communication. The continuation of this system will depend upon whether the elimination of A.V.C. at low audio output levels and in all r-f frequency bands, can be tolerated.

SUBJECT: Aircraft Radio Test - Model XRAT Equipment -
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4. Sidetone from the associated transmitter is applied to the telephones by means of a relay, Enclosure (E). The function of the relay is to transfer the telephones from the receiver output to the sidetone circuit. Break-in operation of the Model XRAT receiver with the Model GO-3 transmitter in flight was not successful at normal operating speeds as the sidetone was present during entire keying period. Bench tests indicated that the sidetone relays would not follow the keying due to the inductive voltage from the transmitter keying relay coil discharging through the windings of the sidetone relay. The contractor should investigate and make the necessary corrections so the receiving equipment will work with any of the naval aircraft transmitters.

5. Image frequency rejection tests were made in flight and no interference was noticed.

6. Flight tests have shown that the local oscillator from the adjacent receiver can completely mask a received signal even when operating under normal condition. This interference was reported in Paragraph 11-B-13 of reference (d) but at that time it did not appear to be as detrimental as was noticed with the subject equipment. A concentrated effort on the part of the contractor to reduce this effect to a minimum should be undertaken as it is believed this feature is one of the most objectionable features in the present design.

7. The antenna circuit will trim to both the fixed and trailing antennas.

8. The receiver random noise under maximum volume, MCW condition was too low for practical measurement.

9. The receiver antenna series condenser should be protected by an adequate safety feature against atmospheric disturbances.

10. The microphonic tendency in the type 12K8 vacuum tube, with the receiver at maximum volume, noticed in flight should be eliminated. Paragraph 11-B-3 of reference (c) and (d).

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11. The receiver instability, when operating at maximum volume CW at the high frequency end of the range, should be eliminated.

12. The receiver output power varies with battery voltage as shown below, when receiving a 17 megacycle signal of 50 microvolts with maximum output impedance of 300 ohms.

BATTERY VOLTS	RECEIVER OUTPUT - MW
10	17
11	25
12	34
13	47
14	65
15	85

13. The flight tests have shown that in the radio frequency band of 13.5 to 27 mc the airplane engine ignition noise is higher than in the normal communication band. By maintaining tight joints on the ignition harness this noise can be reduced to a value which does not seriously interfere.

14. The audio fidelity using 400 cycles as the standard level reference is:

Output Audio Voltage (% that of 400 cycles)	Frequency Cycles
18	40
35	60
50	80
63	100
92	200
100	400
100	1000
93	2000
68	3000
42	4000

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15. With constant input voltage to one of the receivers, the output power of the receiver when operating into a 300 ohm impedance is decreased approximately 60 per cent if the second receiver output is connected in parallel. Tests of output power vs output impedance also indicated that the receiver outputs were designed for a 800 ohm impedance. When two receivers outputs were connected in parallel both receivers operating, the maximum output was obtained with 600 ohms impedance. It is recommended that the receiver impedance be changed so that maximum power can be obtained, two receivers operating, when working into a 300 ohm impedance.

16. A study of the volume control characteristics indicate that the volume control resistance is too large thereby tending to make the volume control too critical. The maximum range required of the volume control is when the receiver is operating with high CW input voltage. Under a condition of one volt r.f. the receiver output is zero for the first 80 degrees of rotation. The contractor should investigate and make the necessary corrections.

S. P. GINDER

Copies to:
Bu.Aero. (2)
Bu.Eng. (1)
N.A.F. (1)

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NAVY DEPARTMENT
BUREAU OF SHIPS
WASHINGTON, D.C.

(938)

JUL 28 1943

From: The Chief of the Bureau of Ships.
To: The Director, Naval Research Laboratory.
Subject: Radio - Bureau of Ships Problems - Closing of.

1. It is requested that further investigation be discontinued on the following problems and that all presently available information pertaining thereto be promptly submitted to the Bureau of Ships.

Prob. No.		Priority
A5-15C	- Test of TBW and RBM Receivers.	A
A32C	- RCA Left-Right Indicator for DZ Series Direction Finders.	A
A33C	- Test of Marker Beacon Receiver.	A
M1-24	- Test of Mouldarta 192-A Insulating Material.	A
M6-14	- Test of Model 510X Radio Tube and Set Tester.	A
M73	- Test of Motor Generator Sets.	A
M76	- Test of Gudeman Co. Paper Capacitors.	A
M78	- Salt Spray Test of IRC Variable Resistors.	A
M81	- Test of Ohio Brass Co. Insulators.	A
M85	- Test of Cornell-Dubilier Capacitors.	A
M90	- Test of Phone Jacks.	A
M91	- Impedance & Attenuation of Submarine Cable.	A
M92	- Test of Porcelain Insulating Material.	A
P-1C	- Test of OAA-2 Frequency Meter.	A
R5-45	- Radiation from Broadcast Receivers.	A
R66C	- Test of UHF Panoramic Receiver.	A
R67C	- Mechanical Tests on Loran Receiver.	A
R72C	- Test of Model RBS Receiving Equipment.	A
R73C	- Test of Model RBZ Receiving Equipment.	A
R74C	- Test of Quartz Crystals in TBS Series Receiver.	A
R78R	- Test of SSD-1 Code Practice Equipment.	A
R79R	- Test of BC-348Q Receiving Equipment.	A
R82C	- Development of Noise Limiters for TCS Receiver.	A

(938)

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Prob. No	Description	Priority
T49C	- Test of Model TBK-12 Transmitting Equipment.	A
T50C	- Test of Model TBL-4 Transmitting Equipment.	A
T58C	- Test of MM Transmitting-receiving Equipment.	A
T60C	- Tests of Shock on TDG Transmitting Equipment.	A
W5-7	- Field Intensity Measurements.	C
{X133C	- Model ABK Reconstruction.	AA
{Req. No. 95		

CLDillon

Copy to:

NRL(210), BuOrd(Re4), VCNO(Op-20-E), COMINCH(F27), BuAer(Aer-31-T), SONED.

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