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DATE 1 April 1937

SUBJECT

FR-1347

Test of Models DP-4, DP-5, DP-6, and DQ-1

Radio Direction Finder Equipments

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Test of Models DP-4, DP-5, DP-6, and DQ-1
Radio Direction Finder Equipments

1 April 1937

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changed to W B Burgess

NAVY DEPARTMENT

BUREAU OF ENGINEERING

Report on

Test of Models DP-4, DP-5, DP-6, and DQ-1

Radio Direction Finder Equipments

(FOR NEW CONSTRUCTION)

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D. C.

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AUTHORIZATION

1. The tests herein reported were authorized by reference (a). Other pertinent data are listed as references (b) to (hh) inclusive.

Reference: (a) BuEng let.C-NOs-45843(4-28-W8) of 27 July 1936.
(b) Specifications RE 13A 474B of 19 Sept.1935.
(c) Contract NOs-45843 and pertinent contract notes dated 26 December 1935.
(d) BuEng Problem D1-7 assigned by BuEng let. S67/69(1-19-W8) of 22 January 1935.
(e) NRL Report No. R-1134, Tests on Models DO, DO-1, DO-2, and DO-3 Equipments dated 13 March 1935.
(f) NRL Report No. R-1141, Test of Loop Structure Assembly of the Model DQ Equipment dated 28 March 1935.
(g) NRL Report No. R-1162, Loop Circuit "Q" Measurements and Defects of Loop Assembly Construction of the Models DO, DO-1, DO-2, and DO-3 Equipments dated 24 May 1935.
(h) BuEng let.C-NOs-45843(2-11-W8) of 18 February 1936 to INM Philadelphia.
(i) BuEng let.S67/13(2-14-W8) of 16 March 1935 to INM Schenectady.
(j) BuEng let.C-NOs-45843(2-11-W8) of 18 Feb.1936 to INM Philadelphia.
(k) BuEng let.NOs-45843(3-30-W8) of 2 April 1936 to INM Philadelphia.
(l) BuS&A let.NOs-45843(SPM-X-10) of 28 Jan.1936 to RCA Mfg. Co. via INM Philadelphia.
(m) BuS&A let.NOs-45843(SPM-X-30) of 20 April 1936 to RCA Mfg. Co. via INM Philadelphia.
(n) BuEng let.C-NOs-45843(4-28-W8) of 5 May 1936 to INM Philadelphia.
(o) BuS&A let.C-NOs-45843(SPM) of 5 May 1936 to RCA Mfg. Co. via INM Philadelphia.
(p) BuEng let.C-NOs-38492(5-1-W8) (X-C-NOs-45843) of 8 May 1936 to INM Philadelphia.
(q) NRL let.S67/69 of 8 July 1936.
(r) BuEng let.C-NOs-45843(7-24-W8) of 27 July 1936 to INM Philadelphia.
(s) Specifications 46-A-1c,Aluminum Alloy Castings.
(t) Specifications 17-I-12,Electrical Indicating Instruments.
(u) Specifications 17-P-4,Molded Phenolic Insulating Material.
(v) Specifications 17-P-5,Laminated Phenolic Insulating Material.
(w) Specifications RE 13A-317F, Ceramic Insulating Material.
(x) Specifications RE-13A-600A, Vacuum Tubes.

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(y) Specifications RE-13A-372G, Fixed Resistors.
(z) Specifications RE-13A-488B, Foil Paper Capacitors.
(aa) Specifications RE-48AA-112K, Molded Mica Capacitors.
(bb) Specifications RE-13A-492B, Potentiometers
(cc) Specifications RE-13A-516A, Nameplates.
(dd) Specifications RE-13A-346U, List of Navy Standard Indicating Instruments, Fixed Resistors and Vacuum Tubes.
(ee) Specifications RE-13A-389J, Mica Capacitors.
(ff) Specifications RE-13A-481B, Jacks, Telephone.
(gg) Specifications SGS(19)-115, Primer, Zinc Chromate.
(hh) Specifications 47-S-20a, Steel, Corrosion Resisting.
(ii) BuEng let.C-NOs45843(12-17-38) of 21 Dec.1936 to INM Philadelphia.

OBJECT OF TEST

2. The object of the test was to determine first, compliance of the Models DP-4, DP-5, DP-6, and DQ-1 radio direction finder equipments with the governing specifications, references (b) and (s) to (hh) inclusive, and such information as is set forth in references (h) to (p) inclusive; second, the presence of desirable features over and above the specific requirements of references (b) and (s) to (hh) inclusive; third, any objectionable features in these equipments which should either be corrected or avoided in future and similar equipments; and fourth, to determine by comparison methods any advantages or disadvantages inherent in the subject equipments over those of reference (d).

ABSTRACT OF TEST

3. The equipment furnished the Laboratory was given a general inspection of mechanical construction and wiring. The electrical tests conducted for the determination of specification compliance as set forth in references (b) and (s) to (hh), inclusive, are given below.

A. Routine Tests for Performance

(a) Sensitivity with loop excitation.
(b) Sensitivity with balance antenna excitation.
(c) Frequency overlap between bands of receiver.
(d) Variation in frequency with rotation of the main tuning dial for each band of the receiver.
(e) Determination of accuracy of calibrations furnished with receiver for each band.
(f) Selectivity with loop excitation - optimum and reduced gain.
(g) Selectivity with balance antenna excitation.
(h) Equality of balance effects at the ± 50 settings of the balancer.
(i) Coincidence of electrical and mechanical centers of balance of the balancer.
(j) Variation of quadrature voltage with respect to variation in the setting of the balancer.

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(k) Ratio of quadrature voltage induced into the receiver by the balance antenna to the in-phase voltage produced by the loop for constant output.
(l) Detuning effects produced by the manipulation of the balancer control.
(m) Image selectivity with loop excitation.
(n) Coupling between antenna and loop circuits.
(o) Range and linearity of sensitivity control with loop excitation.
(p) Resonant overload characteristics with loop excitation.
(q) Variation of audio output with angular rotation of sensitivity control and with constant input.
(r) Variation of noise level with sensitivity control setting.
(s) Accuracy of alignment of beat frequency oscillator.
(t) Variation in output beat note frequency with change in line voltage.
(u) Variation in output beat note frequency with change in signal intensity at optimum gain.
(v) Variation in beat note frequency with change of sensitivity control setting with constant input of high level.
(w) Time constants (overall) with loop excitation.
(x) Transrectification in r.f. amplifying tubes. This test was not performed for reasons given in the text under RESULTS OF TEST.
(y) Overall voltage gain/voltage noise level ratio with loop excitation.
(z) Overall voltage gain with loop excitation.
(aa) A.F. characteristic of audio system.
(bb) Load characteristic of audio output transformer.
(cc) Output hum level.
(dd) Attenuation characteristic of r.f. filter in power unit.
(ee) Variation of plate and heater voltages and power consumption with changes in line voltage.
(ff) Effect of power line frequency variation on performance of power unit.
(gg) Vibration test.
(hh) Temperature and humidity test.
(ii) Stability of r.f. and i.f. oscillators.
(jj) Interstage and overall regeneration at full gain when using vacuum tubes of high mutual conductance.
(kk) Overload selectivity and cross modulation selectivity.

B. Tests on Component Parts

(a) Trimming "range" of loop and balance antenna trimmer condensers.
(b) Accuracy of tracking of ganged tuning condenser. This test was not made for reasons given in text under RESULTS OF TEST.
(c) Measurement of Q of loop alone.
(d) Watertightness integrity of loop assembly.

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(e) Responsiveness and damping factors of the rectifier type output meter on receiver panel.
(f) Salt water immersion tests on chokes, transformers, capacitors, and resistors.

C. Additional Tests not Specifically Covered by Reference (b)(except Test (a) which is included in Reference (b) by Definition Only).

(a) Intermediate frequency selectivity.
(b) Overload characteristics of audio system.
(c) Measurement of r.f. resistance of loop circuit.
(d) Measurement of true inductance and distributed capacitance of loop and associated coupling circuits.
(e) Determination of effective heights of loop over frequency range of receiver.
(f) Determination of effective loop circuit resistnace and input phase angle of loop system as used with the Models DP-5 and DP-6 equipments.

D. Tests for General Performance.

(a) General direction finder performance.
(b) Ease and accuracy of sense determination.
(c) Shielding integrity and lead filtration.

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Conclusions

The subject equipment is, in general, well constructed of good materials. The major exceptions have resulted in a loop and pedestal construction which is not sufficiently watertight for reliable service operation.

The general electrical performance of the equipment is good. There are, however, a few items in which the performance does not equal the specification requirements. The fact that the receiver blocks with an input at the loop center of around 100 microvolts may lead to sense reversal, which is considered a serious defect. The balance sensitivity is considerably less than in the Model DO equipments, which preceded this equipment. The sensitivity is below requirements at one point in the high frequency band and the selectivity in the low frequency band is dangerously close to the specification limits.

After remedy of the few defects as outlined in this report, this equipment shows promise of excelling to a considerable extent, any direction finder equipment previously tested at this Laboratory.

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Recommendations

2-2. It is recommended that the two types of small mica condensers used in the Type CRV-46040 receiver which do not conform in physical dimensions to Specifications RE 48AA 112K be accepted and that the manufacturer be given type numbers for same in order to facilitate the ordering of replacements, and that the potentiometers, which have slightly smaller "A" and "B" dimensions than permitted by Specifications RE 13A 492, be accepted.

2-8. It is recommended that the sharp corners on the balancer and tuning control knobs of the Type CRV-46040 receiver be rounded off to reduce the wear on the black finish at these points.

2-10. It is recommended that the aluminum surfaces as well as the back surface of the main panel of the Type CRV-46040 and/or Type 20049 power unit be better protected from exposure to saline humidities.

2-11. It is recommended that coin silver faced contacts be applied to the bronze spring wiper contacts used on the collector ring brush assembly.

2-15. It is recommended that a range switch be furnished for the volume indicator meter which will operate smoothly throughout its entire range.

2-16. It is recommended that in the case of the 3 foil paper by-pass condensers, which are difficult of replacement as have been previously mentioned in this report, be mounted with screws which fit into fixed nuts that are an integral part of the Type CRV-46040 receiver chassis proper.

2-20. It is recommended that in the Type CRV-46040 the bus wire leads be better supported to prevent possible crystallization from vibration and that they be permanently insulated where they pass through holes in metal that is at a different potential. Also, that the litz wire leads from coils be wax coated especially where the wire is exposed near and over the soldered connections to terminal blocks.

2-33. It is recommended that if the bus wire employed in the r.f. circuits is retained in the Type CRV-46040 receiver, all circuits at d.c. potentials which differ from the chassis or ground potential be properly color coded to indicate roughly the potentials employed, by lacquer markings made plainly visible on such wire.

2-37. It is recommended that if the use of bare tinned bus wire is acceptable in other respects for use in the r.f. circuits, that these wires be properly supported so as to prevent possible vibration and that better insulation be provided at points where they go through shields. See par. 2-37 and 2-39.

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2-47. It is recommended that better protection be provided against the effects of moisture on the Type RI 426 transformer used in this equipment and further that inspection in production be made in the case of each fixed paper condenser to assure that the wax seal around the terminals has not been injured by soldering or other effects from final assembly.

3-8. In view of the manufacturer's comments on the bearing shifts produced by faulty balance and the additional tests being made on the resubmitted equipment, it is recommended that the decision on this point be delayed until completion of the new tests, when addenda to this report will be submitted.

3-9. It is recommended that such modifications be made in the Type CRV-46040 receiver as to assure that there will be no possibility of obtaining a reversal of unilateral or sense bearings as a result of receiver overload.

4-6. It is recommended that acceptance of the dimension of 24.21" for the maximum rotational diameter of the loop be considered as this dimension is the same as that previously furnished with the Model DO equipment.

4-7. It is recommended that the loop housing be redesigned to provide watertightness and that a better method of securing the loop plug terminals on the pedestal terminal block be employed to assure that they will not become loosened under actual operating conditions, thus removing the watertightness integrity that this equipment must possess.

4-10. It is recommended that the 1/16" thick brass plate which covers the collector ring aperture be made thicker or that it be secured at more points to insure better watertightness.

It is recommended that the junction between the pedestal proper and the pedestal head be redesigned to assure that effective watertightness is maintained regardless of the position in which the assembly is mounted.

4-14. It is recommended that the projections on the pedestal head in which the loop dogs engage be provided with indents to receive the washers under the wing nuts thus holding them in place while the wing nuts are tightened.

4-15. Although the manufacturer's representative states that securing holes will be provided in the wing nuts in the production equipment, this feature should not be neglected.

4-43. It is recommended that in the future the 1/8" circumferential tolerance be decreased materially for all drums of any given equipment and that a spring take-up be provided in the cable, or that a provision be inserted to require the complete assembly to operate with over, say 1/4° angular displacement between loop and azimuth scale at any setting after alignment.

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4-49. In order to make good in service the 1/4° angular displacement requirement, it is recommended that the manufacturer insert in the installation instructions the necessary precautions to prevent errors due to faulty arrangement of universal joints.

4-54. It is recommended that the two 3/16" holes in the box wall of the transformer case be eliminated in production equipment.

4-55. It is recommended that all screws which extend through the cases of the Type CRV-47100 loop output and Type CRV-47101 receiver input transformers be either gasketed or provided with some other means to assure watertightness.

4-60. It is recommended that it not be required that the collector rings, phosphor bronze contacts, and brass cover plate over the slip ring compartment be made of aluminum alloy.

4-61. The Laboratory has had no practical experience with the use of zinc chromate primer on aluminum parts. It has, however, observed the results as obtained from the use of iron oxide on the Model DO pedestal and loops when exposed to the weather over a period of 2 years with no other protection and there have been no noticeable signs of deterioration of the surfaces so coated. For this reason no recommendation can be given as to the superiority of the zinc chromate primer over the iron oxide that has previously been used. It is recommended that a hole be provided in the loop housing leading into the space occupied by the plug and jack assembly so that signal generator connections can be made for test purposes and that this hole be threaded and provided with a suitable plug to assure watertight integrity.

4-63. It is recommended that a 3/8" hole be provided in the loop casting so as to permit passage of a signal generator cable to make connection to the loop center for measurement purposes and that this hole be properly threaded so as to receive a pipe plug for watertightness when not in use.

5-3. No recommendation is made relative to the acceptance of the overall depth of the Type CRV-46040 receiver. The specifications allow a depth of 18" while an additional 5-3/8" must be allowed to permit the plug of the power cable to be removed. A definite recommendation will, of course, depend on the space available for such installations.

5-8. It is recommended that the production equipment be furnished with protecting angles on the back of the Type CRV-46040 receiver chassis to permit placing it on its top for servicing without injury to any of its component parts as the manufacturer's representative stated would be done.

5-14. It is recommended that the toggle switch controlling the B supply of the oscillator tube in the Type CRV-46040 receiver be of the greaseless silver plated type instead of the ordinary commercial type as used in the power circuits.

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5-19. It is recommended that the sensitivity control of the Type CRV-46040 receiver be equipped with a graduated scale arbitrarily divided into 10 divisions and numbered on a basis of 0 - 10 and that markings descriptive of the adjustable sense resistors and antenna and loop trimmers be not required.

5-27. It is recommended that the adjustable sense resistors be connected to increase antenna effect (decrease resistance) with clockwise rotation and that the instruction book should state this fact.

5-34. It is recommended that the backlash in the main tuning control of the Type CRV-46040 receiver be reduced for specification compliance.

5-37. It is difficult to make a definite recommendation as regards compliance with the tuning linearity requirement. From a practical operating standpoint this equipment is as good as any similar direction finder equipment in which the same range of frequency has been covered in 3 bands. It is not impossible that the required linearity be obtained, but in view of the tuning range and of the high distributed capacity which must be allowed, particularly with remote control and its associated transmission line and transformers, the design of the variable condenser would require that the rotor condenser plates be of unusual shape which would require a greater space for operation.

5-39. It is recommended that consideration be given to acceptance of the reduced angle at which the main tuning dial of the Type CRV-46040 receiver is visible.

5-50. It is recommended that stability of overall receiver performance be maintained at or below a standard output for all positions of the sensitivity control. This is not true at approximately 240 kilocycles or the third harmonic of the intermediate frequency when the sensitivity control is near the low sensitivity limit.

5-59. It is recommended that a volume indicator meter on the Type CRV-46040 receiver be furnished that will comply with the specifications as regards responsiveness and damping factor even if a larger size instrument is required.

5-61. It is recommended that the "0.6 volt" marking under the "0" calibrated mark on the volume indicator meter be left off in production as it does not refer correctly to the phone output as does the rest of the dial markings.

5-72. The reason for spurious oscillations occurring when certain tubes were used in the first r.f. stage of the Type CRV-46040 receiver was not definitely determined and for this reason no definite recommendation can be made except that if this receiver is to perform in accordance with sensitivity specifications, it will be essential that tube specifications be so tightened as to reject all tubes which possess this undesirable characteristic.

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5-81. It is recommended that the terminals provided for the insertion of a meter in the plate circuit of the second detector tube for alignment purposes be placed between the 220,000 ohm plate resistor and the 47,000 ohm filter resistor back of the .5 mfd by-pass condenser to provide further filtration.

5-96. It is recommended that the alignment between the pointer and the balancer coil of the Type CRV-46040 receiver be improved.

5-98(1). It is recommended that the excessive ratio of quadrature voltage, as induced by the balance antenna, to the in-phase voltage as produced by the loop from a given field strength be accepted as this variation from the specifications should not in any way limit the satisfactory performance of the equipment.

5-101. While it is not desirable to decrease the stiffness of the sense button springs, it is recommended that because of the stiff operation of this button, the manufacturer be instructed to adjust its contacts to operate nearly simultaneously, in order that partial operation of this switch may not result in faulty performance.

5-103. It is recommended that the manufacturer state in the instruction book the frequency at which the sense resistor should be adjusted for best average results over its frequency band.

5-104. It is recommended that all direction finder receivers be so designed as to prevent receiver blocking with the maximum input that the receiver will be expected to employ when taking bearings. The subject receiver will definitely overload with about 2 orders greater input than required for standard output which may result in the attainment of erroneous bearings if taken too hastily or without due consideration for this characteristic.

6-5. Attention is invited to the fact that due to the protrusion of the power cables with their fittings, an additional 1-1/16" in width and 5-11/16" in depth of the Type CRV-20049 power unit will have to be allowed upon installation. No recommendation is made on this item as the specifications are not clear as to whether these extensions over cabinet dimensions are allowed.

6-6. It is recommended that some satisfactory means of mounting the Type CRV-20049 power unit cabinet be provided.

6-19. It is recommended that some more suitable means be provided to assure that the securing screws holding the two halves of the power cable plug housing will not become loosened under service conditions.

6-21. It is recommended that the fuse panel in the Type CRV-20049 power unit be lowered to prevent the possibility of contact with the receiver case when removing or replacing the chassis.

7-2. It is recommended that the sensitivity for the Models DP-5 and DP-6 equipments be increased in the middle of the high frequency band at such points as the specification limits are not met.

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7-3. It is recommended that MCW selectivities in all equipments be improved for the low frequency half of the low frequency band for specification compliance. If this is done, the one point at around 100 kilocycles where the CW selectivity is just outside of the limits should fall within the requirements.

7-4. It is recommended that the image selectivity be improved for all equipments below 185 kilocycles for specification compliance.

7-5. Although the specifications do not cover "blocking" it is important in direction finder work that it not occur at a level where it may be mistaken for a bearing minima. It is therefore recommended that it be required that all direction finder receivers be capable of giving not less than a 6milliwatt output for a range of at least four orders of input, with the receiver adjusted as for a standard sensitivity measurement.

7-12. It is recommended that better tracking of the unicontrol circuits be accomplished to effect an improvement in both sensitivity and selectivity to obtain specification compliance. Better tracking of the sense circuit would improve the sense cancellations at the low end of the high frequency band.

7-18. It is recommended that a reduction in sensitivity control shall not vary the frequency of the detector or heterodyne oscillator more than 100 cycles when the impressed signal is of such value at 1500 kilocycles as to produce maximum output.

7-20. While the equipment did not completely fulfill the requirements as to shielding integrity and lead filtration, approval in this respect is recommended. Since a dummy loop for such tests must be engineered to the receiver, it is recommended that such a dummy loop be required to be submitted with the sample receiver in future cases involving this specification. (This was done voluntarily in the present case, and the failure to pass this test is believed chiefly due to faulty shielding of the dummy loop.)

It is further recommended that since "full gain" produces noise materially in excess of the "10 millivolts" output specified that this specification be rewritten to require use of a sensitivity producing an output noise level within the linear range of the resonant overload curves.

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DESCRIPTION OF MATERIAL UNDER TEST

4. The equipment furnished by the manufacturer consisted of the following units:

Radio Direction Finder Receiver	Type CRV-46040
A.C. Power Unit	Type CRV-20049
Loop Pedestal	No type number.
Loop	No type number.
Loop Output Transformer	Type CRV-47100
Receiver Input Transformer	Type CRV-47101
108" Loop-Receiver Coupling Cable with collector ring brush assembly, and receiver coupling fittings.	
Power Supply Cable	
Complete set of vacuum tubes.	

These units together with a 35 foot transmission line (furnished by the Laboratory) when used in the proper combinations were made to represent an exact set-up for the Models DP-4, DP-5, and DP-6 radio direction finder equipments. An exact set-up for the Model DQ-1 radio direction finder equipment was not possible, owing to the lack of the loop and loop pedestal assemblies which are a part of this equipment and which are especially designed and constructed for submarine service. All equipments are a.c. operated, employ the same type of receiver and the same type of power unit, but differ from one another in the type of loop structure, loop mounting, and in the method of connecting the loop to the receiver. Except for the Model DQ-1 equipment, all equipments employ the same type of loop and loop pedestal. In the case of the Models DP-4 and DQ-1 equipments the loop is directly connected to the receiver by means of a 9 foot cable, while in the case of the Models DP-5 and DP-6 equipments the loop is coupled to the receiver through input and output matching transformers, interconnected by a 35 foot transmission line. The Models DP-5 and DP-6 equipments are identical except for the mechanical arrangements for driving their loops.

5. The units supplied to the Laboratory for test and listed above were manufactured by the RCA Manufacturing Company, Inc., of Camden, N.J. These units were first delivered to the Laboratory on 20 August 1936, returned to the factory on 28 August 1936 for investigation of spurious oscillations and again delivered to the Laboratory on 4 September 1936 on which date tests were begun.

METHOD OF TEST

6. The descriptions of the methods employed in making the several tests listed under ABSTRACT OF TESTS will be made only in general terms. Except as specifically noted, the method employed for making a given test will apply to all equipments.

7. With the exception of tests (gg) and (hh) the tests listed under paragraph 3A were conducted with the equipment set up inside of a screened booth. The location of the loop was such that the effect of the

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screening of the booth upon the inductance of the loop was minimized to the extent of being practically negligible. The power supply line entering the booth was provided with a 1:1 shielded isolating transformer and an r.f. filter, both of which served to filter the line prior to its entrance into the interior of the booth. All a.c. power supply cords associated with the equipment under test and/or a.c. operated measuring equipments were shielded with Belden braid sleeving. Grounding of the shielding on the power supply cords and the equipment under test was established at a common connection on the interior screening of the screened booth, and so selected that the pick-up of external disturbances coming in on the line by the loop was reduced to a minimum.

8. With the exceptions of tests (aa) to (ff) inclusive, the measuring equipment employed for the tests listed under paragraph 3A above consisted of a General Radio Model LC-1 Standard Signal Generator Serial No. 18 and Naval Research Laboratory Output Meter having an internal resistance of 600 ohms, a General Radio Variac, and a Weston Model 341, No. 710 a.c. voltmeter. The line voltage to the equipment under test was controlled by the variac to normal line voltage as indicated on the Weston voltmeter. The audio output was measured on the Naval Research Laboratory output meter while radio frequency voltage, both CW and 30% MCW, were supplied by the standard signal generator. For all tests requiring loop excitation, the radio frequency potential from the standard signal generator was applied at the loop center through a 100 to 1 attenuator (except as specifically noted under the following paragraphs). This attenuator was a part of the output cord of the standard signal generator and consisted of a 50 ohm resistor in series with the high side of the cord and a 1/2 ohm resistor in shunt with the cord. The 1/2 ohm portion of the attenuator was inserted between the grounded mid-point and one side of the loop winding (grid side). The voltage from the standard signal generator was therefore applied across the 1/2 ohm resistance. The purpose of the attenuator was to provide a means for applying an r.f. voltage at the loop center without seriously upsetting the constants of the loop. For those tests requiring balance antenna excitation, the r.f. voltages from the standard signal generator were applied between the antenna terminal and ground through a standard balance antenna as defined by paragraph 8-13 except its resistance was 25 ohms. No attenuator was used in the output cord for these tests.

9. Sensitivity with Loop Excitation. In the measurement of overall sensitivity with loop excitation, the r.f. voltage from the standard signal generator was applied at the center of the loop as described under paragraph 8. The receiver was first tuned to resonance at the frequency of the applied signal by adjustment for a 1,000 cycle beat note. The slide wire of the standard signal generator was then retarded to its zero position and the loop rotated until the influence of stray fields from the standard signal generator was no longer effective. With the standard signal generator turned off, the receiver was adjusted for optimum gain and standard noise level (if the maximum noise level was less than standard, maximum gain was used). The standard signal generator was then turned on again, and the level of the input voltage adjusted until standard output was obtained. The reading of the slide wire dial when divided by 100 was the absolute microvolts input required for standard output at the frequency at which the particular measurement was made. Sensitivities with CW inputs

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were measured at five frequency settings for each band of the receiver; namely, at the two overlap frequencies, and three intermediate frequencies which were in geometric proportion with the overlap frequencies. Similar measurements were made with 30% MCW inputs but only for the Models DP-4 and DQ-1 equipments. Maximum noise level was also measured at each of the five frequency settings at which sensitivity measurements were made but with no applied signal and with the sensitivity control set for maximum gain.

10. Sensitivity with Balance Antenna Excitation. The overall sensitivity of the equipment with the balancer set at its ± 50 settings was measured by applying a CW signal voltage at a given frequency from a standard signal generator to the antenna terminal and ground through a standard balance antenna as described under paragraph 8 above. The receiver was tuned to resonance and adjusted for standard conditions, with the loop orientated to include minimum noise pick-up as described in the preceding paragraph. Sensitivity measurements were made with the balancer set at its ± 50 scale settings at each of the five frequency settings of each band at which sensitivity measurements with loop excitation were made. Similar measurements were made with the "sense" button depressed so as to cut out the balancer circuit and to insert the sense circuit. For these latter measurements the sense resistor for each band was set for zero resistance. Measurement of balancer and sense sensitivity with 30% MCW inputs were conducted on the set-up simulating the Models DP-4 and DQ-1 equipments. Repeat measurements of sense sensitivity were made for the latter equipments with the sense resistors varied throughout their ranges in five steps.

11. Frequency Overlap Between Bands. The frequencies to which the receiver may be tuned at its minimum and maximum settings of the main tuning dial was determined by adjusting the receiver for standard conditions at each of these settings and then calibrating these settings with the standard signal generator. These calibrations were made with CW inputs and with loop excitation.

12. Variation in Frequency with Rotation of Main Tuning Dial. The main tuning dial was calibrated on CW for each band, using a standard signal generator as a calibrating device. CW input voltages were applied to the center of the loop, as described under paragraph 8, and were maintained at such levels as to prevent overloading of the receiver. In making these measurements the rotation of the main tuning dial of the receiver and/or the frequency dial of the standard signal generator was always in the same direction so as to eliminate the effects of mechanical back and torque lash of the dials.

13. Determination of Accuracy of Calibration Furnished with Receiver. The calibration furnished by the manufacturer for each band of the receiver was checked against the corresponding calibrations made at the Laboratory in a manner similar to that described under paragraph 12 above.

14. Selectivity with Loop Excitation. With all receiver adjustments set at resonance as for sensitivity with loop excitation and optimum gain, as described under paragraph 9, the selectivity of the equipment under test was measured with CW input voltages applied at the center of the loop.

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The input voltage was stepped up in multiples of ten times that required at resonance and the corresponding frequencies above and below resonance at which standard output was maintained were recorded. Selectivities were measured at the overlap frequencies and the geometric mean frequency of the overlap frequency of each band. This procedure was repeated but with the receiver gain reduced to such a level that at each frequency which the receiver was tuned, standard output was maintained at resonance for an applied input signal corresponding to a field strength of 50,000 microvolts per meter. Similar measurements at optimum and reduced receiver gain were made with 30% MCW input voltages applied at the loop center. These measurements were made only on the set-up representing the Models DP-4 and DQ-1 equipments.

15. Selectivity with Balance Antenna Excitation. The test procedure for determining the overall selectivity of the equipment with balance antenna excitation was the same as described in paragraph 14 except that the r.f. voltages were applied between the antenna and ground terminal through a standard balance antenna as described in paragraph 8. These measurements were made with the balancer set at +50 dial scale setting with both CW and 30% MCW input voltages and with the receiver adjusted for optimum gain at resonance. Selectivities were measured at the same frequency settings of each band as were the selectivities with loop excitation.

16. Equality of Balance Effects at the +50 Settings of the Balancer. This relation was determined from the sensitivity measurements made with balance antenna excitation and with the balancer set first at +50 and then at -50 dial scale readings, as described in paragraph 10. With the balancer set at either position, the input voltage from the standard signal generator was adjusted for standard output at optimum gain. While the method for determining the equality of maximum balance effect at the two extreme positions of the balancer is not in strict accordance with the method prescribed by the governing specifications, it is believed to be preferable because the desired data may be directly ascertained from the sensitivity readings. Therefore no additional adjustments of the standard signal generator are necessary as they are in the specification method. Either method should produce the same results since they are both predicated on the receiver gain at the frequency at which the measurement is made.

17. Coincidence of Electrical and Mechanical Centers of Balance of Balancer. This test was made to determine the position of the electrical neutral point of the balancer with respect to its mechanical center. The procedure was the same as the method described for the measurement of balancer sensitivity with balance antenna excitation. Measurements were made at the same frequency settings for each band with the receiver adjusted for standard output. It was found that for the high input levels required that special care be taken to balance out all stray voltages induced into the loop by the standard signal generator. This was accomplished by orientating the loop for minimum pick-up and reestablishing the ground connection for each frequency at which the measurement was made. The reestablishment of the ground was necessary due to circulatory currents induced in the screening of the

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screened booth and which varied in magnitude and distribution with frequency. The electrical neutral was ascertained when the position of the ground connection and the orientation of the loop were such that the output voltage was not greater than the noise level at optimum gain setting of the receiver sensitivity control. Under these conditions no signal voltage was being introduced into the loop. CW inputs were applied first, and the above procedure then was repeated with 30% MCW input for the set-up representing the Models DP-4 and DQ-1 equipments.

18. Variation of Quadrature Voltage with Respect to Variation in the Setting of the Balancer. The method of measurement for this test was the same as for determining the balancer sensitivities with balance antenna excitation with CW or 30% MCW r.f. input voltages as described in paragraph 10, except that measurements were made at each 10th division, plus and minus of the balancer dial scale.

19. Ratio of Quadrature Voltage Induced into the Receiver by the Balance Antenna to the In-phase Voltage Produced by the Loop. These ratios were calculated from the data obtained for loop sensitivities and corresponding balancer sensitivities at the ± 50 settings of the balancer as described under paragraphs 9 and 10, respectively. The sensitivity data in either case were converted into terms of microvolts per meter field strength required for standard output. The ratios of the microvolts per meter input with balance antenna excitation to the microvolts per meter input with loop excitation were calculated for five frequency settings for each band for CW inputs, and similarly for 30% MCW inputs where such data were available.

20. Detuning Effects Produced by Manipulation of Balancer Control. With the receiver adjustments the same as for sensitivity measurements with loop excitation, the effect, if any, produced by the manipulation of the balance control over its range upon the initial tuning of the receiver was determined for five frequency settings for each band of the receiver.

21. Image Selectivity with Loop Excitation. The receiver adjustments for the test were the same as for the sensitivity tests with loop excitation as described under paragraph 9 above. The receiver was tuned to resonance at a given frequency and the microvolts input required to produce standard output was noted. The signal generator was then adjusted to a frequency equal to the resonant frequency to which the receiver was tuned plus two times the frequency of the intermediate amplifier of the receiver. The microvolts input required to again produce standard output (without altering the receiver adjustments) was again noted. In some cases it was necessary to remove the attenuator from the output cord of the standard signal generator to obtain sufficient r.f. input to produce standard output at the image frequency. This procedure was repeated with CW inputs at the five frequency settings for each band at which sensitivities with loop excitation were measured. Similar measurements were made with 30% MCW inputs for the test set up simulating the Models DP-4 and DQ-1 equipments.

22. Coupling between Antenna and Loop Circuits. Employing the same test set up and with all receiver controls adjusted as for sensitivity with loop excitation, the receiver was resonated to a given frequency.

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The output cord of the standard signal generator containing the attenuator was removed and the terminals of the standard signal generator connected to the antenna and ground posts of the receiver through a standard balance antenna by means of the conventional output cord. The frequency of the applied signal to the standard balance antenna was then adjusted to ± 10% of the frequency to which the receiver was tuned. The input required to produce standard output was observed, if within the voltage range of the standard signal generator. This test was repeated with 30% MCW inputs at the five frequency settings of each band at which sensitivity measurements were made.

23. Range and Linearity of the Sensitivity Control. The set-up for this test was the same as for sensitivity measurements with loop excitation. The microvolts input required to maintain standard output for various settings of the sensitivity control throughout its range were recorded. These measurements were conducted and the overlap frequency setting of each band of the receiver, first with CW inputs and then with 30% MCW inputs. The latter measurements apply only to the Models DP-4 and DQ-1 equipments.

24. Resonant Overload Characteristics. With the test set up the same as for loop sensitivities, the receiver was tuned to a given frequency and adjusted for optimum gain. The output voltages were then noted for various values of applied signal voltages until receiver blocking occurred. These measurements were conducted at the overlap frequencies of each band of the receiver and with CW inputs. Similar measurements applying only for the Models DP-4 and DQ-1 equipments were made with 30% MCW inputs.

25. Variations of Audio Output with Angular Rotation of the Sensitivity Control. The test set up for this test was the same as for resonant overload except that a constant input voltage was applied at the center of the loop. The sensitivity control was then varied from maximum gain down to a level where the output was no longer measurable and the output voltage noted for each incremental setting of the sensitivity control. These measurements were conducted at the overlap frequency settings for each band of the receiver with three levels of applied CW inputs.

26. Variation of Noise Level with Sensitivity Control Setting. This test was the same as described under paragraph 25 above except that the noise level was measured in addition to the audio output voltage. The input voltage was such as to produce standard output at optimum gain.

27. Accuracy of Alignment of Beat Frequency Oscillator. The standard signal generator was adjusted to the rated frequency of the i.f. oscillator and its r.f. voltage (CW) was applied at the input of the first i.f. amplifier. A Sensitive Research Company microammeter Model S, Serial No. 2342, was inserted in the plate circuit of the second detector and maximum deflection noted with the i.f. oscillator "off". The i.f. oscillator was then turned "on" and the difference in the beats between it and the incoming signal was observed by means of a General Radio interpolation oscillator Type No. 617A, Serial No. 30. The range of adjustment of the i.f. oscillator was similarly determined for four revolutions clockwise and counterclockwise of the polyiron core

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in the oscillator inductance coil.

28. Variation in Beat Note Frequency with Change in Line Voltage. With a test set up and with all receiver adjustments the same as for sensitivity measurements with loop excitation as described in paragraph 9, the change in the beat note frequency was observed by means of the General Radio interpolation oscillator connected across the phone terminals, for a change in line voltage from -5% of normal to normal, and then from normal to +5% of normal. These measurements were made with CW inputs at the overlap frequencies of each band of the receiver.

29. Variation in Beat Note Frequency with Change in Signal Intensity. With the test set up as described under paragraph 9, and under conditions of CW reception with optimum gain, the change in beat note was observed by means of a General Radio interpolation oscillator connected across the phone output for changes in input from 0.5 microvolt up to such values as to produce maximum output. These observations were made at the overlap frequencies of each band of the receiver.

30. Variation in Beat Note Frequency with Change of Sensitivity Setting. With the test set up the same as described under paragraph 9, and under conditions of CW reception, and with an impressed signal of such value as to produce the maximum available output, with full gain, the change in beat note frequency was observed, by means of a General Radio interpolation oscillator connected across the phone output, for a reduction of the setting of the sensitivity control down to a point where the output was just audible. These observations were made at the overlap frequency settings of each band of the receiver.

31. Overall Time Constants. Time constants were measured only for the set up simulating the Model DP-4 equipment and were measured at 100 and 1500 kilocycles. The output of the receiver was fed to a cathode ray sweep circuit which in turn operated a cathode ray tube. The input applied at the center of the loop consisted of the carrier frequency from the General Radio LC-1 standard signal generator having superimposed on it a d.c. pulse supplied by a General Radio beat frequency oscillator operating through an electronic keyer. The d.c. pulse had an amplitude of approximately 15 volts peak. The electronic keyer is of Laboratory manufacture, while the cathode ray sweep circuit was a product of the General Radio Company.

32. Transrectification. This test was not made for reasons given under RESULTS OF TESTS.

33. Overall Voltage Gain/Voltage Noise Ratio x 10^6. These ratios were calculated for five frequency settings of each band of the receiver from the sensitivity measurements made with loop excitation and CW inputs as described under paragraph 9.

34. Overall Voltage Gain. The overall voltage gain was calculated for each overlap frequency of each band of the receiver from data obtained from the resonant overload measurements,(par. 25). Calculations

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were made for several outputs from standard down to approximately 1 milliwatt.

35. The equipment used for the tests whose methods of procedure are described in paragraphs 36, 37, and 38, and relating to tests (aa) to (cc) of paragraph 3A consisted of a General Radio beat frequency audio oscillator Type 713A, Serial 141, a General Radio microvolter Type 546A, Serial 119, a General Radio wave analyzer, Type 636A, Serial No. 102, and an NRL output meter having an internal resistance of 600 ohms, and a decade box.

36. A.F. Characteristic of Audio System. The frequency response characteristic of the audio system of the receiver was measured by applying an audio signal from a General Radio beat frequency audio oscillator to the grid of the second detector tube through a General Radio microvolter and measuring the output voltage of the amplifier by means of a General Radio wave analyzer used as a vacuum tube voltmeter. The input voltage was maintained at a constant value and the output voltages observed. The frequency of the oscillator was varied in convenient steps from 30 to 10,000 cycles. The variation of the audio response was then converted in terms of decibels gain and/or attenuation with respect to zero level assumed to be at 1000 cycles.

37. Load Characteristic of Audio Output Transformer. The test set up was the same as described under paragraph 36 above. The input signal was adjusted for a 6 mw output across a decade box adjusted for 600 ohms. The output voltage was measured with a General Radio wave analyzer as for the previous test. The input signal was adjusted for 1000 cycles and its amplitude held at a constant value throughout this test. The decade resistance was then varied in convenient steps from 10 to 10,000 ohms and the output voltage noted for each step. These readings were then converted into milliwatts of audio output.

38. Output Hum Level. The total hum level was determined by measuring the amplitudes of the 60 cycles fundamental and as many of its harmonics as could be measured by means of a General Radio wave analyzer connected across the 600 ohm output of the receiver. The set up was the same as described in paragraph 36 above with an applied signal having a frequency of 1000 cycles. The input was increased to produce outputs ranging from 1 to 30 milliwatts and measurements were made of the amplitudes of the harmonics at this signal in addition to the harmonics of the 60 cycles hum frequency.

39. Attenuation Characteristic of R.F. Filter in Power Unit. These measurements were made employing a General Radio LC-1 standard signal generator as the source of r.f. potential and a General Electric all wave receiver, Model 81, as a detector. Power was applied to the power unit. The General Electric receiver was operated from a separate a.c. line from that used for the power unit to avoid feed back of the r.f. voltage through the lines. An r.f. signal (modulated) of a given frequency was applied to the power unit through a blocking condenser. The antenna-ground terminals of the General Electric receiver were then connected across the input of the power unit through a blocking condenser.

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The input of the standard signal generator was then adjusted for a given deflection on an output meter across the receiver terminals. The receiver was then connected across the +B and/or filament lead with respect to ground, and the input from the standard signal generator readjusted to produce the same deflection of the receiver output meter. The ratio between these two signal generator voltages is a measure of the attenuation offered by the filter system of the power unit to that frequency. The procedure was repeated for several frequencies from 100 to 1500 kilocycles.

40. Variation of Plate and Heater Voltage and Power Consumption with Changes in Line Voltage were measured with the power unit operating at normal full load and with all dial lamps and the azimuth scale lamp lighted and "off". The line voltage was varied from 90 to 125 volts in steps of 5 volts. The plate and heater voltages and power consumption were measured at each step.

41. Effect of Power Line Frequency Variation on Performance of Power Unit. This test was not made since the power transformer in the power unit operates at normal line frequency without appreciable heating, and its size indicates that satisfactory performance could be expected when it is operated within the power frequency range required by these specifications.

42. Vibration Test. The Type CRV-46040 receiver, with shock absorbing rubber mounts, was placed on a vibrating table for test at various frequencies. As no evidence was found to show special susceptibility to vibration at any frequency up to 30 cycles, the tests were conducted at a frequency of 15 vibrations per second, using a vertical table movement of about 1/16th inch, with input by signal generator to the center of the dummy loop, observing audio frequency outputs on an output meter and the output frequency was checked against the General Radio interpolation oscillator. The receiver was adjusted to standard CW sensitivity, and the test conducted with CW input, monitoring the output with phones. In addition, violent blows of the hand were applied to the receiver and power unit cases while receiver output was under observation. Observations at 113 and 1415 kilocycles were made to determine the variation in sensitivity and output beat frequency during 15 minutes of sustained vibration.

43. Temperature and Humidity Test. The equipment furnished the Laboratory was placed inside of the temperature-humidity chamber in the Laboratory shop. The receiver and power unit were set up and placed in operation with the chassis of the power unit partially removed from its cabinet, and the chassis of the receiver entirely removed from its cabinet. Owing to the noise conditions in the shop, it was found that the input voltages from a standard signal generator could not be applied to the receiver through the medium of its loop. The voltage was therefore applied between the grid of the 1st radio frequency amplifier tube and ground through a shielded transmission line. The output was connected to a General Radio interpolation oscillator for observing the drift in beat note. Time permitted the completion of only one complete cycle in which the temperature was varied from +25° C at 50% humidity up to 50° C at 90% humidity then to -21° C and back again to 25° C at

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50% humidity. The cycle was not continuous but was interrupted at the close of each work day. More complete details of this test will be found under RESULTS OF TEST. Sensitivity measurements were made with CW inputs and loop excitation before and after this test.

44. Stability of R.F. and I.F. Oscillators with the equipment set up as for the Model DP-4 equipment and with loop excitation, sensitivity, and maximum noise measurements as described under paragraph 9 with CW inputs were made with the i.f. and r.f. oscillator tubes replaced by tubes having high mutual conductances as required by the governing specifications. Observations were also made to determine if spurious oscillations or evidences of instability were created by the manipulation of the receiver controls.

45. Interstage and Overall Regeneration at Full Gain When Using Vacuum Tubes of High Mutual Conductance. This test was similar to that described under paragraph 44 above. In this case, however, the original tubes were used in the oscillators while all other r.f. tubes were replaced by tubes having high mutual conductances as required by the governing specifications.

46. Tests for Overload and Cross Modulation Selectivity. Tests were made with the equipment furnished by the manufacturer set up as for the Model DP-4 equipment. The Type CRV-46040 receiver was adjusted for standard conditions and for CW operation with sufficient input from a standard signal generator, applied to the center of the loop, to produce a 6 mw output at 1000 cycles. This voltage was applied through a resistor in series with the generator output so that this generator would not so load a second generator as to affect its output voltage. The 6 ohm output of the second signal generator was connected at the loop center with 0.5 volt of 200 cycle, 30% modulated CW of the interfering frequency plus the desired signal voltage from the first generator. The frequency of the second signal generator was varied from a point off resonance, through resonance, and thence to a point beyond resonance where it had no effect on the output of the desired 1,000 cycle beat note. The points observed at both sides of resonance where the interfering signal was just audible, where it gave a 6 mw output, where the desired signal became unreadable, and where blocking occurred were noted.

47. Trimming Range of Loop and Balance Antenna Trimmer Condensers. The trimmer condensers were trimmed to the loop when connected to the receiver with the 9 foot cable. Their capacities for these settings as well as their minimum and maximum capacities were measured at 1,000 cycles on a General Radio Type 650A, Serial No. 103 impedance bridge. Thus was determined the available range for each trimmer condenser used in the loop circuit. A measurement of the capacity of the 9 foot cable - also made on the General Radio impedance bridge permitted a determination of trimmer range compliance with these specifications as applied to the loop trimmers. For test of the balance antenna trimming condensers, the standard signal generator (Model LC-1) was connected through the specified 20 microhenries of dummy antenna inductance having 25 ohms of resistance, and a variable dummy antenna capacitance (General Radio precision condenser, Type 222, Serials 78 and 493) to the antenna-ground terminals of the receiver, using its internal output meter for trimming.

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purposes. With sense resistors adjusted for minimum resistance, and with sense button depressed, frequencies were impressed as follows: low band, 250 kilocycle; medium band, 550 kilocycles, high band, 1500 kilocycles; in accordance with antenna trimming instructions. With receiver tuned to the constant frequency input, the procedure was to find the lowest and highest values of dummy antenna capacitance with which the antenna circuit could be resonated. Each of the three bands has its individual trimming condenser.

48. Accuracy of Tracking of Ganged Tuning Condensers. This test was not made for reasons given under RESULTS OF TESTS.

49. Measurement of Q of Loop Alone. The Q of the loop alone was indirectly determined for a frequency range of from 550 to 1500 kilocycles by measuring the r.f. resistance at various frequencies within this range on a General Radio radio frequency bridge Type 510C, Serial No. 23 and calculating the corresponding Q's from the measured r.f. resistances and the true inductance of the loop. The loop was tuned by means of a General Radio precision condenser Type 722H, Serial 199, connected across the loop terminals. The input r.f. voltage from the bridge was applied at and in series with the center of the loop. Similar measurements and calculations were made for the loop coupled to the loop pedestal and associated 9 foot cable. Also, similar measurements and calculations were made for the loop coupled to the loop pedestal and 35 foot transmission line and its associated coupling transformers. All measurements were made using the substitution method. (Refer also to paragraph 56 for method.)

50. Watertightness Integrity of Loop Assembly. The loop Q for several frequencies was measured before and after an immersion test. The immersion test was of 46 hours duration and consisted of submerging the loop in fresh water in an inverted position, to cover all joints and seams in the loop housing, leaving two inches of the casting, which contains the terminal block, above water.

51. Responsiveness and Damping Factor of Rectifier Type Output Meter. The meter was tested for responsiveness and damping factor in accordance with paragraph 6(a) 5 of Specification 17-I-12, ref.(t). The values submitted herein were the result of averaging numerous observations.

52. Salt Water Immersion Tests for Chokes, Transformers, Capacitors, and Resistors. The immersion tests for the chokes, transformers, paper capacitors, and resistors were conducted in accordance with paragraphs 2-46 and 2-47 of the governing specifications, reference (b). The requirements for the capacitor tests as outlined in reference (z) are considered to have been covered by the tests made in accordance with reference (b).

53. Intermediate Frequency Selectivity. Using the set-up described under paragraph 9 for sensitivity with loop excitation, the intermediate frequency selectivity was measured with CW inputs and for five frequency settings in each band of the receiver. For each frequency to which the receiver was tuned, the input from the standard signal generator was ad-

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justed until standard output was attained at optimum receiver gain. The frequency of the standard signal generator was then adjusted for the i.f. frequency and the input required for standard output (without altering the receiver adjustments) was again noted. The ratio of the input required at the i.f. frequency to the input required at the frequency to which the receiver is tuned is, when expressed in decibels, the attenuation the receiver introduces to the i.f. frequency at the frequency to which the receiver is tuned.

54. Overload Characteristics of the Audio Amplifier. The set-up for this test was the same as described under paragraph 36. All measurements were made at 1,000 cycles. The input was varied from 10 to 10,000 millivolts in convenient steps and the outputs across the phone and volume indicator circuits were measured with a General Radio wave analyzer used as in paragraph 36.

55. Measurement of R.F. Resistance of Loop Circuit. The radio frequency resistance of the loop circuit of the Model DP-4 equipment was made at 5 frequencies within each band of the receiver by direct measurement on a General Radio Type 516C radio frequency bridge and using the substitution method of measurement. The radio frequency signals (CW) for the several frequencies at which measurements were made were applied to the bridge input terminals from a General Radio Type LC-1 standard signal generator, Serial No. 18. The Model DO-1 direction finder receiver was used as a detector. The loop center was connected across the "Series Resistor" terminals of the bridge. The procedure followed in making these measurements was as follows: (a) A shunt was connected across the loop connection and close to the loop so that the resistance of the connecting lead could be included in the initial adjustment of the bridge. (b) The bridge was then adjusted for balance at a given frequency with the decade resistance arm adjusted for a known resistance. (c) The shunt across the loop input was then removed and the loop tuned to resonance with the condenser in the receiver with no power applied to the receiver. Simultaneously, the resistance of the decade was reduced by an amount equivalent to the resistance of the loop circuit under test - as indicated by a "null" being obtained at the output terminals of the Model DO receiver. The difference between the original setting of the decade and the final setting is the true r.f. resistance of the loop circuit under test at the frequency of measurement. This procedure was repeated for the Models DP-5 and/or DP-6 equipments except certain modifications had to be made in the method of measurement as described under paragraph 59. ? should be 58 ?

56. Measurement of True Inductance and Distributed Capacitance of Loop and Associated Coupling Circuits. The loop, loop pedestal, and 9 foot cable as used for the Model DP-4 equipment were set up in their normal relation with one another. CW signals from a General Radio standard signal generator, Serial No. 18, were applied to the loop center (the attenuator was not used for this test). A General Radio Type 222, Serial 138, precision variable condenser was connected across the receiver input terminals of the 9 foot cable. A slide back vacuum tube voltmeter was connected across the condenser and used only as a resonance indicator. The circuit under test was then tuned to resonance at several frequencies and the dial readings of the precision condenser recorded. From these

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readings together with the calibration curve for the condenser, the capacity required to resonate the circuit under test at the several test frequencies was determined after subtracting the input capacity of the vacuum tube voltmeter. With the data obtained, the true inductance and distributed capacitance of the circuit may be obtained after first plotting a wave length squared vs. capacity curve. Similar measurements were made for the loop, loop pedestal, and 35 foot transmission line. Measurements were also made on the loop alone, and on the loop and 9 foot coupling cable without the loop pedestal. The transmission line coupling transformers were measured on the Q meter, determining the resonant frequency for the various taps when associated with 400 μμf capacity. This effective inductance was measured in a balanced circuit as used, and by testing the unbalanced halves of the separate windings.

57. Determination of Effective Heights of Loop. The effective height of the loop over the frequency range of 100 to 1500 kilocycles was determined by calculations from the number of turns of the loop winding and the dimensions of the loop.

58. Determination of Effective Loop Circuit Resistance and Input Phase Angle of Loop System as Used with the Models DP-5 and DP-6 Equipments.

(a) In the method of paragraph 56 for determination of loop circuit resistance, resonance of this circuit was indicated by rebalancing the bridge with variation of resistance only. This was permissible because a simple series resonant circuit was under test. However, when the same method was attempted for the transmission line connected DP-5 and DP-6 equipments, it was immediately evident that unity power factor in the loop circuit as seen from the loop center could not be achieved by tuning the receiver, for all frequencies, and that when it was achieved, the tuning point was not normal for the frequency. This led to the adoption of another method.

(b) In the CRV-46040 receiver, a vacuum tube voltmeter was connected across the grid circuit of the first detector tube, and shunted by a 50,000 ohm resistor to effectively broaden the tuning of this circuit. With the receiver energized, the voltage so measured is effectively proportional to that developed on the r.f. amplifier grid. For a given frequency, the signal generator was inserted at the loop center and the receiver tuned for a maximum on the vacuum tube voltmeter. The signal generator was then connected to drive the r.f. bridge, and the loop center connected to the bridge "series resistor" posts, as in paragraph 55, and the loop resistance measured as before, except that both resistance and reactance were measured, the latter by variation of the calibrated capacity in this leg of the bridge. The effective reactance of the loop circuit was directly equal to the difference between the bridge circuit reactances with and without the loop in circuit. The receiver tuning points found by this method agreed closely with those found in normal receiver tuning for the same frequencies.

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59. General Direction Finder Performance. For this test, the equipment was set up at the north roof mount of Building No. 12, employing a balance antenna adjacent thereto and slanting to the top of the west tower. This is a position whose general direction finding characteristics are known. Observations were made on available signals from 113 kilocycles to 1460 kilocycles, mostly local traffic and broadcasting stations. Opposite ness and quality of minima, freedom from drag or shift, and reaction of balance, tuning or sensitivity on accuracy were studied.

60. Ease and Accuracy of Sense Determinations. Operation of the sense feature was studied as installed for and under similar conditions to the tests of paragraph 59.

61. Shielding Integrity and Lead Filtration.

(a) The receiver and power unit were installed in a test truck associated with a shielded loop of design similar to its own (Model DO-1) arranged for exciting the loop center from a signal generator. Field strength was determined by measuring the output of the receiver, excited by the field under test via loop set at maximum, then rotating the loop to the minimum position, and matching the observed output by substitution of energy at exactly the same frequency from the signal generator, and calculating from the known effective height of the loop the equivalent field strength. The truck was moved as required in the radiation fields of various transmitters to select desired field strengths.

(b) Field strengths inside the truck body probably were somewhat less than the values found at the overhead loop, owing to the presence of various conductors. Such a condition is considered to favor the receiver in the tests.

(c) The dummy loop employed was furnished with the receiver, arranged to plug directly into the loop terminals of the latter, and was trimmed to the receiver. This dummy loop is not an exact match for the standard loop at all frequencies, but is considered a close approximation by the manufacturer's representative.

(d) The output of the receiver at various frequencies and field strengths was observed by its own and external output meters.

62. Sense and Balance Circuit Tracking. The tests were made on the Model DP-4 connection, employing the dummy antenna, with all trimmers properly adjusted. The Q meter was used as a driver, its vacuum tube voltmeter connected to measure the potential across its series capacity. All sense resistors were at zero. For a given setting of the driver, receiver resonance was found and the scale reading recorded. Then the receiver was retuned to show resonance of the antenna circuit on the vacuum tube voltmeter. From the two receiver scale readings, using Plate 1, the percentage of detuning was calculated.

DATA RECORDED DURING TEST

63. Complete data were recorded for all tests conducted and this information is contained in Tables 1 to 14 and Plates 1 to 105 appended hereto.

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PROBABLE ERRORS IN RESULTS

64. Prior to the tests the equipment under test and all measuring instruments incorporating tubes or other devices which are dependent upon constant temperature for stability were allowed to operate for a sufficient length of time to permit stabilization to take place. The line voltage for the a.c. operated equipments was controlled with a General Radio "Variac."

65. Periodic calibration of the wave analyzer and the audio frequency oscillator, employed in connection with some of the tests, was made to assure consistent and reliable results.

66. All tests were carefully conducted so as to maintain minimum errors in observations and in the manipulation of the controls of the equipment under test or of the measuring equipment.

67. For the purpose of discussing the probable errors in tests, the tests may rightfully be classified under the headings given below. The estimates are based on actual measured results and when considering these estimates, it should be borne in mind that in the overall accuracy the error of one instrument in one direction oftentimes cancels the error of some other instrument employed in the same test and vice versa so that the net result is several times more accurate than the rated accuracy of either one of the instruments taken separately.

(a) Radio frequency measurements employing a standard signal generator, audio oscillator for correct beat note determination, an output meter and interpolation oscillator.

Name of Test	Estimated Overall Accuracy Applying to All Equipments
1. Sensitivity (Loop and/or balance antenna excitation)	± 10%
2. Frequency Overlap	± 0.1%
3. Variation of frequency with rotation of main tuning dial.	± 0.1%
4. Frequency as used for calibration purposes.	± 0.1%
5. Selectivity:	
Sensitivity	± 10%
Frequency	± 0.1%
6. Equality of balance effects at ± 50 setting of balancer	± 10%
7. Coincidence of electrical and mechanical centers of balance	± 0.1%

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8.	Variation of quadrature voltage with respect to variation of setting of balancer	± 10%
9.	Image Selectivity	± 15%
10.	Sensitivity control characteristics (Range, linearity, variation of audio output)	± 10%
11.	Resonant Overload	± 10% up to cut off ± 25% beyond cut off
12.	Variation of noise level with gain setting	± 10% for high levels ± 15% for low levels
13.	Frequency stability with changes in line voltage, input signal intensity and sensitivity control setting	± 5 cycles
14.	Accuracy of alignment of i.f. oscillator	± 0.1%
15.	Time constant	0.002 second
16.	Overall voltage gain/voltage noise ratios	± 10%
17.	Overall voltage gain	± 10%
18.	Vibration test	± 25% in frequency
19.	Temperature and humidity test	± 25% in frequency
20.	Stability of i.f. and r.f. oscillators	± 10%
21.	Overload selectivity and cross modulation selectivity (voltages)	± 10%

(b) Audio frequency measurements employing a beat frequency audio oscillator, a microvolter, output meter and a wave analyzer.

	Name of Test	Estimated Accuracy Applying to All Equipments
1.	A.F. characteristic of A.F. Amplifier	± 0.5 db
2.	Load characteristic of audio output transformer	± 5%
3.	Output hum level	± 10%

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4. Overload characteristic of audio system	± 5%

(c) Loop and loop circuit radio frequency resistances and Q values employing the use of a radio frequency bridge, a standard signal generator, auxiliary receiver and precision type of variable condenser.

Name of Test	Estimated Accuracy
1. Loop and/or loop circuit radio frequency resistance	± 0.5 ohm
2. Loop circuit Q.	1%

(d) Loop circuit constants, employing for their determination a standard signal generator, precision type of variable condenser, slide back voltmeter, Q-meter, and impedance bridge.

Name of Test	Estimated Accuracy
Trimming Range of Loop Trimmer Condensers	± 3 μμf.
Trimming Range of Antenna Trimmer Condenser	± 10 μμf.
True inductance of loop and associated leads	± 10%
Distributed capacitance measurements	± 3%
Inductance of loop load coils	± 3%

(e) Voltage and power consumption variations with line voltage variation measurements are accurate to within 2%.

(f) General direction finder performance.

(g) Bearing observations on local signals. 0.25°

RESULTS OF TESTS

68. The following are the results of the tests, the paragraph numbers corresponding with those of the specifications.

1-1. The Models DP-4, DP-5, DP-6, and DQ-1 equipments do not comply with all of the requirements of the governing specifications and hence cannot be considered entirely suitable and satisfactory for Naval service.

1-2. Each of the subject equipments employs a rotatable loop as the directional collector and may additionally employ a single

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wire antenna for "sense" determinations and "balancing" purposes.

1-3. The equipment furnished by the manufacturer was not complete for any model of equipment covered by this report. The omissions which made any model incomplete were the loop drive assemblies, azimuth scale assemblies, and the loop structure for the Model DQ-1 equipment. However, the units furnished were such that when used in suitable combinations, set-ups simulating the electrical characteristics of any one of the subject equipments could be made for test purposes with the exception of the Model DQ-1 equipment. In this report it will be assumed that the electrical characteristics of the loop structure for the Model DQ-1 equipment are the same as for the Model DP-4 equipment. This is not strictly so, but for all practical purposes and intents may be assumed to be so.

1-4. Each equipment covers a frequency range of from 100 to 1500 kilocycles without hiatus and except as specifically noted in the report operates in accordance with these specifications.

1-5. Each equipment is capable of operating with equal satisfaction on pure or modulated continuous wave radio signals, either keyed or unkeyed except as noted in this report.

1-6. Each equipment is capable of operating in accordance with these specifications from a rated power source of 110 volts, 60 cycles, single phase alternating current.

1-7. The component units comprising each type of direction finder equipment are as follows:

Model DP-4 Equipment

CRV-46060 Receiver, complete with one set of vacuum tubes.
CRV-20049 Power Unit, complete with line filters and rectifier tube.
Modified CRV-69006 Loop Assembly.
Modified CRV-69007 Loop Pedestal Assembly (Drive and Azimuth Scale Assemblies not furnished)
Loop-receiver connecting cable (9 ft. long) with brush assembly and attachments.
Power Supply Cable and Attachment Plugs.

Model DP-5 and DP-6 Equipments

CRV-46040 Receiver, complete with one set of vacuum tubes.
CRV-20049 Power Unit, complete with line filters and rectifier tube.
Modified CRV-69006 Loop Assembly.
Modified CRV-69007 Loop Pedestal Assembly (Drive and Azimuth Scale Assemblies not furnished)
CRV-47100 Loop Output Transformer with cable and collector ring brush assembly.
CRV-47101 Receiver Input Transformer with cable and receiver attachments.
Power Supply Cable and Attachment Plugs.
35 ft. Transmission Line (furnished by the Laboratory)

Note: The Models DP-5 and DP-6 equipments are identical except for their respective loop drive mechanisms.

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Model DQ-1 Equipment

Same as for the Model DP-4 equipment except loop and loop pedestal assemblies are especially constructed for submarine service as described under reference (f). The loop and/or loop pedestal assemblies for this equipment were not furnished by the manufacturer.

Photographs of the equipment furnished by the manufacturer are shown on Plates 101 to 105 inclusive.

1-8. No comment can be rendered by the Laboratory.

2-1. The general specifications listed in par. 2-2 have been referred to in these tests.

2-2. The following materials in the subject equipments appear, from a visual inspection, to be satisfactory, but no chemical analyses or other tests have been made to affirm the exact compliance with the specifications: aluminum alloy castings, molded phenolic insulating material, laminated phenolic insulating material, ceramic insulating materials, zinc chromate primer, corrosion-resisting steel.

The following types of vacuum tubes are used and are included in Specifications RE 13A 600A: Types 38636, 38076, 38646, and 38593.

Molded mica condensers used in the subject equipment differ from Specifications RE 48AA 112K in their physical dimensions. They are, in general, smaller than the standard Type B and it is claimed by the manufacturer that they have better moisture-resisting qualities than other makes commercially procurable. There are two sizes employed, and as they differ from the standard specifications, it is recommended that type numbers be assigned in order to facilitate obtaining replacements as needed.

The potentiometers employed are manufactured by the Wirt Company and in general comply with Specifications RE 13A 492. The A and B dimensions are, however, slightly smaller than this specification calls for. This type of potentiometer has been accepted in other equipment previously submitted by this manufacturer.

The following comments apply to Specifications RE 13A 346U. The only indicating instrument used in this equipment is the volume indicator. This instrument is not included in this specification, but has been tested in accordance with the governing specifications, RE 13A 474. Refer to par. 5-59 for comments.

The only wire wound resistor used in this equipment has a resistance of 5,000 ohms. It has an overall length of 1-13/16" over the terminal connecting bands. These dimensions are not included in the governing specifications. Refer to par. 2-46 for comments.

None of the types of tubes employed is included in Specifications RE 13A 346U. They are all covered, however, in Specifications RE 13A 600A. No mica condensers are used which are of the types included in

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Specifications RE 13A 389J. The telephone jacks are of the long spring type and are interchangeable with the jacks called for by Specifications RE 13A 481B.

2-3. Each equipment is in general ruggedly constructed of excellent materials. Refer to pars. 2-10, 2-11, 2-47, and 4-7 for exceptions.

2-4. The workmanship is generally of excellent quality. Refer to pars. 2-8, 2-15, 2-16, 2-47, 2-20, 4-7, 4-14, 4-15, 4-54, and 4-55.

2-5. All items entering into the construction of the equipment furnished, when taken together with the protective means provided, are believed to be resistant to the corrosive action of moist sea air except as noted in pars. 2-10 and 4-61.

2-6. The interiors of the cabinets housing the Type CRV-46040 receiver chassis and Type CRV-20049 power unit chassis, as well as that of the case surrounding the ganged variable condenser assembly of the receiver have been treated with a zinc chromate primer. The back of the main panel as well as all other aluminum parts forming the chassis of the receiver and/or power unit have been given a sand blast and clear lacquer finish.

2-7. The interiors of the cabinets of the Type CRV-46040 receiver and Type CRV-20049 power unit have been finished with an aluminum paint in all places where it is required.

2-8. The exteriors of the cabinets of the Type CRV-46040 receiver and Type CRV-20049 power unit have been finished with a durable black wrinkle standard Navy finish. The tuning and wave change knobs on the receiver are of aluminum and are finished with black wrinkle finish. It has been observed, from such little use as the receiver has had, that at the sharp corners of the knobs the finish has worn through, exposing the bright metal. If the control knobs are so designed that there will be no sharp edges, it is probable that this finish will be adequate.

2-9. The finish on the operating panel of the Type CRV-46040 receiver and/or Type CRV-20049 power unit match the cabinet exterior.

2-10. Metal parts of the receiver and/or power unit chassis have been finished so as to present a reasonably uniform appearance and depend chiefly on lacquer over a sand blast finish for protection from exposure to saline humidities. From the appearance, it would seem that a thicker coating of lacquer is desirable.

2-11. The use of iron or steel, except for electromagnetic purposes, has in general been kept to a minimum in the equipment furnished the Laboratory.

2-12. Lock washers have been furnished throughout the equipment with the exception of the cover plates for the ganged variable condenser housing, band switch compartment, and the i.f. oscillator compartment in the Type CRV-46040 receiver. It was stated by the manufacturer's representative that this was an oversight. There is no evidence that the use

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of corrosive soldering flux has been used in any unit.

2-13. The fixtures on the operating panel of the Type CRV-46040 receiver are of non-magnetic material and have been finished with either black wrinkle or black oxidized finish.

2-14. Each equipment contains as many integral units which are as interchangeable electrically and mechanically as can be expected for equipments of this type.

2-15. In each equipment, the number of friction or pressure contacts has been kept to a minimum and when used, these contacts are, in general, so designed as to prevent the development of noises due to shock, vibration, and by exposure to moist salt atmosphere or continued use over a long period of time. The exception to this statement is that the range switch on the volume indicator meter of the Type CRV-46040 receiver appears to be operating under an abnormal strain due to friction of the contacts when rotating from the "off" to the +15 db position.

2-16. In general, the integral parts of each unit are so mounted as to permit the replacement of those likely to become defective without extensive disassembly. There is, however, an exception to this rule in the case the two foil paper condensers mounted in the band switch compartment of the Type CRV-46040 receiver directly under the ganged variable condenser assembly and another directly below the r.f. oscillator socket. In the case of the first two, it will be necessary that the entire ganged variable condenser assembly be loosened from its mounting and raised to make the screw heads accessible for removal of the condenser. In the case of the latter, it will be necessary that a by-pass condenser plate be removed to make the screw heads accessible. This difficulty could be remedied by either providing fixed screw studs permanently attached to the receiver chassis frame or by providing nuts attached to the chassis in such a manner as to prevent rotation so that the necessary operations for replacement could be accomplished wholly from the condenser side of the chassis.

2-17. No rivets have been used in the mounting of any component part in any unit of the equipment furnished which may be subject to replacement.

2-18. Appropriate nameplates have been affixed to all major units. If the loop coupling transformers are considered major units, they are without nameplates but are marked with type numbers.

2-19. The design and construction of the equipment furnished is such that microphonic disturbances arising from vibration are unusually low.

2-20. The connections involved in wiring of the major units are generally satisfactory. There are exceptions, however, as for instance in the Type CRV-46040 receiver, where the antenna lead running from the balancer compartment to the tuning condenser, the r.f. oscillator plate

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lead running from the band switch to the socket, and the balancer coil lead running from the balancer coil terminal block to the sense switch. The Litz leads running from the antenna tuning coils to the terminal lugs appear to be unnecessarily long. In this connection, it is recommended that these and similar wires not only be shortened to reduce the possibility of excessive movement from vibration, but that the exposed wire at such terminals be coated with wax to minimize the possibility of corrosion.

2-21. Ample ventilation has been provided on the Type CRV-46040 receiver and/or Type CRV-20049 power unit.

2-22. Thumb screws are provided to secure the front panel of the Type CRV-46040 receiver and of the Type CRV-20049 power unit to their respective cabinets. In either instance, the construction of the thumb screws is such that the panel can be placed in its final position without interference from the screws. The holes into which the thumb screws engage are countersunk and the screw tips are pointed so that they readily engage when turned. This system is a decided improvement over that employed in other direction finder equipment tested at this Laboratory.

2-23. The insulation from ground for all r.f. and i.f. circuits of the subject equipments is of isolantite or micalex. The only exception to this rule is in the case of the sense resistors in the Type CRV-46040 receiver. These resistors are mounted on a bakelite panel, but it is understood that this was allowed the manufacturer in correspondence with the Bureau of Engineering.

2-24. All metal parts of all panel controls are maintained at ground potential.

2-25. The subject equipment has been found to function satisfactorily between the limits of -25° C and +50° C.

2-26. It would appear from a visual inspection and from the tests conducted, mentioned in the paragraph above, that items entering into the construction of the subject equipment are capable of operating continuously in any ambient temperature between the limits of -10° C and +51.5° C.

2-27. The equipment furnished is considered to have been designed to take care of any electrical loads within the limits set by the fuses provided therein.

2-28. No comment, as this paragraph is self-explanatory.

2-29. The design is such that the equipment furnished will operate satisfactorily (except for shift of minimum) and without damage on a moving platform inclining up to 45° from the vertical in any direction.

2-30. The design and construction of the equipment furnished is considered rugged and should withstand the effects of gun fire better than any similar equipment previously tested.

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2-31. No comment, as this applies only to the manufacturer.

2-32. No electrolytic capacitors are used in any unit of the equipment furnished for test.

2-33. The wire used for power circuits in the equipment furnished for test has been color coded. The r.f. circuits in the Type CRV-46040 receiver employ tinned copper wireswhich are not identified by color. Some form of color coding should be used on these wires and the instruction book should include a description of this coding to facilitate servicing.

2-34. All wire used in the subject equipments, except where rigidity is required in r.f. circuits, is of stranded, soft annealed copper of suitable cross section to provide ample and safe current-carrying capacity and/or mechanical strength.

2-35. All wire used in the subject equipments where excessive heat does not exist is rubber covered. (Refer to comments on pars. 2-38 and 2-39 below.)

2-36. Refer to comments on par. 2-40 below.

2-37. Refer to par. 2-39(1) below. In the Type CRV-46040 receiver, all radio frequency leads are of bare tinned copper wire, with the exception of the leads employed in the sense circuit and for the balancer coil. The leads used in the sense circuit are rubber covered, while the single high potential lead running to the balancer coil is insulated with isolantite beads. It would appear that it is intended that all high r.f. leads shall have insulation. Although none has been provided except as mentioned herein, it is believed that lower losses will obtain and that the performance of the equipment will probably excell that which might be expected with any form of insulation that might be provided. This assumes that all leads are properly supported and that the wires are sufficiently well insulated at points where they go through shields as to prevent the possibility of grounding from vibration or disarrangement due to servicing and handling. Refer to comments on par. 2-39.

2-38. A sample of the wire employed in the power circuits of the Type CRV-46040 receiver was separately submitted for test. This was rubber and braid covered. It withstood the 1,000 volt dielectric test. The aging test was not conducted as this Laboratory is not equipped to make these tests and it is understood that the New York Navy Yard is especially equipped for this work. Samples will be forwarded to New York Navy Yard, if the Bureau so desires.

2-39. The only covered wire used in the "high side" of the r.f. circuits is in the sense circuit of the Type CRV-46040 receiver, bare bus wire being employed elsewhere. A sample of this wire gave a power factor, after 100 hours at 90% relative humidity and 38° C, of 0.02, which is well within the specifications.

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2-40(1). The asbestos covered wire samples submitted for test complied with par. 2-38(1) in that it withstood the 1,000 volt dielectric test and it did not drip when heated to 90° C for 1 hour.

2-40(2). The first sample submitted supported combustion. The manufacturer's representative furnished a second sample which did not support combustion and passed the dielectric tests.

2-41. The foil paper capacitors for power filtering purposes and employed in the Type CRV-46040 receiver and/or Type CRV-20049 power unit have a maximum of 4 mfd. in a single container. They comply with Specifications RE 13A 488B except that the size and shapes are not covered by these specifications and they were not permanently marked as to capacity. The variation from a mean value of capacitance is very small and if their rated capacitance is within the limit of the measured values, they will comply with par. 4-1 of Specifications RE 13A 488B. The results of tests made on the sample capacitors are as follows:

(a) Capacitors rated at .007 mfds. had capacity values lying between 0.0077 and 0.0079 mfds.

(b) Capacitors rated at 1 mfd. all had capacity values within 5% of the rated capacity, and ten out of twelve capacitors had capacity values within 3% of their rated capacity. The capacities of these condensers lie between 0.91 and 1.0 mfds.

(c) Capacitors rated at 4 mfds. all had capacity values within 8% of their rated value, and eleven out of twelve capacitors had capacity values within 5%. Eight out of the twelve capacitors had capacity values within 3%. The lowest measured capacity was 3.80 mfds. and the highest measured capacity was 3.98 mfds.

In lieu of the life test, as called for in par. 4-5 of reference (z), the tests called for in Specifications RE 13A 474 were made, which calls for 5 cycles of salt water immersion and temperature variation.

2-42. The sample choke coils Type CRV-30070 and resistors withstood exposure to immersion. One of the Type RI-426 transformers did not. The units were cadmium plated and hermetically sealed in metal containers to the extent indicated below. The hermetical seal in the case of the smaller condensers should be retained if soldering to the lug provided is done while the condenser is in an upright position so that the wax seal will not be broken. The larger condensers are also sealed with wax around the terminals and as these terminals are screw type studs, it is possible that the connections to lugs be soldered before attaching to the condenser studs. If this procedure is not followed, it is possible that the wax may leave the terminal from soldering heat and reduce the effectiveness of the seal. Refer to par. 2-46 for results of humidity tests on resistors.

2-43, 2-44, 2-45. Refer to par. 2-46.

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2-46. The type tests called for under this paragraph for resistors, capacitors, transformers, and chokes were performed with the following results.

Eleven 5000 ohm wire wound IRC resistors were put through five salt water immersion cycles with a temperature variation of from 65 to 0° C as specified, with no failures, and less than 1% change in resistance. Two choke coils, Type CRV-30070, when tested as above, showed practically no change in resistance of the winding or change in insulation resistance from terminal to case after the fifth immersion.

Two transformers, Type RI 426, with three windings, withstood five immersions with practically no change in resistance of the several windings and with no decrease in insulation resistance from windings to case, or between the windings, except that in one case after the fifth immersion the insulation resistance between two of the windings had dropped from over 2000 megohms to approximately 0.05 megohm as observed with a 1,000 volt megger. It is understood that these units were similarly tested before they were submitted, so it is possible that each unit actually underwent considerably more then five immersions. This one unit did fail, however, when considered on the basis of the governing specifications. Both the transformers and chokes were furnished with flexible leads coming out of the impregnating material. Their cases were cadmium plated in a satisfactory manner. The 4 mfd. paper condensers appeared to have cadmium plated cases which after completion of the immersion tests were still in good condition.

The first group of condensers submitted consisted of the following:

10 - 4 mfd. Type 72028-507
11 - 1 mfd. Type CG-48553, also marked 72024-502
10 - .007 mfd. Type 72025-510.

Three of the 4 mfd.,2 of the 1 mfd., and 4 of the .007 mfd units failed after the third immersion test. It is understood that all of the units submitted had previously been subjected to the five cycles of test. The manufacturer's representative submitted a complete lot of new condensers which were tested with the following results. The 4.0 mfd. condensers in the new lot bore the type number 72028-510 and were cadmium plated instead of black enamelled.

The second group of fixed capacitors submitted were tested to determine capacity, ability to stand a flash potential of 2-1/2 times the working voltage, and ability to withstand five cycles of salt water immersion with sudden transfer from a 65° C to a 0° C bath. (Specifications RE 13A 488B, pars. 4-1 to 4-4, and Specifications RE 13A 474B, pars. 2-25, 2-26, 2-43 to 2-47. The results are given below.

Flash voltage test. All capacitors of all three types passed the flash test of 2-1/2 times the rated working voltage applied between terminals and from terminals to case.

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Leakage. All .007 capacitors withstood the five immersion cycles satisfactorily both as to leakage between terminals and from terminals to case.

All 1 mfd. capacitors similarly passed the salt water test without a failure.

All of the 4 mfd. capacitors passed the immersion test as regards leakage between terminals. However, three of the twelve units had a larger change in leakage resistance from terminal to case than the specification limit of 75%. These capacitors are test samples 7, 10, and 16, as numbered by the contractor.

In an effort to maintain the temperature of the bath at 65° C during the third immersion, some of these capacitors were slightly overheated, resulting in the melting of a considerable part of the wax around the terminals of capacitors 7, 10, and 16. Since no failure occurred until after this overheating and since the only failures involve units from the terminals of which most of the wax had been melted off, it is believed no failure would have occurred if the temperature specified had not been exceeded. It is therefore recommended that all of these capacitors be considered to be suitable for Naval use and to have complied with the specifications regarding leakage after the immersion test.

2-47. One of the Type RI 426 transformers failed as its leakage resistance at the end of the last cycle greatly exceeded the specification limits. The wire wound resistors and chokes passed the tests and are considered satisfactory. The second lot of capacitors were found to be within specification limits except for leakage from terminal to case after the fifth immersion due presumably to melting of the wax seal when subjected to a higher temperature than the specifications require. Refer to par. 2-46.

The following paragraphs apply, in general, equally well to each of the equipments covered by this report; namely, the Models DP-4, DP-5, DP-6, and DQ-1 equipments. The term "equipment" will be used in a general sense and may be applied to any one of the above-named equipments.

3-1. The equipment is capable of indicating the true direction of propagation of CW or MCW radio signals when installed upon Naval vessels or at Naval shore establishments in accordance with the method incorporated in its design, and in accordance with these specifications, when properly calibrated, with an accuracy limited only by the vagaries of wave propagation and strength of signal.

3-2. The equipment is of the minimum (null) indicating type.

3-3. The equipment is capable of producing both bilateral and unilateral indications.

3-4. A vertical antenna is employed with the equipment for use in obtaining perfect minima (balance) and also for obtaining unilateral indications. This antenna does not connect directly or mechanically to the loop. The constants of the test antenna used are shown in Table 13.

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3-5. The equipment is designed for operation with a balance sense antenna meeting the electrical requirements of these specifications under standard balance antenna and may be trimmed to variations in antenna capacity from -50 to +650%.

3-6. The equipment is capable of producing absolute and complete zones of silence (with respect to the signal being received) at the bilateral minimum positions on either CW or MCW signals having radiation field intensities greater than 20,000 microvolts per meter.

3-7. The bilateral minima on opposite sides of the loop do not depart from true 180° displacement by more than one half of one degree at any frequency within the range of the equipment when properly adjusted. (Refer to remarks in par. 3-8)

3-8. It is not possible to vary the position of the minima from 180° displacement or vary both together more than one degree with any combination of variations of the tuning or sensitivity controls, on available signal fields up to about 20,000 microvolts per meter. On relatively strong signals at 630 kilocycles, it was found possible to shift the minima a maximum of about five degrees by deliberate unbalance, with residual signal so strong that the minimum width for a 1 decibel rise on each side was about 40°. In this case, the signal variation from minimum to maximum was only 3.5 decibels. In another case, at 950 kilocycles, a shift of 20° was noted, this case requiring for sharp minima, high balancer scale readings on either side. There was a relatively high deviation shown by this station at good balance. The general condition appears to be that well balanced minima are opposite; that they remain opposite when equally unbalanced, but that for any given balancer setting, well away from zero, one minimum is, of course, nearer balance than the other, and these minima may be off the opposite by amounts ranging up to 20 or more degrees. These errors are worse at the higher frequencies, and are somewhat worse with the transmission line. They become worse also, for those conditions requiring greater balancing voltage; i.e., higher balancer scale settings for sharp minima.

The effects noted above have not been recorded before at this Laboratory. Ordinarily, it has been considered that minima strictly opposite must be correct, as fault in the equipment normally displaces minima from the opposite. This is still believed correct, for properly balanced conditions. The manufacturer having taken exception to the conditions of test and having stated his belief that the shifts reported are due to the vagaries of wave propagation and existed in the Model DO equipments, further tests have been under taken. It has been established that similar effects exist under duplicate conditions with the Model DO equipment. It is conceivable that for certain frequencies and directions of propagation, the coupling of the balance antenna to other conductors, some of which are tuned, may result in distorted phase relations, a possible cause of the errors noted. The manufacturer finds no such errors in an ideal location, where only small balance e.m.f.'s are required. This might be so even though the fault were with the equipment.

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Attention is invited to the fact that the entire fields of the loop and balance antenna are a portion of the equipment, and that the installation conditions may, by coupling to other circuits, upset careful design work by altering the important phase relation between antenna and loop circuit voltages. The Laboratory set-up is considered comparable to average shipboard conditions.

The resubmitted equipments are undergoing further tests as this is written. During these tests, further investigation regarding the source of these errors will be made.

3-9. Unilateral indications are obtainable with sufficient clarity to be unmistakable. After the initial adjustment of the sense resistors, unilateral indications are obtained by depressing the "sense" button, and observing the signal for maximum and minimum at 90° each way from a given bilateral observation. Since an average value of sense resistor will be set for each band, it follows that the shape of the sense characteristic will vary materially over any given band. While a single sense observation, preferably for a dip in output, would usually be sufficient, it is deemed safest to obtain a rise on one side and a dip on the other for absolute security. If too high a signal level is used, an increase of receiver input may, by overloading, show a decrease in signal output. This could, therefore, cause a reversal of the sense indication, unless the outputs are always observed on the output meter, the upper limit of which is below the overload point. In general, it is necessary to decrease the sensitivity materially in order to make sense observations after bilateral operation.

As Section IV of the governing specifications covers the mechanical details of the loop and operating assemblies and as only parts have been furnished for test, only that part of the governing specifications which refers to the parts submitted will be covered herein.

The items furnished for test are as follows:

(a) 1 Loop assembly Type CRV-69006 modified for the Model DP-4 equipment.
(b) 1 Loop pedestal CRV-69007 modified for Models DP-4, DP-5, and DP-6 equipments.
(c) 1 Loop output transformer Type CRV-47100.
(d) 1 Receiver input transformer Type CRV-47101.
(e) 1 Receiver Type CRV-46040
(f) 1 Power unit, CRV-20049
(g) 1 Loop receiver connecting cable with brush assembly and attachments (non-rubber covered)
(h) 1 Loop receiver connecting shield with rubber covering.
(i) 1 Receiver power cable with attachment plugs.

Items (a) to (d) inclusive apply to the loop and its operating assembly and will be covered in this section.

The items not furnished are as follows:

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(aa) Operating pedestal (with mounting shims and fiducial mark assembly.
(bb) Azimuth scale.
(cc) Hand wheel.
(dd) Cable drums.
(ee) Deck bearings (with mounting shims).
(ff) Universal joints.
(gg) Deck bearing and pressure hull fittings (for DQ-1)
(hh) Loop assembly (for DQ-1)
(ii) Wood shims for loop pedestal.

The specification paragraphs which do not apply to the items furnished are omitted from comment.

4-5, 4-6. The loop employs a square cross section tubular housing which is circular in shape and houses the winding for radio reception purposes. Its extreme diameter is approximately 24.21 inches as measured through the center diagonally across the outer face. The loop diameter is 24 inches. The loop therefore will not rotate symmetrically in a 24 inch circle.

4-7. The loop assembly is not watertight. The loop was submerged in an inverted position, to cover all joints and seams, leaving two inches of the casting which holds the terminal block above water. After 46 hours it was found that the assembly had leaked to contain about five pints of water. The loop Q was measured at several frequencies before immersion and after. In the latter case the water was drained out through the terminal holes. The following results were obtained.

Cap. across loop	Frequency	Q before immersion	Q after immersion
40	2375	45	22
75	1985	68	40
100	1805	75	50
158	1500	89	64
250	1240	95	74
350	1080	94.5	79
450	958	94.5	83

The above test shows that the insulation (ceramic) employed is good, but its watertightness is unsatisfactory. The loop was disassembled but a careful study both before and after did not disclose definitely the point or points where leakage occurred. It is believed, however, to have occurred at the edges of the outer band which forms a greater part of the periphery of the loop. This band is secured by two clamping screws which draw the two ends of the band together and pull it against a fabric insert bakelite strip of similar dimensions. The edges of both the band and the bakelite were coated with some form of cement or wax which was very brittle and had practically no adhesive qualities when cold. It is believed that variation in temperature would cause sufficient expansion or contraction to give a sufficient movement of the band or strip as to

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break any seal that this brittle cement may have possessed.

The terminal block at the base of the loop is not watertight in its present form. The micalex terminal block is drilled with oversize holes for the four leads which come out of the loop housing and the jack terminal holes are not watertight. This terminal block is protected from water when the loop is mounted on the pedestal by a rubber gasket on top of the pedestal which clamps between the loop and pedestal when the three securing dogs are tightened. The terminal block at the top of the pedestal is of micalex and is clamped against a vellumoid packing coated with rubber cement to prevent water from entering the loop if it is mounted in an inverted position. This assembly appears to be waterproof except that the terminal plugs became loosened during the tests which would permit water to seep through around the terminals unless tight. These terminal plugs are mounted in lead washers which have presumably compressed to take the tension off of the lock washers. Some more positive means of securing these plugs should be provided which will assure watertightness.

4-8. The loop is designed for mounting on a loop pedestal assembly which is suitable for deck or overhead mounting and which carries a collector ring assembly at the mounted end. The loop pedestal assembly is provided with ball bearings at opposite ends in which the loop shafting rotates and these bearings are so designed as to be capable of taking full thrust in either direction. Means are additionally provided for securing the operating shafting to the loop shaft either directly, through cable operated drums or through universal joints, as specifically required by the governing specifications.

4-9. The loop pedestal and loop securing arrangements are of such design as to permit mounting in either an upright or an inverted position through a wood or steel deck not in excess of 2 inches. The pedestal base is 12 inches in diameter.

4-10. The loop pedestal is provided with a plug in the rotating shaft which will be just above the roller bearing at the collector ring end when mounted in an inverted position. The shaft is provided with drain holes to prevent water from collecting over this plug. Watertightness is obtained at the top of the pedestal by the means and to the extent given in par. 4-7 above. The brush assembly with its attached cable is mounted on a semi-cylindrical plate which is fastened to the loop pedestal casting by four 10-32 screws, one at each corner. This plate is of 1/16" thick brass and measures 3" x 6" and is mounted over 1/32" thick rubberized packing. This is similar to the method employed in mounting the brush assembly in the Model DO equipments. Although this Laboratory has had no reports as to the ability of this type of construction to prevent water from entering the pedestal it would appear that a stiffer plate with more screws and thicker packing would afford greater protection.

The loop support casting provides a skirt over the junction with the pedestal, when mounted in an upright position, which should afford a reasonable protection from rain or spray. If mounted in an inverted

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position this design would be unsatisfactory. It is understood that a redesign with which the Laboratory is not familiar and on which no comments as to its effectiveness can be made, has been submitted to the Bureau of Engineering.

4-11, 4-12. The amount of rake or crown that can be accommodated in mounting depends upon the shims provided. None was submitted for test.

4-13. No tests were made to determine the capability of the loop and pedestal to withstand 90-mile wind velocities, but the structure would appear to have sufficient strength to pass such a test.

4-14. The design of the loop pedestal and loop is such as to permit quick detachment of the loop from the pedestal without tools. Tightening of the wing nuts causes the clamping dogs to slip away from the points on the clamping projections which would give the most positive lock. Indents should be furnished on the under side of these projections to prevent the dogs and thin washers from slipping outward.

4-15. The wing nuts are not provided with holes for securing wires, but the studs have had their threads upset to the extent that wing nut removal is difficult. The manufacturer's representative states that securing holes will be provided in the wing nuts in the production equipments.

4-16 to 4-49 inclusive cover the operating pedestal, deck bearings, azimuth scale, hand wheels, drums and universal joints, none of which were submitted for test. It is noted that specification 4-43 permits a total drum circumference variation of 1/8 inch. This amounts roughly to 1° and means, with the 450° rotation required, that if two drums dissimilar to this extent were used together, that errors of 1° must occur. For instance, assuming that the scale zero comes within the 90° overlap sector, turning the handwheel and scale exactly 360° to zero again must rotate the loop shaft 359 or 361°. This is inconsistent with specification 3-1. It is believed that closer machining tolerances are practical. In this connection, it is not evident from the specifications which contracting party is to furnish the driving cable. Provision should be made for the use of a spring take-up to keep the cable taut.

Specifications 4-47, 4-48 and 4-49, while requiring universal joints, are not entirely definite in respect to the accuracy of the angular drive. Attention is invited to the principle that universal joints must be used in pairs, and that the forks on the intermediate shaft must be parallel to avoid angular distortions between the driving and driven shafts. The possible distortion increases with the obliquity of the intermediate shaft, and at the 10% slope of specification 4-47 amounts to a maximum of about one-half degree. This error is worth correcting, as it merely involves mounting the forks parallel on the intermediate shaft. If greater slopes are ultimately used, directions for proper installation would be much more important.

4-50. The Type CRV-47100 loop output transformer and the Type CRV-47101 receiver input transformer were furnished for test and permit operation of the Type CRV-46040 receiver within the limits of "loop trim" as specified without limiting performance in accordance with these

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specifications, with a 35-foot transmission line.

4-51. The governing contract states that this paragraph shall not apply in view of the requirements of par. 7-2(2) of governing specifications, RE 13A 474B.

4-52. The Type CRV-47100 and CRV-47101 transformers are complete in themselves, ready for installation. They are housed in a cast aluminum alloy casting with a rubber gasketed cover plate which is fastened in place with screws. A plate is also fastened to the casting which extends beyond the base by about 11/16" and is drilled to provide means for mounting on a flat surface. The connections to the transformers are made through shielded leads. The shields are of the "Breeze" type with a rubber covering over the woven wire shield and are furnished with "Breeze" type screw fittings at each end.

4-53. No switches are employed with the Type CRV-47100 and CRV-47101 transformers.

4-54. The only provisions made in the Type CRV-47100 and CRV-47101 transformer cases for connection between the transformers are two 3/16" holes spaced 3/4" through the case wall, and a boss in the box wall opposite to the fitting furnished. The two holes should not be present in production equipment.

4-55. The Type CRV-47100 and CRV-47101 transformers are spraytight but not watertight unless the screws which extend through the cases for the internal coil mountings are gasketed. Refer to comments on par.4-52 above.

4-56. The Type CRV-47100 and CRV-47101 transformer cases are within the size limitations specified, being 5-7/8" long, 4-1/8" deep, and 5-5/8" high. The base dimension becomes 4-1/8" x 7-1/4" with the mounting plate that is attached to the base.

4-57. Refer to comments on par. 4-52 above. The shielded cables for connection of the Type CRV-47100 and CRV-47101 transformers to the loop and/or receiver are each 17-1/2" long, including fittings.

4-58. When proper holes are bored in the cases of the Type CRV-47100 and CRV-47101 transformers for the fittings used with the transmission line adopted at the time of installation, the design will be satisfactory for operation.

4-59. The weights of the loop and loop pedestal assemblies are as follows:

Loop Assembly	19.7 pounds
Loop Pedestal	37.35 pounds

The other units covered by this paragraph were not furnished.

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4-60. The cast metal parts of the loop and loop pedestal assemblies are of aluminum alloy. The exceptions to the specification calling for aluminum alloy which are not specifically allowed are the collector rings, phosphor bronze contacts and the brass cover over the slip ring compartment. It is apparent that none of these latter items should be of aluminum alloy. It is claimed by the manufacturer's representative that the slip rings are of monel metal. The phosphor bronze spring contacts are plated with what appears to be dull nickel. This plating has worn through on 5 out of the 8 contact fingers. In one case, the exposed bronze presents a very rough appearance. The monel metal slip rings appear to have a very smooth surface throughout the contact area. It is believed that the use of silver contact buttons riveted into the bronze springs would provide a more satisfactory contact.

4-61. The pedestal casting, loop housing, cases for the Type CRV-47100 and CRV-47101 transformers, and collector ring aperture cover plate are painted inside and out with red iron oxide. The shaft coupling is likewise painted on its exterior surfaces. The pedestal shaft is bare aluminum. No zinc chromate primer has been used.

4-63. The loop winding mid-points are each grounded to the loop housing which, in effect, forms the connector strap. A signal generator may be coupled to the loop center by removing these connections from ground and clamping them under two screws provided in the micalex terminal block which provides the necessary insulation and terminals for the generator connection. There is some difficulty, however, in bringing these generator leads out of the loop pedestal assembly as the loop housing overlaps the pedestal head for 1/2" with approximately 1/16" clearance between the overlapped parts. This requires that the generator connections pass through this clearance and that the loop housing ring be separated from the pedestal base by the thickness of the generator conductors when the signal generator is connected for use. This may affect the continuity of ground from the loop housing to the pedestal unless special precautions are taken. It would appear very advantageous if a hole were provided in the loop housing leading into the space occupied by the plug and jack assembly so that the signal generator connections could be made without special leads and precautions. This hole could be satisfactorily closed by a pipe plug when not in use.

5-1. This specification is general in its scope and the subject equipment submitted for test complies except in such specific instances as are mentioned independently in this report.

5-2. The Type CRV-46040 receiver is housed in a suitable metal cabinet which contains integral therewith all necessary apparatus to permit the receiver to function in accordance with the governing specifications, reference (b), except as specifically noted, in combination with a loop assembly, antenna power unit and head telephones. Plate 101 shows a photograph of the receiver housed in its cabinet, while Plates 102 and 103 show photographs of the top and bottom views, respectively, of the receiver chassis.

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5-3. The dimensions of the cabinet of the CRV-46040 receiver are as follows:

	Actual Dimensions	Specification Dimensions
Height	12-7/8 inches	14 inches
Depth	17-5/16 "	18 "
Width	23-7/8 "	24 "

The shock absorber mountings add 1" to the overall height of the receiver cabinet and an additional 6-3/8" should be allowed overhead at the left hand end for the attachment of the loop cable and antenna as illustrated on Plate 101. The control knobs and front panel require an additional 2-1/8" in front, while the power supply cable and plug require an additional 5-3/8" at the rear of the cabinet to permit the removal of the cable plug. Reference (ii) states that the space available for installation does not permit the clearance at the rear of the receiver which would be required for removal of the power cable plug in its present location. The cabinet of the Type CRV-46040 receiver is lower and deeper than that of the receiver for the equipments listed under reference (d). Dimensions of this cabinet are given under par.98 of reference (e). In the case of these equipments, the power supply cable to the receiver is permanently attached to a terminal strip located inside and at the rear of the receiver cabinet. The power supply cable is small in diameter and has greater flexibility. Hence, the space necessary behind the cabinet, for installation, is considerably less. The method employed for connecting the power supply cable to the receiver of the subject equipment is a distinct improvement over that employed for the equipments listed under reference (d) because it greatly facilitates servicing. In the former method, the connection of the power supply cable may be made as easily with the receiver chassis in or out of its cabinet, whereas in the latter method the power supply terminal block must be removed from the cabinet if the power supply is to be connected to the receiver chassis when it is removed from its cabinet.

5-4. The cabinet of the Type CRV-46040 receiver is designed for table mounting and is provided with four No. 45 "Lord" shock absorbers each of which mounts with screws at each of four corners. The mounting holes at the four corners are 2-1/2" apart.

5-5. The Type CRV-46040 receiver weighs 86.5 pounds which is in excess of the specifications by 20.5 pounds but is within the contractural specification which allows 100 pounds

5-6. The design and construction of the receiver is such that the panel secures to the chassis with all integral parts attached thereto and is removable from the cabinet as an assembly for tube changing and servicing purposes without disturbing the cabinet. No special access doors are provided for tube insertion.

5-7. The interior of the receiver cabinet is provided with flat tracks upon which the receiver chassis slides to permit the easy removal of the receiver chassis without binding or chafing. This construction is

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superior to that employed for the type of receiver used with the requirements listed under reference (d). In this earlier model, button guides are employed in the bottom of the receiver cabinet. The runners at the base of the receiver chassis slide under these buttons and it is possible when sliding the receiver chassis in its cabinet to miss the rear buttons and not only bind the chassis in the cabinet, but also do damage to some of the shielding on the top side of the receiver chassis.

5-8. The design of the receiver chassis with respect to the mounting of integral parts is such that when removed from the case it may be placed on a flat surface on the base, back, or either side without possibility of damage or derangement of any of the component parts. This assumes that the power supply cable plug is removed. It is further understood that the contractor expects to furnish protecting angles on the back of the receiver chassis to permit placing it on its top without injury to any of its component parts.

5-9. The front frame of the receiver is provided with two handles of the drawer-pull type to permit the removal of the receiver chassis from its cabinet without putting any strain on any of the control knobs or dials.

5-10. The front of the receiver panel is finished with a standard black wrinkle finish to match the exterior finish on the receiver cabinet. The rear of the receiver panel, except for a flat black lacquer border approximately 1/2" wide, has a sand blast finish over which there is a thin coating of clear lacquer. The thin coating does not appear to be ample protection against the corrosive action of salt, humid atmosphere.

5-11. The control designations are all engraved on the receiver panel, with the exception of the balance control which has a photo-etched nameplate.

5-12. The panel of the receiver includes the following controls and/or devices.

(1) Main tuning control.
(2) Frequency band change switch.
(3) Sensitivity control.
(4) On-off switches:
    (a) Line voltage to power unit.
    (b) Panel and azimuth scale indicator lamps.
    (c) CW-MCW switch.
(5) Balance control.
(6) Sense push button switch.
(7) Two phone jacks.
(8) Output volume indicator.
(9) Output volume indicator range switch.
(10) Two panel lights.

The Type CRV-46040 receiver employs one tuning control for both antenna and loop tuning. The type of receiver employed with the equipments (Model DO, etc.) listed under reference (d) requires a separate tuning control for antenna tuning. The subject receiver is, therefore, better

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than the latter in this respect.

5-13. The design and construction of the mounting of integral parts is such as to minimize the effects of shocks and vibration both on performance and with respect to damage. See par. 2-2 for workmanship regarding greater rigidity or support of receiver wiring.

5-14. The band switches, variable capacitor contacts, and sense switch contacts employ silver facings. The CW-MCW switch, which may be considered as a power switch, as it controls the "B" supply to the i.f. oscillator tube, is an ordinary commercial type toggle switch. Although this complies with the specifications, difficulty has been experienced with similar switches used for similar purposes.

5-15. The only electrical indicating instrument used on the receiver is the output volume indicator which is of the 2-1/2" diameter flush mounting type.

5-16. Anti-glare glass has been provided for the output volume indicator meter.

5-17. No special tests have been made on the output volume indicator meter to determine the degree of protection provided against prolonged exposure at high humidities. The only meter submitted was included in the sample receiver and this meter was put through one temperature cycle at between 85 and 90% humidity as mentioned elsewhere in this report.

5-19. The operating panel has words or phrases,descriptive of the purpose of the particular control and/or devices and with the exception of the balance control, are engraved adjacent to each major control or device. The balance control is identified by a photo-etched nameplate which includes a graduated scale in addition to the descriptive word for the control. It is believed that it would be advantageous to add a graduated scale for reference with the pointer on the sensitivity control knob. The use of such a scale will require a different type of knob. The three adjustable sense resistors on the main panel, and the antenna and loop trimming adjustments, six in number, on the top of the receiver, are unmarked, with the intention of requiring reference to the instruction book for their adjustment during installation. This is considered good practice.

5-20. The Type CRV-46040 receiver is of the uni-controlled type having but one main tuning control.

5-21. The frequency range of the Type CRV-46040 receiver is from 100 to 1500 kilocycles without hiatus, the range being covered by three positions of the band change switch.

5-22. The Type CRV-46040 receiver employs band switching for all frequency changes and includes all necessary inductances permanently within the chassis.

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5-30. No friction driven verniers are used.

5-31. The main tuning dial is calibrated on the basis of 1000 equal divisions, each 100 divisions being marked on the vernier dial and each 10 divisions on the counter dial. Each 10 vernier divisions and each counter division is marked with appropriate figures.

5-32. The main tuning is accomplished by vernier control only.

5-33. The main tuning vernier has a 20:1 ratio.

5-34. The vernier of the main tuning control is of the worm and split gear type with spring take-up. It is easy running, but is not entirely free from back-lash. In spots it is believed to exceed slightly the 1 vernier division allowed.

5-35. The only vernier other than the main tuning control is that provided for the balancer.

5-36. The design of the vernier of the main tuning control is very similar to that used on other equipment furnished by the manufacturer of the subject receiver, and although this particular control is not free from back-lash, other controls incorporating this same design have demonstrated the practicability of the design. The balance vernier is similar to that employed in the Type CRV-46031 receiver which is a part of the Models DO-1, DO-2, and DO-3 equipments. It appears, however, that this particular vernier control has been made more rugged and operates more smoothly.

5-37. Plate 1 shows a calibration curve for each of the three bands of the Type CRV-46040 receiver. The variation in frequency for each ten divisions of the dial scale as tabulated for each band of the receiver in Table 1. Included under this table also are the limiting values for frequency variation allowable for any limiting values are based upon the method described for their determination in this specification. The variation in frequency with dial setting does not meet the requirements of these specifications for any setting above 825 divisions for any band. Inasmuch as the same condenser is employed for tuning each band, the failure of the receiver to meet this specification in one of its bands indicates it will obviously fail to comply in the same degree in all bands. The manufacturer's representative is aware of this failure. However, he has called attention to the fact that the ganged tuning condenser furnished in the model contains handmade plates. It is claimed by him that while the ganged tuning condenser proposed for the production models will possess a more uniform frequency variation per ten divisions of dial scale from 0 to 825, it is doubtful that much improvement could be made from 825 to 1,000 scale settings over that furnished in the model without resorting to a much larger condenser, physically, and of very special and impractical design. Reference (ii) states that the Bureau concurs with the impracticability of attempting to greatly improve the linearity of frequency variation with dial scale settings from 825 to 1000. It is understood that the Bureau will initiate steps to authorize the necessary change in the specification requirements.

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5-38. The indicator dial window for the main tuning control is lighted with two suitably arranged lamps which may be replaced by the removal of a cover plate that is attached to the main panel by two screws. The balancer indicator dial is illuminated by a single lamp located within a housing, with a light aperture so arranged as to throw light only at such an angle as to make the dial visible. It is not believed that the illumination is sufficiently intense to impair the darkness integrity of the operating room.

5-39. The markings on the main tuning control dial are visible at an angle of approximately 45° from a perpendicular erected from the panel. This limits the angle at which the dial is visible to 15° less than that specified. It would be far from a simple matter mechanically to retain the advantages of the dial lighting system provided and the size of the control knob, which is none too large, and at the same time greatly increase the angular range of visibility. The Bureau's approval of visibility of the main tuning control dial on the Type CRV-46040 receiver submitted for trial is given under reference (ii).

5-40. The main tuning dial, including the digit counter of the main tuning control, is placed behind the panel and is viewed through a window.

5-41. The window of the main tuning control is provided with antiglare glass secured to its retainer by metal clips locked with screws, making an entirely satisfactory arrangement.

5-42. The window of the main tuning dial is of such size that two figures are visible simultaneously on both the vernier and the counter dials at such angles as given in par. 5-39 above.

5-43. Numerical markings and graduations on the vernier and counter dials of the main tuning control are engraved and filled with black wax. The dials themselves are white. These markings, as well as all other engraved letters and/or numerals, and the markings on the photo-etched nameplate for the balance control, are easily readable at a distance of 24" under normal operating conditions.

5-44. Three calibrated charts are provided which are mounted in a frame behind a non-glare celluloid window on the front of the receiver panel.

5-45. Each calibration chart is provided with spaces for recording the necessary receiver settings for 45 frequencies.

5-46. The receiver has been furnished with calibration settings recorded on a chart for the following frequencies.

Each even 25 kilocycles for the low frequency band.
Each even 50 kilocycles for the medium frequency band.
Each even 100 kilocycles for the high frequency band.

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5-47. The calibrations required by par. 5-46 and furnished with the receiver are accurate to better than 2% for each of the recorded frequencies as demonstrated by the data shown under Table 2. Complete calibration curves measured at the Laboratory are shown on Plate 1.

5-48. The calibration chart has been provided with a protective cover of transparent, non-shatterable material.

5-49. A manually operated sensitivity control has been provided which is operable from the front panel of the receiver.

5-50. The range of the sensitivity control of the Type CRV-46040 receiver is shown on Plates 71, 72, and 73 for the set-up simulating the Models DP-4 and DQ-1 equipments, and on Plates 73, 74, and 75 for the set-up simulating the Models DP-5 and DP-6 equipments. Curves are shown on Plates 71, 72, and 73 for CW and 30% MCW inputs and for CW inputs only on Plates 73, 74, and 75. For all curves the input required for standard output with the sensitivity control adjusted for optimum gain is taken as the zero decibel reference level. The attenuation in overall receiver gain with angular rotation of the sensitivity control was calculated from the change in absolute microvolts input into the loop center required to maintain standard output. The range of the sensitivity control for all equipments and for CW or 30% MCW inputs, is greater than 100 decibels as required by reference (b) when these attenuations are expressed in terms of absolute microvolts input into the center of the loop and with standard conditions taken as the reference level. It will become at once apparent from an examination of the data shown under column "G" of Table 3, that the requirements of this specification are inconsistent with those of par. 7-2 governing the sensitivity requirements which are, in general, met by all equipments. In order to meet the specification requirement of 100 decibels attenuation for a CW input equivalent to 50,000 microvolts per meter field strength, the overall sensitivity of the equipment under consideration would necessarily have to be much higher than is required by par. 7-2 of reference (b). Complete data is given under Table 2 for the several equipments covered by this report. These data show for each of the overlap frequencies of each band, the sensitivities at optimum gain (zero decibels reference level), the attenuation realized and expressed in terms of absolute microvolts input into the center of the loop, with the sensitivity control retarded to either its minimum position or at such a setting where an r.f. input of 1/2 volt produced standard output; and the attenuation realized with the sensitivity control retarded so that standard output was obtained for a CW input equivalent to 50,000 microvolts per meter. With the test set-up simulating the Model DP-4 equipment, it was observed that at the 250 kilocycle setting for the low frequency band and with the sensitivity control retarded to its 22° setting, a reaction occurred. This reaction appeared to be due to overloading of the first detector and was attended by another signal which beat with the incoming signal. This overloading became more pronounced as the sensitivity control was further retarded toward its minimum setting with its output signal decreasing instead of remaining constant for increasing signal input with corresponding decrease in gain. At the same frequency setting

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on the medium frequency band, there was no evidence of this reaction although the sensitivity and selectivity are very nearly the same as for the low frequency band at this frequency.

5-51. No measurements were made for transrectification, it being felt that the results of other tests indicate that no harmful transrectification exists. It may be concluded that in view of the fact that with the receiver adjusted at such gain as to maintain standard output and with an input of 50,000 microvolts per meter, the selectivity was not altered from that obtained under standard conditions at any frequency at which measurements were made. Had transrectification taken place the selectivity at reduced gain would have been broadened. Also, it should be noted from column "C" of Table 3, that the gain setting for standard output for an input equivalent to 50,000 microvolts per meter is not at zero but considerably away from the minimum gain setting for any of the test frequencies. Obviously then, if transrectification did not take place at these gain settings, it would not occur at minimum gain settings for the same input.

5-52. The sensitivity control operates in such a manner that the selectivity of the receiver does not fall below the requirements of par. 7-3 of reference (b) when measured with any resonant input equivalent to 50,000 microvolts per meter with the receiver gain reduced to such a point as to maintain standard output. Selectivity curves measured under these conditions are shown on Plates 44 to 46, inclusive, for CW inputs, and on Plates 50 to 52, inclusive, for 30% MCW inputs for the Models DP-4 and DQ-1 equipments. Similar curves are shown on Plates 56 to 58, inclusive, for CW inputs for the Models DP-5 and DP-6 equipments. These selectivities were all measured with loop excitation. The selectivity curves shown on these plates are generally better than for the equipments listed under reference (d).

5-53. The sensitivity control of the Type CRV-46040 receiver operates in such a manner as to provide for a linear relationship within $\pm$ 6 decibels between its angular rotation and the audio output in decibels for any constant input up to such value as to produce maximum output except at the one point as mentioned in par. 5-50. Curves are shown for CW inputs on Plates 77 to 79, inclusive, for the Models DP-4 and DQ-1 equipments and on Plates 80 to 82, inclusive, for the Models DP-5 and DP-6 equipments. It will be noted from the curves that the rate of change of audio output changes at approximately the 120° setting of the sensitivity control. This is due to the construction of the sensitivity control which has a two section resistance element, each section differing from the other in its taper law. The rate of change of audio output with angular rotation of the sensitivity control of the type of receiver employed with the equipments listed under reference (d) is more nearly constant than for that of the subject receiver and requires a greater rotation for the same degree of attenuation.

5-54. The sensitivity control of the receiver operates in such a manner as to permit a variation in output for any constant value of input in steps less than 2 decibels.

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5-55. The sensitivity control operates in such a manner that the noise level is reduced in approximately direct proportion to the output signal from maximum output down to such a level where the noise level was too small to measure. The variation of noise level with output voltage is shown by curves on Plates 83 to 85, inclusive, for the Models DP-4 and DQ-1 equipments and on Plates 86 to 88, inclusive, for the Models DP-5 and DP-6 equipments. Each measurement was made with a constant CW input applied at the loop center and of such a magnitude as to produce standard output at optimum gain. This was taken as the reference level. The output voltage and noise voltage were then measured for several settings of the sensitivity control both above and below the setting for optimum gain.

5-56. During the period of the subject tests operation of the sensitivity control did not introduce any noticeable extraneous noises in the audio output.

5-57. All variable resistors used as a part of the sensitivity control are of the wire wound construction.

5-58. A rectifier type output volume indicator meter has been provided and is mounted in the front panel of the receiver.

5-59. The volume indicator output meter does not approach the speed of the so-called "instantaneous" type previously tested at this Laboratory. Its "responsiveness" and "damping factor" are .625 and 3.0, respectively, instead of 7.5 and 40.0 as required by the governing specifications. It is understood that the specifications were written around a larger meter and that the instrument manufacturer was unable to meet the specifications due to the smaller size, but the figures given by this manufacturer to the contractor show the subject instrument to have a better "responsiveness" and "damping factor" than the Laboratory's tests show. It would appear that for the subject equipment, where there is plenty of space and particularly as the instrument will be referred to for observation of small deflections, a larger meter that could have the characteristics specified would be preferable. Reference (ii) states, however, that the Weston Electrical Instrument Company can furnish a meter of the present size, 2-1/2" diameter, having a "damping factor" between 16 and 200, with a period for one complete swing measured at zero and as defined in reference (b), of 0.6 second or less. The representatives of the Weston Electrical Instrument Company have agreed to submit a sample to the Bureau for test. The characteristics of the present instrument are as follows:

Instrument proper	2-1/2" flush mounted.
Zero level (approximate mid-scale)	60 microvolts
Reference output impedance	600 ohms
Full scale	+5 decibels
Minimum calibration	-10 decibels
Calibration	1 decibel unit plus: two decibel units minus.
External range extension	3 steps as follows: direct, add 5 decibels, add 10 decibels, add 15 decibels, off.
Instrument resistance	5000 ohms.

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5-60. The rectifier type of output volume indicator meter is provided with a 5-position dial switch slightly below and approximately 1-5/8" to the left of the center line of the instrument. This arrangement is necessary to provide symmetry of controls. The switch provides for the following full scale readings of the instrument, reading from left to right:

Direct, add 5 decibels, add 10 decibels, add 15 decibels, off.

5-61. The output volume indicator meter is calibrated in 1 decibel units from zero level to +5 decibels and in 2 decibel units from zero level to -10 decibels, the zero being at approximately mid-scale. There is a marking under the zero calibration of "0.6 volt" which refers to the actual voltage required for instrument operation, but as it does not apply to the phone output of the receiver, which should be approximately .19 volts, it is recommended that it be left off the scale of the production instruments. The Bureau concurs with this recommendation in reference (ii) and further suggests that any other markings on the face of the instrument, such as "Rectifier Type" which is desired to more readily identify it with the manufacturer's symbols, should be so placed as not to be confused with the Navy type designation or considered a part thereof.

5-62. The range switch of the output volume indicator meter operates in such a manner as to pad the output transformer so as to maintain an approximately uniform output impedance with the switch on any tap, including the "off" position.

5-63. The volume indicator instrument is transformer coupled to the output tube using a separate winding on the output transformer and requires 72 microwatts of power for zero level.

5-64. The antenna and loop terminals are located on the top of the receiver.

5-65. The receptacle for the power supply cable is located 5 inches from the table level and 4-5/8 inches from the right hand end and at the rear of the receiver cabinet. The azimuth cable receptacle, also located at the rear of the receiver cabinet, is 7-1/2 inches from the table level and 6 inches from the right hand end of the cabinet.

5-66. The power supply cable plug receptacle is designed for receiving the power supply cable plug and is the male section of this connector assembly.

5-67. CW reception is provided for by means of a separate heterodyne oscillator.

5-68. No variable type of oscillation control is provided on the receiver.

5-69. A CW-MCW switch controls the plate supply to the second oscillator tube in such a manner as to render it instantaneously operative or inoperative with the tube cathode emittive.

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5-70. The oscillators (r.f. and i.f.) in the receiver are so designed and adjusted as to provide suitable values of excitation for the detectors with tubes approaching the maximum and minimum limits for mutual conductance permitted by the governing specifications.

5-71. R.F. and I.F. oscillator tubes having mutual conductances as high as 1260 and as low as 1075 micromhos will oscillate at any frequency within the operating range of the subject receiver without spurious oscillations. Sensitivity and maximum noise data measured with the original oscillator tubes replaced by tubes having different values of mutual conductance are given under Table 5. It will be noted that no appreciable change was effected either in the sensitivity or maximum noise level of the equipment under test at any of the test frequencies.

5-72. The amplifier stages of the receiver were equipped with tubes having mutual conductances varying from 1760 to 1840 micromhos, the highest available at the Laboratory, and there was no indication of instability or spurious oscillations, except as mentioned in par. 5-50. It should be mentioned, however, that before the receiver tests started, difficulty was experienced in obtaining a satisfactory low noise level at certain settings of the main tuning dial of the receiver. This was traced to some form of spurious oscillation existent in the r.f. stage which employs a Type 6D6 Navy Type 38646 tube. Several tubes were tested in this stage and it was found that approximately 20% of the tubes available at the Laboratory, which included about 50 furnished by the manufacturer, possessed this characteristic. Tubes possessing this characteristic when placed in other stages had no noticeable effect on the noise level. It is understood that the manufacturer has had a conference on this situation with the Bureau of Engineering and that it was concluded that the tests be made with such tubes as did not increase the noise level or did not possess this peculiar characteristic. The reasons for the spurious oscillation have not been determined at this Laboratory, but such tests as have been made indicate that it is a tube and not a circuit characteristic.

5-73. A total of 9 tubes are employed with each of the subject equipments and are as follows:

Type CRV-46040 Receiver

R.F. Amplifier Tube	RCA Type 6D6	Navy Type 38646
1st Detector Tube	RCA Type 6D6	Navy Type 38646
1st I.F.Amplifier Tube	RCA Type 6D6	Navy Type 38646
2nd I.F.Amplifier Tube	RCA Type 6D6	Navy Type 38646
2nd Detector Tube	RCA Type 6C6	Navy Type 38636
A.F.Amplifier Tube	RCA Type 76	Navy Type 38076
R.F.Oscillator Tube	RCA Type 6C6	Navy Type 38636
I.F.Oscillator Tube	RCA Type 6C6	Navy Type 38636

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Type CRV-20049 Power Unit

Rectifier Tube RCA Type 5Z3 Navy Type 38593

The tube complement of the receiver and power units of the equipments listed under reference (d) is as follows:

RCA Type 39 - Navy Type 38039 tubes used in r.f. amplifier, 1st detector, and 1st and 2nd i.f. amplifiers.

RCA Type 37 - Navy Type 38037 tubes used for 2nd detector and 1st audio amplifier.

RCA Type 38 - Navy Type 38038 tubes used for r.f. and i.f. oscillators.

RCA Type 80 - Navy Type 38080 tube used for power unit.

5-74. The types of tubes employed in the Type CRV-46040 receiver and in the Type CRV-20049 power unit are considered to be entirely satisfactory for the purposes intended, except as mentioned in par. 5-72.

5-75. Each resonant circuit of each frequency band both r.f. and i.f. of the Type CRV-46040 receiver is provided with an adjustable "trimmer" to permit all equipments to be accurately trimmed. Antenna trimming is accomplished by means of air dielectric trimmer condensers having a nominal capacity of 100 μμf maximum. These adjustments are made through holes in the top of the receiver cabinet. In addition to these trimmers, the antenna load coils, of which there is one for each band, have adjustable "poly-iron" cores for adjusting the initial inductances of these coils. The loop circuit trimming is accomplished in a similar manner except that adjustable iron cored load coils are used only for the low and medium frequency bands, there being no load coils in the high frequency band. The same type of air dielectric trimmer condensers are employed as for the antenna circuit and are also adjustable through holes in the top of the receiver cabinet. The resonant circuits of the r.f. amplifier consist of adjustable "poly-iron" cored inductances for the low and medium frequency bands and an air cored inductance for the high frequency band. All three coils are trimmed with air dielectric trimmer condensers having a nominal rating of 100 μμf maximum capacity. A similar arrangement of coils and trimmer condensers is employed for the r.f. oscillator. Each of the transformers used for the i.f. amplifiers consists of two inductances having adjustable "poly-iron" cores and are magnetically coupled on the same coil form. Fixed capacitors are connected across each inductance and tuning is accomplished by the adjustment of the "poly-iron" core. These adjustments are accessible through a hole in the top of the shield can. The trimming of the r.f. and i.f. circuits is made at the factory. Trimming of the antenna and loop circuits must be done at installation. All trimmers in the r.f. and i.f. circuits appear to have sufficient electrical leeway to permit proper alignment with vacuum tubes having characteristics within the maximum and minimum values permitted by Specifications RE 13A 600A, reference (x).

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5-76. Each loop trimmer condenser in the Type CRV-46040 receiver has a nominal capacity of 100 μμf. The settings of these condensers when adjusted for the standard 9 foot loop receiver coupling cable, which has a capacity of 33.50 μμf, are as follows:

Low frequency band	-	64	μμf.
Medium " "	-	43	"
High " "	-	26	"

These trimmer condensers therefore have sufficient range as not to limit the performance of the subject equipments with a ± 50% variation in the length of the shielded coupling cable. It should be noted that this statement applies to the Models DP-5 and DP-6 equipments where a 35 foot transmission line and coupling transformers are employed, because the reflected capacity across the loop terminals of the receiver is approximately the same as though the 9 foot cable were employed in the Models DP-4 and DQ-1 equipments. The antenna trimmer condensers are of the same size and type as employed for the loop circuits and have sufficient range to permit the use of an antenna having a capacity of from 90 to 1500 μμf. This last figure is by no means the limit, but was the highest capacity tried at the Laboratory and it was not considered worthwhile to carry the measurements further.

5-77. All r.f. trimming condensers of the Type CRV-46040 receivers are of the air dielectric type with nickel plated plates mounted on isolantite and are so constructed as to depend upon rotational friction to retain their adjustment. This friction appears to be ample to preclude movement during transportation or normal service. These trimmer condensers are vastly superior to the mica dielectric padding condensers employed in the Type CRV-46038 receiver used with the Models DP, DP-1, DP-2, and DP-3 equipments or the Type CRV-46039 receiver used with the Model DQ equipment. Not only will this adjustment be more permanent under conditions of vibration, but their capacities will be less affected by changes in temperature and humidity.

5-78. The design of the Type CRV-46040 receiver provides means for trimming the loop and antenna circuits of each band by use of an internal insulated screw driver, or an insulated wrench through holes in the top of the receiver cabinet, while the receiver chassis is inside of the cabinet and the receiver is in an operating condition. This is in pleasing contrast to the Type CRV-46038 and/or CRV-46039 receiver used with the equipments listed under reference (d), with which trimming of the loop and antenna circuits can be accomplished only by removing the receiver chassis from its cabinet and applying power to the receiver by means of an auxiliary power supply cable, or by dismounting the power supply terminal strip from the inside of the rear of the cabinet so that the leads may be extended to the power supply terminal strip on the receiver chassis. This procedure is most inconvenient and aggravates the wear on the power supply cable which could have been avoided had holes been provided in the top of the receiver cabinet for the insertion of a trimming tool. Also, only one trimming condenser is provided for tuning the loop circuits, this condenser being connected between antenna and ground. The loop circuit has adjustable trimmer condensers for each band

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but the adjustments of two of these condensers are sealed at the factory leaving but one; namely, that for the high frequency band, accessible for adjustment at the installation of the equipment.

5-79. The antenna and loop trimmer condensers for each band of the Type CRV-46040 receiver, when set but once for each band, permit specification performance over the complete frequency range of any band. For the tests conducted on the subject equipments, the loop and antenna circuit for each band was trimmed at the high overlap frequency for that band. In the case of the CRV-46038 and/or 46039 receivers, reference (d), antenna and loop trimming are done but once and then at 1500 kilocycles.

5-80. The receiver chassis of the Type CRV-46040 receiver has been provided with two terminals so located in the detector circuit as to permit the insertion of a d.c. microammeter to read detector output increments for alignment purposes and selectivity measurements. No such provision is made in the Type CRV-46038 and/or CRV-46039 receivers, reference (d).

5-81. These terminals are at present so located that there is but 100mmfds. of by-pass to ground ahead of the meter that will be used for alignment purposes. It is recommended that these terminals be placed between the 220,000 ohm plate resistor and the 47,000 ohm filter resistor back of the .5 mfd by-pass condenser which will provide better filtration.

5-82. These terminals are provided with a short circuiting link to keep them permanently closed for normal operation.

5-83. The receiver is provided with two long spring type transformer output jacks which are interchangeable with Navy standard jacks and are connected in parallel across the output transformer. They are mounted on the front panel and are entirely insulated therefrom.

5-84. The output transformer was not disassembled to determine its construction, but from the tests made there was no indication of the presence of r.f. potential in the telephone receivers and/or cords.

5-85. The output transformers of the Type CRV-46040 receiver complies with this specification. Plate 94 shows that the output impedance is approximately 700 ohms, although very little change is effected on the output for a load impedance varying from 500 to 1000 ohms.

5-86. The cabinet of the Type CRV-46040 receiver and all parts exterior thereto are so arranged as to operate at ground potential.

5-87. The receiver appears to be capable of operating continuously in an ambient temperature of 51.5° C without damage to or deterioration of any parts thereof excluding normal life deterioration of vacuum tubes and a possibility of oil condenser breakdown as evidenced by the tests made on the first lot of paper condensers submitted.

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5-88. The Type CRV-46040 receiver employs a superheterodyne circuit with a tuned loop and a tuned r.f. plate circuit preceding the first detector.

5-89. Means has been provided on the Type CRV-46040 receiver to permit the balancing (with respect to the input of the first vacuum tube) of all quadrature voltages arising in or from the loop. The device by which this is accomplished shall be referred to as the "balancer."

5-90. The "balancer" is contained within the receiver cabinet and mounted on the front panel of the receiver chassis. It is operated from a single panel vernier control.

5-91. The "balancer" panel control operates through a vernier having a 10:1 ratio.

5-92. No direct control of the "balancer" is provided, control being accomplished only by vernier action.

5-93. The balancer is provided with a calibrated scale having zero center with 50 divisions both left and right with every 10th division appropriately marked on the basis of 50-0-50.

5-94. The dial scale for the balancer is marked "+" to indicate clockwise rotation of the balancer and "-" to indicate counterclockwise rotation from zero.

5-95. The design of the balancer is such that the electrical and mechanical centers of balance coincide within 5% (2-1/2 divisions) of each half of the balancer dial scale. Measurements show that the center of electrical balance occurs at +0.5 divisions for the low frequency band, at -2.0 divisions for the medium frequency band, and at -2.5 divisions for the high frequency band. These figures are independent of frequency within their respective bands.

5-96. The variation in balancer sensitivity measured at each 10th division at the center of balance of the balancer dial setting is shown on Plates 16 to 21 inclusive for each of three frequency settings of each band of the receiver with CW and/or 30% MCW inputs applied to a standard balance antenna. These curves apply on the Models DP-4, DP-5, DP-6, and DQ-1 equipments. The curves show the field strength in microvolts per meter required at the several settings for standard output with the receiver gain adjusted for optimum conditions. It will be noted from the curves that the input required for standard output at the center of the balance approaches infinity. Table 4 shows the variation in input voltages at the $\pm$ 50 settings of the balancer control for each frequency at which measurements were made. At any frequency the total difference between the inputs at the two extreme settings of the balancer control is expressed as a percentage of the average of these two values of inputs. On this basis, specification compliance is not met at all frequencies at which measurements were made. However, it is believed that specification compliance can be met by the simple expedient of resetting the pointer

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on the control so that it will traverse the entire dial scale. In its present position on the sample receiver, the pointer does not exactly reach the +50 setting on the dial scale. This defect is considered to be one of a mechanical rather than electrical nature and can be avoided by closer inspection at the time of manufacture. In general, the balancer sensitivities are better for the medium and high frequency bands of the subject equipments than for the corresponding bands of the equipments listed under reference (d). The reverse is true, however, in the case of the low frequency band of either group of equipments.

5-97. The design of the balancer is such that the quadrature voltage variation, with respect to the variation of the balancer setting, is, for all practical purposes and intents, within the limits of the 1.6 to the 2.4 power of such setting at any frequency within the range of the Type CRV-46040 receiver. The relationships between these two variables are shown on Plates 22 to 27 inclusive for CW and for 30% MCW inputs, in which the ratios between the quadrature voltage at the $\pm$ 50 settings to the quadrature voltage at any other plus or minus settings are indicated. The latter settings correspond in sign with the 50 setting and are plotted against balancer dial setting in divisions, plus or minus. On the same curves are shown the limiting curves, the area between which is cross sectioned to show more clearly the extent to which the curves calculated from measured balancer sensitivity data are within the specification limits. The curve for any frequency was plotted by taking the ratio of microvolts per meter input at +50 to the microvolts per meter input at each of the 10 major scale divisions on the plus side of the scale and plotting these values against their corresponding scale setting. Similar calculations were made for the minus side of the scale. Obviously, then, the ratios at +50 and -50 settings are each equal to unity. Having thus plotted the curve, the limiting curves were plotted using the following formula so as to make for centralization of the main curve within the area bounded by the limiting curves.

$$Y_o = K_o \triangle^{1.6}$$

$$Y_1 = K_o \triangle^{2.4}$$

$$\text{where } K_o = \frac{\frac{E_{50}}{E_x}}{\triangle^n}$$

$\triangle$ = balancer dial setting in division.

E_{50} = microvolts per meter at +50 setting.

E_x = microvolts per meter at "x" setting other than 50.

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In calculating K_o, E_{50}/E_x was a constant chosen for a given balancer dial setting that would centralize the quadrature voltage curve within the bounds of the limiting curves. For all of the limiting curves shown on Plates 22 to 27, a value of $E_{50}/E_x = 0.11$ for $\Delta = 30$ and $n = 1.6$ were proved to be most suitable. The same constant, K_o, was used for the calculations of the Y_o and Y_1 ordinates. Theoretically, the setting for the center of balance would occur at zero setting on the balancer scale and the ratio of E_{50}/E_x would be zero. However, owing to small extraneous and unavoidable couplings, the center of balance will and does vary from band to band.

5-98. The percentage ratio of the maximum quadrature voltage induced into the receiver by the standard balance antenna to the maximum in-phase voltage produced by the loop is shown for each of the 5 frequency settings to which the loop was tuned for each band of the receiver by curves on Plate 28 for CW inputs, and on Plate 29 for 30% MCW inputs for the Models DP-4 and DQ-1 equipments, and for CW inputs on Plate 30 for the Models DP-5 and DP-6 equipments. The ratios are based on equivalent field strengths; i.e., microvolts per meter for both quadrature and in-phase voltages. Specification compliance is met at all frequencies except those of the low frequency band of the Models DP-4 and DQ-1 equipments, and at all frequencies within the range of the Models DP-5 and DP-6 equipments. All measurements were made with the receiver adjusted for optimum gain and such inputs as were necessary to produce standard output, the inputs being applied first at the center of the loop and then through a standard balance antenna with the loop tuned to the frequency at which the measurement was made. This procedure is the second method of the governing specifications and is believed to be the better method. This specification is not completely met by the subject equipments, as was also the case reported in reference (d). For the latter equipments, the ratios of the quadrature to in-phase microvolts per meter inputs for standard output are badly out of proportion at the high frequency end of the high frequency band. The subject equipments show the same tendency, with additional weakness over the whole low frequency band.

5-99. The balancer provided in the Type CRV-46040 receiver operates in a smooth and even manner without sticking or jerking and is capable of being reset by calibration data easily within one division of the dial scale marking for any pre-determined quadrature voltage.

5-100. The design of the balancer is such that its variation from zero to maximum in either direction with loop excitation does not introduce any noticeable amount of detuning at any working frequency of such magnitude as to affect either the sensitivity or the selectivity of any equipment.

5-101. A sense circuit is provided in the Type CRV-46040 receiver to permit the determination of the general absolute direction of the source of radio signals; i.e., unilateral or sense indication. The circuit is so arranged that it may be cut in at will by depressing and holding a push-button switch operated from the front panel. This switch is ruggedly constructed and requires a firm pressure to assure proper connection of the sense circuit.

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5-102. Sense determinations are made by rotating the loop, depressing the sense button and usually decreasing the gain to avoid overloading, thus requiring three operations in addition to the usual tuning operations.

5-103. The sense indications are sufficiently definite for all equipments to permit unquestionable determinations to be rapidly made at any frequency within the range of either equipment. In view of the fact that a non-locking push-button must be depressed for sense operation, it is not believed that any attempt will be made to operate any of the equipments unilaterally for accurate bearing determinations. Unilateral minima are sharp only for that frequency in each band of the receiver for which the sense resistance has been accurately adjusted. For other frequencies, in each band, unilateral minima are less critical but still definite. It is recommended that the manufacturer state in the instruction book for each equipment the frequency for each band at which the sense resistance should be adjusted to give the best average results over the entire frequency range of each band. Attention is invited here to the fact that the provision for sense determinations in the subject equipments is superior to that provided in the equipments listed under reference (d) because of the adjustable sense resistors provided and accessible for adjustment from the front panel. Non-adjustable sense resistors of preassigned values are provided in the older equipments.

5-104. If the receiver outputs are held below overload, sense indications are not reversible by manipulation of any of the receiver controls. Above the limits of the volume indicator meter, it is possible to produce reversal of sense indications with careless operation. One means of precluding this reversal is to take both unilateral minimum and maximum readings, the dip on the one side usually being more pronounced than the rise on the other side. If serious overloads exist, both sides will show dips, one much more pronounced than the other.

5-105. Sense determinations can be accomplished for any equipments without the necessity of altering the physical length, height, or arrangement of the sense-balance antenna provided that the sense antenna resistors have been properly adjusted to existing conditions at the time of installation

6-1. The Type CRV-20049 power unit contains all necessary apparatus and equipment to permit the operation of the Type CRV-46040 receiver in accordance with the requirements of the governing specifications, reference (b), on 110 volts, 60 cycle, single phase, a.c. line. A filter is provided in the line side of the power transformer which embodies by-pass condensers from each side of the line to ground. Since these by-pass condensers do not constitute direct metallic grounds on the line, the performance of the power unit will not be impaired if it be operated from a supply line with either side grounded. Plate 101 shows the front view of the power unit housed in its cabinet, while a bottom view of the chassis is shown in Plate 103. A schematic diagram of the circuit employed is shown on Plate 99. The Type CRV-20049 power unit is especially designed for the Models DP-4, DP-5, DP-6, and DQ-1 equipments and differs very materially from that employed for the Models DP, DP-1, DP-2, DP-3 and DQ equipments, both in its circuit design and in the parts used and the

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arrangement of these parts on the chassis. The general appearance of the front panel and cabinet is, however, the same as for the power unit used for the latter equipments.

6-2. No batteries of any description are employed.

6-3. No regulating devices are employed in the subject power unit. A two-stage r.f. filter is employed in each side of the line feeding the primary of the power transformer. Each stage consists of an r.f. filter reactor having an adjustable poly-iron core and a by-pass condenser to ground. In contrast, the r.f. filter employed in the power unit for the equipments listed under reference (d) consists of a laminated iron cored reactor of conventional design but having two windings, one in series with each side of the line. The input and output terminals of this reactor are each shunted with a fixed condenser across the line. In addition, there is, ahead of the filter reactor, a capacity filter from each side of the line to ground.

6-4. The Type CRV-20049 power unit is contained in a separate metal cabinet and is suitable for operation with the cabinet and chassis at ground potential.

6-5. The overall dimensions of the cabinet of Type CRV-20049 power unit are as follows:

	Actual Dimensions	Allowable Dimensions
Width	18-1/16 inches	18 inches
Height	8-7/8 "	10 "
Depth	8-1/8 "	8 "

At installation, an additional allowance of 1 inch should be made in the width to accommodate the power supply lead with its rigid fitting, while the handles and front panel will add to the overall depth by 1-5/16 inches. With the outlet receptacle for the receiver power supply cable in its present location at the rear of the chassis, a clearance space of 5-3/8 inches will be required in the back of the power unit cabinet to permit the removal of the plug on the end of the receiver power supply cable from the outlet receptacle and to allow for the minimum radius of bend in the cable. Reference (ii) states that this additional space requirement in the rear of the cabinet is in excess of that available and suggests the Bureau's preference that this outlet be located at the right side of the cabinet facing the receiver. However, a location on the front of the panels will be considered by the Bureau provided that the plug be far enough from the edges of the cabinet or panel so that space is available to grasp the plug for insertion or removal for any position in which the power unit is likely to be mounted. In the case of the power unit for the equipments listed under reference (d), the receiver power supply cable is smaller in diameter and the power unit and each of the several leads is provided with a terminal lug which is secured to a terminal block located on the chassis sub-base and at the right front corner.

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The cable and plug arrangement provided with the subject equipments are decidedly superior to those furnished with the equipments listed under reference (d). The dimensions of the power unit furnished with these latter equipments are given in reference (e).

6-6. No provision has been made in the sample Type CRV-20049 power unit for mounting. It is the manufacturer's intention that the instruction book give the installer the latitude to drill such holes in the cabinet as are necessary for the mounting required. If screw-on bolt heads or nuts protrude into the bottom of the cabinet from such mounting, there will be an interference which will prevent insertion of the chassis in the cabinet unless due allowance be made in the design of the chassis.

6-7. The design is such that the panel secures to the chassis with all integral parts attached thereto and is removable from the cabinet as an assembly for tube changing, servicing, and other purposes without disturbing the cabinet.

6-8. Tracks are furnished in the bottom corners of the cabinet on which the chassis slides, thus permitting easy removal of the chassis without binding or chafing.

6-9. The power unit panel has been provided with suitable handles for easy removal of the chassis from its cabinet.

6-10. Knurled screws have been provided for securing the panels of the power unit to its cabinet. The method of securing the panel of the power unit to the cabinet is the same as employed for the Type CRV-46040 receiver and is very satisfactory.

6-11. No provision has been made on the cabinet of the power unit for ventilation. As shown on Plate 101, the panel has been provided with five holes at the top and a like number at the bottom for ventilating purposes. Each hole is approximately 15-16 inch diameter and each row of holes is backed by a metal screen. Due to the small dissipation of heat from this unit, it is believed that the ventilation provided is adequate.

6-12. The exterior of the cabinet and front panel of the power unit is furnished with a black wrinkle finish to match the exterior of the other units of the equipment furnished for test.

6-13. The interconnecting cable for use between the Type CRV-20049 power unit and the Type CRV-46040 receiver has been furnished as a part of the sample equipment. This cable is not only shielded but has a rubber cover which should provide a much better degree of protection from the effects of salt humid atmosphere than has previously been supplied in any similar power cables. The interconnecting cable furnished measures 6 ft. 11 in. which exceeds the specified length of 5 ft. (± 2 inches).

6-15. The cable is of the multi-conductor shielded type with a soft rubber protective cover over the shielding.

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6-16. The cable was not disassembled to determine the symmetry of the conductors but the finished cable does give a smooth round assembly.

6-17. The construction and lay of the cable is such as to provide unusual flexibility for the size of the cable with practically no tendency to "set." The rubber covering provides excellent protection to the woven shielding thereunder and will equalize the strain on the individual strands which should prevent damage from many cycles of flexing.

6-18. Both ends of the cable are equipped with female connector plugs suitable for mating with male ends included as part of the Type CRV-46040 receiver and Type CRV-20049 power unit.

6-19. Connection plugs provided on the interconnecting power supply cable are capable of withstanding shell pressures in excess of 200 pounds without permanent distortion or damage. The plug is, in general, rugged and provides good electrical contact. The only criticism to the design is that the terminal housing is not believed to be satisfactorily secured to the plug proper. The housing is secured by two 6-32 screws which thread into extruded holes in the thin sheet metal shell which surrounds the plug proper. The thickness of this metal does not provide much more than a single thread and as a result the screws constantly become loose in spite of the use of lock washers. A better method of securing should be provided.

6-20. The metal housing and shells of the plug appear to be made of brass with a black nickel finish.

6-21. Both sides of the supply lines are protected with fuses contained within the power unit and in a location easily accessible for replacement. In the sample power unit the fuse panel has been mounted so close to the top of the panel that it is possible when replacing the chassis in the cabinet to ground the fuses or clips. It is understood that the manufacturer intends to lower this fuse panel in production so as to avoid this possibility.

6-22. The radio frequency filter provided for both sides of the a.c. lines and ahead of the primary of the power transformer of the CRV-20049 power unit are capable of attenuating any radio frequency from 100 to 1500 kilocycles more than 60 decibels specified by the governing specification, reference (b). This statement is true whether the attenuation be measured between either side of the input lines and +B or either filament lead with respect to ground. The attenuation was so great as to be unmeasurable at any frequency with the measuring equipment available. The radio frequency filters provided in the Type CRV-20049 power unit are vastly superior to those furnished in the power units for the Models DP, DP-1, DP-2, DP-3, and DQ equipments. In this latter instance and by reference to Plate 99 of reference (e), it becomes apparent that very little attenuation was afforded at 100 kilocycles and that the maximum attenuation of approximately 65 decibels occurs at 600 kilocycles. In general, the attenuation is less than 60 decibels over the frequency range of from 100 to 1500 kilocycles.

6-23. Although no special regulation features have been provided in the Type CRV-20049 power unit, the regulation is sufficient that the governing specifications, reference (b), are met in all respects where regulation

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would deserve consideration. The variation of the plate and heater supply voltages with and without full load, as well as the variation in the line power consumption under full load, with line voltage, are shown by the curves on Plate 97.

6-24. The Type CRV-46040 receiver and particularly the Type CRV-20049 power unit are capable of operating without overheating or damage to any part and with equal performance in accordance with these specifications at line voltages ± 10% of normal (110 volts). Attention is invited, however, to the fact that the oil paper condensers used in either unit may leak unless better constructed than the first samples submitted.

6-25. The Type CRV-46040 receiver and the Type CRV-20049 power unit will operate satisfactorily at any frequency from 55 to 65 cycles a.c.

Electrical Requirements. It has been previously mentioned in an earlier part of this report that the apparatus furnished by the manufacturer was such that when used in suitable combinations, set-ups could be made to represent the Model DP-4 or the Models DP-5 and DP-6 radio direction finder equipments. The Model DQ-1 equipment is very similar to the Model DP-4 equipment, except for the construction of the loop and loop pedestal assemblies, both of which were designed for submarine service. Since the same type of receiver is employed with either of the Models DP-4 or DQ-1 equipments, the difference in the performance of one of these equipments with respect to the other will be predicated on the characteristics of their respective loops. Reference to NRL Report No. R-1141 (reference (f)) and to NRL Reports Nos. R-1134(reference (e)) and R-1162 (reference (g)) will show that the variation in loop circuit Q with frequency is practically the same for the Model DQ equipment as for the Models DO, DO-1, and DO-2 equipments. Thus it may be concluded that the characteristics of the loop as employed with the Models DQ and/or DQ-1 equipments are essentially the same as for the Models DO, DO-1, or DO-2 equipments. Comparing the curves on Plate 3 of reference (g) with corresponding curves on Plate 5 of this report, it will be noted that the characteristics of the loop as employed with the Model DP-4 equipment are superior to those of the loop used with the Model DQ-1 equipment. However, for all practical purposes and intents it may be assumed that the performance characteristics as reported herein for the Model DP-4 equipment are applicable to the Model DQ-1 equipment. In the following discussion and the discussions of other tests involving the loop circuit and reported in earlier portions of this report, this assumption has been made.

7-1. The tests for determining the electrical performance of the subject equipments were conducted under the following conditions, except where specific exceptions are noted:

(1) The equipment under test was operated on 110 volts, 60 cycles, single phase, a.c.

(2) For loop excitation, r.f. inputs were introduced into the center of the loop and across a 1/2 ohm resistor inserted between one side of the loop and its grounded

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mid-point. This resistor formed a part of a 100 to 1 attenuator which was a part of the output cable of the standard signal generator used for the test. For balance antenna excitation, r.f. inputs for the standard signal generator were applied across the antenna terminal and ground through a standard balance antenna. No auxiliary attenuator was used in the output cord of the standard signal generator.

(3) The audio outputs were measured with respect to a 600 ohm non-inductive resistance as an output load.

(4) Except where the specification requirements necessitated altering the position of the sensitivity control, the sensitivity control was maintained at such adjustment that standard noise level of 60 microwatts or less was obtained with no input signal.

(5) The tests were conducted using the vacuum tubes furnished with the receiver by the manufacturer. Other tubes were substituted before completion of the tests to determine the effects of tube replacement on the performance of the equipment.

7-2. Sensitivity measurements with either loop or balance antenna excitation were made at five frequency settings for each band of the Type CRV-46040 receiver. Sensitivity curves are shown on Plate 10 for CW inputs and on Plate 11 for 30% MCW inputs for the Models DP-4 and DQ-1 equipments. Similar curves are shown on Plate 13 for the Models DP-5 and DP-6 equipments measured with CW inputs. On all of the plates, the curves labeled "loop" were measured with loop excitation. Those labeled "sense", "Bal. +50", or "Bal. -50" were measured with balance antenna excitation. "Sense" sensitivities were, of course, measured with the "sense" button depressed. "Bal. +50" and "Bal. -50" indicate the two extreme settings of the balancer at which balancer sensitivities were made. All of the curves are plotted in terms of microvolts per meter (field strength). For any given frequency, the sensitivity of the equipment under consideration with loop excitation may be expressed in terms of absolute microvolts at the loop center by multiplying the microvolts per meter at that frequency by the effective height of the loop at the same frequency. The effective height of the loop at any frequency may be obtained from Plate 2. The absolute microvolts input applied to the standard balance antenna for "sense" or "balancer" sensitivities may be obtained for any frequency by multiplying the microvolts per meter by a factor of 2, the assumed effective height of the standard balance antenna at all frequencies. "Sense" sensitivities shown on Plates 10, 11, and 13 were measured with the "sense" resistances reduced to zero. The curves shown on Plate 12 show the effect on sense sensitivities by the insertion of resistance in the sense circuits. These curves cover the total range of the adjustable "sense" resistors and are applicable to all equipments.

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The governing specifications give no specific limits for balancer and sense sensitivities. With respect to the sensitivities with loop excitation, the Models DP-4 and DQ-1 equipments more than comply with the specification requirements at all frequencies, being of the order of 0.3 microvolts absolute for CW inputs and 0.20 microvolts absolute for 30% MCW inputs. The sensitivities with loop excitation in the case of the Models DP-5 and DP-6 equipments with CW input comply with the requirements of these specifications at all but 1170 kilocycles where the sensitivity is 1.22 microvolts absolute instead of 1 microvolt as required. Closer tracking of the ganged tuning condenser in compliance with the governing specifications will undoubtedly correct this defect. The ratio between the sensitivity at any frequency for the Models DP-5 and DP-6 equipments relative to the corresponding sensitivity for the Models DP-4 and DQ-1 equipments is of the order of approximately 2.25 to 1. This is a measure of the loss incurred by the use of the transmission line and coupling transformers. The variations in the maximum noise level with frequency for the Models DP-4 and DQ-1 equipments are shown in the curves on Plate 14. Similar curves are shown on Plate 15 for the Models DP-5 and DP-6 equipments. While the specifications do not specifically limit the noise level, it is obviously essential that the equipments must necessarily possess low noise levels to comply with the specifications for sensitivity. The maximum noise level at any frequency for all equipments is considered as being low.

The sensitivities of these subject equipments with loop and/or standard balance antenna excitation are generally better than the corresponding sensitivities at any frequency for the Models DO, DO-1, DO-2, or DO-3 equipments as listed under reference (d).

7-3. Selectivity at Optimum Gain. Selectivities were measured with loop excitation at three frequency settings of each band and with the receiver adjusted for optimum gain and standard output at resonance. Selectivity curves applying to the Models DP-4 and DQ-1 equipments are shown on Plates 41, 42, and 43 for CW inputs and on Plates 47, 48, and 49 for 30% MCW inputs. Similar curves are shown for CW inputs on Plates 53, 54, and 55 for the Models DP-5 and DP-6 equipments. The limiting curves as defined in the governing specifications are drawn on each of the plates. It has been assumed that the limiting values apply equally well to 30% MCW inputs. The selectivities with CW inputs are well within the specification limits at all frequencies for all equipments except at the low frequency end of the low frequency band. The selectivity with an input for the low frequency end of the low frequency band for any equipment is so close to the limiting curve between 10 and 100 times resonant input as to allow no tolerance for production. With 30% MCW input, the selectivities for all equipments are within the specification limits at all frequencies except those of the lower half of the low frequency band. In this range the selectivities fail to comply with the specification limits to a greater and greater degree with decreasing frequency, being at their worst at 100 kilocycles.

Selectivities measured with respect to standard balance antenna excitation at the same frequency settings as were the selectivities with loop excitation, and with the same receiver adjustments, are shown on Plates 59, 60, and 61, for CW inputs and on Plates 62, 63, and 64 for 30% MCW inputs.

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These selectivities are very nearly identical with their corresponding selectivities with loop excitation, and apply to all equipments.

The selectivities of the equipments listed under reference (d) are generally poorer than the corresponding selectivities of the subject equipments when measured under the same operating conditions. The use of high Q r.f. transformers with poly-iron cores and isolantite coil forms contribute largely to the improved selectivities of the subject equipments.

7-4. Image Selectivity. Curves showing the image selectivity and measured at five frequency settings of each band and with the receiver adjusted for optimum gain and standard output at resonance, and with loop excitation are shown on Plate 31 for CW and 30% MCW inputs for the Models DP-4 and DQ-1 equipments. Similar curves for CW inputs are shown on Plate 32 for the Models DP-5 and DP-6 equipments. Specification compliance is not met by any equipment for frequencies lower than approximately 185 kilocycles. As an explanation of the curves shown on Plates 31 and 32, attention is invited to the fact that the points plotted are the image selectivities at the resonant frequencies at which measurements were made. The actual image frequency is recorded on the curve sheets for each point on the curves. As a matter of record, it should be mentioned that in the measurement of image selectivity, the r.f. voltage from the standard signal generator was inserted in the grid side of the loop. This fact is emphasized inasmuch as it has a bearing on the shape of the curves obtained for the medium frequency band of either equipment and to a large extent accounts for the peaks occurring at 455 kilocycles on Plate 31, 450 kilocycles on Plate 32.

7-5. Resonant Overload Characteristics. Resonant overload characteristics measured at the low and high frequency ends of each band, with loop excitation, and with the receiver adjusted for optimum gain, are shown for CW and 30% MCW inputs on Plates 65, 66, and 67 for the Models DP-4 and DQ-1 equipment, and for CW inputs on Plates 68, 69, and 70 for the Models DP-5 and DP-6 equipments. Resonant overload, as defined by par. 8-8 of the governing specifications, is for any frequency and for any equipment, greater than 6 milliwatts as required and as demonstrated by Table 10. It will be noted from each of the curves, however, that for a CW input receiver blocking occurs at an input less than two orders higher than is required for standard output and for a 30% MCW input, receiver blocking occurs at an input only a little greater than one order above that required for standard output. In actual practice, if the receiver gain is kept low, this blocking action should cause no concern in taking bearings. However, should an operator be working with a relatively high gain setting, it would be possible for him to obtain a reversal in bearing through this feature. Therefore it is recommended that in the production equipments, that the range over which the output will remain substantially constant for increasing signal intensities be extended to four orders or be equivalent in this respect for the Models DO, DO-1, DO-2, and DO-3 equipments. The manufacturer's representative has suggested, as stated in reference (ii), that the blocking feature be corrected by means of an AVC circuit which would respond only for such signal intensities as would produce outputs greater than 6 milliwatts. The resonant overload characteristics of the equip-

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ments listed under reference (d) are very similar to those reported under reference (e). In these equipments receiver blocking does not occur for inputs as great as four orders above those required for standard output.

7-6. Maximum Audio Output. Maximum audio output ranges from 23.4 to 29.3 milliwatts for CW operation and from 12.1 to 20.0 milliwatts for MCW operation of the Models DP-4 and DQ-1 equipments. It ranges from 22.2 to 25.4 milliwatts for CW operation of the Models DP-5 and DP-6 equipments. Complete data are given under Table 10.

7-7. Overload Selectivity and Cross Modulation Selectivity. Tests were made with the equipment furnished by the manufacturer set up as for the Model DP-4 equipment. The Type CRV-46040 receiver was adjusted for standard conditions and for CW operation and with sufficient input from a standard signal generator applied at the center of the loop to produce a 6 milliwatt output at 1,000 cycles. A second standard signal generator with a 0.5 volt, 200 cycle, 30% modulated output was connected in parallel with the first standard signal generator at the loop center. The frequency of the second standard signal generator was varied from a point off resonance through resonance and thence to a point beyond resonance where it had no effect on the output of the desired 1,000 cycle beat note. The points observed at both sides of resonance where the interfering signal was just audible, where it gave a 6 milliwatt output, where the desired signal became unreadable and where blocking occurred, were noted. This procedure was followed at 250, 375, and 1311 kilocycles with the results as shown on Table 8. In making these tests it was observed that numerous spurious responses were existent throughout the band. Although these cannot be attributed to either overload selectivity or cross modulation, they are a form of interference that would seriously limit the usefulness of a direction finder. They are, however, characteristic of superheterodyne receivers and with such receivers of conventional type can be reduced by greater pre-selection ahead of the first detector and by use of a higher intermediate frequency. In the subject equipment it would be impractical to employ a higher i.f., particularly for the low frequency band and additional pre-selection would involve more tuned circuits and greater space. The spurious responses observed near to the resonant frequency of the receiver have been tabulated for receiver settings of 250 and 375 kilocycles. The part of the spectrum covered is sufficient to show the magnitude of this type of interference. The interfering signal was the 0.5 volt output of a signal generator having a 200 cycle, 30% modulated CW signal. The frequencies listed do not include that part of the spectrum affected by cross modulation as included in the appended Table 8. Table 9 shows the frequencies at which these responses occur and the receiver output in milliwatts for each measurement when the interfering signal frequency was varied with the receiver set for a given frequency.

7-8. Output Hum Level. The output hum level of the Type CRV-46040 receiver is 0.0387 microwatt, which is well within the specification limits of 0.1 microwatt. Plate 96 shows an analysis of a 1,000 cycle output signal of the audio amplifier for outputs ranging from 1 to 30 milliwatts and measured across a 600 ohm non-inductive load. The 1,000 cycle input voltage was applied to the grid of the second detector tube.

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7-9. Time Constants. The time of recovery of the Type CRV-46040 receiver from a sharp impulse of 15 volts d.c. peak applied at the loop center at receiver resonance is approximately 3 milliseconds at 1500 kilocycles and 6 milliseconds at 100 kilocycles. These time constants are well within specification limits of 0.02 second. The test was made with the equipment set up as for the Model DP-4 equipment. The d.c. impulse was superimposed on the CW carrier in each case.

7-10. Frequency Drift with Change in Temperature. A discussion of the results of the tests made to determine compliance with this specification is given under par. 7-22.

7-11. Adjustment of Beat Frequency Oscillator. Tuning of the beat frequency oscillator is accomplished by an adjustable iron core in the inductance coil. Four revolutions of the core varies the oscillator frequency approximately 1.5 kilocycles. The provision made for adjusting the oscillator is such that its frequency may be adjusted to a degree of accuracy better than that required by this specification. The adjustment made may be locked and once made can be expected to be permanent. In the sample Type CRV-46040 receiver, the frequency of the oscillator differed from the desired frequency; namely, 81.5 kilocycles by 185 cycles, or 0.225%. Specification compliance, therefore, is amply met.

7-12. Tracking of Unicontrolled Circuits. No tests were made for determining the tracking of the unicontrolled circuits. The ganged tuning condenser furnished in the sample Type CRV-46040 receiver employs handmade plates. It is claimed by the manufacturer's representative that these plates are not exact and are inferior to those that will be employed in the ganged tuning condensers in the production equipments. Such tests as are required by this specification are necessarily elaborate for the degree of accuracy with which they must be made. The time involved would not be justified by the results that would be obtained on a ganged tuning condenser that is admittedly inferior to that proposed for the production equipments.

7-13. Frequency Drift with Change of Line Voltage. The performance of the Type CRV-46040 receiver or its associated Type CRV-20049 power unit is not affected by a line voltage variation of $\pm$ 5% from normal. The data given under Table 11 show that the drift in beat note frequency is not greater than 20 cycles at any of the frequencies at which measurements were made for any change in line voltage as required by this specification.

7-14. Overall Voltage Gain/Voltage Noise Level Ratio for the Models DP-4 and DQ-1 equipments, including the loop for CW reception; i.e. overall gain/noise x 10^6, is shown for five frequencies in each band on Plate 89. Similar curves are shown on Plate 90 for the Models DP-5 and DP-6 equipments. Specification compliance is met by the Models DP-4 and DQ-1 equipments, but not by the DP-5 or DP-6 equipments. Attention is invited to the fact that the requirements of the specification are not consistent with par. 7-2, which permits a sensitivity of 1 microvolt at all frequencies and irrespective of the kind of loop connection employed. To be consistent with par. 7-2, the voltage gain to noise voltage ratio should be 10 and not 20. It is recommended, therefore, that future specifications should limit the sensitivity

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for direct connected loop equipments to 0.5 microvolts with a corresponding voltage gain/noise voltage ratio of 20 and for transmission line equipments the sensitivity should be limited to 1 microvolt with a corresponding voltage gain/noise voltage ratio of 10. On this basis, the transmission line equipments (Models DP-5 and/or DP-6 equipments) would comply with the exception of one point; namely, at 1170 kilocycles, where the sensitivity fails to comply with par. 7-2. The requirements of this specification are not met by any of the equipments listed under reference (d). It should be further noted that reference (ii) recommends that this specification be stricken from the governing specifications, reference (b), since it is considered as being irrelevant.

7-15. The Overall Voltage Gain of the Models DP-4 and DQ-1 equipments as measured at the low and high frequency ends of each band of the Type CRV-46040 receiver, with the receiver adjusted for CW reception with optimum gain, does not show a decrease at any output level from standard down to a level where measurements could be made with any degree of accuracy. The curves on Plate 91 show this statement to be apparently true for an output equal to noise level. Similar curves showing similar results are shown on Plate 92 for the Models DP-5 and DP-6 equipments.

7-16. The Audio Frequency Response Characteristic of the audio amplifier of the Type CRV-46040 receiver is shown on Plate 93 and lies well within the specification limits of $\pm$ 4 decibels between 400 and 1000 cycles. No low pass filter is employed.

7-17. Frequency Drift with Change of Input Signal Intensity. The requirements of this specification are amply met by all equipments when operated under conditions of CW reception with optimum gain and with a change of input signal intensity of from 0.5 microvolt per meter to such values of input as to provide maximum output. The greatest change in beat note frequency occurs at 1500 kilocycles where the drift in frequency is 4 cycles.

7-18. Frequency Drift with Change in Sensitivity Control Setting. Any of the subject equipments, when operated under conditions of CW reception and with an impressed signal at the loop center of such value as to produce maximum output with full gain, a reduction of the sensitivity control of the Type CRV-46040 receiver does not vary the beat note frequency by more than 100 cycles. However, if the input is such as to produce the maximum available output, specification compliance is not met at 1500 kilocycles where the change in beat note frequency is 121 cycles. Complete data are given under Table 12.

7-19. Antenna-Loop Inter-Coupling. Any of the subject equipments, when operated with the balancer of the Type CRV-46040 receiver set full "on" in either direction and with the loop tuned to a frequency 10% removed from the frequency being impressed on the balance antenna terminal (through a standard balance antenna), no output signal was noticeable above noise level, with an applied CW input of 500,000 microvolts absolute. Tests were not made at other frequencies than the two at 10% off receiver resonance. Attention is invited to par. 7-7 which shows the effect of applying a 500,000 microvolt signal at the loop center at frequencies other than 10% off re-

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ceiver resonance. It can be assumed that the coupling from the antenna to the loop circuit will be at least as great as though applied directly to the loop center for frequencies on that side of loop resonance approaching the antenna tuning which is about 25% removed therefrom.

7-20. Shielding Integrity. The receiver was set up in the radio truck and taken to locations in the fields of several local transmitters with the following results.

Station	Frequency	Field V/M	Dummy	Signal
WJSV	1460 kcs	1.25	Out	Noise +3 db
NAA	113 "	5.0	In	Noise +9 "
NAA	325 ±	5.0	Out	Noise +1.5 db
"WA" Beacon	950	0.017	In	Barely audible
WRC	630	1.75	Out	Noise +2 db
WMAL	630	0.0055	Out	Not audible
WMAL	630	0.0055	In	Noise +2 db

The above results indicated that the dummy loop was not properly shielded. The shielding was improved and the ground lead shortened and tests were again made with the dummy loop tuned to 950 kilocycles with the following results.

Station	Frequency	Field V/M	Dummy	Signal
WRC	950 kcs.	2.5	In	Noise +24 db
"	950 "	2.5	Out	Noise + 1 db
"	950 "	1.5	Out	Not audible
"	950 "	1.5	In	Noise +19 db

It would appear from the above tests that the dummy loop was still improperly shielded and that with proper shielding and with the antenna hole in the case properly closed, the equipment would pass the specification requirements.

7-21. Vibration Test. The equipment was set up as for the Model DP-4 equipment, with the receiver on an aircraft vibration table and the following tests were made.

The receiver was tuned to 113.2 kilocycles, the table movement was adjusted to 1/16" and after 15 minutes of vibration the beat note had changed 8 cycles and the sensitivity gained 0.7 decibel. There was no indication of increased output on the output meter due to vibration with no signal present. The receiver was adjusted for 1415 kilocycles and a similar run made. The beat note change after 15 minutes was 73 cycles and the sensitivity had increased 1.3 decibels. During these tests it was impossible to measure the amount of beat note change due to vibration but observation showed that vibration had no effect upon the readability of signals that could be heard above the noise in the room. All vibration was applied in a vertical direction but observations were made to determine that there was no noticeable microphonic disturbance from hard hand blows on all sides of the receiver and power pack. Type CRV-46040 receiver is exceptionally free from micro-

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phonic effect from vibration.

7-22. Temperature and Humidity Cycle. The complete equipment including loop, transformers, and transmission line were placed in a humidity tank at 25° C with 50% humidity. These conditions prevailed for 3 hours to permit stabilization. Receiver sensitivities were made at 3 points in each band and the receiver was finally adjusted to 1500 kilocycles and the cycle started. During this cycle above 10° C, attempt was made to maintain the humidity between 85 and 90%. Below this temperature the humidity was unknown but was kept at a value low enough to prevent precipitation or frosting. The temperature was increased in steps of approximately 5° up to 50° C remaining at a given temperature long enough to permit the drift in frequency to stabilize. The time required for stabilization was so great as to permit that only a part of the cycle be made each work-day. On the first day a maximum of 50° C was obtained, which was reduced to 24° C during the night. The next day the temperature was reduced to -25° C and the sensitivity as well as the frequency drift was observed at each change in the temperature. During the night the temperature drifted from -23° to -10° at which point similar runs were started and observations made up to 25° C with 50% humidity. It should be mentioned in connection with this test that signal generator voltage was fed to the first grid of the receiver rather than through the loop, transmission line, and transformer circuit. This was necessitated by the fact that the loop circuit picked up so much extraneous noise as to make measurements at a reasonable sensitivity setting impracticable. The sensitivity change did not exceed 12.5 decibels during this cycle. The frequency change was appreciable during the period that a temperature change was being effected. This is not believed to have been due to temperature variation, but to humidity change which could not be avoided during the temperature change. It was observed that as soon as the degree of humidity became stabilized, the frequency drift ceased and in the change from one stabilized level of temperature and humidity to another, the variation was not great as indicated by Table 7. Sensitivity measurements made at the end of this run indicated that the sensitivity had not decreased at the worst point by more than 3 decibels.

7-23. Following the temperature and humidity cycle and after remaining inoperative for 3 hours at a temperature of 25° C with 50% humidity, the sensitivity was not appreciably changed and, if anything, slightly improved. No other tests were made after this cycle, feeling that the results of the sensitivity measurements were a satisfactory indication of the effects of this cycle on receiver performance.

7-24. Loop Q. The Q of the loop alone between 550 and 1500 kilocycles ranges from 88.5 to 123. While the loop was exposed to the temperature and humidity cycle as described under par. 7-22, no measurements were made for Q after exposure, in view of the fact that the performance of the entire equipment after exposure was generally better than before. It was reasonable, therefore, to assume that the Q of the loop remained unchanged after exposure. Radio frequency resistances and corresponding Q's for the loop alone, and with the loop pedestal and coupling systems as used with the Models DP-4, DP-5, DP-6 equipments are shown on Plates 4 and 5 respectively.

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The results of the tests conducted on the subject equipments which have a direct bearing on the final determination of the performance characteristics of these equipments and which are not directly covered by the governing specifications, reference (b), except by definition, are herein reported.

Wave Length Squared Curve for Determining the True Inductance and Distributed Capacitance of Loop System. Plate 3 shows the wave length squared curve for determining the true inductance and distributed capacitance of the loop, loop pedestal, and 9 foot cable as used with the Model DP-4 equipment; the loop, loop pedestal, loop output transformer, loop input transformer, and 35 foot transmission line as used with the Models DP-5 and DP-6 equipments; the loop and 9 foot coupling cable and finally the loop alone. The calculations of the true inductances of these several combinations (except for the combination as for the Models DP-5 and DP-6 equipments, in which case the calculation is for the reflected inductance) are based on the following equation.

$$L = \frac{\frac{\Delta \lambda^2}{\Delta c}}{3.553}$$

where L = true or reflected inductance in microhenries.

$\frac{\Delta \lambda^2}{\Delta c}$ = incremental slope of the curve.

3.553 = a constant.

The distance from the origin to the intercept of any curve with the axis of abscissae determines the distributed capacitance of the particular combination to which the particular curve refers. Data on the true or reflected inductances and distributed capacitances for the loop, loop pedestal, and coupling devices as employed with the Models DP-4, DP-5, and DP-6 equipments are given on Plate 3. It will be noted that the true inductances as determined for curves A and B are the same, indicating good matching between the transmission line and its associated coupling transformers as employed for the Models DP-5 and DP-6 equipments.

A breakdown of the data derived from the curves in Plate 3 shows the following values of inductance and distributed capacitance.

	True Inductance Microhenries	Distributed Capacitance Micromicrofarads
Loop alone	56.3	37.0
Loop pedestal leads down to slip rings	1.4	21.0
9 ft. coupling cable leads from slip ring brushes to point of attachment to receiver chassis	3.0	41.0

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The ratios of the loop output and receiver input transformer used in combination with the 35 foot transmission line are such as to reflect an inductance of 60.7 microhenries and a capacitance of 102 micromicrofarads across the receiver input terminals for the transmission line.

Inductance of Loop Output and Receiver Input Coupling Transformers. Table 14 shows the effective inductance of the transformer windings in the loop coupling circuit for Models DP-5 and DP-6. These windings are universal wound coils on isolantite forms and without the iron cores used in the Model DO-3 equipment. Each form has one-half the total winding 3-1 or 3-2, tapped at 5 and 4 respectively. One coil may be moved with respect to the other; thus, by mutual inductance adjustment, varying the total balanced inductance 1-2, and its balanced tap 4-5. The coupling between 4-5 and 1-2 is tight. It is stated by the manufacturer's representative that these transformers are superior to those employed in the Model DO-3 equipment. The absence of the iron core should aid in the necessarily accurate balance of the transformers. Any unbalance existing might throw the minima off the opposite. It will be noted that there is a small unbalance in the line taps of the Type CRV-47101 transformer.

Inductance of Load Coils in Loop Circuit. The true inductances of the loop circuit load coils as determined from their measurement of the "Q" meter are as follows:

Band	Total Inductance (microhenries)		
HF	20.5	Bal. at -50, Sense Button Out	Wiring only, no actual loading used.
	19.8	" " " " " In	
	21.4	Bal. at 0, " " Out	
	20.1	" " " " " In	
MF	378	Total and includes inductance in HF Band	
LF	2940	Total and includes inductance in HF and MF Bands	

Effective Height of Loop. The calculation of the effective heights of the loop between a frequency range of 100 to 1500 kilocycles is based on the following equation.

$$h = \frac{w\,a\,N}{3} \times 10^{-12}$$

where

h = effective height of loop in meters

a = area of loop in square centimeters

N = number of turns

w = $2\pi f$, where f = frequency in cycles.

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The loop is wound with 8 turns and the mean diameter of the loop is 54.2 centimeters. The effective height of the loop varies from 0.00387 to 0.0581 meter between 100 and 1500 kilocycles respectively. A curve showing this relation is plotted on Plate 2.

Radio Frequency Resistance of Loop Circuits. Plate 6 shows the variation in the radio frequency resistance of the loop circuit with frequency for the three bands of the Model DP-4 equipment. The circuits to which the curves apply include the loop, loop pedestal, 9 foot coupling cable and the load coils within the receiver proper. It will be observed that the three curves shown for any band, the variation in resistance is not great over the frequency range covered by that band. Similar curves are shown on Plate 8 for the Models DP-5 and DP-6 equipments and the circuits to which they apply include in addition to the loop and loop pedestal, the 35 foot transmission line and loop input and output transformers. However, the resistances contributed by the loop and transmission line, as well as the coupling transformers, appear across the receiver input terminals as a lumped resistance and may be considered as being a reflected resistance. Unlike the curves on Plate 6, those on Plate 8 possess marked irregularities. These irregularities are due to the lack of unity power factor coupling between the loop load circuits owing to the leakage reactances of the coupling transformer used with the Models DP-5 and/or DP-6 equipments. The degree of phase shift of the loop input circuit and the corresponding effective loop circuit reactance are shown in Plate 34. These facts could have been more definitely established by further measurements and detailed investigation. However, the scope of the problem did not warrant the time for such a study. The r.f. resistance curves shown on Plates 6 and 8 are so radically different from the corresponding curves for the equipments listed under reference (d) as to make comparison rather difficult. The chief reason for their differences is that poly-iron cored load coils are employed in the Type CRV-46040 receiver whereas air cored load coils are used in the receiver employed with the equipments listed under reference (d).

Loop Circuit Q's. The loop circuit Q's for the subject equipments were calculated from the true loop circuit inductances (including load inductances) as discussed above and shown on Plate 3 and the radio frequency resistances shown on Plates 6 and 8 from the following relations:

$$Q = \frac{\omega L}{R}$$

where

L = loop circuit inductance (including load inductances) in henries

R = radio frequency resistance of loop circuit, in ohms. (Refer to curves on Plates 6 and 8)

$\omega = 2\pi f$, where f = frequency in cycles per second.

(The usual assumption is made that condenser losses are negligible.)

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Loop circuit Q's are shown on Plate 7 for the Model DP-4 equipment and Plate 9 for the Models DP-5 and DP-6 equipments. It will be noted that the curves on Plate 7 show no irregularities as was the case for the corresponding curves in Plate 6, except that the setting of the balancer coil affects the loop circuit Q in the high frequency bands to a slight extent. The curve on Plate 9 for the low frequency band of the Models DP-5 and DP-6 equipments possesses a reversal in slope as compared with the curves for the medium and high frequency bands. This is due to the characteristic of the corresponding r.f. resistance curve shown on Plate 8 and resulting from lack of unity power factor coupling between the loop load circuits as has already been explained in the preceding paragraph. It will be noted also that in the case of the Models DP-5 and DP-6 equipments, the setting of the balancer has no effect on the loop circuit Q at any band. It may be said in passing that the loop circuit Q's of the Model DP-4 equipment are generally higher, while the loop circuit Q's of the Models DP-5 and DP-6 equipments are higher for the low frequency band and lower for the medium and high frequency bands than for the corresponding equipments listed under reference (d).

Loop Circuit Selectivities are shown on Plates 35, 36, and 37 for the Model DP-4 equipment, and in Plates 38, 39, and 40 for the Models DP-5 and DP-6 equipments. These selectivities are calculated from the loop circuit Q's at the several resonant frequencies for which the selectivity curves are shown. The calculations are based on the Universal Resonance Curve as given in Terman's "Radio Engineering."

Overload Characteristics of Audio Amplifiers. The curves on Plate 95 show the overload characteristics of the audio amplifier of the Type CRV-46040 receiver. The curves are self-explanatory and no further comment is necessary. Comparison of these curves with those shown in Plate 92 of reference (e) shows that the total audio output of the audio amplifier of the Type CRV-46040 receiver is very nearly the same as for the phone output of the audio amplifier of the receiver used for the equipments listed under reference (d). However, in the former instance, the maximum available phone output is less due to the power consumed by the output volume indicator meter.

Intermediate Frequency Selectivity curves are shown on Plate 33 for CW inputs applied at the loop center for the Models DP-4, DP-5, DP-6, and DQ-1 equipments. It will be observed that the intermediate frequency selectivity at any frequency for the direct connected loop equipments is very nearly the same as for the transmission line equipments and further that the selectivity becomes poorer as the frequency approaches the intermediate frequency.

Sense and Balance Circuit Tracking. The curves of Plate 100 show that the sense circuit tracks well except at the low end of the high frequency band. While the tracking error reaches [redacted]%, this is not necessarily serious, as this circuit is used with inserted resistance. The balance circuit is always tuned from 19 to 28% lower than the loop, which is apparently adequate to insure proper phasing.

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8-1 to 8-13 inclusive. The definitions as presented by these paragraphs of the governing specifications were applied in making the tests described in this report.

9-1 to 9-5. Under METHOD OF TESTS of this report a complete description of the test procedure followed for each test has been given.

10-1 to 10-4. No spare parts were furnished in accordance with these specifications. Several resistors, capacitors, chokes, and transformers, however, were submitted for salt water immersion tests.

11-1 to 11-15. No instruction book was furnished by the manufacturer. Therefore, no comments relative to these specifications can be advanced by the Laboratory.

12-1. These specifications are outside of the scope of the problem. No comments can be advanced by the Laboratory.

69. The following is a summary of defects observed in the test of the subject equipments.

2-2. There are two types of small mica condensers used in the Type CRV-46040 receiver which do not conform with Specifications RE 48AA 112K in their physical dimensions. The "A" and "B" dimensions as given under Specifications RE 13A 492 are slightly less than permitted.

2-8. The black wrinkle finish has worn through on the sharp corners of the balancer and tuning control knobs on the Type CRV-46040 receiver.

2-10. The surface of the aluminum chassis as well as the back of the main panel of the Type CRV-46040 receiver and/or Type CRV-20049 power unit appear to have insufficient protection from the effect of saline humidities.

2-15. The volume indicator meter range switch on the Type CRV-46040 receiver does not operate smoothly between the "off" position and the "+15 db" position.

2-16. Three of the foil by-pass condensers in the Type CRV-46040 receiver unit are mounted in such a manner as not to be easily replaceable.

2-20. Some of the bus wire leads in the Type CRV-46040 receiver are so long as to require better support to prevent excessive vibration with possible crystallization. These bus wires can become grounded where they go through chassis holes as in some cases no insulation has been provided except the small clearance of the hole.

2-33. No color coding has been used in any of the r.f. circuit wiring where tinned bus wire has been employed in the Type CRV-46040 receiver.

2-37. The wire used in the r.f. circuits is not insulated or treated, as bare tinned bus wire is used throughout.

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2-47. One of Type RI 426 transformers failed in that its leakage resistance at the end of the fifth cycle of test greatly exceeded the specification limits.

3-8. The displacement of the two minima for any of the subject equipments can be varied by more than 1° and up to as much as 20° by a faulty balance at the higher frequencies. (See par. 3-8)

3-9. There is a possibility of a reversal of sense indication if receiver overload is mistaken for a null indication.

4-6. The maximum loop rotational diameter is 24.21", which exceeds the specification limit by .21 inches.

4-7. The loop assembly is not watertight and the terminal jack plugs on the pedestal became loosened from such handling as accompanied these tests.

4-10. The 1/16" thick brass semi-circular plate which fits over the loop collector ring aperture may become a weak point as regards watertightness as it is secured only at its corners over the 1/32" thick rubberized packing. The skirt provided on a pedestal head over the junction of the head with the pedestal proper is not properly designed to afford protection from rain or spray when it is mounted in an inverted position.

4-14. When the loop pedestal securing dogs are tightened, they have a tendency to slip outward from the pedestal center instead of remaining in the position that would assure the more permanent clamped position.

4-15. The wing nuts have not been provided with holes for securing wires.

4-54. Two 3/16" holes spaced 3/4" apart have been drilled through the transformer case wall opposite the cable fitting furnished which should not be present in the production equipment.

4-55. The loop output and receiver input transformers are not watertight through use of screws in the transformer cases which have not been gasketed. The units are, however, considered as spraytight.

4-60. The slip rings, phosphor bronze contacts, and brass cover over the slip ring compartment are not of aluminum alloy as called for. This is not believed to be a defect as it is apparent that these items should not be made of this material.

4-61. The pedestal casting, loop housing, transformer cases, and collector ring aperture cover plate are painted with red oxide instead of zinc chromate primer as specified. The pedestal shaft has no coating whatever.

5-3. Although the dimensions of the Type CRV-46040 receiver proper are within the specification limits, mention is made of the fact that an additional 5-3/8" must be allowed at the back of the receiver cabinet to permit power cable plug removal. This would mean that the total depth

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of the receiver equipment will be 22-7/8" instead of the 18" allowed.

5-34. The main tuning control of the Type CRV-46040 receiver has backlash at points in excess of 1 vernier division.

5-37. The variation in frequency of the Type CRV-46040 receiver with tuning dial rotation departs from linearity by a greater amount than the specifications permit in all bands from 825 to 1,000 divisions.

5-39. The markings of the main tuning dial of the Type CRV-46040 receiver are not visible at an angle of 60° from the perpendicular. The visibility is at present limited to a 45° angle.

5-50. The requirements of this paragraph can not be accomplished due to an inconsistency in the specifications which would require that the sensitivity be greater for the sensitivity control tests than is required under the sensitivity requirements as specified in par. 7-2. A noticeable reaction occurs at the high frequency end of the low frequency band near the minimum end of the sensitivity control such that the output does not remain constant for increasing inputs with corresponding decrease in gain setting. The desired signal is accompanied by another of spurious origin which indicates instability at this point and the output is not controlled normally by the sensitivity control.

5-59. The volume indicator meter on the Type CRV-46040 receiver does not appear to have the characteristics of the so-called "instantaneous" type of instrument and its "responsiveness" and "damping factor" are considerably less than specified.

5-72. It was observed that about 20% of the tubes available did not operate in the r.f. stage without the introduction of spurious oscillations resulting in higher than normal noise level at definite points within the range of the receiver. These points had a definite harmonic relationship to each other.

5-96. The movement of the pointer of the balancer of the Type CRV-46040 receiver does not coincide with the rotation of the balancer coil in a manner that at the two extremes of the balancer rotation the pointer is exactly at the ± 50 dial scale readings. See Table 4.

5-98(1). In the case of the low frequency band with a direct connected loop the ratio of quadrature voltage, as induced by the balance antenna, to the in-phase voltage as produced by the loop for a given field intensity exceeds the specification limit.

6-5. The Type CRV-20049 power unit cabinet width is 1/16" greater than allowed, while the depth is 5/16" greater. For installation an additional 1" will have to be allowed for the power cable rigid fitting and 5-3/8" in the depth for the output power supply plug and cable.

6-6. No provision has been made for mounting the Type CRV-20049 power unit and if it is intended to use bolts and nuts or screws through drilled holes in the bottom of the box it is probable that the heads or nuts of same will interfere with chassis movement in the cabinet.

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6-19. The power cable plug housing is in 2 parts which are secured by two 6-32 screws which thread into extruded holes in the thin sheet metal shell. These screws have a tendency to loosen.

6-21. The fuse panel of the Type CRV-20049 power unit is mounted so close to the top of the panel that it may become grounded when the chassis is being removed or replaced in its case.

7-2. The sensitivity with loop excitation for the Models DP-5 and DP-6 equipments is 1.22 microvolts around 1170 kilocycles instead of 1 as required.

7-3. The selectivity in the lower half of the low frequency bands of all equipments is outside the specification limits when measured with an MCW input.

7-4. The image selectivity requirements are not met in any equipment below 185 kilocycles.

7-18. The frequency variation as a result of sensitivity control variation exceeds the specification limit of 100 cycles at 1500 kilocycles.

CONCLUSIONS

70. The subject equipment is, in general, well constructed of good materials. The major exceptions have resulted in a loop and pedestal construction which is not sufficiently watertight for reliable service operation.

71. The general electrical performance of the equipment is good. There are, however, a few items in which the performance does not equal the specification requirements. The fact that the receiver blocks with an input at the loop center of around 100 microvolts may lead to sense reversal, which is considered a serious defect. The balance sensitivity is considerably less than in the Model DO equipments, which preceded this equipment. The sensitivity is below requirements at one point in the high frequency band and the selectivity in the low frequency band is dangerously close to the specification limits.

72. After remedy of the few defects as outlined in this report, this equipment shows promise of excelling to a considerable extent, any direction finder equipment previously tested at this Laboratory.

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Table 1

Variation in Frequency per Ten Divisions
of Dial Scale Type CRV-46040 Receiver
Models DP-4, DP-5, DP-6, and DQ-1 Radio Direction Finder Equipments

Low Frequency Band		Medium Frequency Band		High Frequency Band	
Dial Scale Divisions	Frequency variation per 10 divs. of dial scale kcs.	Dial Scale Divisions	Frequency variation per 10 divs. of dial scale kcs.	Dial Scale Divisions	Frequency variation per 10 divs. of dial scale kcs.
0- 50	1.34	0- 50	3.20	0- 50	8.20
50-100	1.46	50-100	3.42	50-100	8.80
100-150	1.48	100-150	3.36	100-150	8.60
150-200	1.44	150-200	3.12	150-200	7.80
200-250	1.50	200-250	3.30	200-250	9.20
250-300	1.52	250-300	3.40	250-300	8.80
300-350	1.56	300-350	3.58	300-350	9.70
350-400	1.74	350-400	3.72	350-400	9.90
400-450	1.86	400-450	3.80	400-450	10.40
450-500	1.58	450-500	3.80	450-500	9.80
500-550	1.80	500-550	3.60	500-550	10.00
550-600	1.72	550-600	3.60	550-600	10.80
600-650	1.60	600-650	3.20	600-650	9.40
650-700	1.40	650-700	3.20	650-700	9.00
700-750	1.50	700-750	2.80	700-750	8.80
750-800	1.54	750-800	3.40	750-800	9.20
800-825	1.80	800-825	2.60	800-825	11.60
825-850*	1.92	825-850*	4.20	825-850*	12.40
850-875*	2.04	850-875*	4.40	850-875*	15.20
875-900*	2.60	875-900*	5.20	875-900*	16.80
900-920*	2.80	900-920*	6.00	900-920*	20.00
920-940*	2.70	920-940*	5.00	920-940*	17.50
940-960*	1.50	940-960*	2.50	940-960	10.00
960-980*	0.50	960-980*	1.50	960-980*	2.50
980-1000*	0.05	980-1000*	0.50	980-1000*	1.00
Specification limits for any 10 divisions of dial scale=1.86 kilocycles max.; 1.265 kcs min.		Specification limits for any 10 divisions of dial scale=4.07 kilocycles max.; 2.77 kcs min.		Specification limits for any 10 divisions of dial scale=12.0 kilocycles max.; 8.17 kcs min.	

* Designates regions outside of specification limits.

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Table 2

Accuracy of Dial Scale Calibrations
Type CRV-46040 Receiver
Models DP-4, DP-5, DP-6, and DQ-1 Radio Direction
Finder Equipments

Low Frequency Band				Medium Frequency Band				High Frequency Band			
Dial Scale Divs.	Freq. Cal. kcs RCA	NRL	% Error	Dial Scale Divs.	Freq. Cal. kcs RCA	NRL	% Error	Dial Scale Divs.	Freq. Cal. kcs RCA	NRL	% Error
15	100	99	+1.010	59	250	251	-0.398	70	600	598	+0.334
185	125	126	-0.800	207	300	298	+0.671	184	700	694	+0.864
345	150	150	± 0	352	350	249	+0.402	292	800	788	+1.520
490	175	174	+0.571	485	400	399	+0.251	395	900	887	+1.475
630	200	197	+1.500	617	450	445	+1.125	498	1000	993	+0.703
795	225	224	+0.443	785	500	498	+0.402	597	1100	1103	-0.272
912	250	249	+0.400	900	550	545	+0.918	695	1200	1197	+0.250
								802	1300	1292	+0.618
								879	1400	1383	+1.23
								932	1500	1490	+0.667

Specification limit: 2% of recorded frequency.

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Table 3

Range of Sensitivity Control
Type CRV-46040 Receiver
Models DP-4, DP-5, DP-6, and DQ-1 Radio Direction Finder Equipments

		A			B			C		
Band	Freq. Kcs.	Sens. Control Deg.	Absol. uv input	Atten-uation db.	Sens. Control Deg.	Absol. uv input	Atten-uation db.	Sens. Control Deg.	Absol. uv input	Atten-uation db
Models DP-4 and DQ-1 Equipments - CW Operation										
LF	100	261	0.372	± 0	0	352,000	119.51	128	193.5	54.32
LF	250	260	0.250	± 0	0	220,000	118.89	107	484	65.76
MF	250	255	0.248	± 0	0	202,000	118.11	99	484	65.80
MF	550	235	0.245	± 0	0	48,000	105.85	60	1065	72.77
HF	550	262	0.420	± 0	0	500,000	121.51	103	1065	68.1
HF	1500	242	0.290	± 0	0	112,000	111.73	53	2950	80.2
Models DP-4 and DQ-1 Equipments - MCW Operation										
LF	100	290	0.238	± 0	22	500,000	126.44	194	193.5	58.20
LF	250	290	0.178	± 0	11	400,000	127.00	155	484	68.70
MF	250	288	0.150	± 0	11	500,000	130.50	139	484	70.16
MF	550	269	0.140	± 0	0	178,000	122.00	94	1065	77.62
HF	550	290	0.322	± 0	0	413,000	122.14	145	1065	70.40
HF	1500	295	0.141	± 0	0	407,000	129.2	88	2950	86.4
Models DP-5 and DP-6 Equipments - CW Operation										
LF	100	260	0.80	± 0	10	500,000	115.92	156	193.5	47.67
LF	250	261	0.50	± 0	0	409,000	118.15	117	484	59.72
MF	250	252	0.52	± 0	0	352,000	116.59	110	484	59.40
MF	550	232	0.52	± 0	0	102,000	105.8	79	1065	66.19
HF	550	262	0.78	± 0	18	500,000	116.14	117	1065	62.73
HF	1500	240	0.75	± 0	0	273,000	111.17	77	2950	71.87

Notes: A designates receiver adjustments for standard conditions and uv input required for standard output.

B designates receiver adjustments for minimum gain and the uv input required to maintain standard output. The attenuation thus obtained is in terms of absolute values of input

C designates receiver adjustments for an input equivalent to 50,000 uv per meter input and the attenuation attained with the gain reduced as to maintain standard output.



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Table 4

Variation of Maximum Balance Effect at ± 50 Settings of Balancer Models DP-4, DP-5, DP-6, and DQ-1 Radio Direction Finder Equipments

Band	Freq. Kcs.	Microvolt input at +50	Microvolt input at -50	Average Microvolt Input	Total Percent Difference*
		CW Operation			
LF	100	1760	1550	1655	12.70
LF	160	610	580	595	5.04
LF	250	650	580	615	11.35
MF	250	192	203	197.5	5.58
MF	370	111	118	114.5	6.11
MF	550	130	135	132.5	3.77
HF	550	100	100	100	0
HF	900	42.5	43.0	42.75	1.17
HF	1500	45	45	45.0	0
		MCW Operation			
LF	100	1100	810	955	30.4
LF	160	390	402	396	3.03
LF	250	630	580	605	8.25
MF	250	103	111	107	7.47
MF	370	58	60	59	3.39
MF	550	68	69	68.5	1.4
HF	550	71	69	70.0	2.86
HF	900	22.5	22.5	22.5	0
HF	1500	24.5	23.2	23.85	5.45

*Specification limit 5% in voltage

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Table 5

Effect of Tube Replacements in Oscillator Circuits on Sensitivity and Maximum Noise Level with Loop Excitation Models DP-4, DP-5, DP-6, and DQ-1 Radio Direction Finder Equipments

Tube Replacements in R.F. Oscillator Only - CW Input

		Original Tube in R.F.O. Gm=1175. Ip=2.1		Replacement Tube in R.F.O. Gm=1075. Ip=1.73		Replacement Tube in R.F.O. Gm=1260. Ip=2.45	
Band	Freq. kcs	uv Input	Max. noise level volts	uv Input	Max. noise level volts	uv Input	Max. noise level volts
HF	1500	0.347	2.70	0.333	2.70	0.328	2.60
HF	550	0.421	1.10	0.405	0.84	0.400	0.95
MF	550	0.268	2.80	0.310	3.00	0.288	3.10
MF	250	0.302	1.30	0.300	1.38	0.297	1.40
LF	250	0.290	1.50	0.302	1.38	0.280	1.35
LF	100	0.430	1.15	0.430	1.17	0.400	1.15

Tube Replacements in I.F. Oscillator Only - MCW Input

		Original Tube in I.F.O. Gm=1160. Ip=2.0		Replacement Tube in I.F.O. Gm=1075. Ip=1.73		Replacement Tube in I.F.O. Gm=1260. Ip=2.45	
Band	Freq. kcs.	uv Input	Max. noise level volts	uv Input	Max. noise level volts	uv Input	Max. noise level volts
HF	1500	0.215	1.10	0.195	1.15	0.195	1.25
HF	550	0.370	0.08	0.365	0.19	0.365	0.08
MF	550	0.180	1.75	0.195	2.25	0.200	1.57
MF	250	0.210	0.22	0.215	0.22	0.202	0.19
LF	250	0.265	0.19	0.252	0.22	0.245	0.19
LF	150	0.288	0.23	0.305	0.23	0.400	0.19

Gm in micromhos
Ip in milliamperes

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Table 6

Sensitivity with Loop Excitation
Before and After Subjection of Equipment
to Temperature and Humidity Test

Model DP-4 Equipment with CW Input

Band	Frequency kcs	Original Sensitivity Microvolts	Final Sensitivity after cycle microvolts
LF	100	0.340	0.361
LF	160	0.305	0.282
LF	250	0.265	0.210
MF	250	0.291	0.226
MF	320	0.295	0.220
MF	550	0.271	0.224
HF	550	0.440	0.350
HF	900	0.261	0.250
HF	1500	0.333	0.300

Table 7

Effect of Temperature and Humidity
on Performance of Type CRV-46040 Receiver

Sensitivity at Optimum Gain Before Test			Temperature = 25°C Humidity = 50% After Test		
Band	Frequency kcs	uv Input to r.f. Grid	Band	Frequency kcs	uv Input to r.f. Grid
LF	100	7.1	LF	100	7.0
	160	5.0		160	5.5
	250	5.0		250	5.8
MF	250	5.8	MF	250	6.15
	370	6.0		370	8.0
	550	7.2		550	8.0
HF	550	6.35	HF	550	6.8
	900	11.25		900	12.2
	1500	9.20		1500	13.0

Note: All sensitivities are measured with receiver adjusted for optimum gain. Measurements were made after receiver had been given sufficient time to stabilize at the given temperature and humidity.

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Table 7 (continued)

Effect of Temperature and Humidity on Performance of CRV-46040 Receiver at 1500 Kilocycles.

Time Period	Temp. Range °C	Humidity %	Freq. Drift kcs	Sensitivity uv	Noise Level Volts	Remarks
Start 9:30 a.m.	+25	50	none	11.0	0.19	Receiver in chamber during previous night at approx. 25°C - 50% humidity.
9:30am - 12:35 pm	+25	50 to 90	0 to +7.0	13.0	0.20	Drift varied up and down while humidity was being brought up to 90%.
12:35pm - 1:00 pm	+25 to +35	90	+7.0 to +3.0	16.0	-	Drift rapidly in downward direction.
1:00pm - 1:53 pm	+35	90	+3 to 0	16.0	-	Stability approached.
1:53pm - 2:25 pm	+35 to +45	90	0 to -3	17.0	-	
2:25pm - 2:45 pm	+45	90	-3 to -13	26.0	-	Low noise level.
2:45pm - 3:03 pm	+45 to +50	90	-13 to -16	28.0	-	Low noise level.
3:03pm - 3:30 pm	+50	90	-16 to -25	34.5	-	Direction of drift reverses.
3:30pm - 3:46 pm	+50	90	-25 to -22	34.5	0.055	
3:46pm - 4:27 pm	+50 to +25	90	-22 to +7.0	15.5	0.22	Increase in frequency very rapid with decrease in temperature-stability reached at 4:27 p.m.
4:27pm - 8:30 am	+25 to +21	91	+7 to +3	11.5	0.112	Original frequency and sensitivity nearly reached.
8:30am - 9:03 am	+21 to +15.5	49	+3 to +6	11.5	0.125	Note drop in humidity.
9:03am - 9:14 am	+15.5 to +13.3	43	+6 to +8	11.0	0.135	
9:14am - 9:30 am	+13.3 to +9.5	42	+6 to +9	-	-	Impossible to measure sensitivity due to pickup of keyed transmitter.
9:30am - 10:30am	+9.5 to +6	55	+9 to +10	-	-	
10:30am - 10:47am	+6 to 0		+10 to +10.7	10.5	0.150	Wet and dry bulb thermometers removed from chamber.
10:47am - 12:40pm	0 to +6.7	-	+10.7 to +8.0	11.0	0.150	Power off from 10:47 a.m. to 12:40 p.m.

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Table 7 (continued)

Time Period	Temp. Range °C	Humidity %	Freq. Drift kcs	Sensitivity uv	Noise Level Volts	Remarks
12:40pm - 12:53pm	+6.7 to 0	-	+8 to +10.7	11.0	0.155	
12:53pm - 1:09pm	0 to -10	-	+10.7 to +11.0	10.5	0.165	
1:09pm - 1:58pm	-10 to -18	-	+11 to +13.0	11.0	0.21	
1:58pm - 2:56pm	-18 to -22	-	+13.0 to +14.0	10.8	0.20	
2:56pm - 4:15pm	-22 to -26	-	+14.0 to 14.5	11.0	0.20	
4:15pm - 9:00am	-26 to +10	80	+14.5 to +7.0	0.5	0.30	Equipment remained over night.
9:00am - 9:35am	+8	40	+7.0 to +8.0	10.5	0.36	
9:35am - 9:45am	+8 to +22	9	+8.0 to +8.1	-	-	Wobbly beat note, lasting approx. 5 min.
9:45am - 10:25am	+22 to +25	50	-			Wobbly beat note.
10:25am - 11:38am	+25	50	+8.0 to +8.1	11.2	0.30	All wobbling of beat note ceased. Sensitivity returned to nearly normal. Frequency also returned to nearly normal.

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Table 8

Two Signal Generator Tests for Cross-Modulation

(Interfering signal applied to loop center, 0.5 volts of 200 cycle 30% modulated CW. Receiver adjusted for standard conditions and CW operation with 6 mw output.)

Model DP-4 Equipment

	Kcs. below resonance	Kcs. above resonance	% below resonance	% above resonance
250 kilocycles				
(a) Interfering signal just audible	4	7	1.6	2.8
(b) Interfering signal 6 mw	3.2	6	1.28	2.4
(c) Desired signal unreadable	2.5	5	1.0	2.0
(d) Receiver blocked	2	4	.8	1.6
375 kilocycles				
(a) Interfering signal just audible	5.8	5.8	1.5	1.5
(b) Interfering signal 6 mw	5	5.3	1.23	1.41
(c) Desired signal unreadable	4.5	3.8	1.2	1.01
(d) Receiver blocked	3	2	.8	.53
1311 kilocycles				
(a) Interfering signal just audible	8	22	.61	1.69
(b) Interfering signal 6 mw	6	9	.38	.65
(c) Desired signal unreadable	4	6	.32	.47
(d) Receiver blocked	1	1	.076	.076

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Table 9

Sum and Difference Responses Resulting From An Interfering Signal of 0.5 volt (CW, 200 cycle 30% modulated) applied to the Loop Center.

Model DP-4 Equipment

Signal generator frequency	Receiver output milliwatts	Receiver tuning
146	.21	250 kcs
148	5.0	"
163.5	0.6	"
169.5	10.0	"
183.5	.8	"
187	9.0	"
194.5	16.0	"
207.5	17.5	"
216	4.5	"
224.8	9.0	"
226	27.0	"
227	9.0	"
228.7	25.0	"
230	13.5	"
231	15.0	"
232	15.0	"
233.3	1.5	"
234	10.0	"
234.5	25.0	"
235	27.0	"
236	15.0	"
236.5	16.0	"
238.5	9.0	"
239.4	22.0	"
241	26.0	"
243	17.0	"
243.5	12.0	"
255	18.5	"
264	2.0	"
270	3.2	"
291	27.5	"
371	5.0	"
192.5	6.0	375 kcs
276.5	.2	"
270.2	1.2	"
362.8	6.0	"
366.5	17.0	"
381.5	18.0	"
384.0	19.0	"
436	7.6	"
578	10.5	"
987	13.0	"
1090	10.5	"

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Table 10

Resonant Overload and Maximum Output

Band	Freq. Kcs.	CW Input at Resonant Overload	Milliwatts Output at Resonant Overload	Maximum Output Milliwatts
	Models DP-4 and DQ-1 Equipments - CW Operation			
LF	100	1.10	23.0	25.4
LF	250	0.74	20.5	23.7
MF	250	0.62	22.0	28.7
MF	550	0.80	23.0	25.9
HF	550	1.30	22.0	23.4
HF	1500	1.00	25.0	29.3
	Models DP-5 and DP-6 Equipments - CW Operation			
LF	100	1.70	17.0	22.6
LF	250	1.30	18.5	22.2
MF	250	1.35	17.5	22.7
MF	550	1.40	21.0	24.0
HF	550	2.00	19.0	23.5
HF	1500	1.80	20.0	25.4

Table 11

Frequency Drift with Change of Line Voltage

Models DP-4, DP-5, DP-6, and DQ-1 Radio Direction Finder Equipments

Band	Freq. kcs	Change in Beat Note Frequency - Cycles 104.5 to 110 volts	110 to 115.5 volts
LF	100	+11.5	-10.0
LF	250	+22.0	-16.0
MF	250	+ 9.0	- 8.0
MF	550	+26.0	-23.0
HF	550	- 6.0	+ 7.0
HF	1500	-22.0	+25.0

Specification limit - 400 cycles.

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Table 12

Frequency Drift with Change of Sensitivity Control

Models DP-4, DP-5, DP-6, DQ-1 Radio Direction Finder Equipments

Band	Freq. Kcs.	Change in Beat Note Frequency - cycles
LF	100	29
LF	250	46
MF	250	29
MF	550	65
HF	550	16
HF	1500	121*

*Specification limit - 100 cycles.

Table 13

Balance-Sense Antenna Constants

Frequency kcs	Eff. Capacitance uuf	Eff. Resistance ohms
506	223	5.8
700	231	5.4
1050	267	7.8
1350	312	15.7

Points could not be obtained at direction finder test frequencies of 630, 950, 1310, and 1460 kilocycles, owing to received energy from the carriers of these broadcast stations.

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Table 14

Inductance of Loop Coupling Transformers

Unit	Terminals	Q	L
CRV-47100	1 and 2 (Brushes)	72	251 uh eff.
CRV-47100	4 and 5 (Line)	48	165 " "
CRV-47101	1 and 2 (Receiver)	66	197 " "
CRV-47101	4 and 5 (Line)	40	87 " "

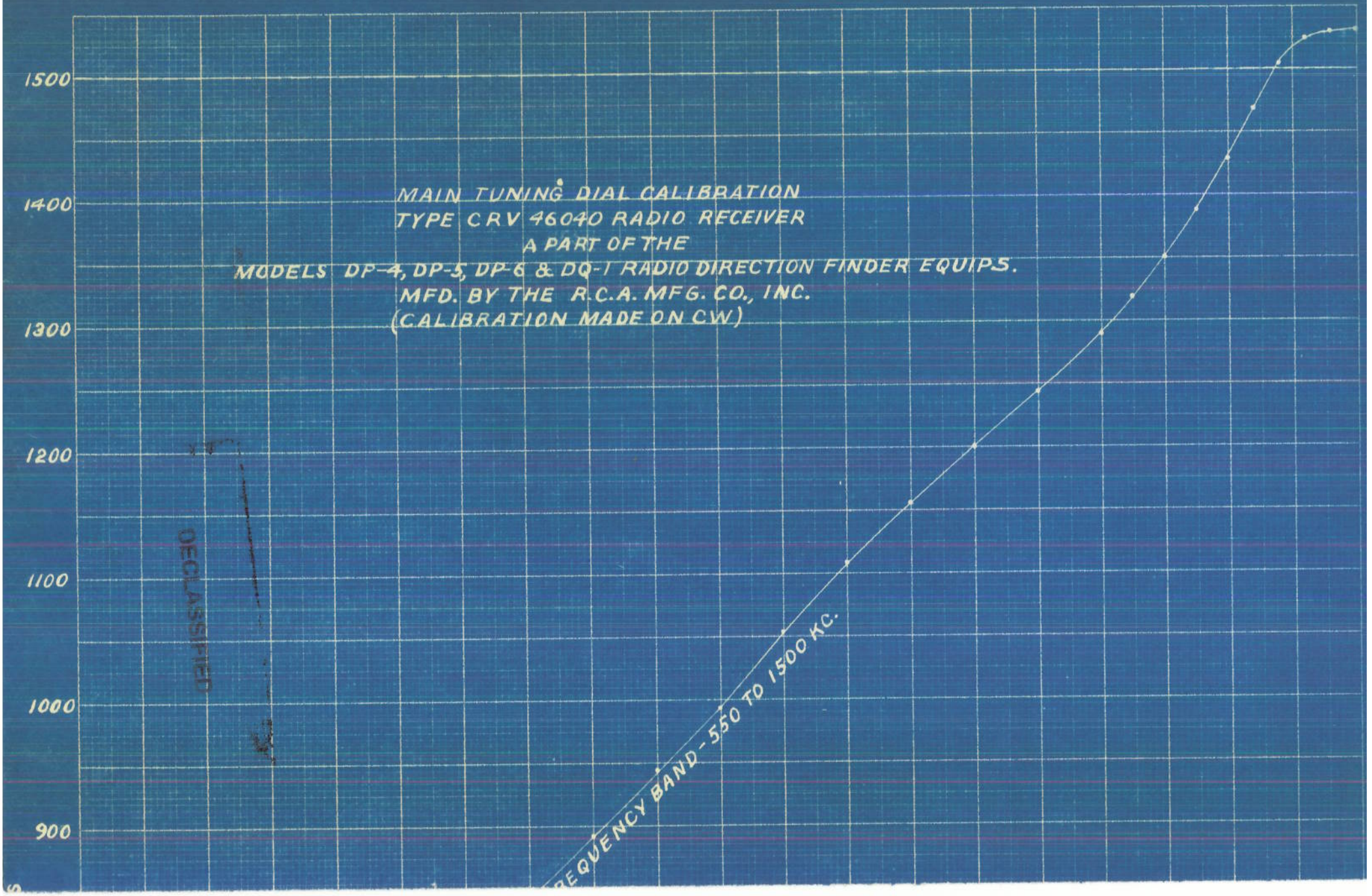
Measured balanced with 200 uuf to resonate.

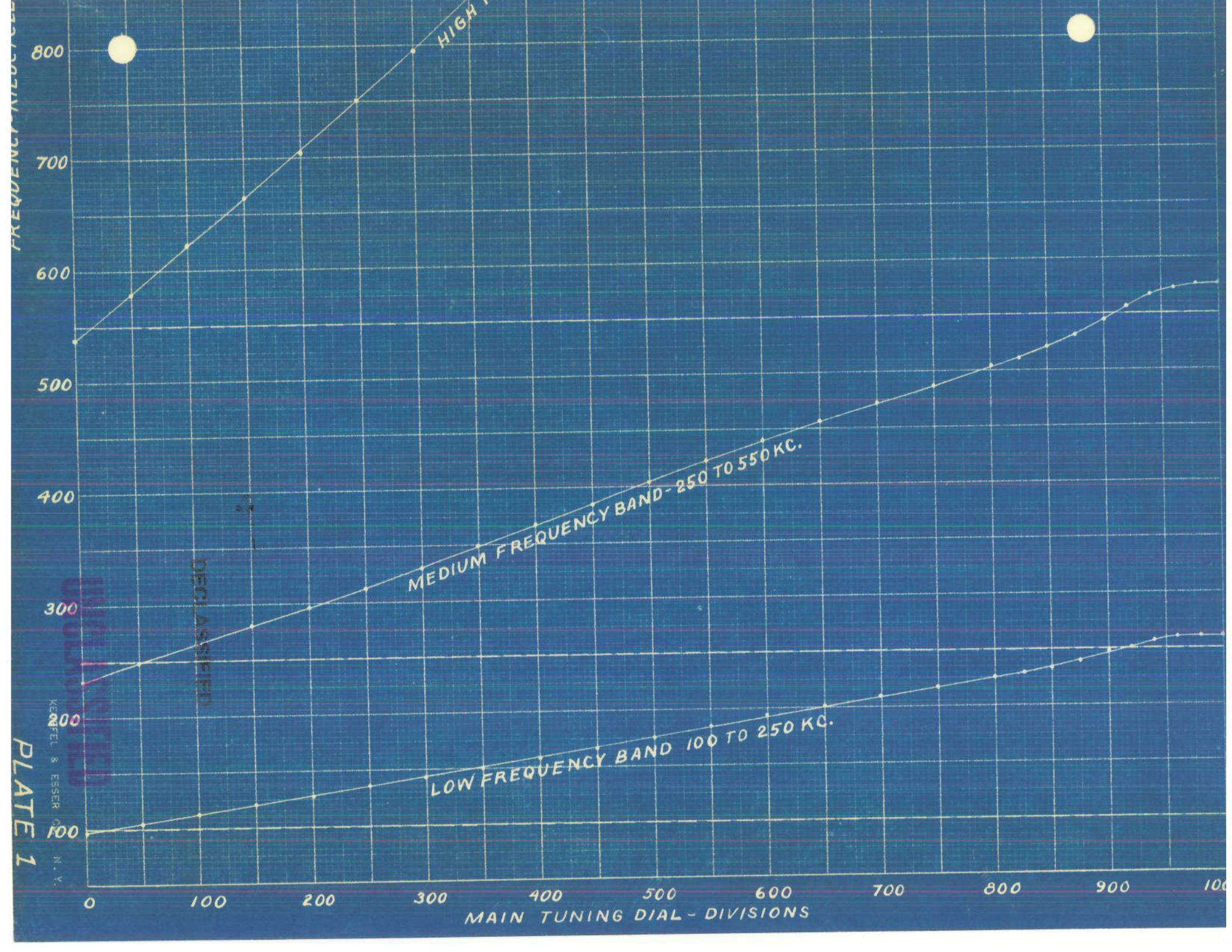
CRV-47100	1 and 3	55	97 uuf eff.
CRV-47100	2 and 3	54	97 " "
CRV-47100	4 and 3	33	43 " "
CRV-47100	5 and 3	32	42 " "
CRV-47101	1 and 3	57	87 " "
CRV-47101	2 and 3	54	87 " "
CRV-47101	4 and 3	35	41 " "
CRV-47101	5 and 3	32	38 " "

Measured with #3 terminal grounded and 400 uuf to resonate.

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ENGRAVING 334-3. X 10 TO THE HALF INCH.
WHEN ORDERING STATE COLOR OF DRAWING OR TRACING PAPER OR CLOTH
PRINTED IN U. S. A.
100% RAG PAPER

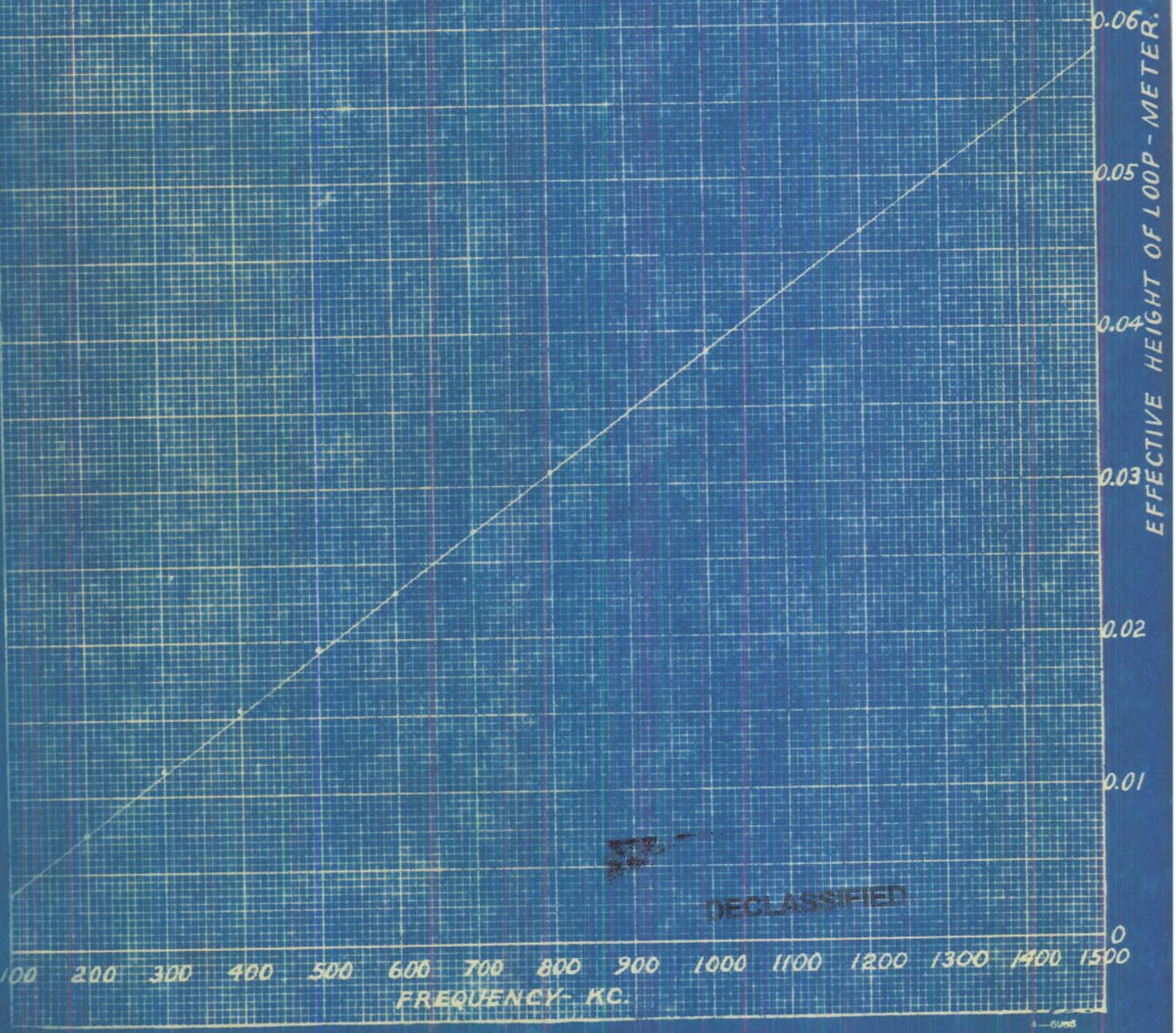



FREQUENCY - KILOCYCLES
800
700
600
500
400
300
200
100
HIGH
MEDIUM FREQUENCY BAND - 250 TO 550 KC.
LOW FREQUENCY BAND 100 TO 250 KC.
0
100
200
300
400
500
600
700
800
900
MAIN TUNING DIAL - DIVISIONS
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KEUFEL & ESSER CO. N.Y.
PLATE 1

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

DATE

CALCULATED EFFECTIVE HEIGHT OF LOOP VS. FREQUENCY
CRV 69006 LOOP ASSEMBLY
A PART OF THE
MODELS DP-4, DP-5 & DP-6 RADIO DIRECTION FINDER EQUIP'S
MFD. BY THE R.C.A. MFG. CO., INC.



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SHEET

PLATE 2

IF SHEET IS READ THIS WAY (HORIZONTALLY) THIS MUST BE TOP. IF SHEET IS READ THE OTHER WAY (VERTICALLY) THIS MUST BE TOP.

WAVELENGTH SQUARED CURVE

CURVE A - LOOP, PEDESTAL AND 108" C

CURVE B - LOOP, PEDESTAL INPUT & OU
TRANSMISSION LINE AS USE

CURVE C - LOOP AND 108" COUPLING CA

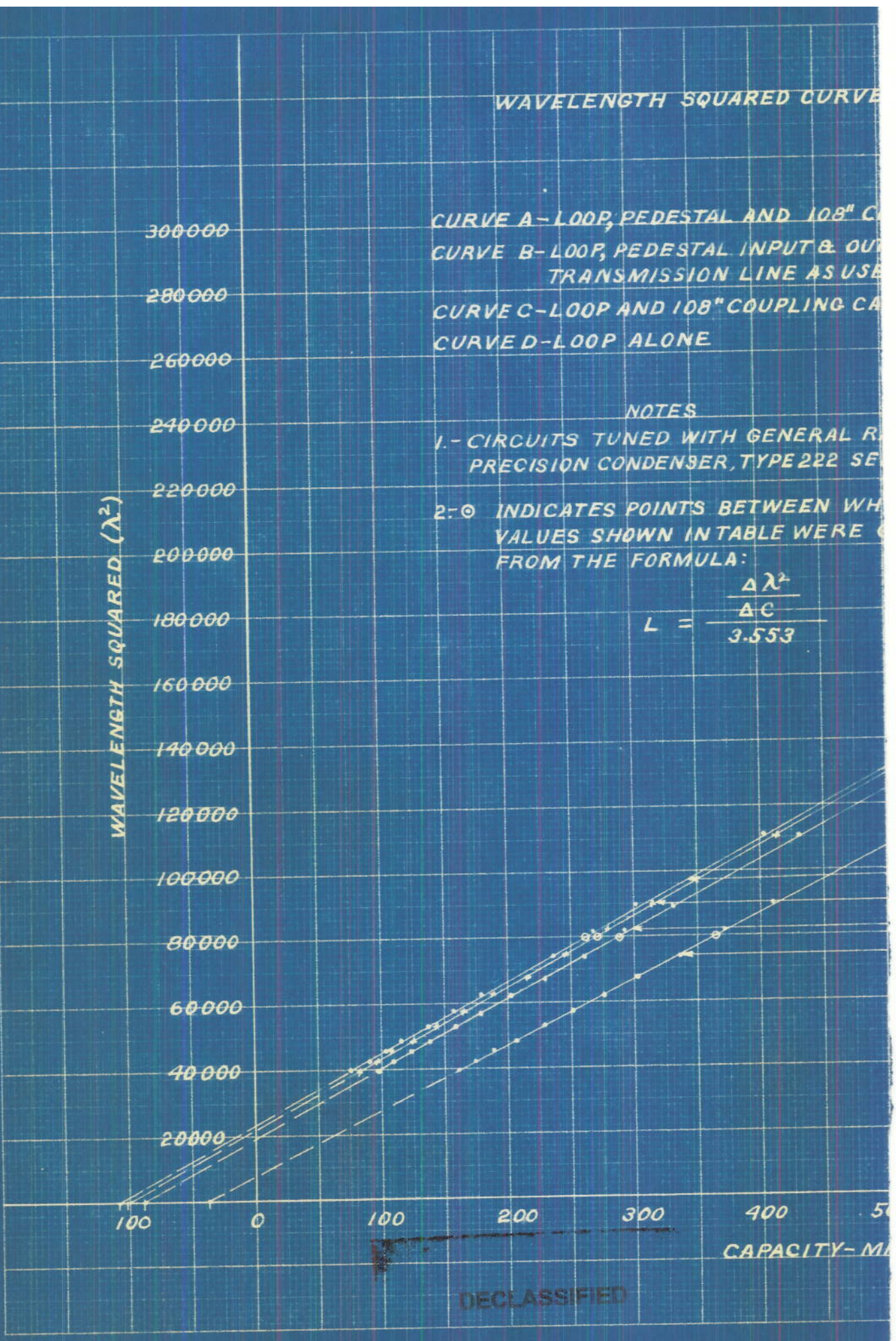
CURVE D - LOOP ALONE

NOTES

1. - CIRCUITS TUNED WITH GENERAL R
PRECISION CONDENSER, TYPE 222 SE

2. - ⊙ INDICATES POINTS BETWEEN WH
VALUES SHOWN IN TABLE WERE
FROM THE FORMULA:

$$L = \frac{\frac{\Delta \lambda^2}{\Delta C}}{3.553}$$



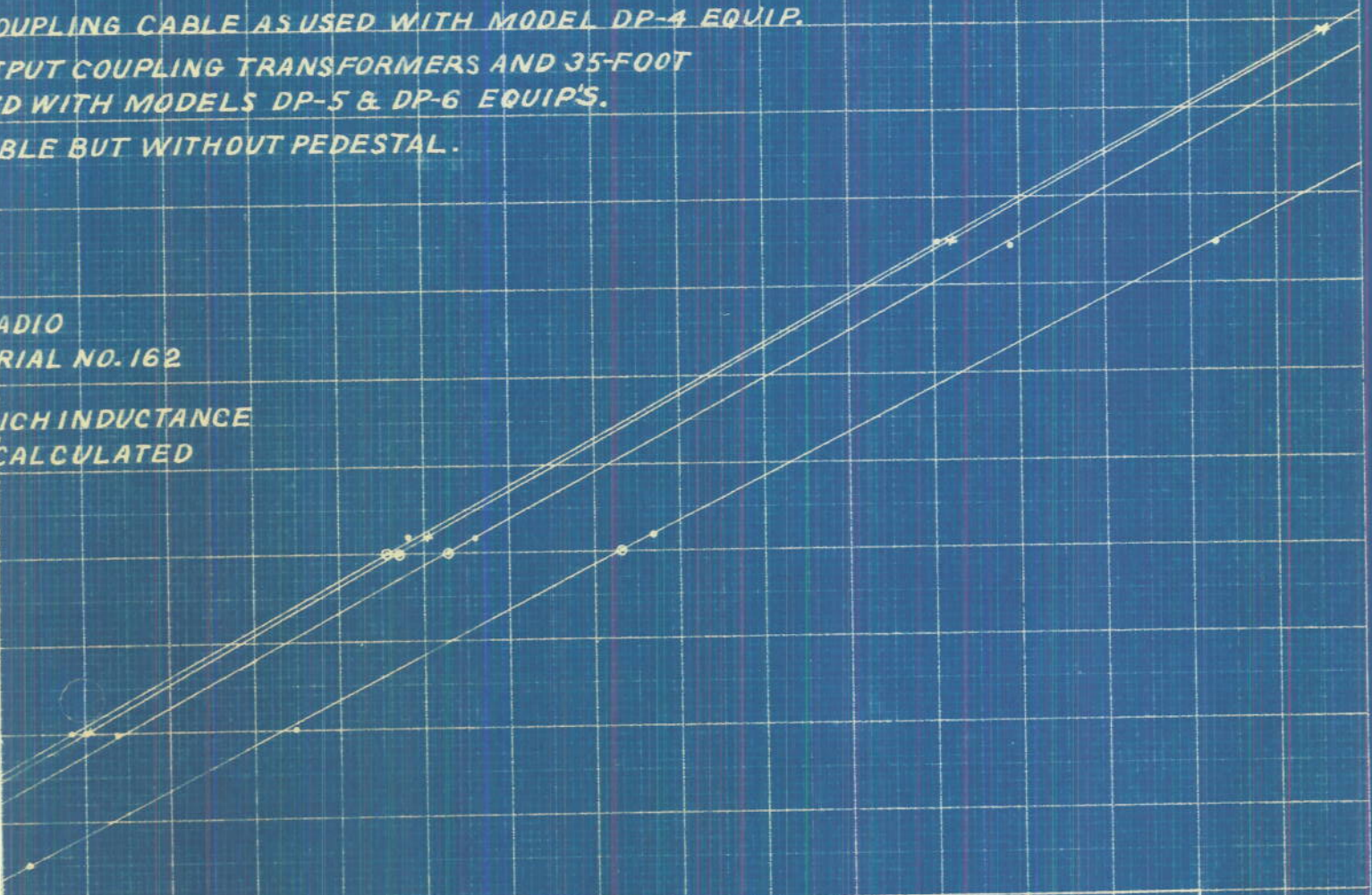
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FOR DETERMINING TRUE INDUCTANCE AND DISTRIBUTED CAPACITANCE

OUPLING CABLE AS USED WITH MODEL DP-4 EQUIP.
PUT COUPLING TRANSFORMERS AND 35-FOOT
D WITH MODELS DP-5 & DP-6 EQUIP'S.
BLE BUT WITHOUT PEDESTAL.

ADIO
RIAL NO. 162

ICH INDUCTANCE
CALCULATED



CURVE - A
CURVE - B
CURVE - C
CURVE - D

CURVE	*TRUE TOTAL INDUCTANCE	* TOTAL DISTRIBUTED CAPACITANCE
	MICROHENRIES	MICRO-MICROFARADS
A	60.7	109.0
B	60.7	102.0
C	59.3	88.0
D	56.3	37.0

*NOTE - FOR CURVE B, THESE FIGURES ARE REFLECTED VALUES

00 600 700 800 900 1000 1100 1200

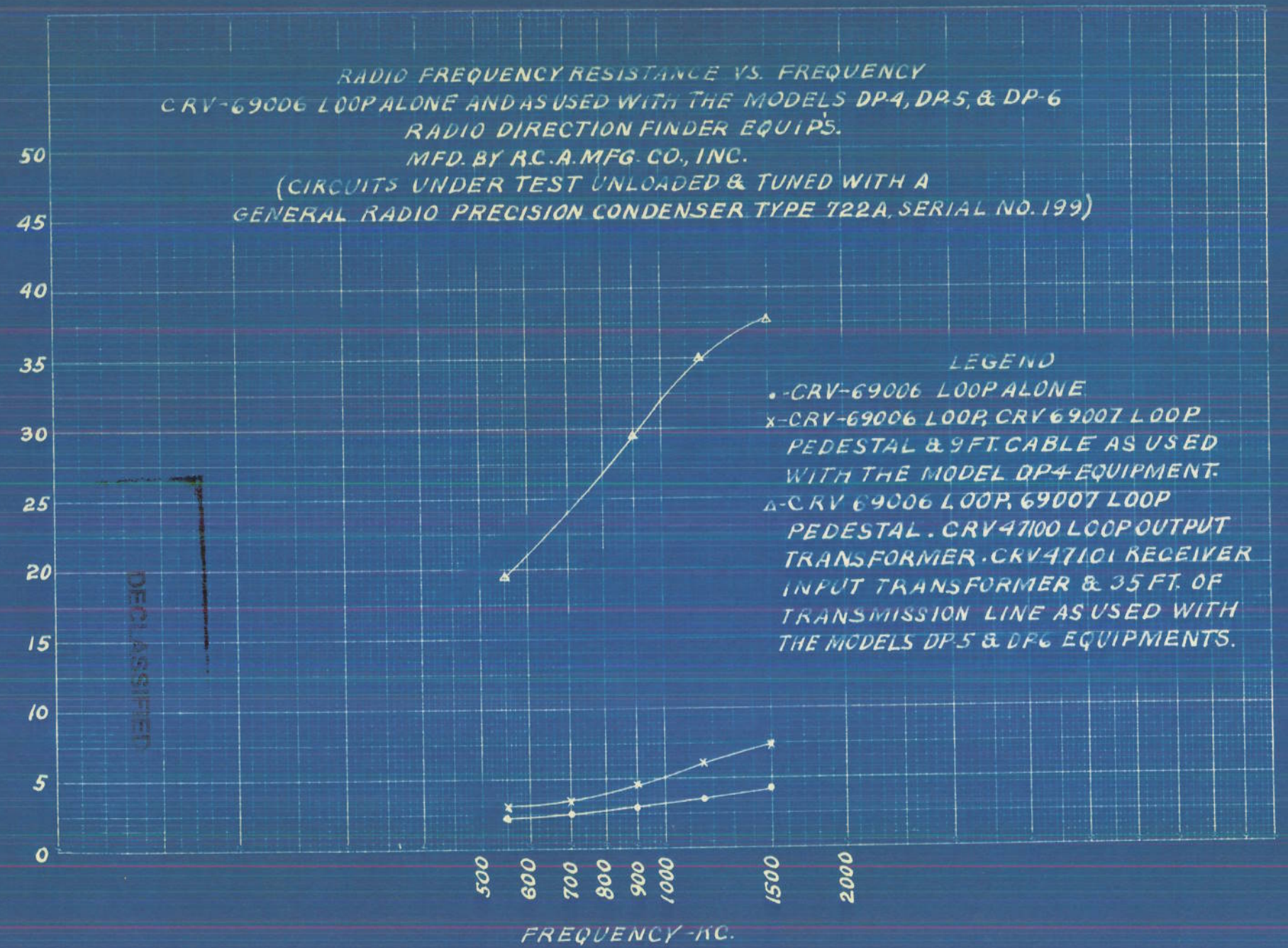
CRO-MICROFARADS (C)

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KEUFFEL & ESSER CO. N.Y.

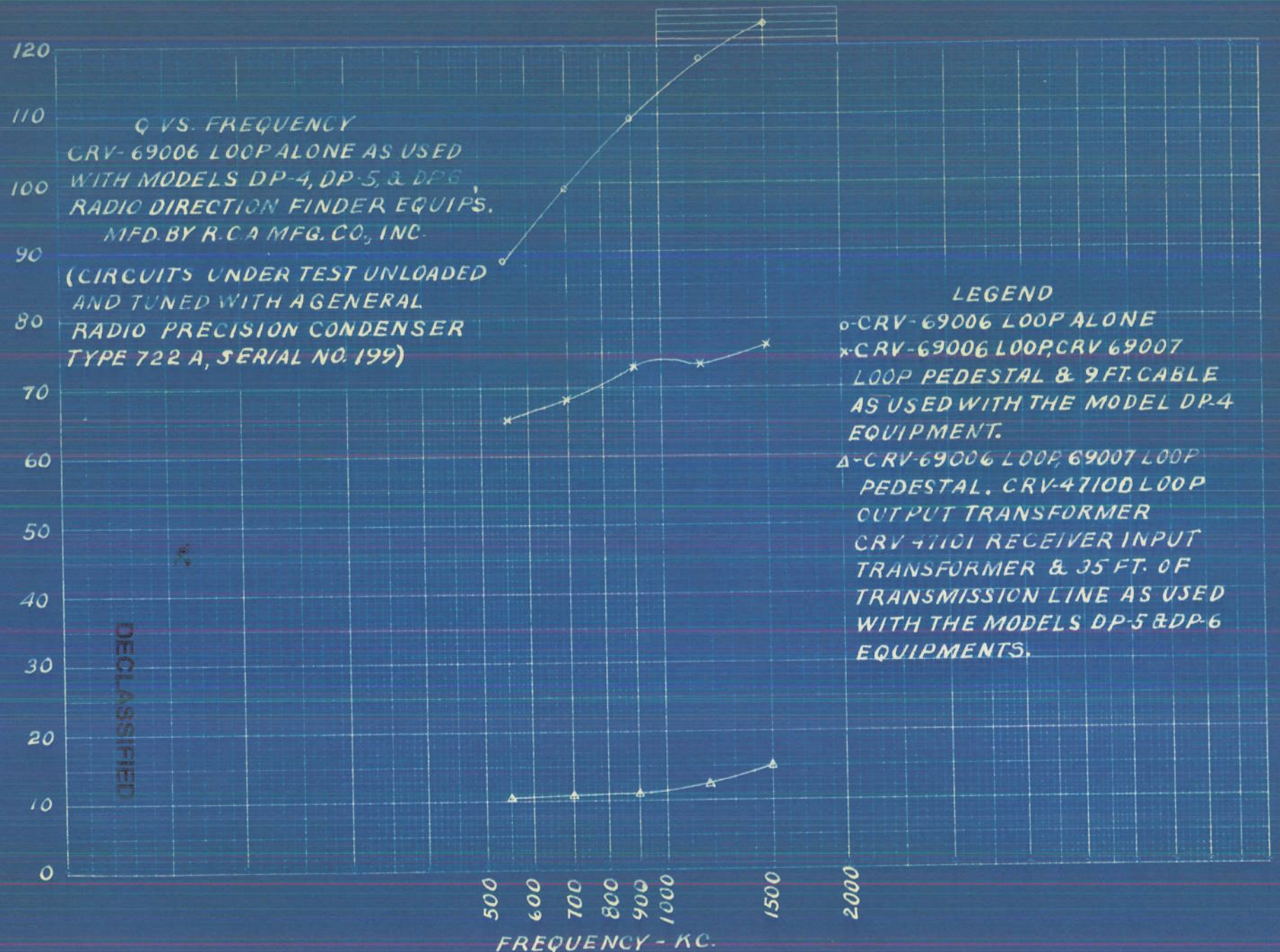
PLATE 3

RADIO FREQUENCY RESISTANCE VS. FREQUENCY
CRV-69006 LOOP ALONE AND AS USED WITH THE MODELS DP-4, DP-5, & DP-6 RADIO DIRECTION FINDER EQUIPS.
MFD. BY R.C.A. MFG. CO., INC.
(CIRCUITS UNDER TEST UNLOADED & TUNED WITH A GENERAL RADIO PRECISION CONDENSER TYPE 722A, SERIAL NO. 199)



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PLATE 4



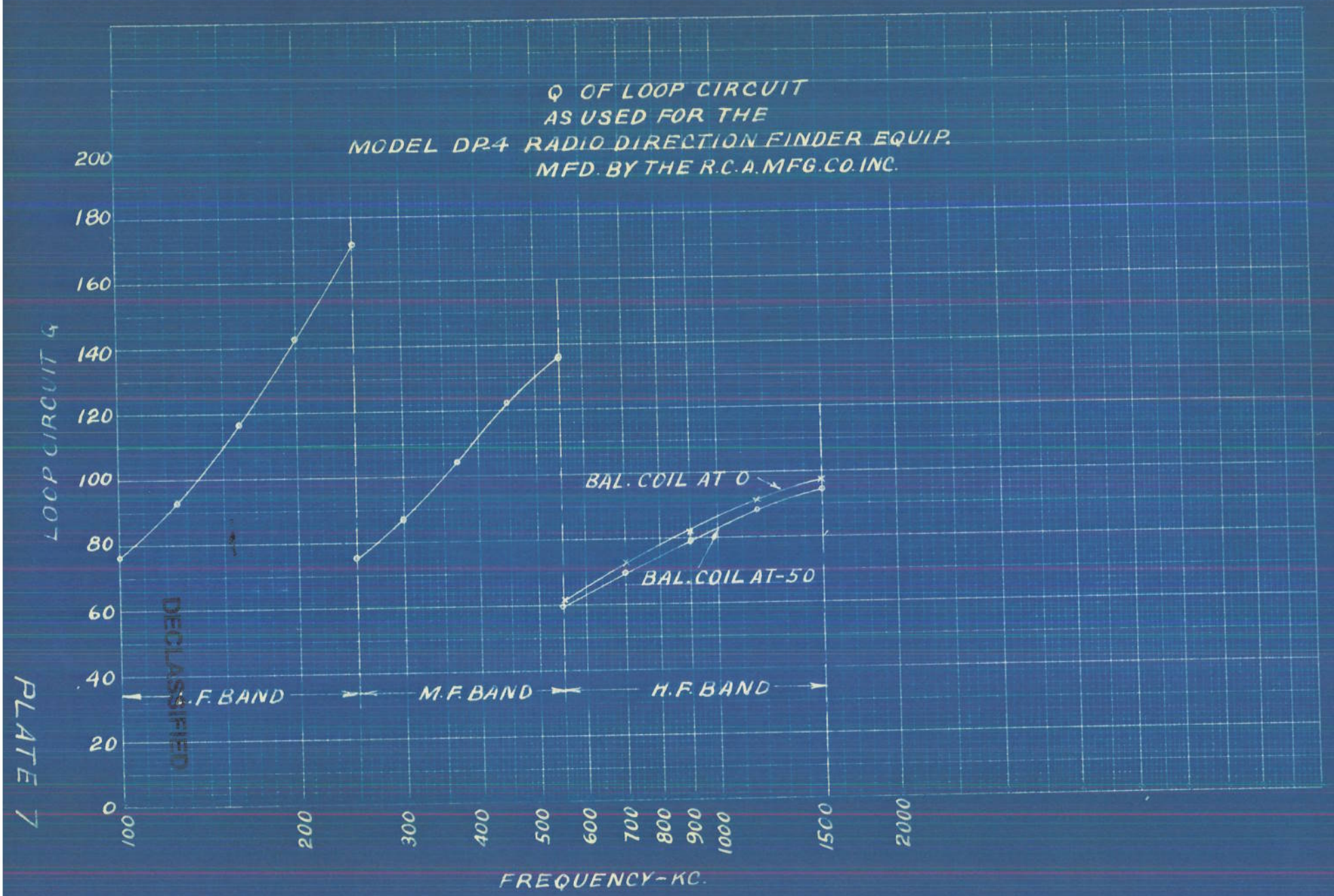
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PLATE 5

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PLATE 6

NO. 31,193. 20 DIVISIONS PER INCH—120 DIVISIONS—BY TWO 4 1/2-INCH CYCLES RATIO RULING.



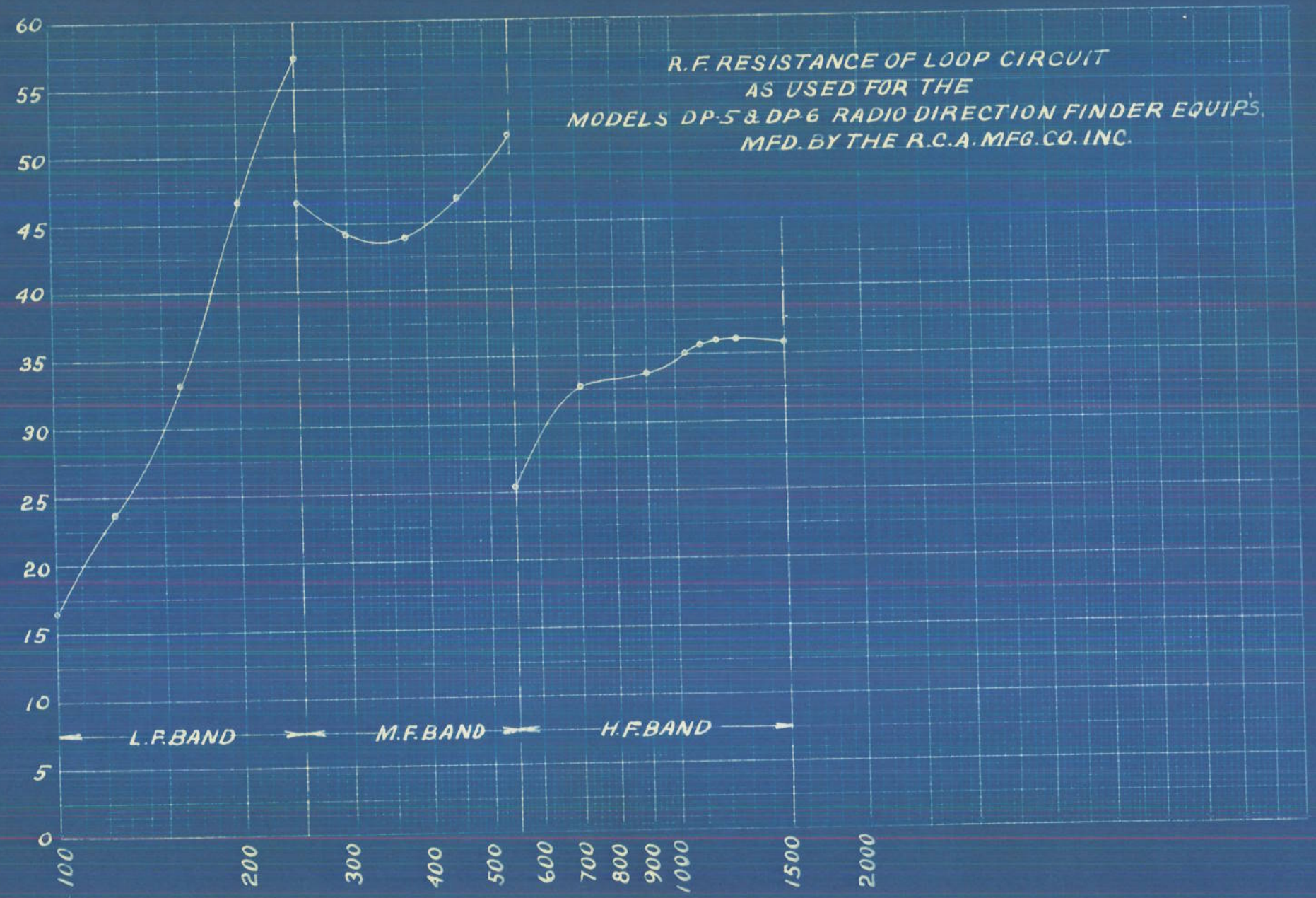
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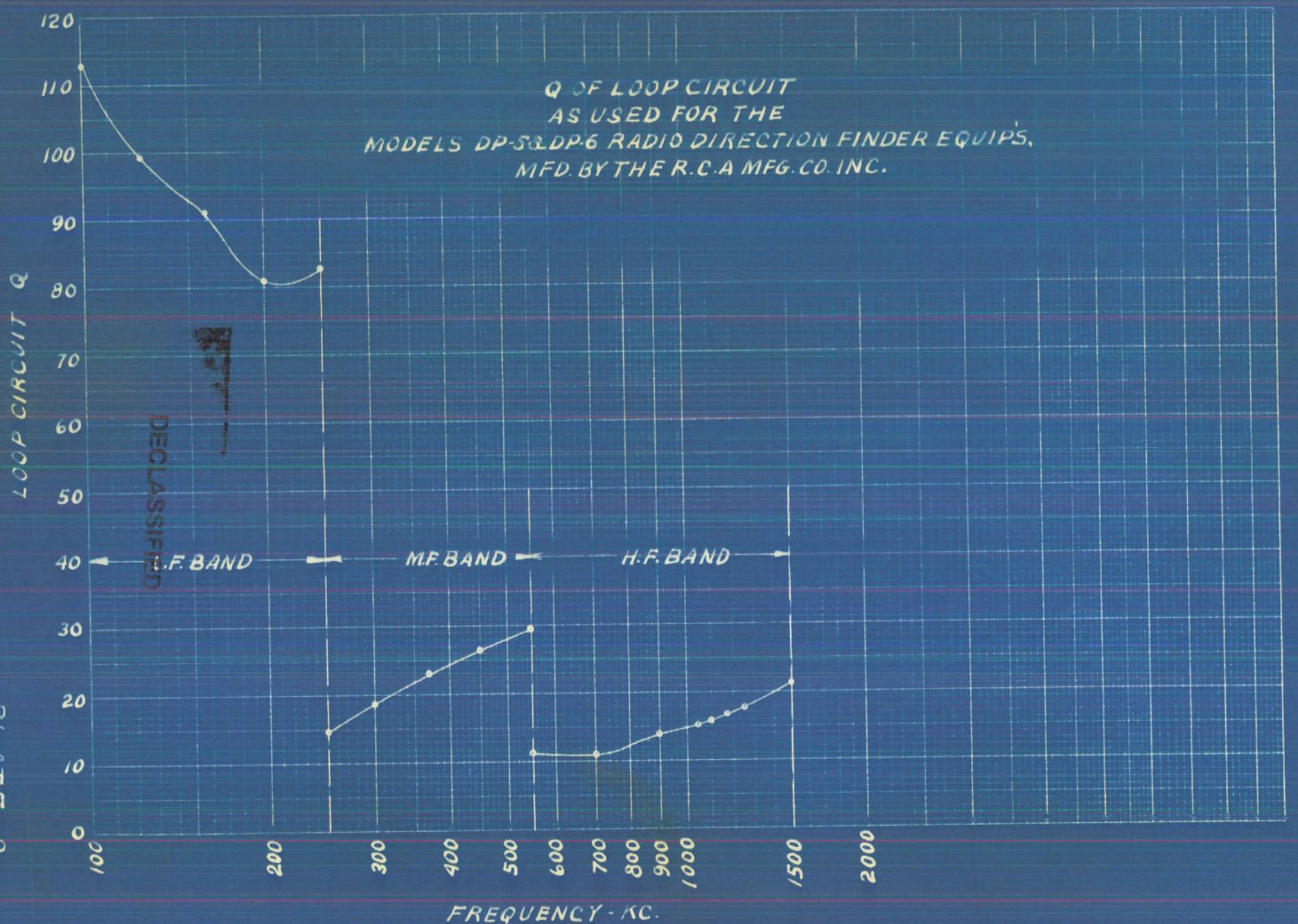
PLATE 7

NO. 31,193. 20 DIVISIONS PER INCH (120 DIVISIONS) BY TWO 4 1/2-INCH CYCLES RATIO RULING.
CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS.

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PLATE 8



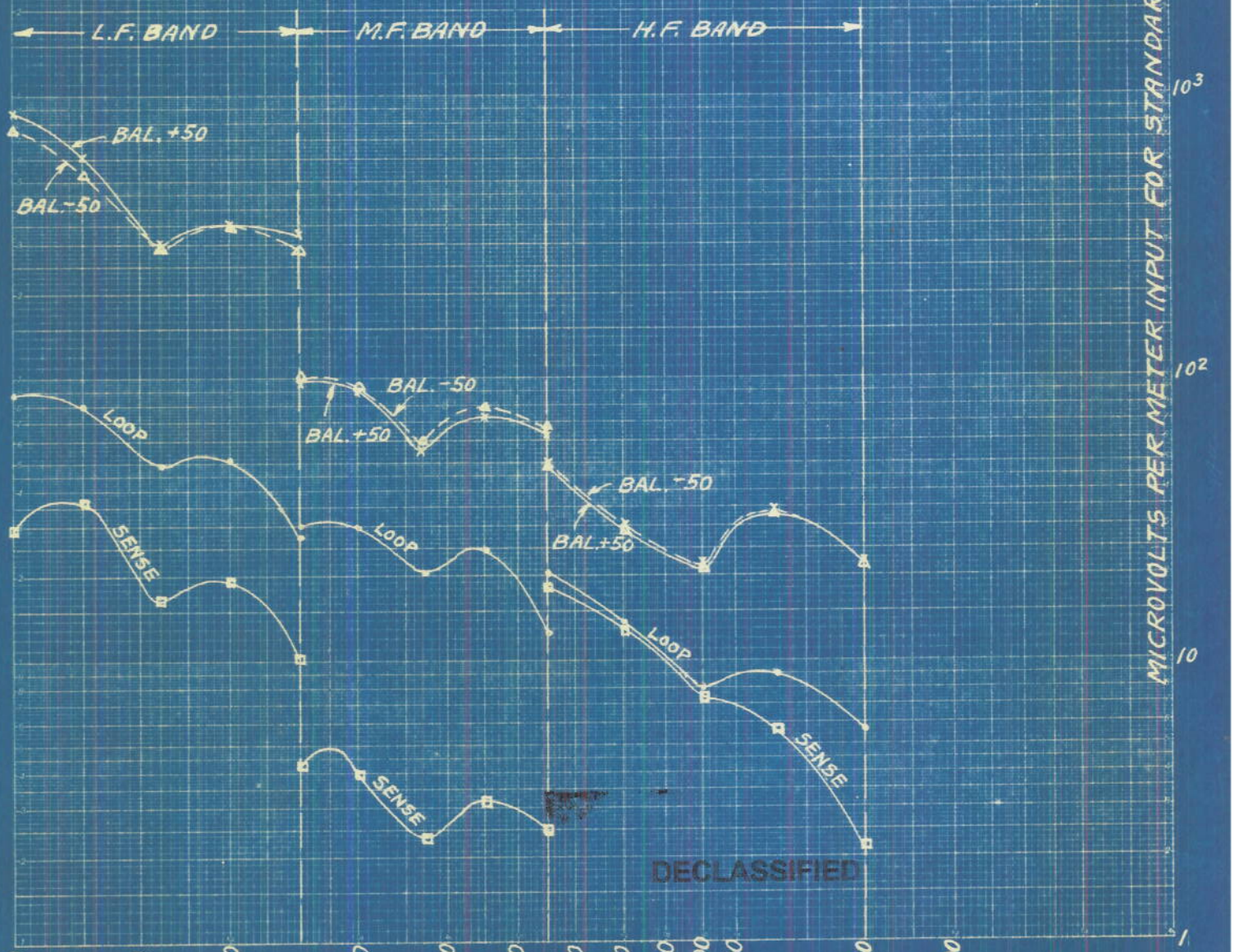


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PLATE 9

LOOP, SENSE & BALANCER SENSITIVITY
CW CARRIER INPUT

MODELS DP-4 & DQ-1 RADIO DIRECTION FINDER EQUIP'S.
MFD. BY THE RCA MFG. CO. INC.



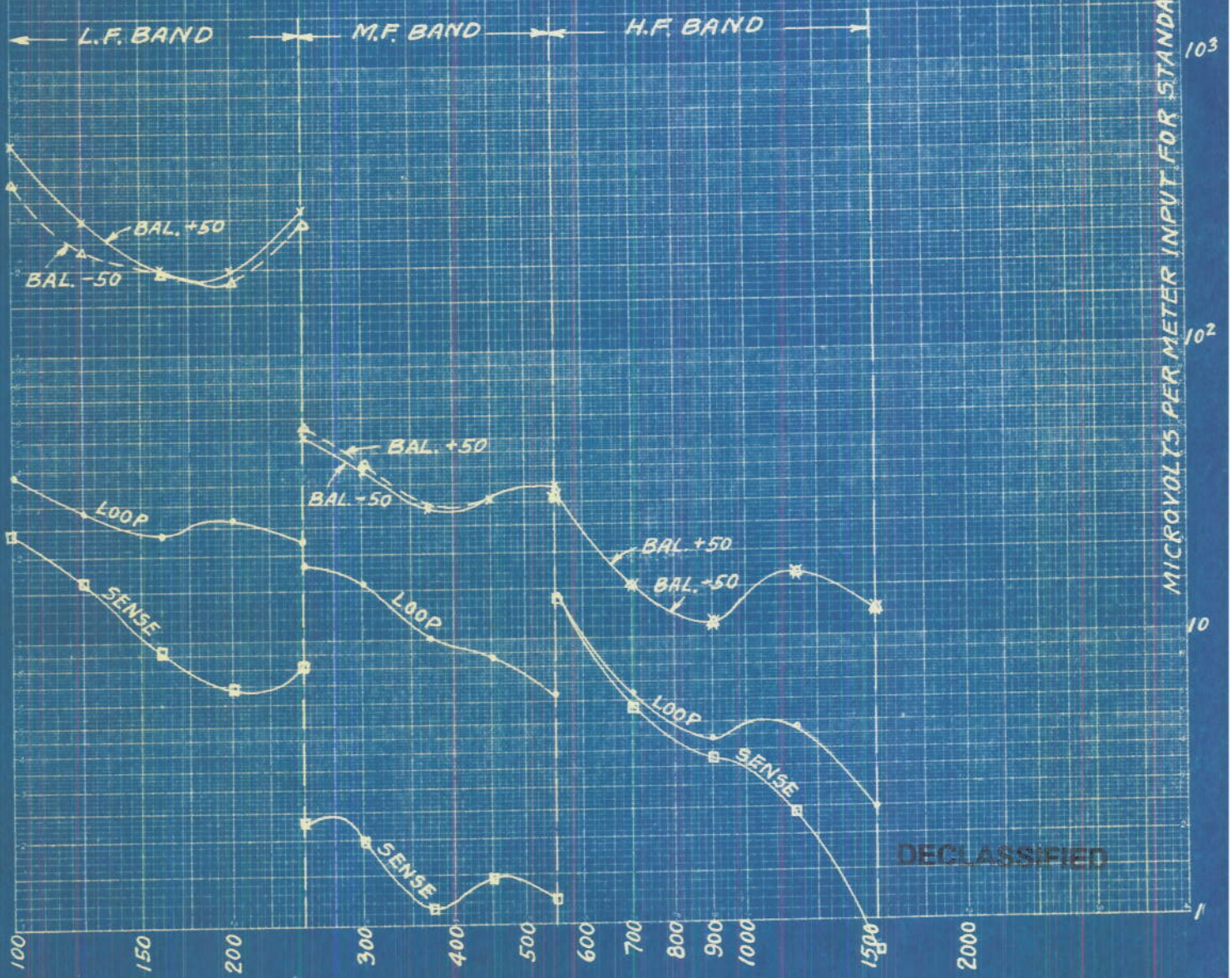
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PLATE 10

LOOP, SENSE & BALANCER SENSITIVITY

30% MODULATED CARRIER INPUT

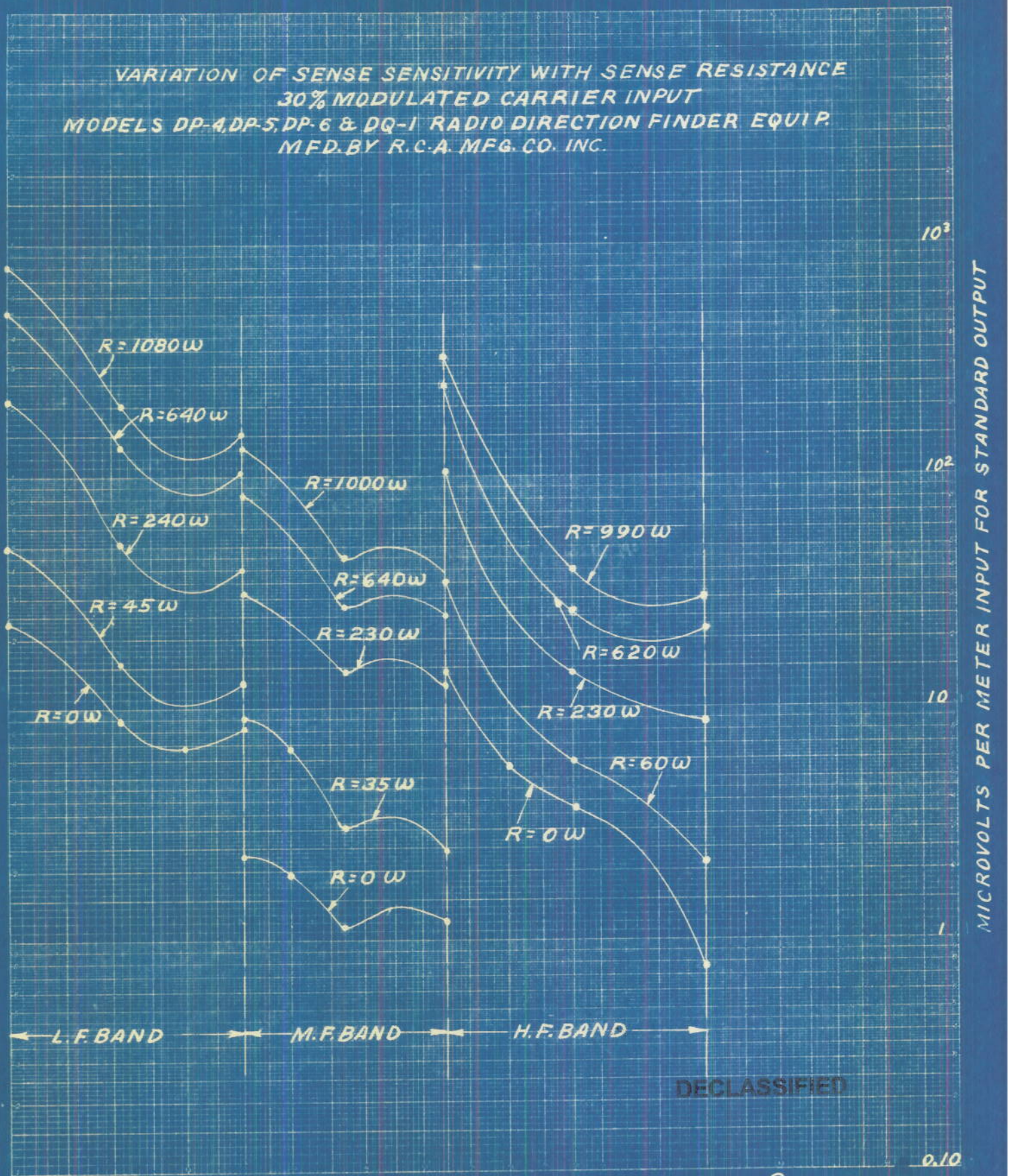
MODELS DP-4 & DQ-1 RADIO DIRECTION FINDER EQUIP'S.
MFD. BY THE RCA. MFG. CO. INC.



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PLATE 11

VARIATION OF SENSE SENSITIVITY WITH SENSE RESISTANCE
30% MODULATED CARRIER INPUT
MODELS DP-4, DP-5, DP-6 & DQ-1 RADIO DIRECTION FINDER EQUIP.
MFD. BY R.C.A. MFG. CO. INC.



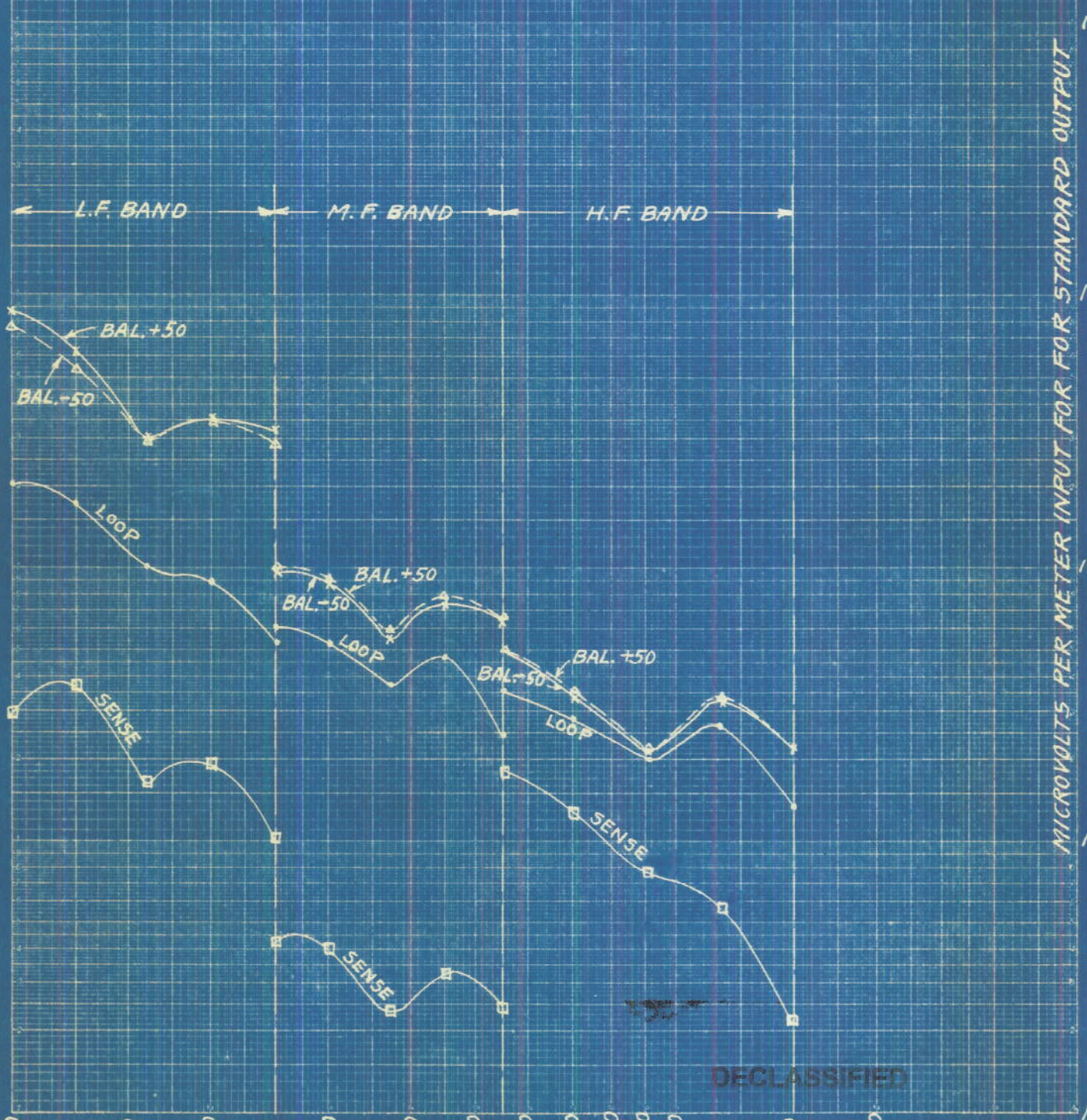
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PLATE 12

NO. 31119. LOGARITHMIC 1 4/10 BY 5 CYCLES. CODE BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS

LOOP, SENSE & BALANCER SENSITIVITY
CW CARRIER INPUT

MODELS DP-5 & DP-6 RADIO DIRECTION FINDER EQUIP'S.
MFD. BY THE RCA. MFG. CO. INC.

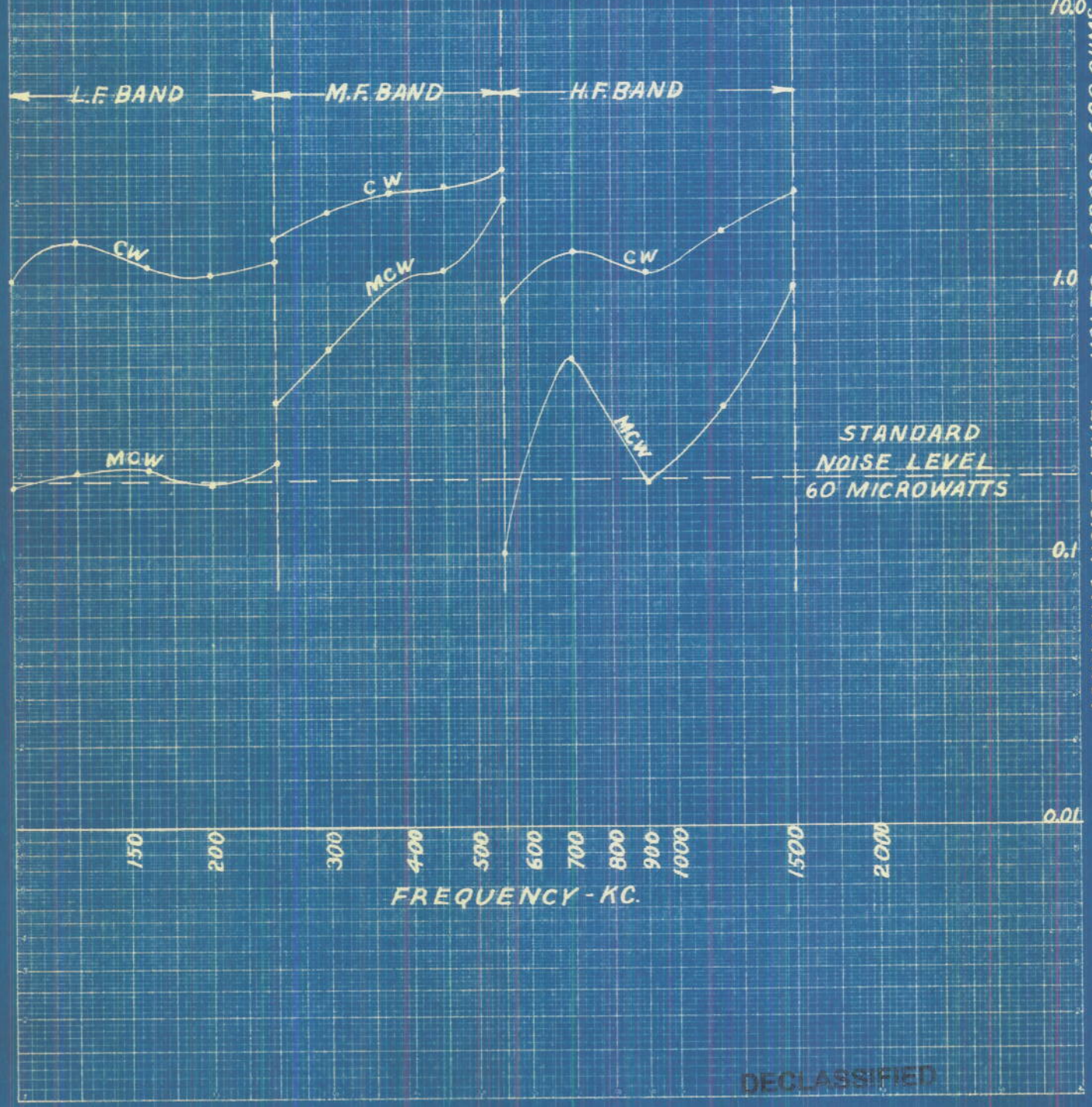


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PLATE 13

NO. 3111S. LOGARITHMIC 1-4-10 BY 5 CYCLES. KEUFFEL & ESSER CO. NEW YORK. NORWOOD, MASSACHUSETTS

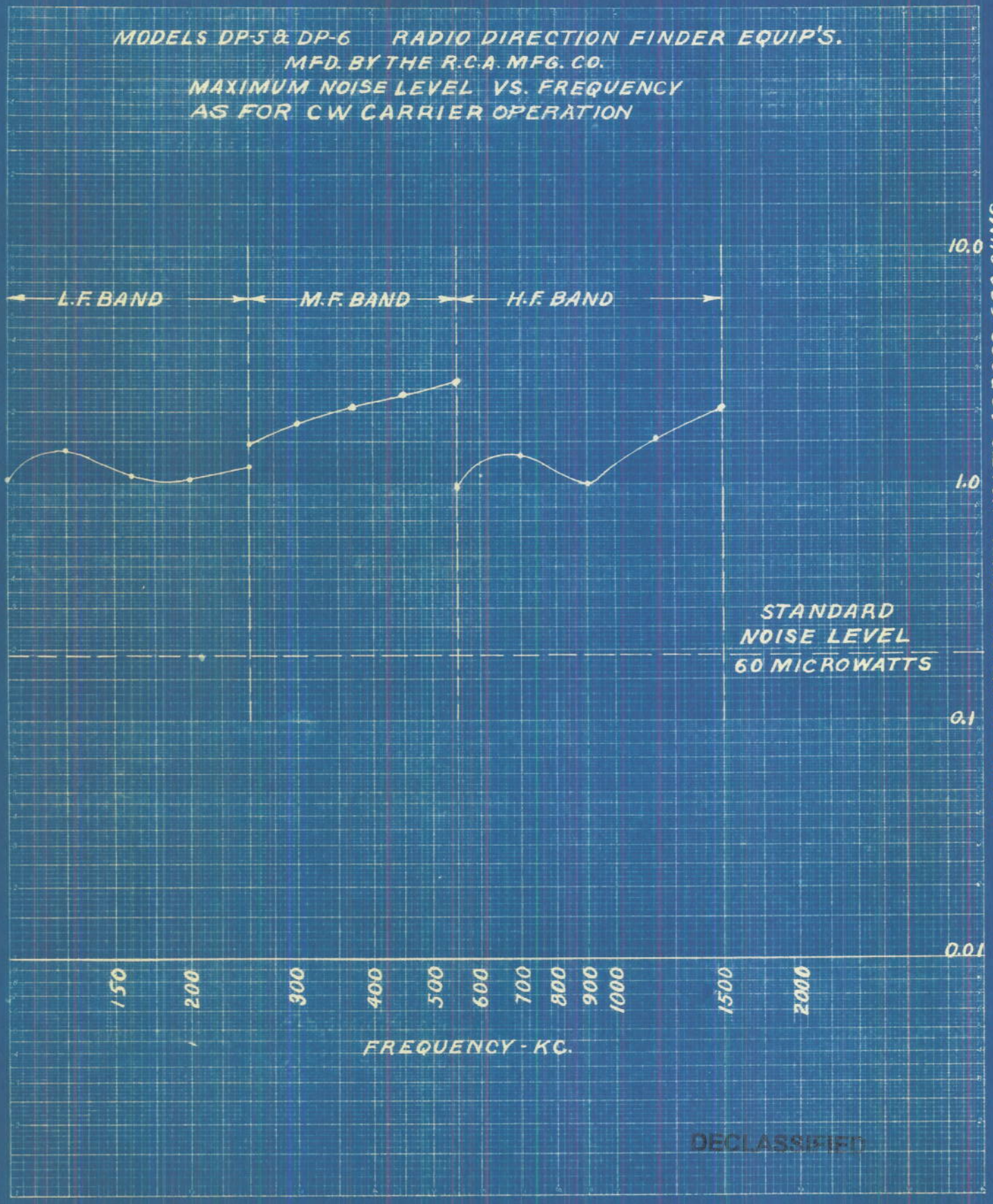
MODELS DP-4 & DQ-1 RADIO DIRECTION FINDER EQUIP'S.
MFD. BY THE R.C.A. MFG. CO.
MAXIMUM NOISE LEVEL VS. FREQUENCY
AS FOR CW & 30% MODULATED CARRIER OPERATION



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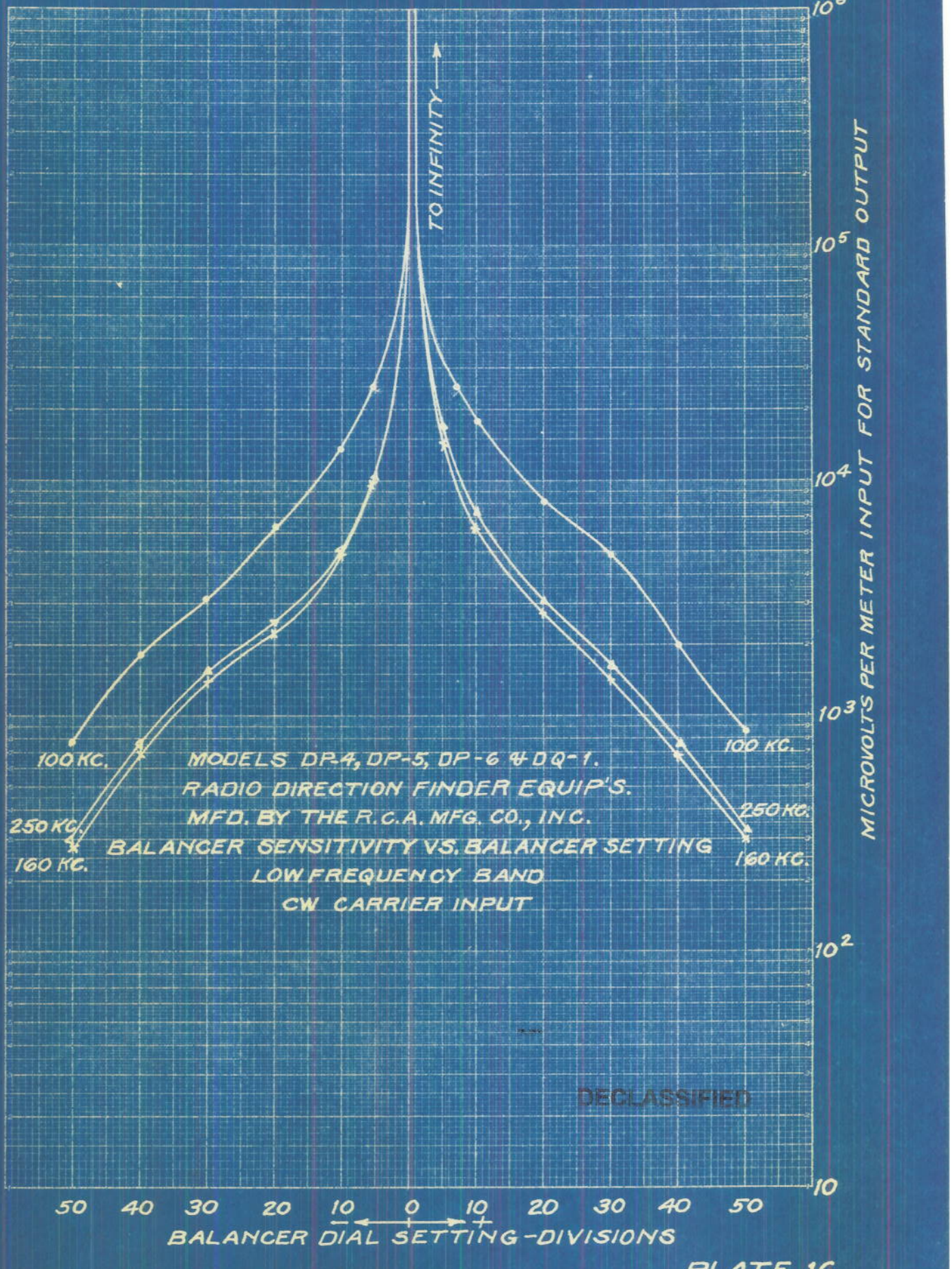
PLATE 14

MODELS DP-5 & DP-6 RADIO DIRECTION FINDER EQUIP'S.
MFD. BY THE R.C.A. MFG. CO.
MAXIMUM NOISE LEVEL VS. FREQUENCY
AS FOR C.W. CARRIER OPERATION



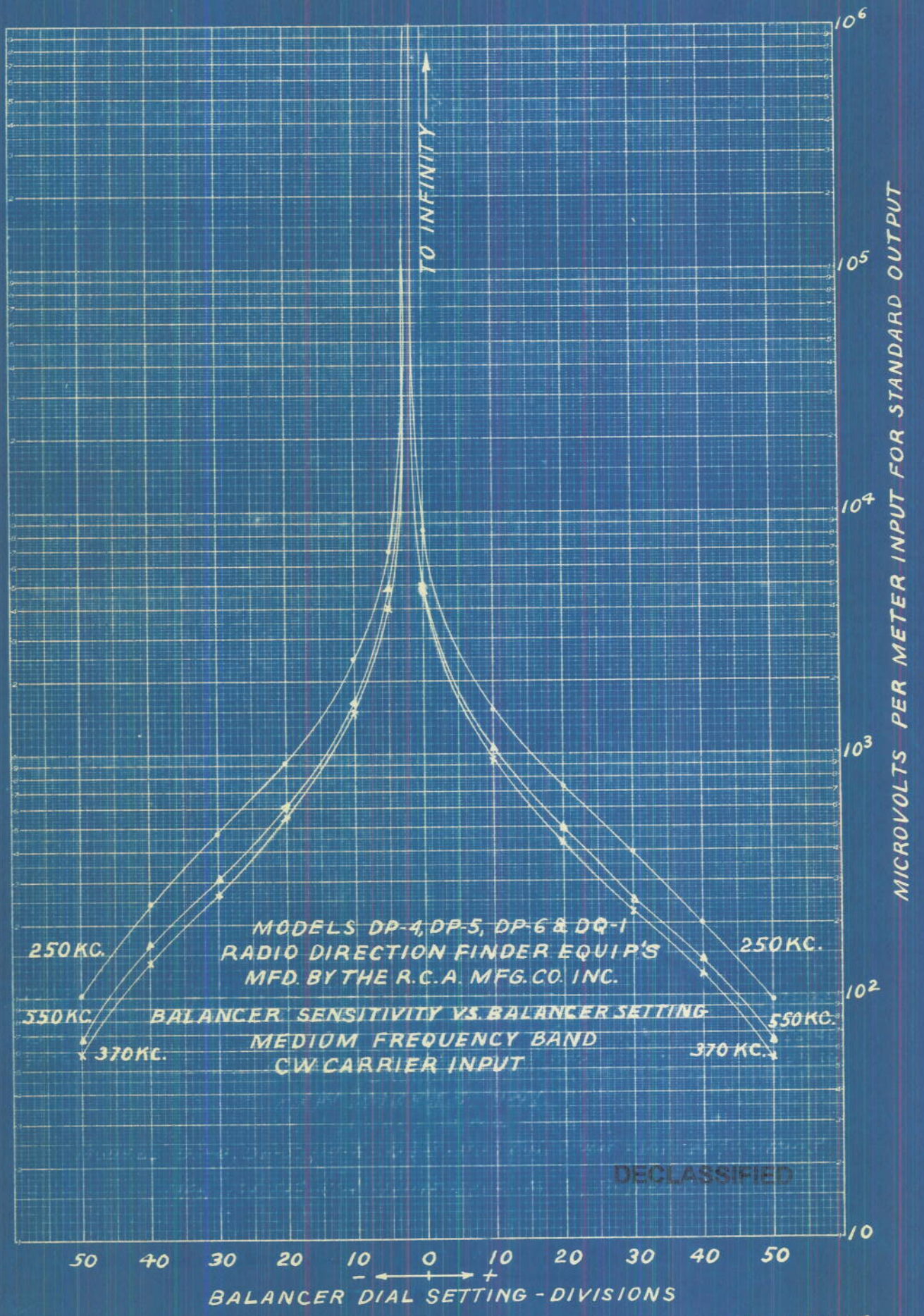
DECLASSIFIED

PLATE 15



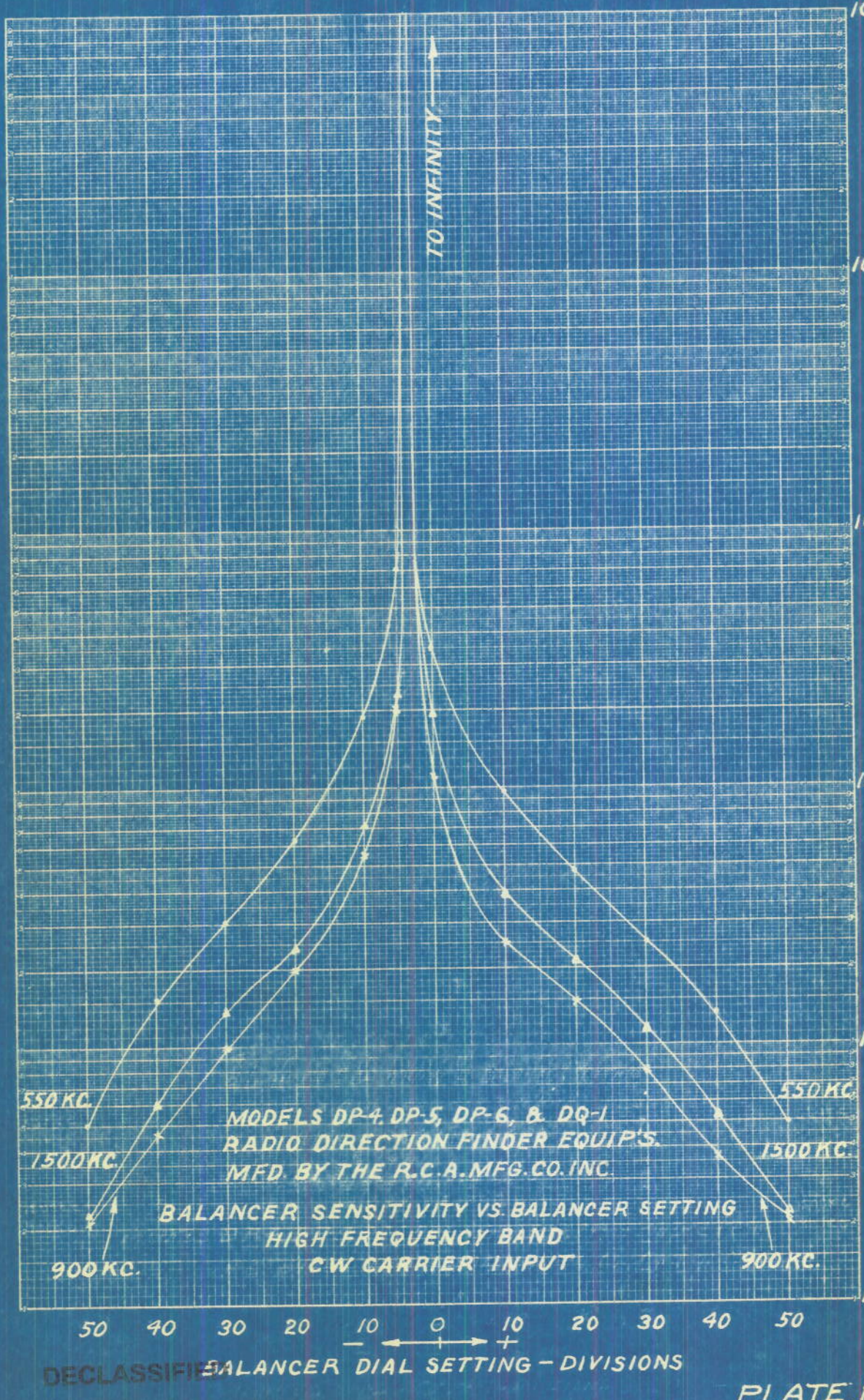
DECLASSIFIED

PLATE 16



DECLASSIFIED

PLATE 17



DECLASSIFIED

PLATE 18

CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS

CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS

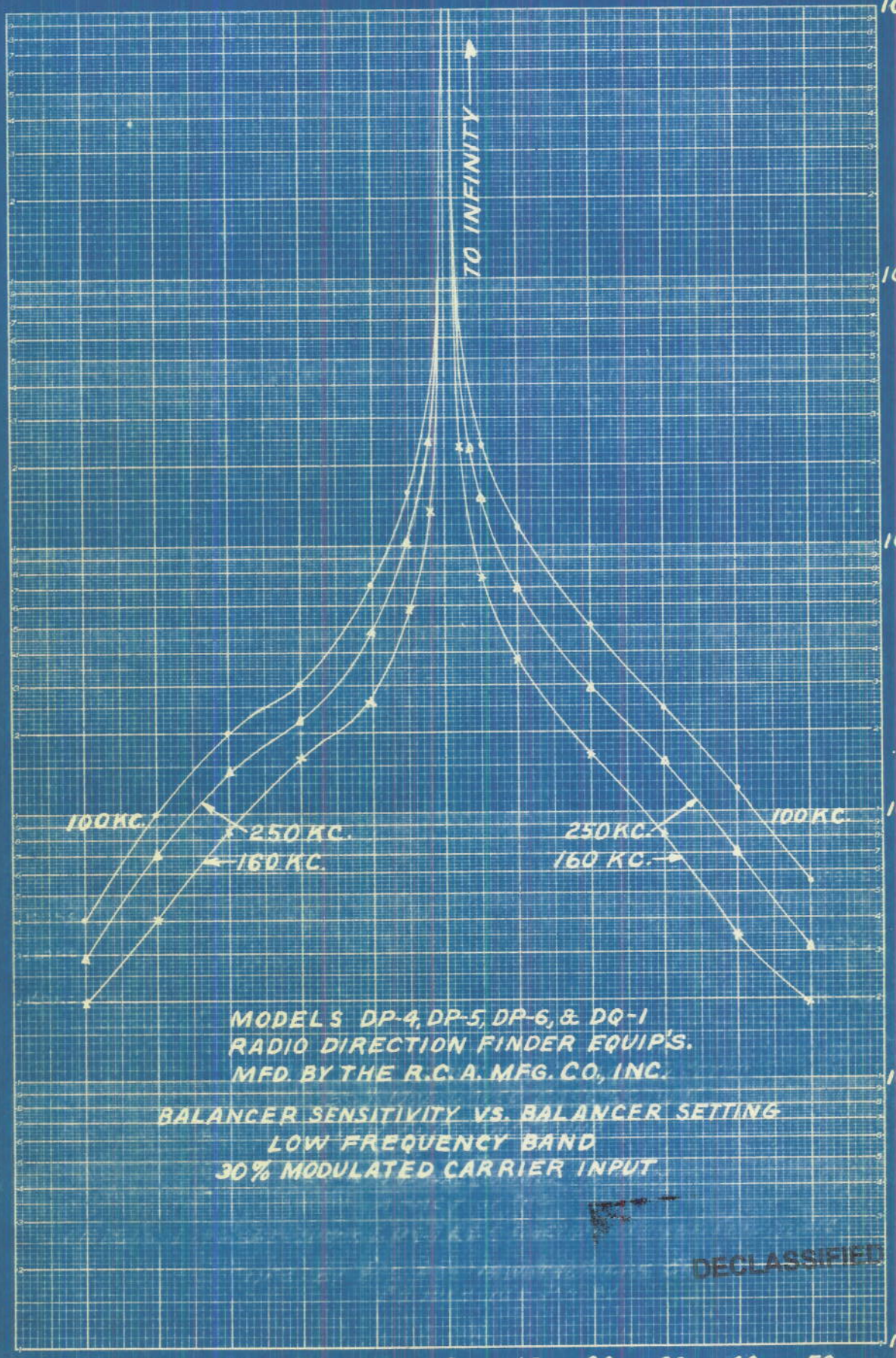
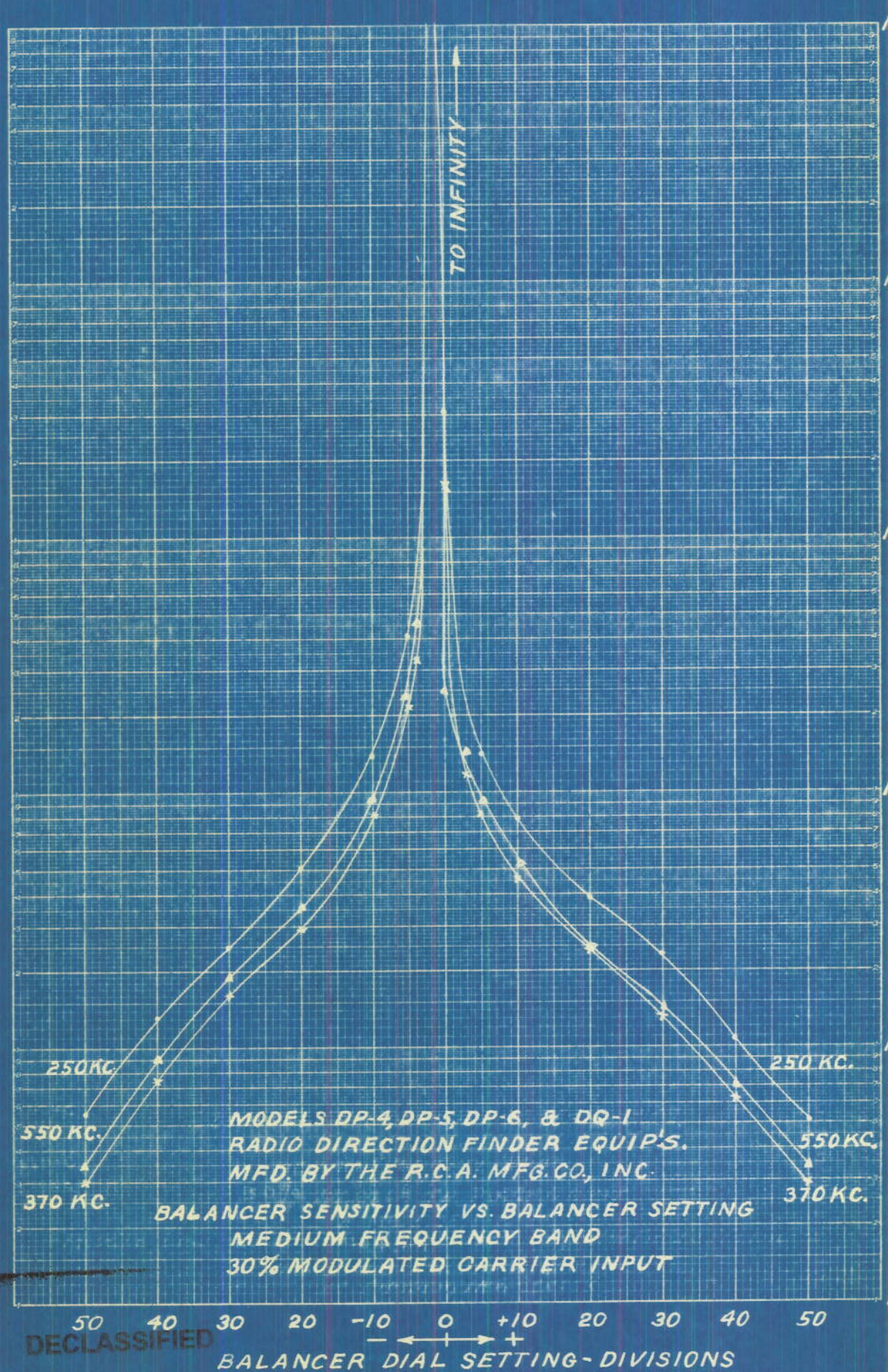


PLATE 19



DECLASSIFIED

PLATE 20

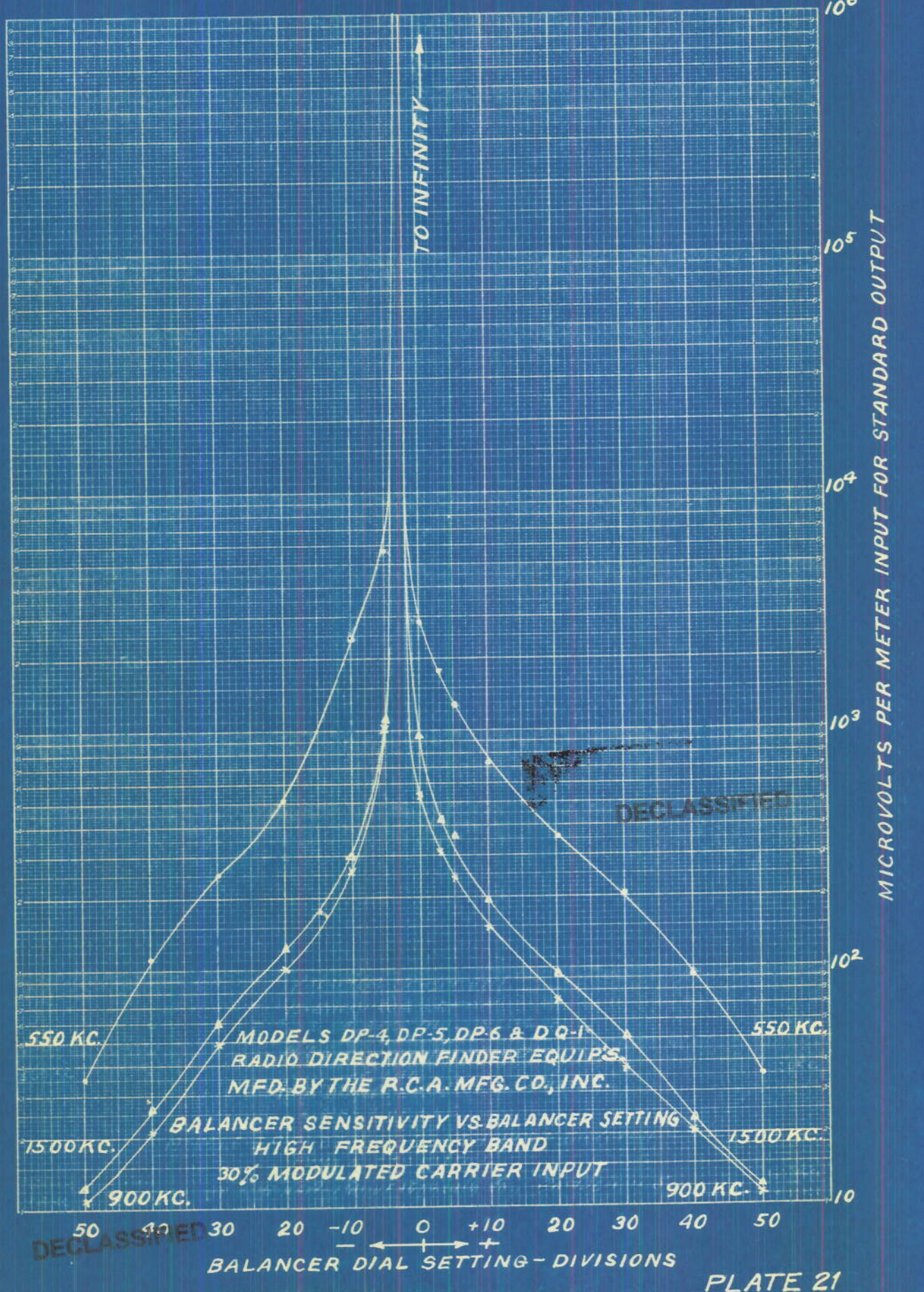
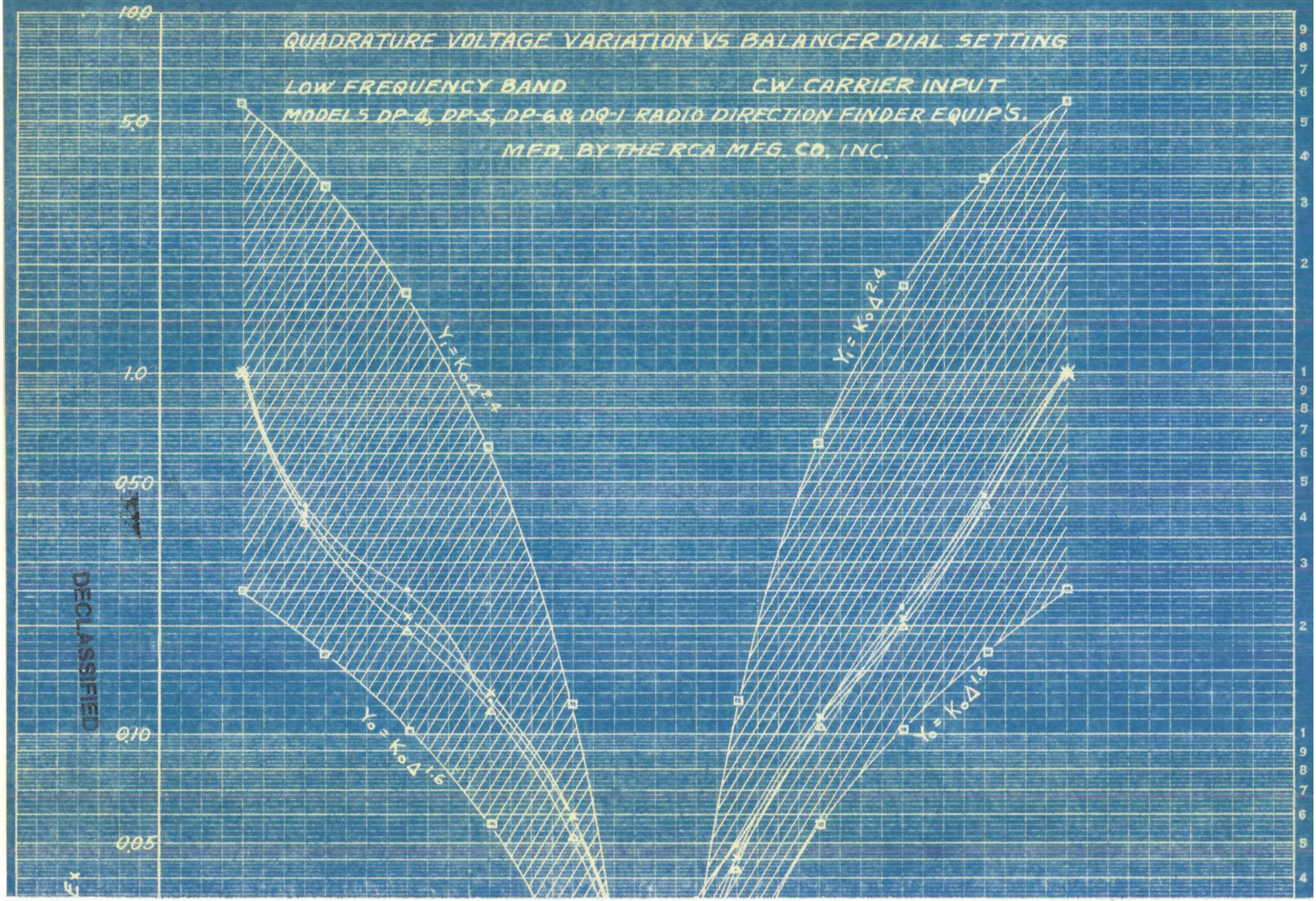

TO INFINITY
10^6
10^5
10^4
10^3
10^2
10
MICROVOLTS PER METER INPUT FOR STANDARD OUTPUT
550 KC.
1500 KC.
900 KC.
550 KC.
1500 KC.
900 KC.
MODELS DP-4, DP-5, DP-6 & DQ-1
RADIO DIRECTION FINDER EQUIP'S.
MFD. BY THE R.C.A. MFG. CO., INC.
BALANCER SENSITIVITY VS. BALANCER SETTING
HIGH FREQUENCY BAND
30% MODULATED CARRIER INPUT
50 40 30 20 -10 0 +10 20 30 40 50
BALANCER DIAL SETTING - DIVISIONS
DECLASSIFIED
DECLASSIFIED

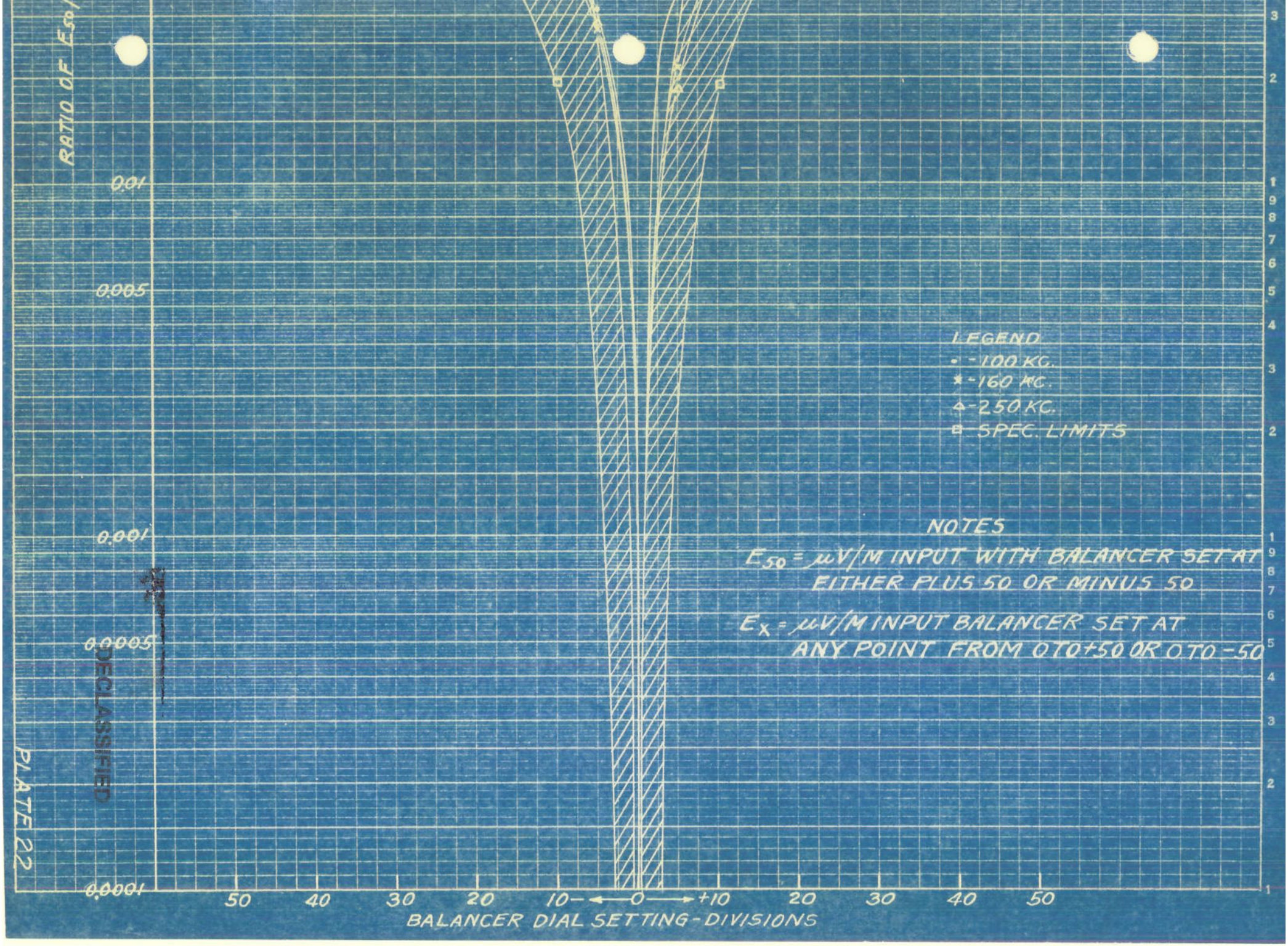
PLATE 21

NO. 4113. POLYPURPOSE: 62 DIVISIONS BY 5 3-INCH CYCLES RATIO RULING.

CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS



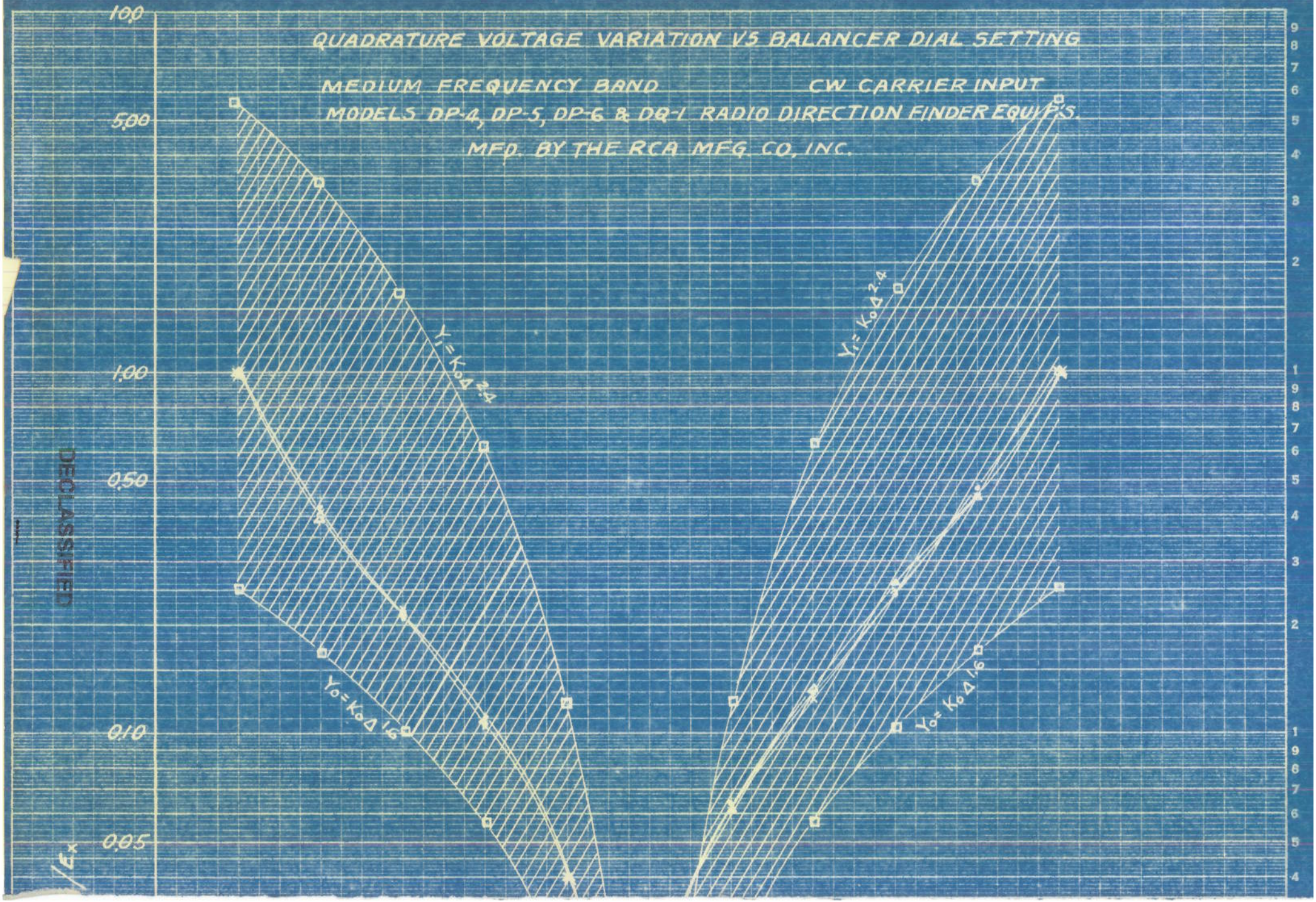
DECLASSIFIED



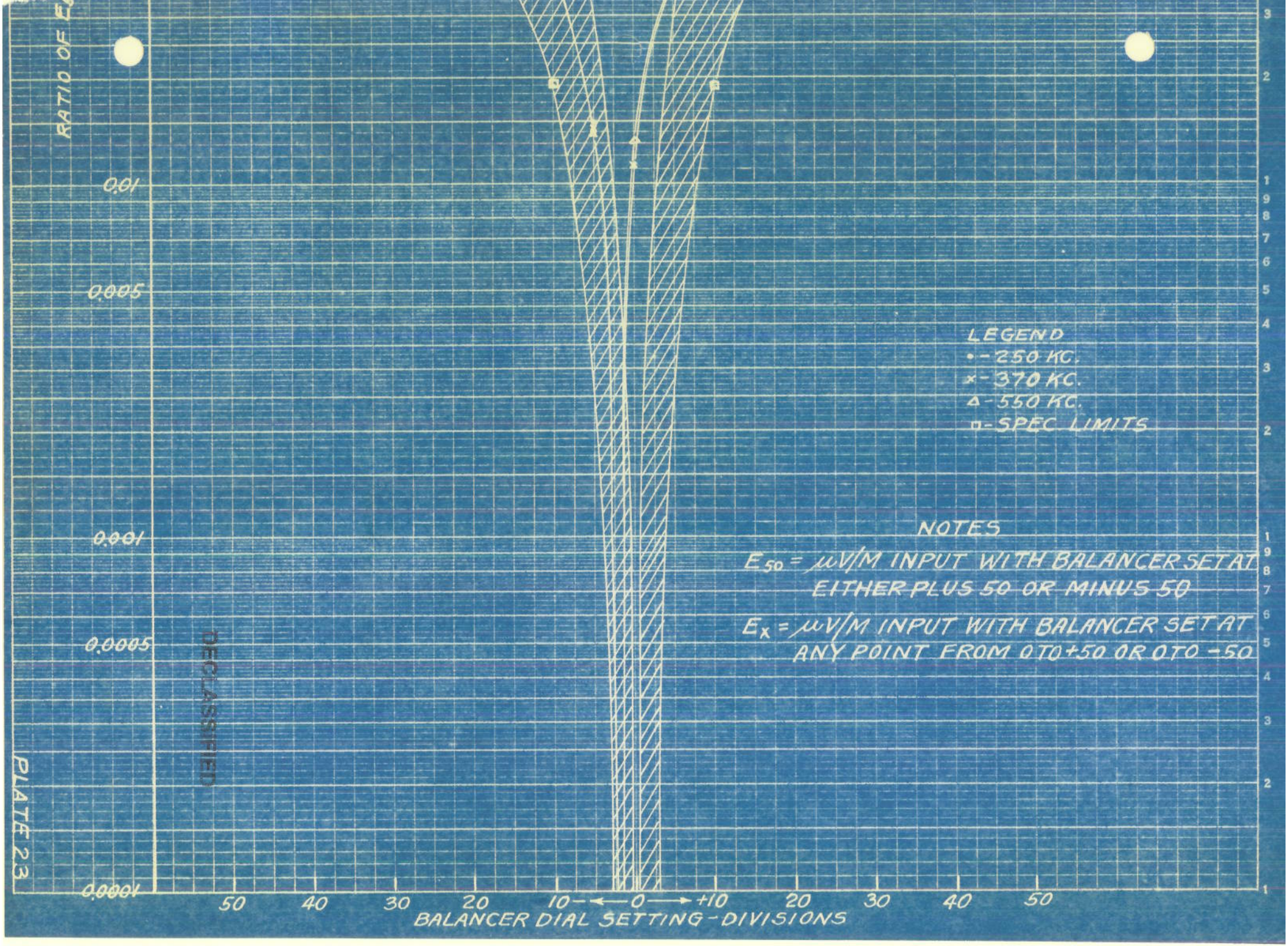
DECLASSIFIED

PLATE 22

NO. 4113. POLYPURPOSE: 62 DIVISIONS BY 5 3-INCH CYCLES RATIO RULING.
CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS



DECLASSIFIED

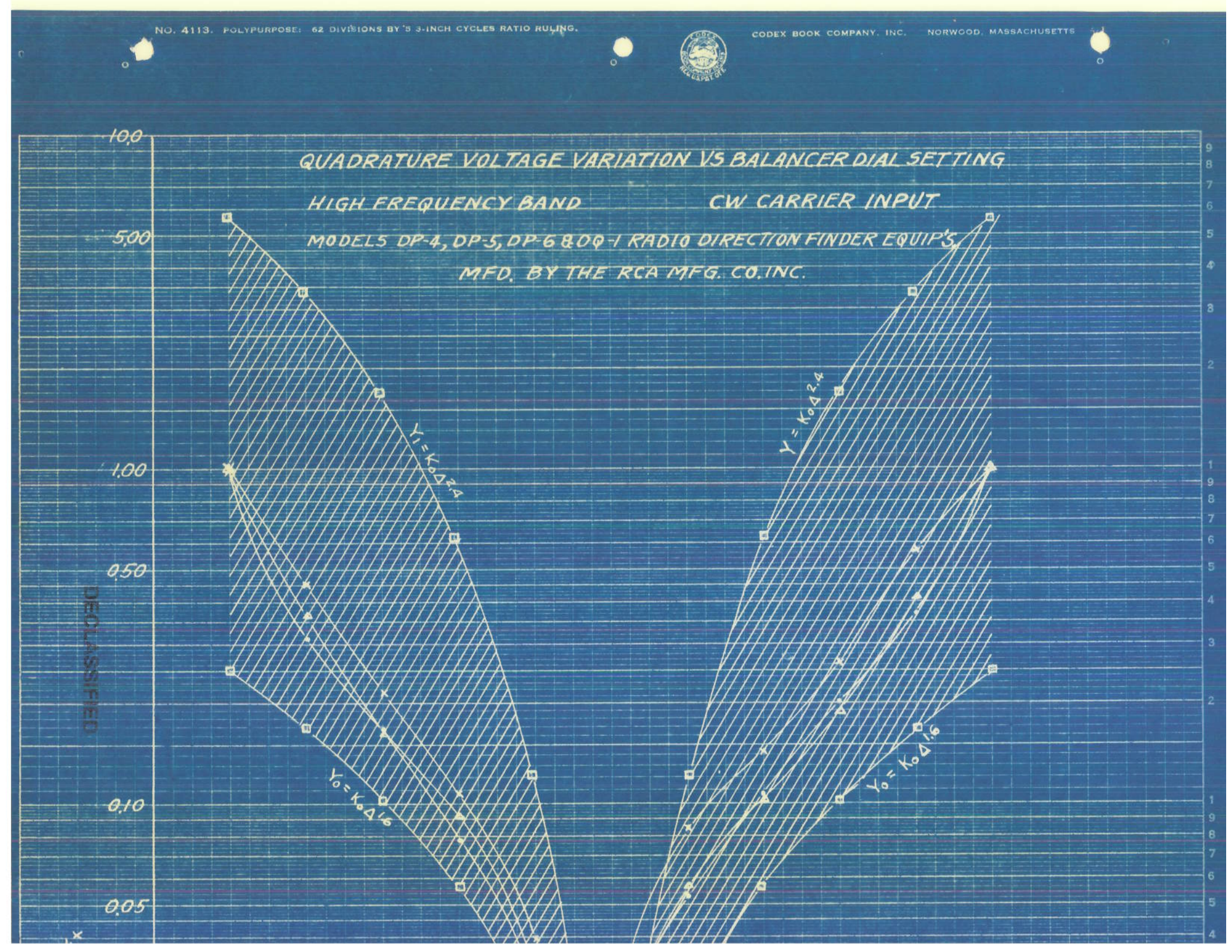


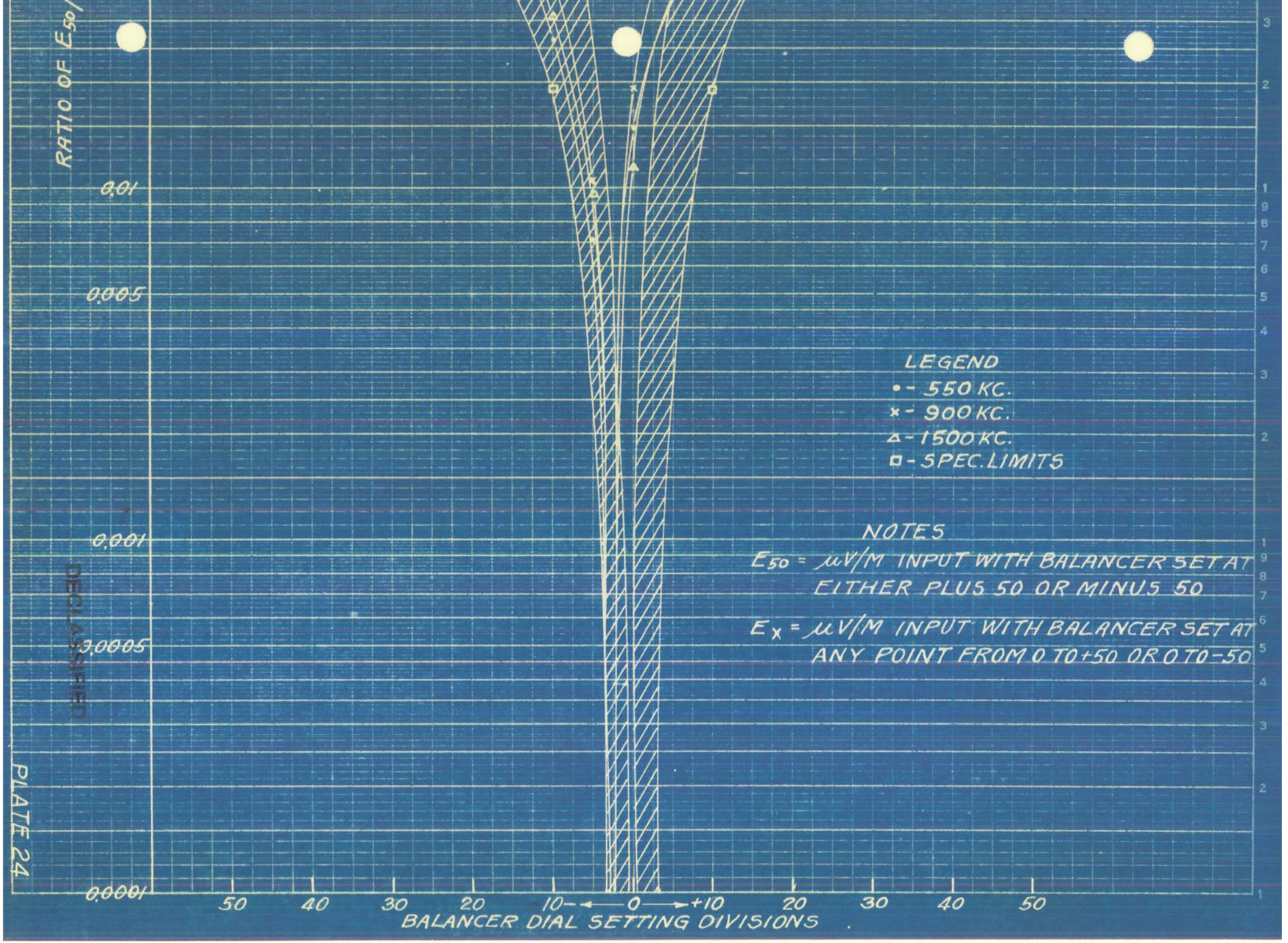
DECLASSIFIED

PLATE 23

NO. 4113. POLYPURPOSE: 62 DIVISIONS BY 5 3-INCH CYCLES RATIO RULING.

CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS




RATIO OF E50/
0.01
0.005
0.001
0.0005
0.0001
50
40
30
20
10
0
+10
20
30
40
50
BALANCER DIAL SETTING DIVISIONS
LEGEND
• - 550 KC.
× - 900 KC.
△ - 1500 KC.
□ - SPEC. LIMITS
NOTES
E50 = μV/M INPUT WITH BALANCER SET AT EITHER PLUS 50 OR MINUS 50
Ex = μV/M INPUT WITH BALANCER SET AT ANY POINT FROM 0 TO +50 OR 0 TO -50
DECLASSIFIED
PLATE 24

NO. 4113. POLYPURPOSE: 62 DIVISIONS BY 5 3-INCH CYCLES RATIO RULING.

CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS

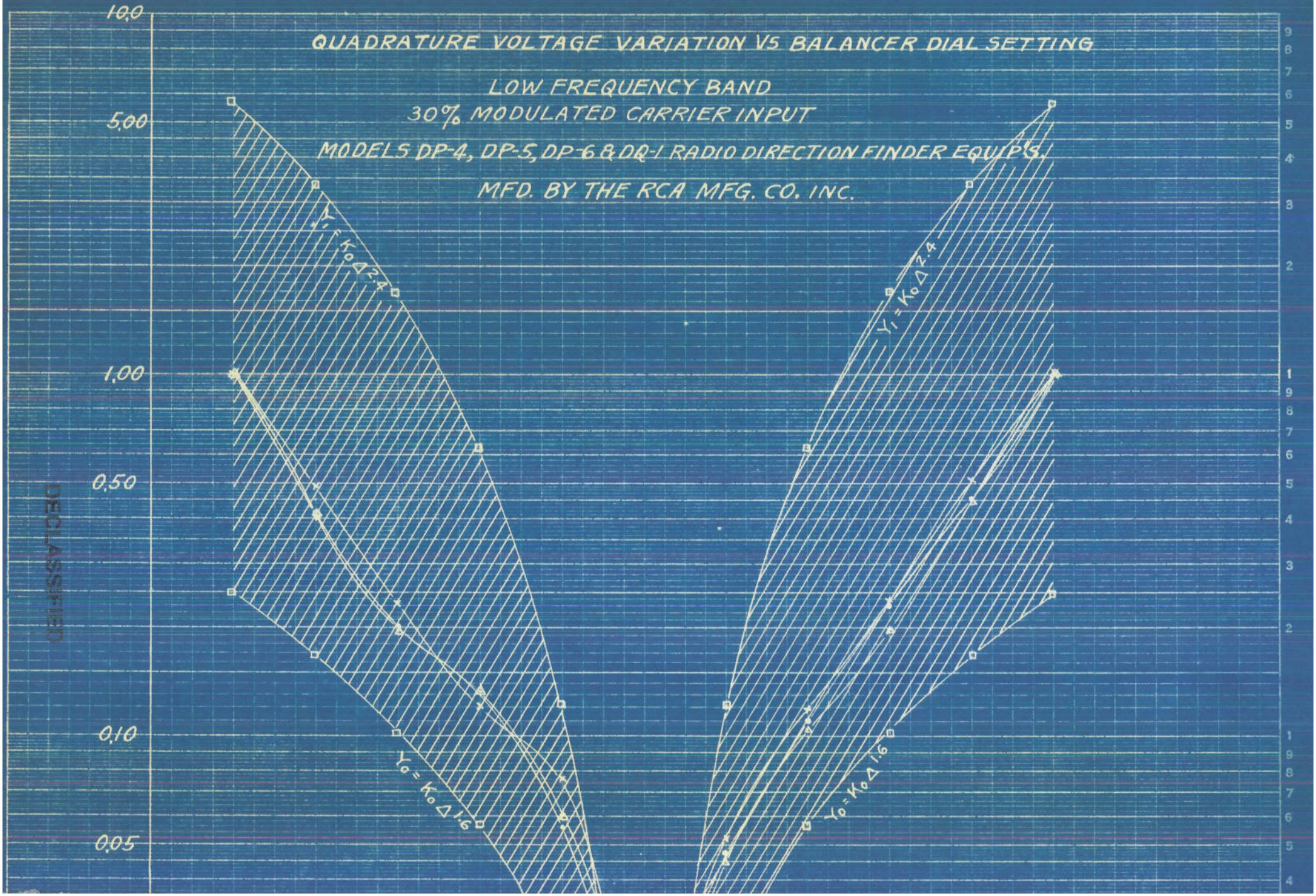
QUADRATURE VOLTAGE VARIATION VS BALANCER DIAL SETTING

LOW FREQUENCY BAND

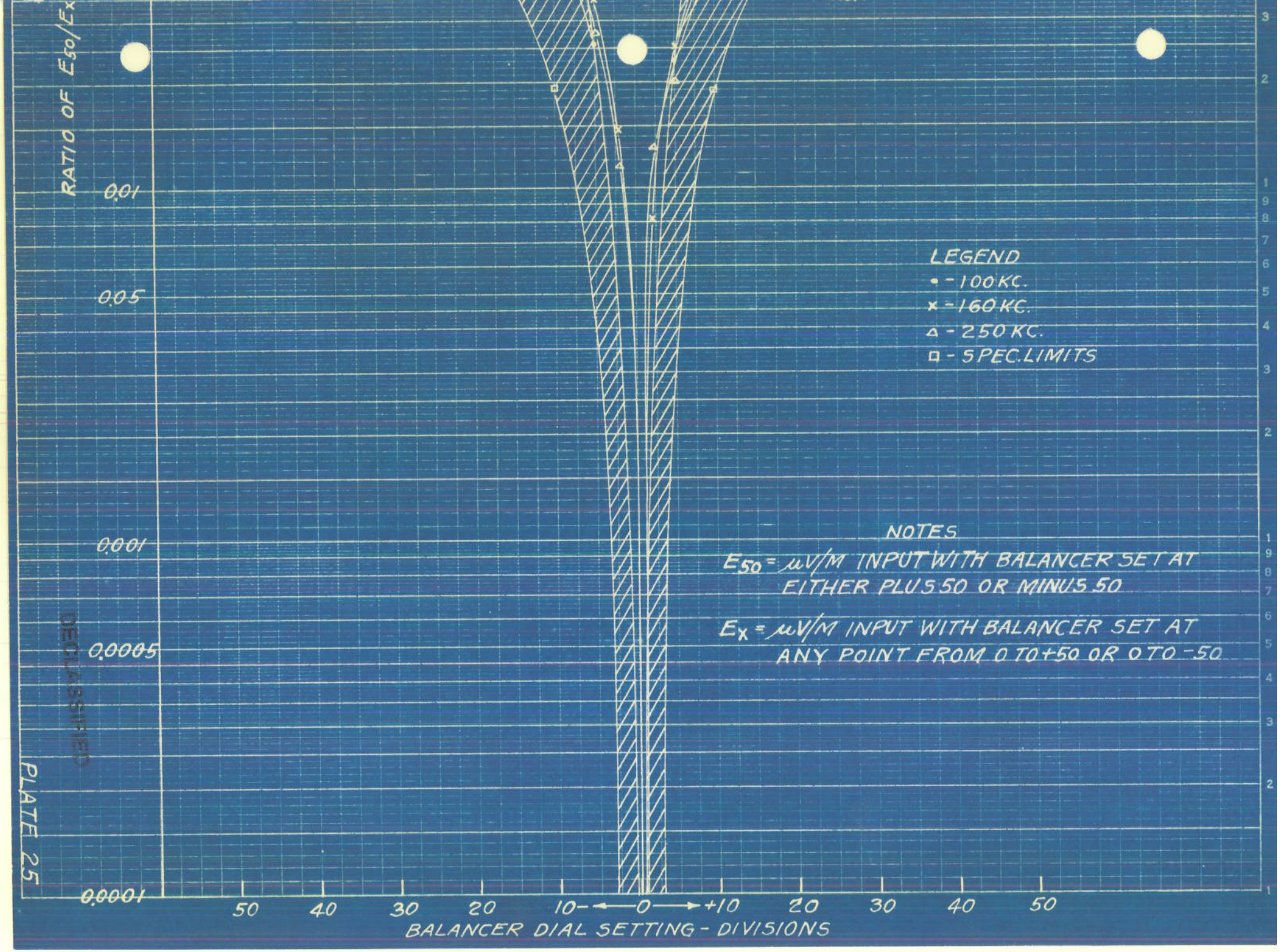
30% MODULATED CARRIER INPUT

MODELS DP-4, DP-5, DP-6 & DQ-1 RADIO DIRECTION FINDER EQUIP'S.

MFD. BY THE RCA MFG. CO. INC.



DECLASSIFIED



DECLASSIFIED

PLATE 25

NO. 4113. POLYPURPOSE; 62 DIVISIONS BY 5 3-INCH CYCLES RATIO RULING.

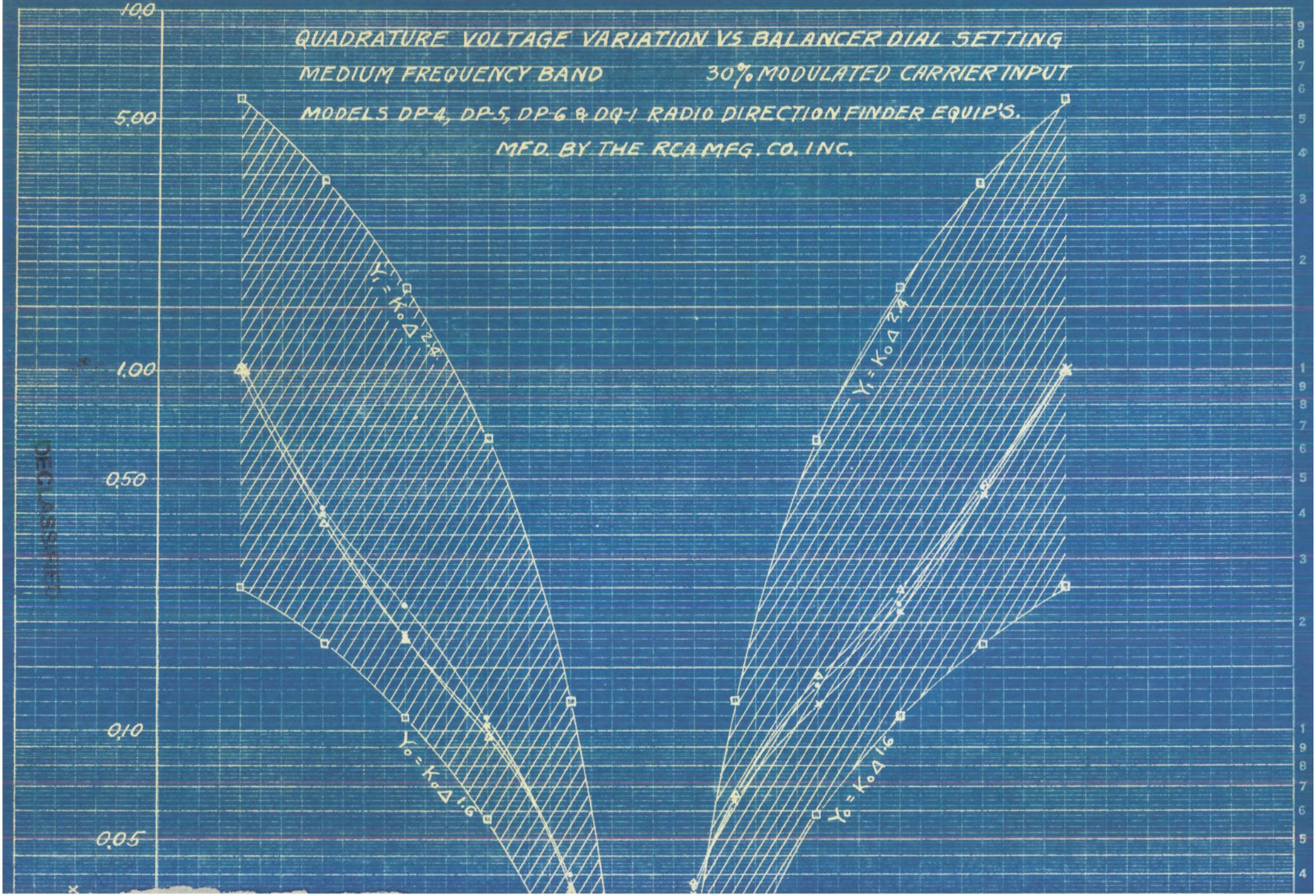
CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS

QUADRATURE VOLTAGE VARIATION VS BALANCER DIAL SETTING

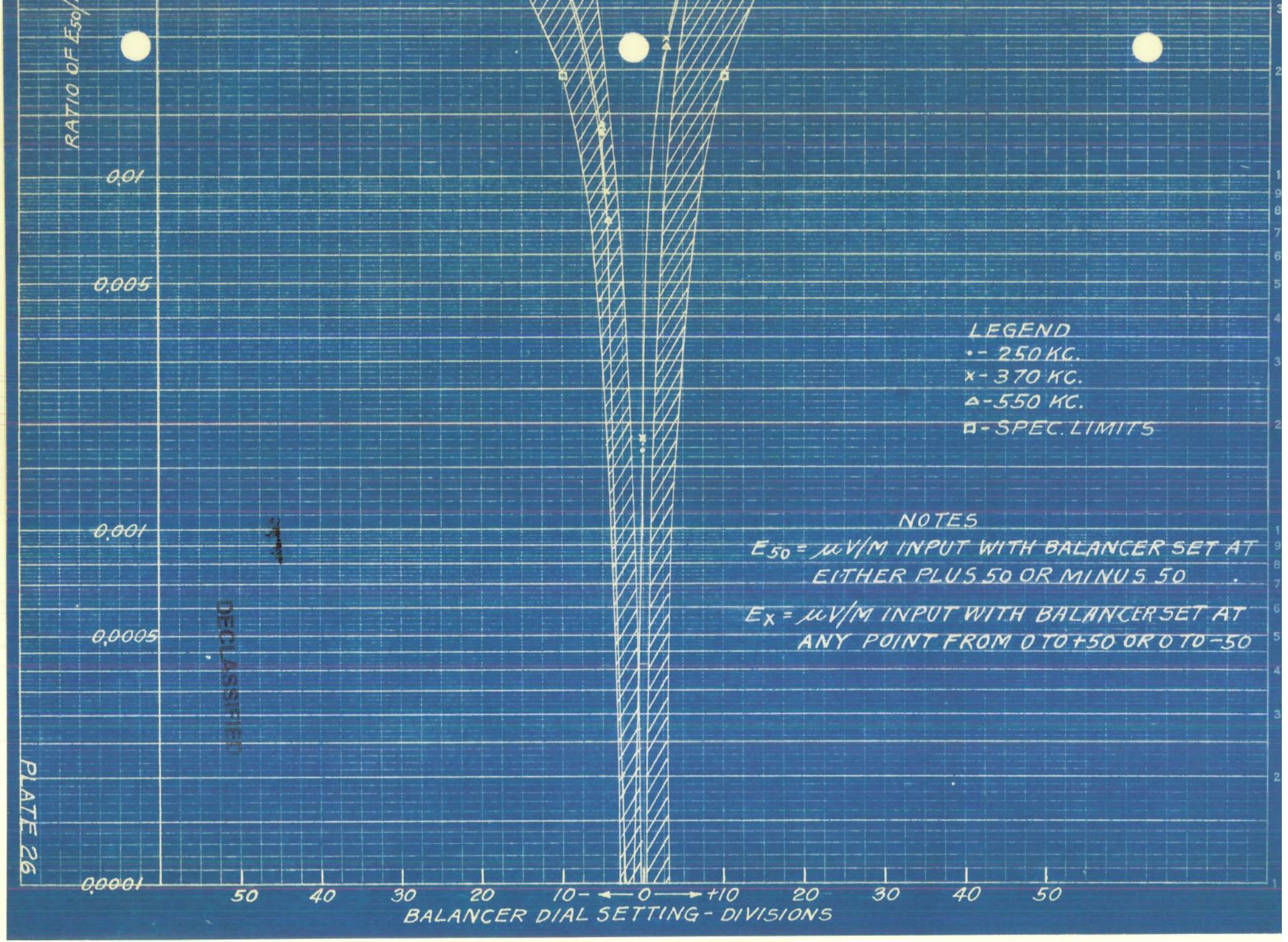
MEDIUM FREQUENCY BAND 30% MODULATED CARRIER INPUT

MODELS DP-4, DP-5, DP-6 & DQ-1 RADIO DIRECTION FINDER EQUIP'S.

MFD. BY THE RCA MFG. CO. INC.



DECLASSIFIED

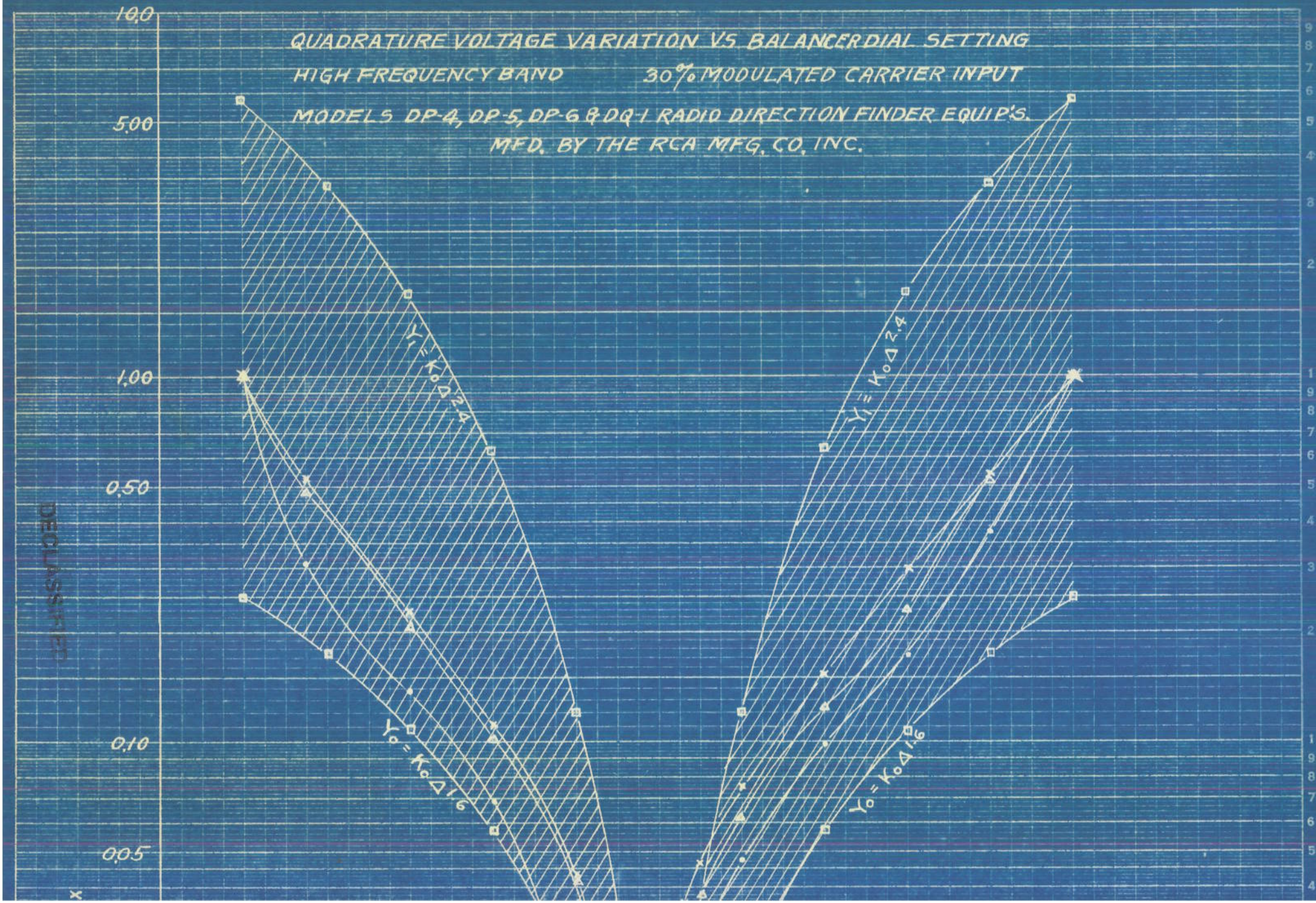


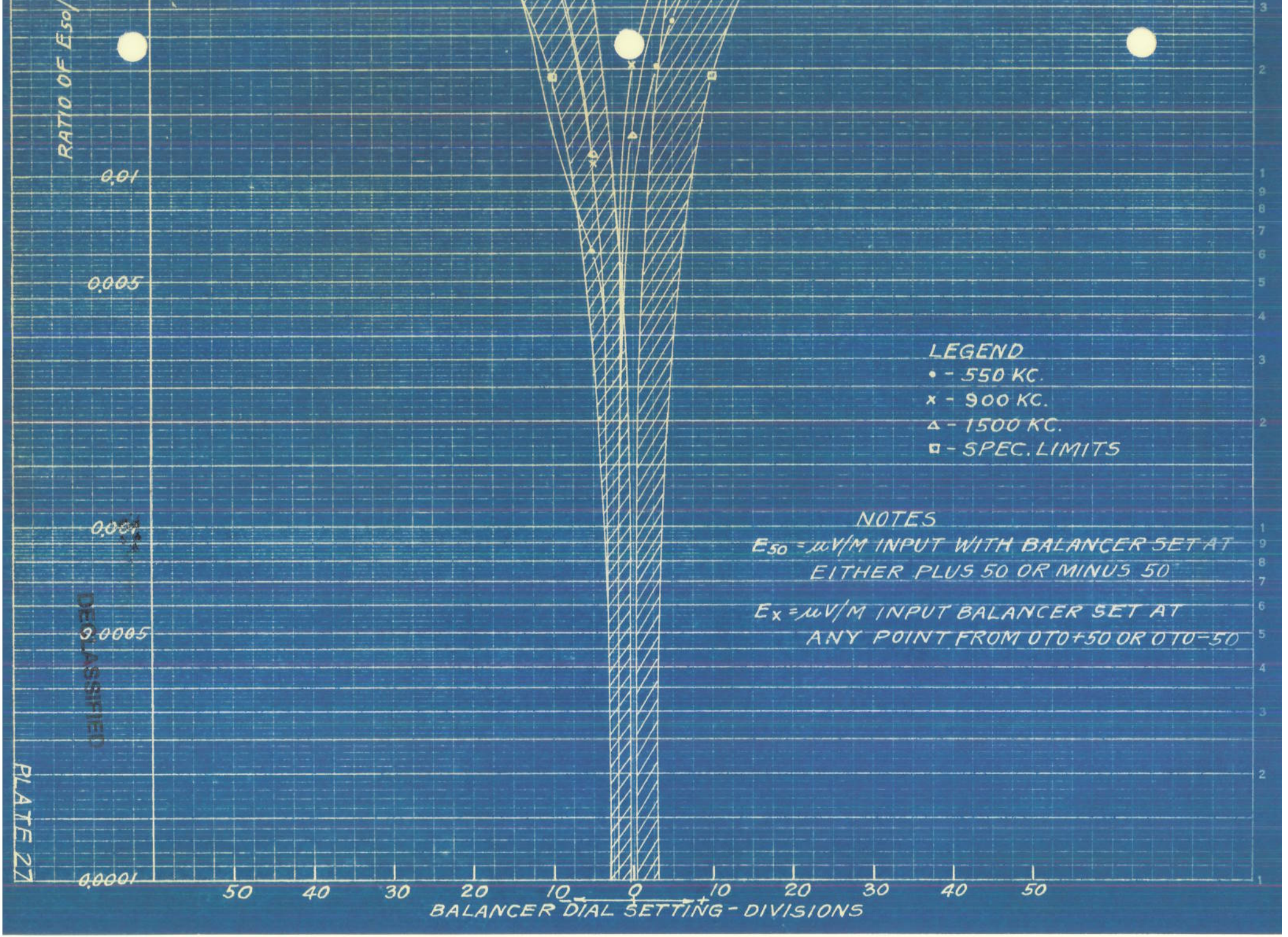
DECLASSIFIED

PLATE 26

NO. 4113. POLYPURPOSE: 62 DIVISIONS BY 5 3-INCH CYCLES RATIO RULING.

CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS

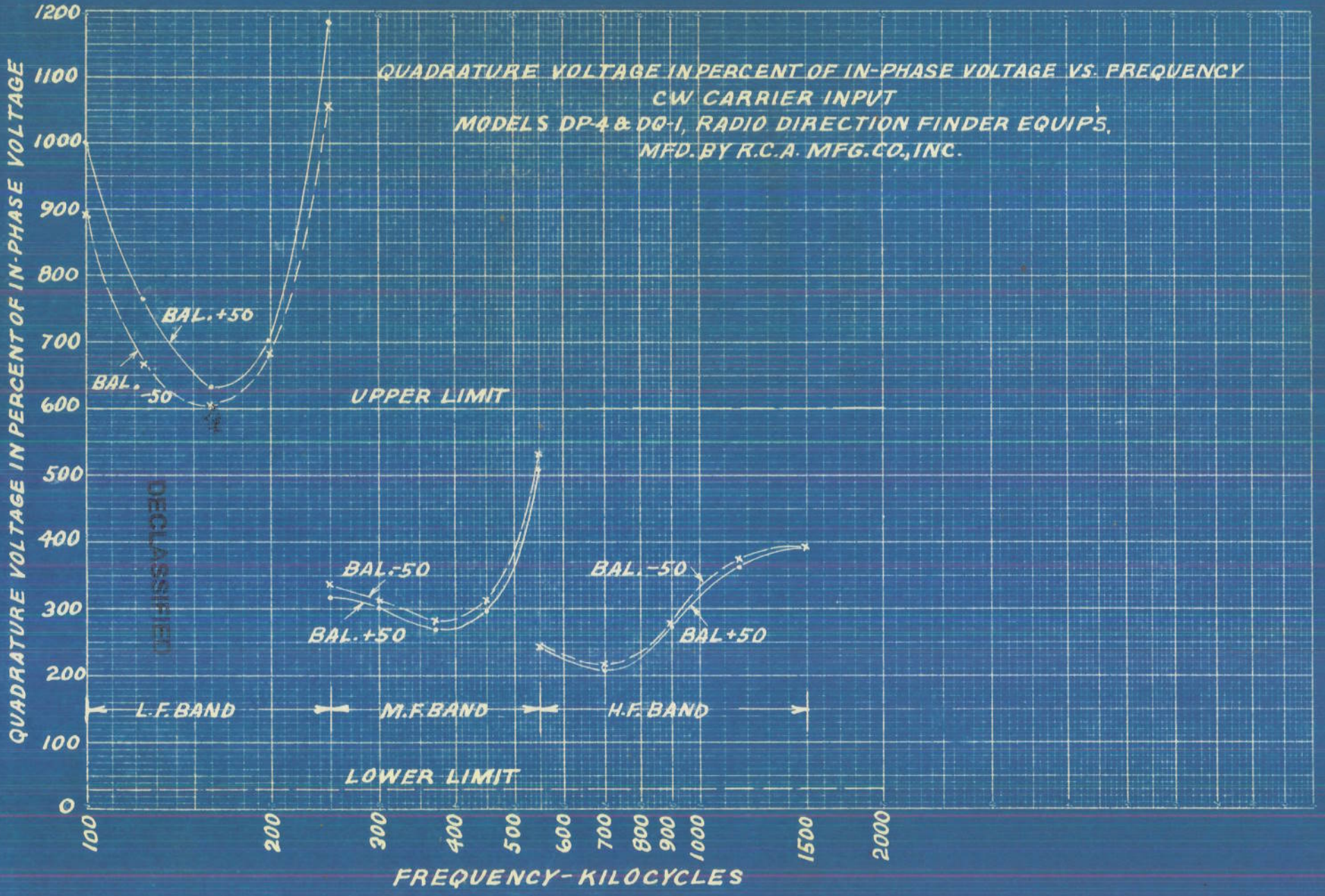




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PLATE 27

NO. 31,193. 20 DIVISIONS PER INCH (120 DIVISIONS) BY TWO 4 1/2-INCH CYCLES RATIO RULING. CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS.



DECLASSIFIED

PLATE 28

NO. 31,193. 20 DIVISIONS PER INCH (120 DIVISIONS) BY TWO 4 1/2-INCH CYCLES RATIO RULING.
CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS.

QUADRATURE VOLTAGE IN PERCENT OF IN-PHASE VOLTAGE VS. FREQUENCY
30% MODULATED CARRIER INPUT
MODELS DP-4 & DQ-1, RADIO DIRECTION FINDER EQUIPS, MFD. BY R.C.A. MFG. CO., INC.

QUADRATURE VOLTAGE PERCENT OF IN-PHASE VOLTAGE

1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0

BAL. +50
BAL. -50
UPPER LIMIT
BAL. -50
BAL. +50
BAL. +50
BAL. -50
L.F. BAND
M.F. BAND
H.F. BAND
LOWER LIMIT

100 200 300 400 500 600 700 800 900 1000 1500 2000

FREQUENCY - KILOCYCLES

DECLASSIFIED

PLATE 29

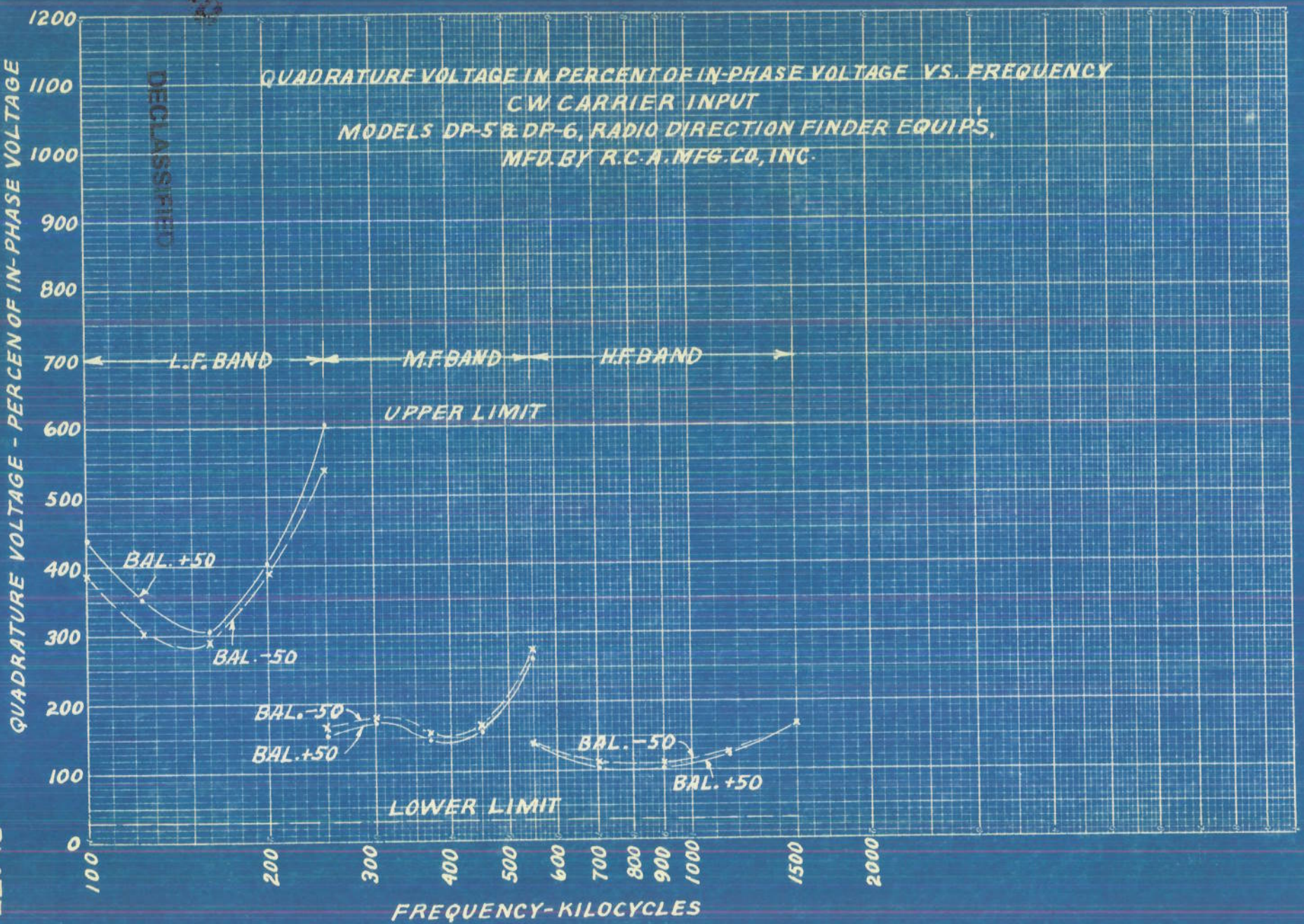
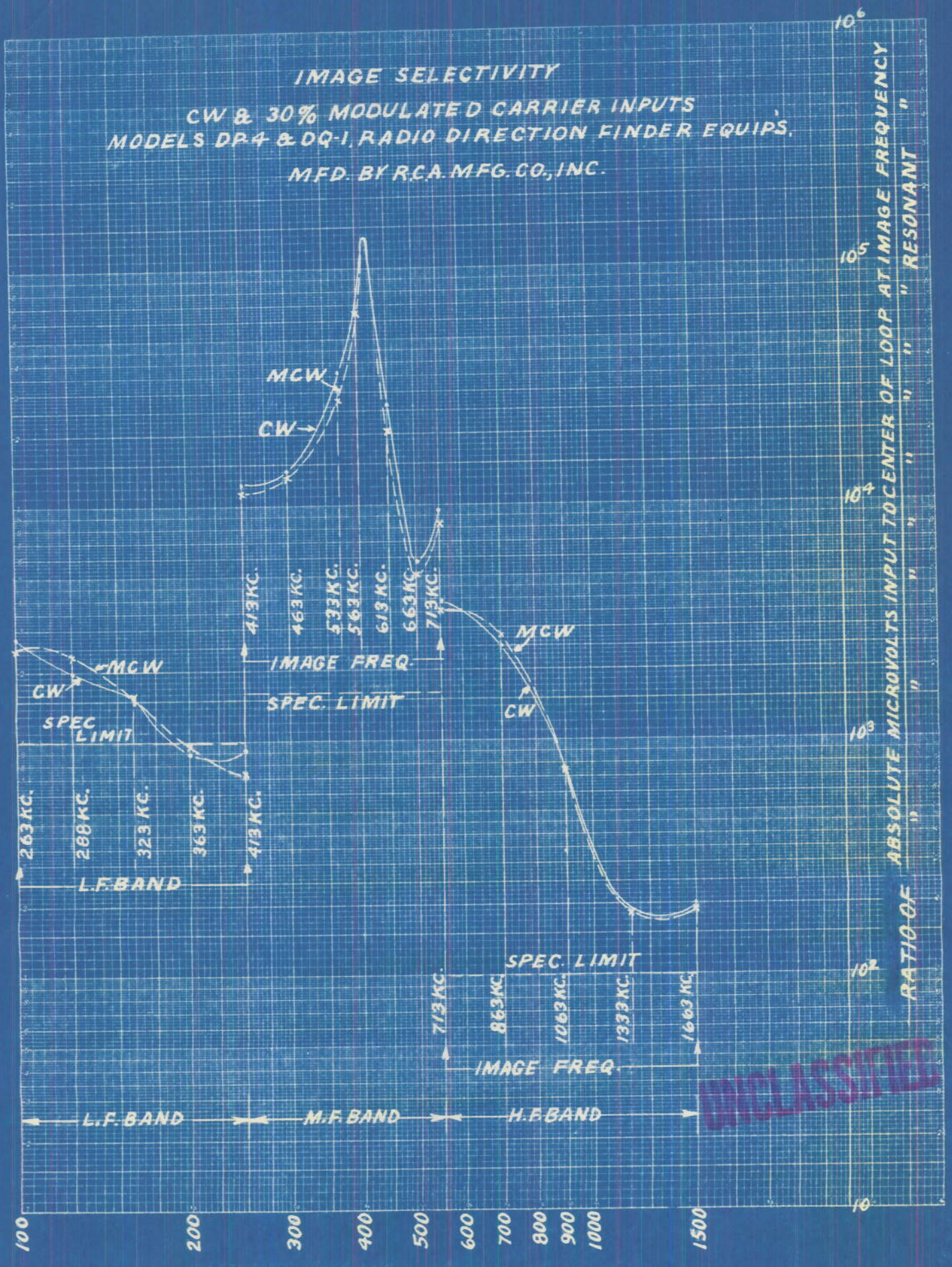

QUADRATURE VOLTAGE IN PERCENT OF IN-PHASE VOLTAGE VS. FREQUENCY
C.W. CARRIER INPUT
MODELS DP-5 & DP-6, RADIO DIRECTION FINDER EQUIPS.
MFD. BY R.C.A. MFG. CO., INC.
DECLASSIFIED
QUADRATURE VOLTAGE - PERCEN OF IN-PHASE VOLTAGE
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
L.F. BAND
M.F. BAND
H.F. BAND
UPPER LIMIT
LOWER LIMIT
BAL. +50
BAL. -50
BAL. -50
BAL. +50
BAL. -50
BAL. +50
100
200
300
400
500
600
700
800
900
1000
1500
2000
FREQUENCY - KILOCYCLES

PLATE 30

CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS
NO. 3169. ONE YEAR BY MONTHS. PLAIN AND RATIO RULING.

IMAGE SELECTIVITY

CW & 30% MODULATED CARRIER INPUTS
MODELS DP-4 & DQ-1, RADIO DIRECTION FINDER EQUIPS.
MFD. BY R.C.A. MFG. CO., INC.

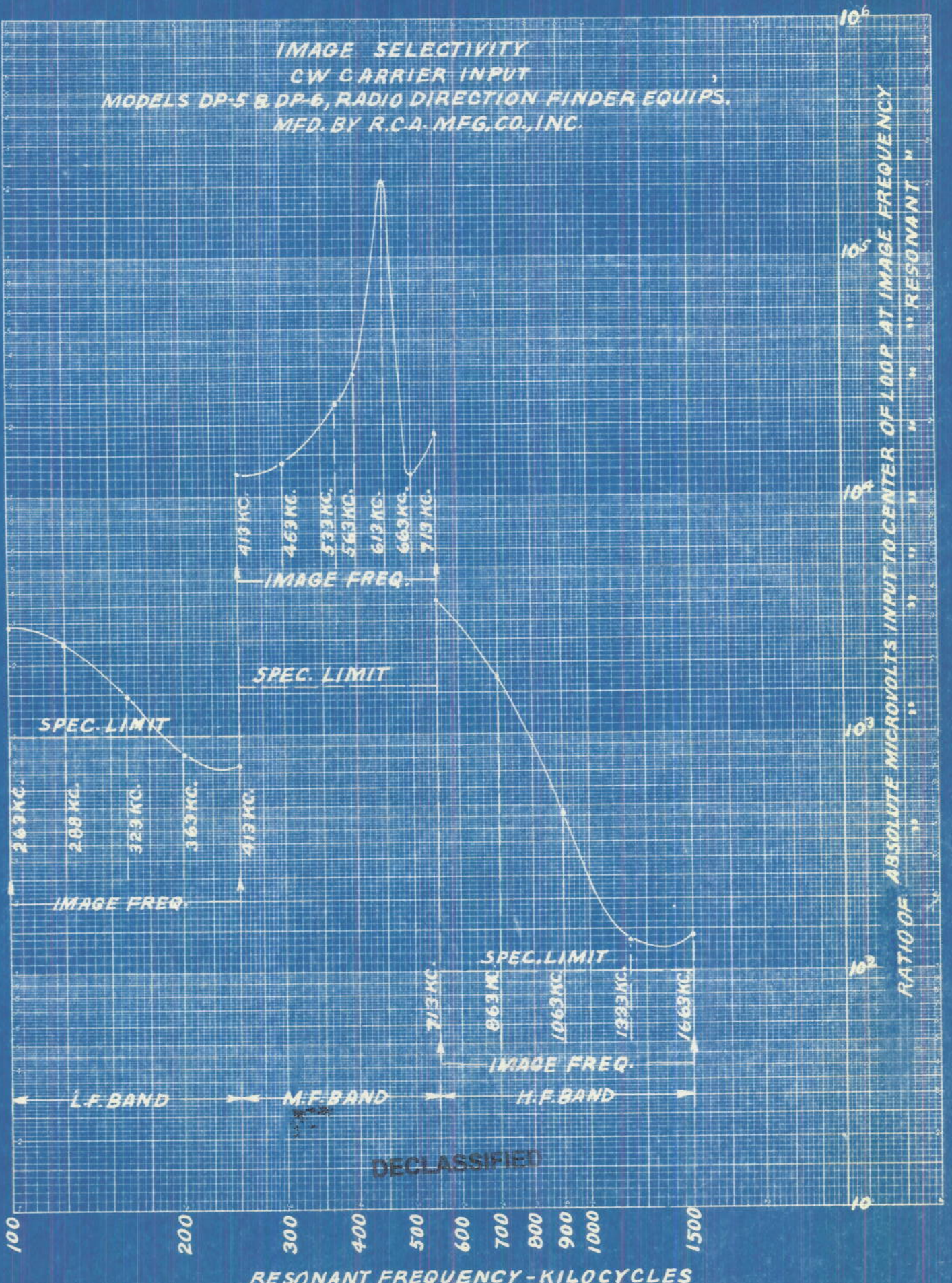


UNCLASSIFIED

PLATE 31

CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS
NO. 3169. ONE YEAR BY MONTHS. PLAIN AND RATIO RULING.

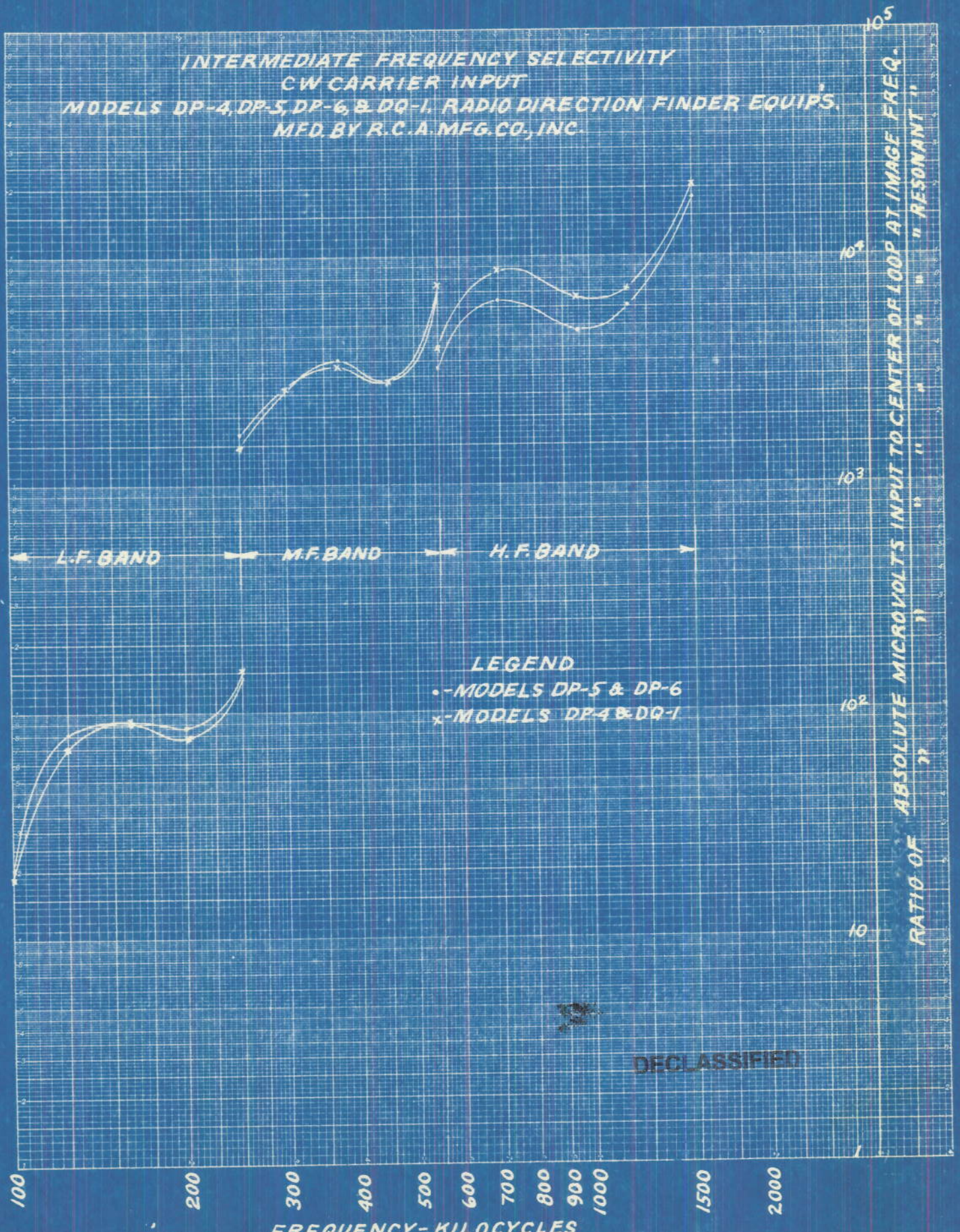
IMAGE SELECTIVITY
CW CARRIER INPUT
MODELS DP-5 & DP-6, RADIO DIRECTION FINDER EQUIPS.
MFD. BY R.C.A. MFG. CO., INC.



DECLASSIFIED

PLATE 32

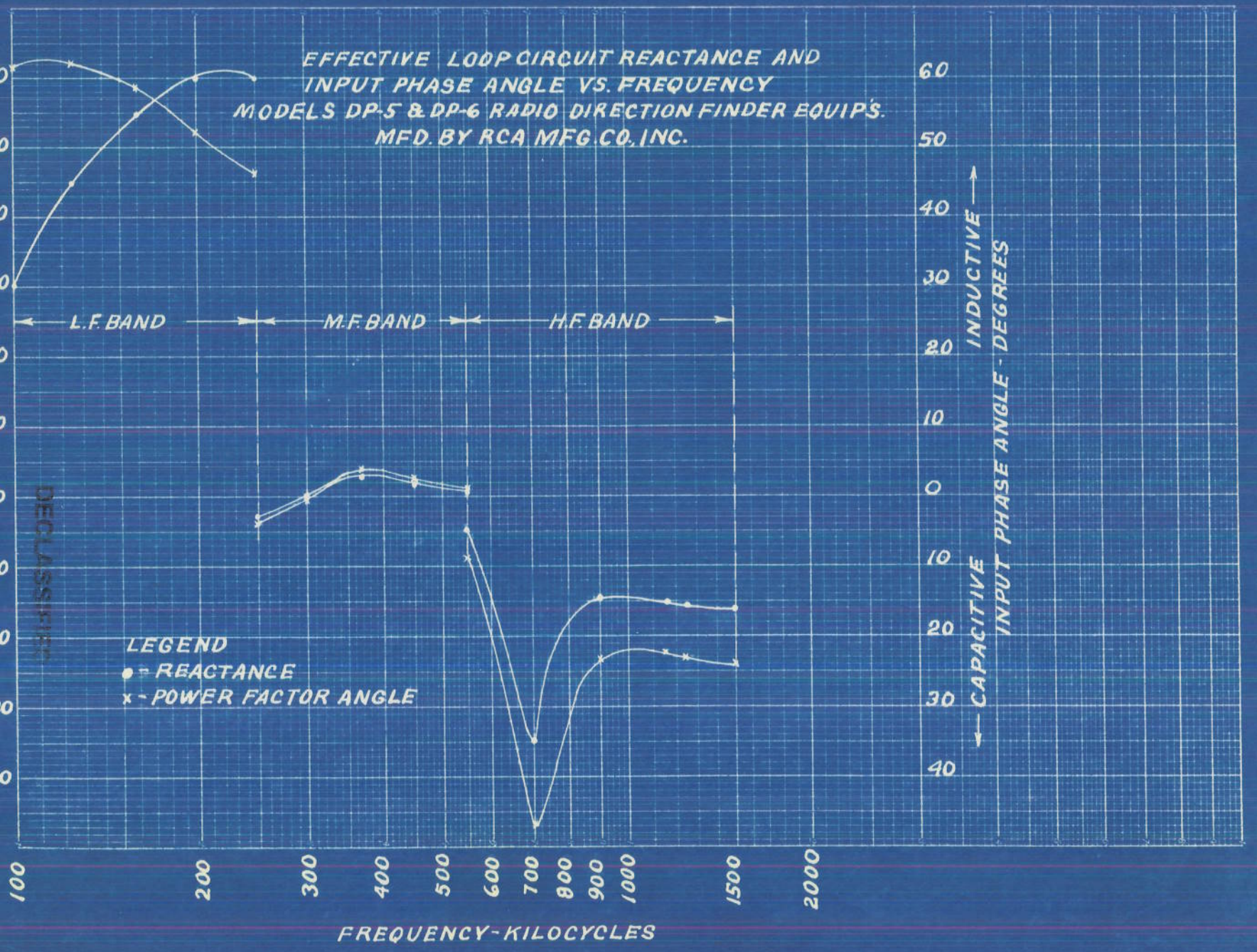
INTERMEDIATE FREQUENCY SELECTIVITY
C W CARRIER INPUT
MODELS DP-4, DP-5, DP-6, & DQ-1, RADIO DIRECTION FINDER EQUIPS. MFD. BY R.C.A. MFG. CO., INC.



DECLASSIFIED

PLATE 33

PLATE-34



DECLASSIFIED

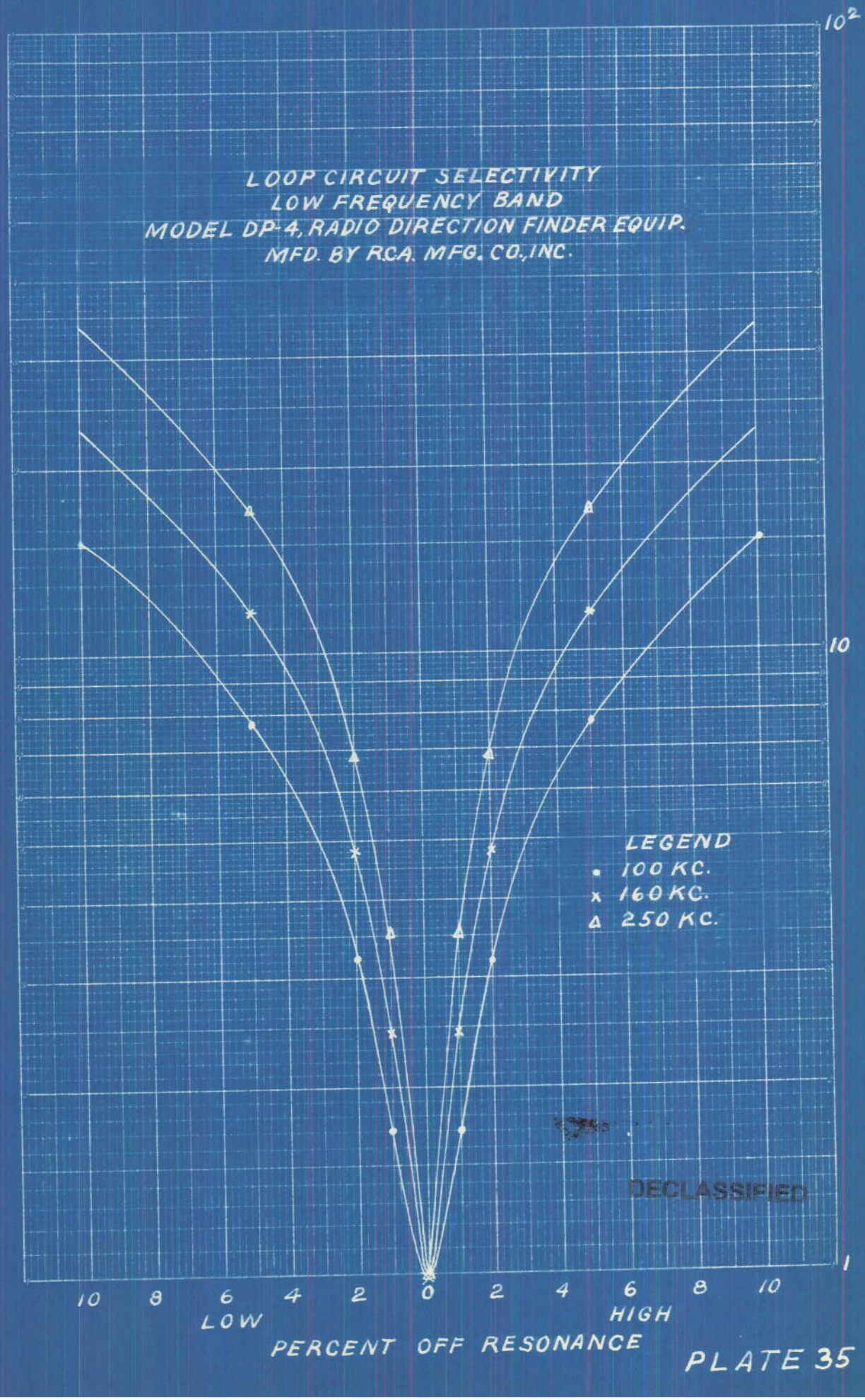
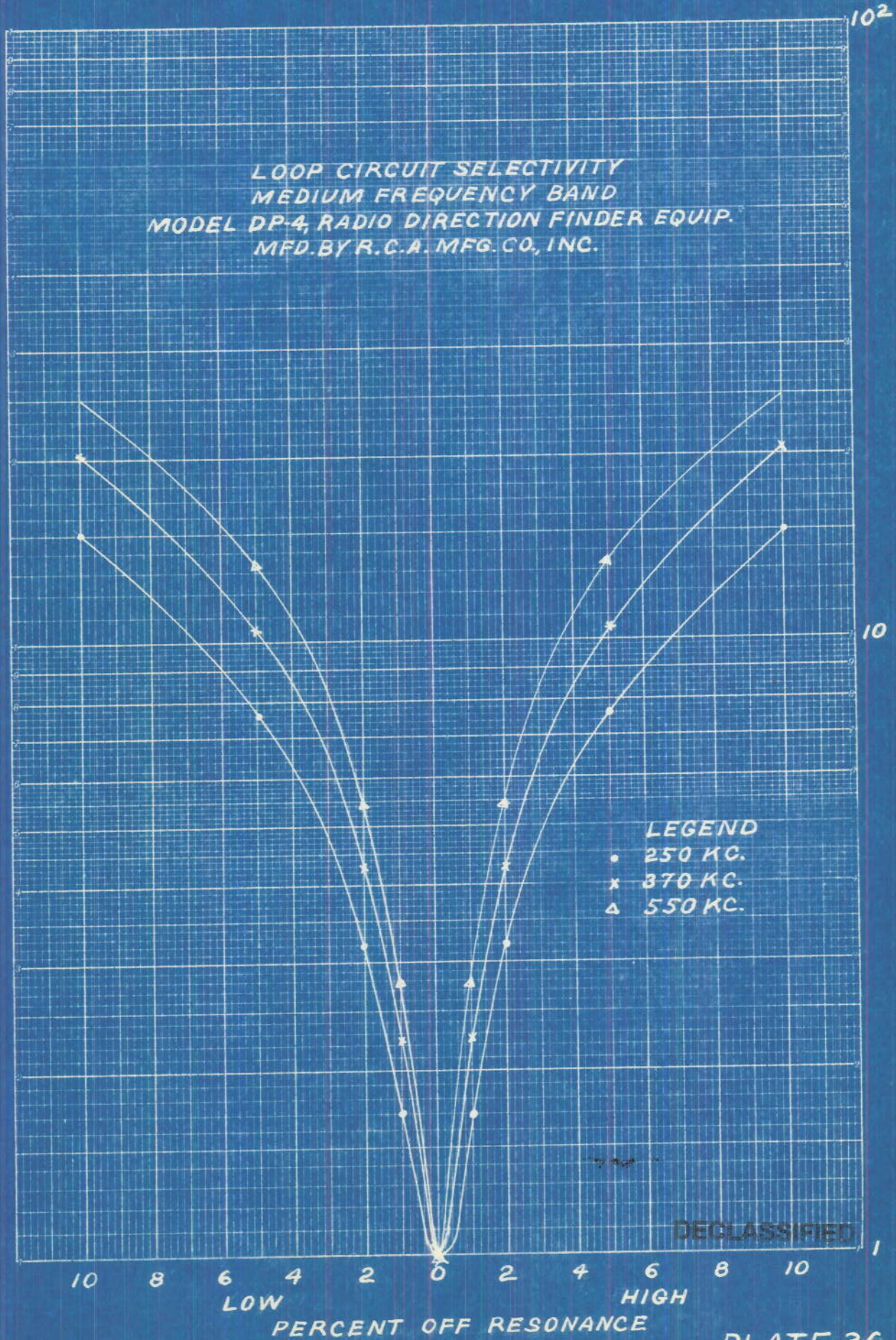


PLATE 35

NO. 31193. 20 DIVISIONS PER INCH (1/20 DIVISIONS) BY TWO 4 1/2-INCH CYCLES RATIO RULING.
KEUFFEL & ESSER CO. NEW YORK



DECLASSIFIED

PLATE 36

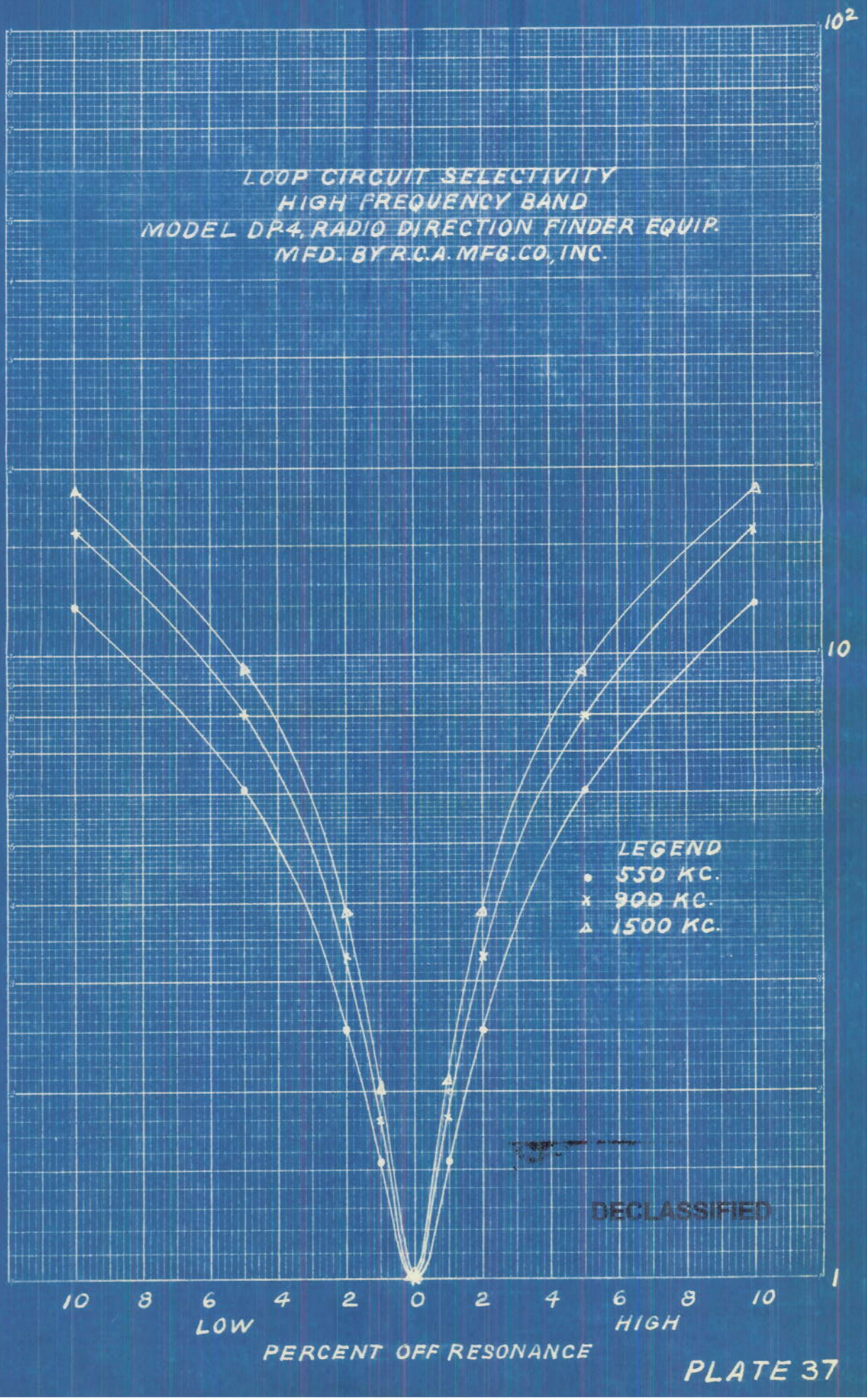
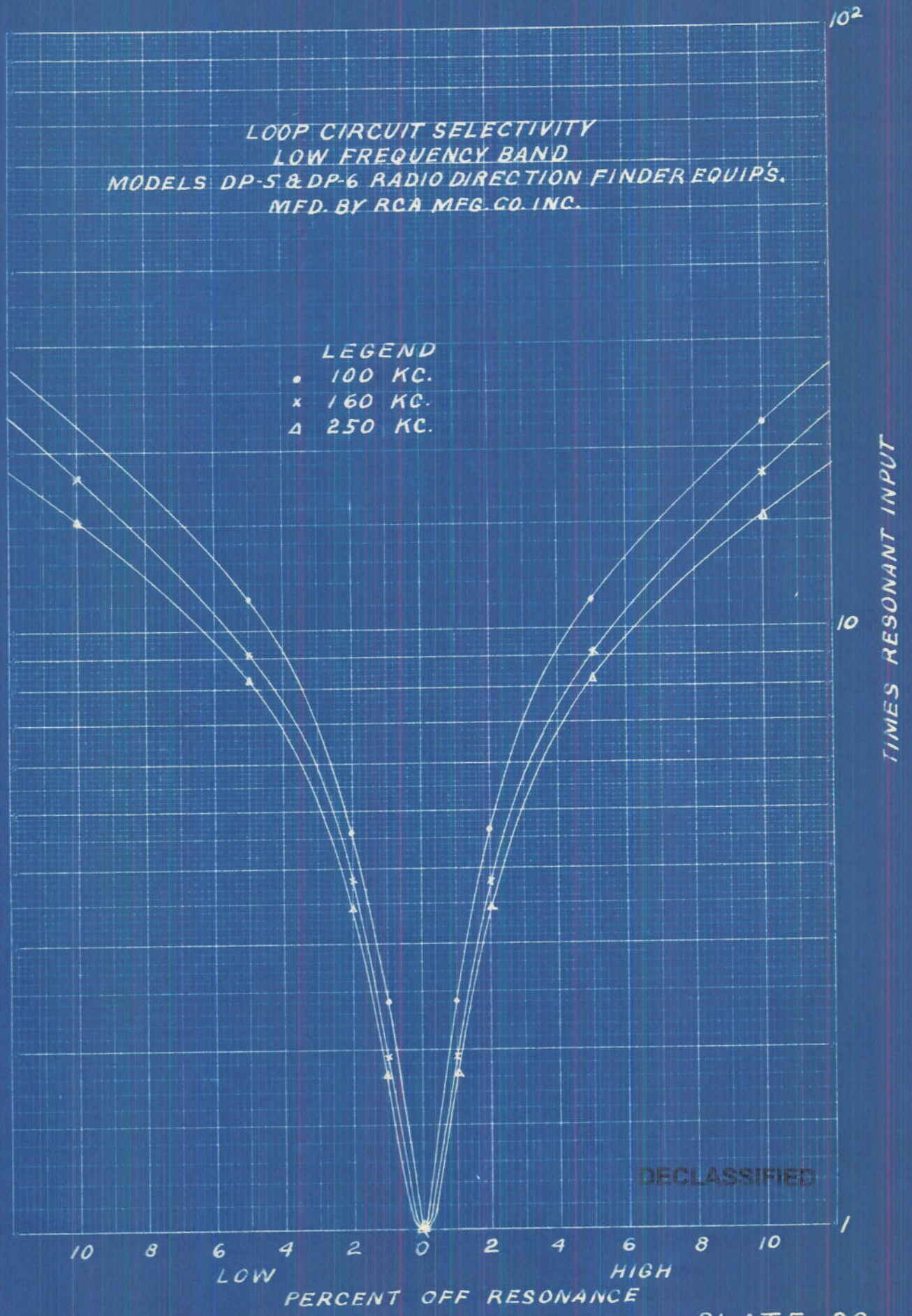


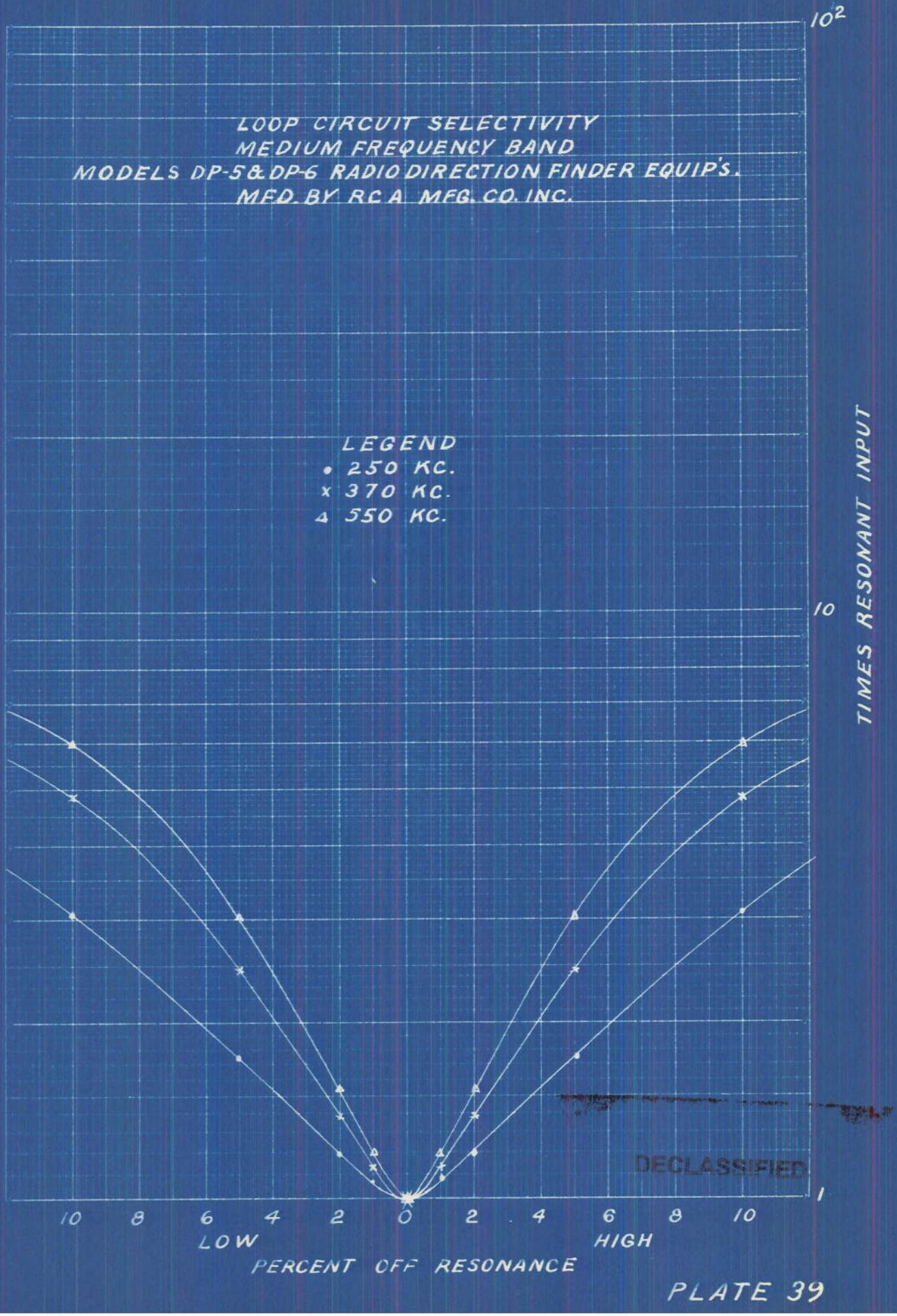
PLATE 37

NO. 31,193. 20 DIVISIONS PER INCH (120 DIVISIONS) BY TWO 4 1/2-INCH CYCLES RATIO RULING. CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS.



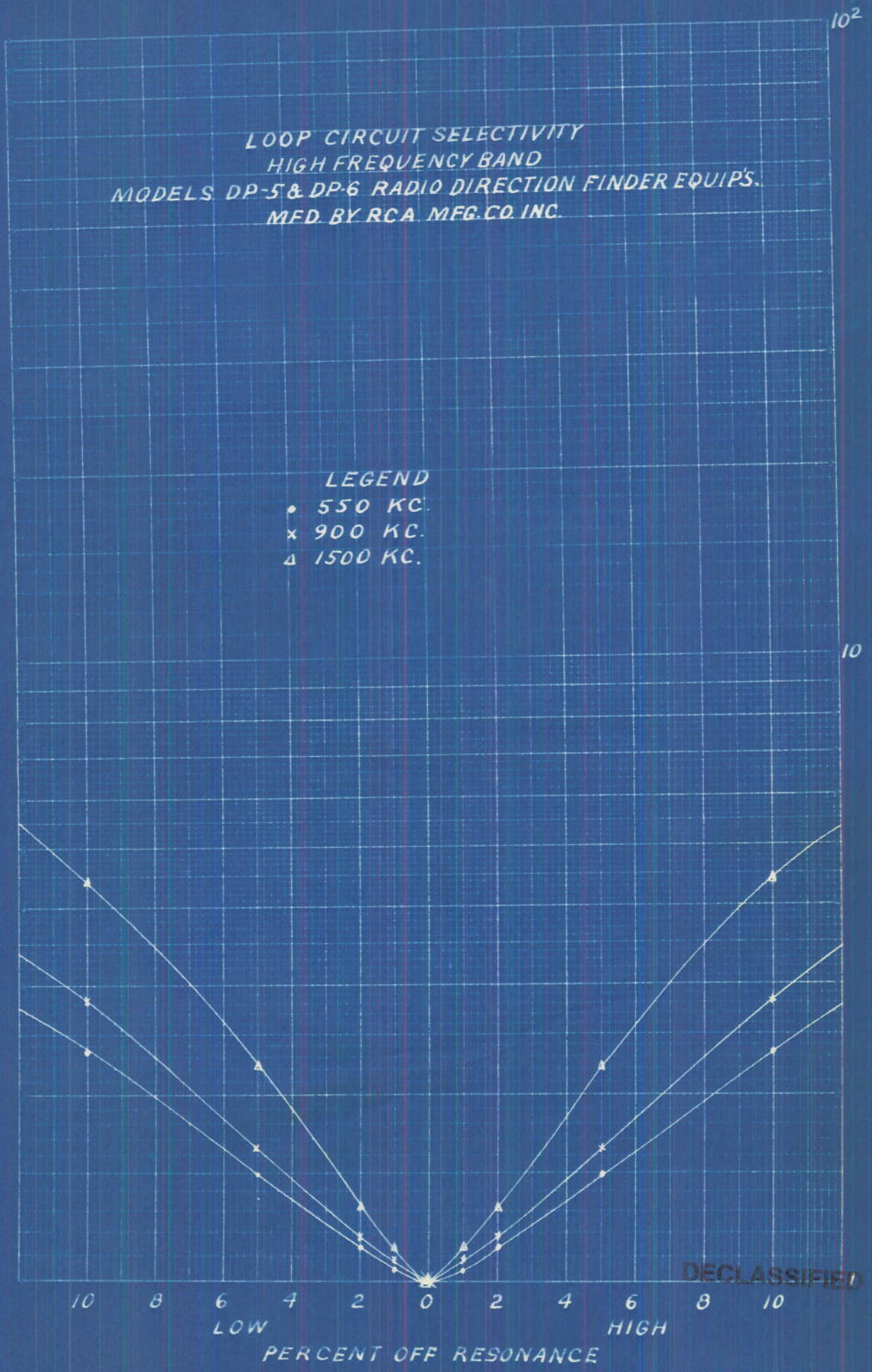
DECLASSIFIED

PLATE 38



DECLASSIFIED

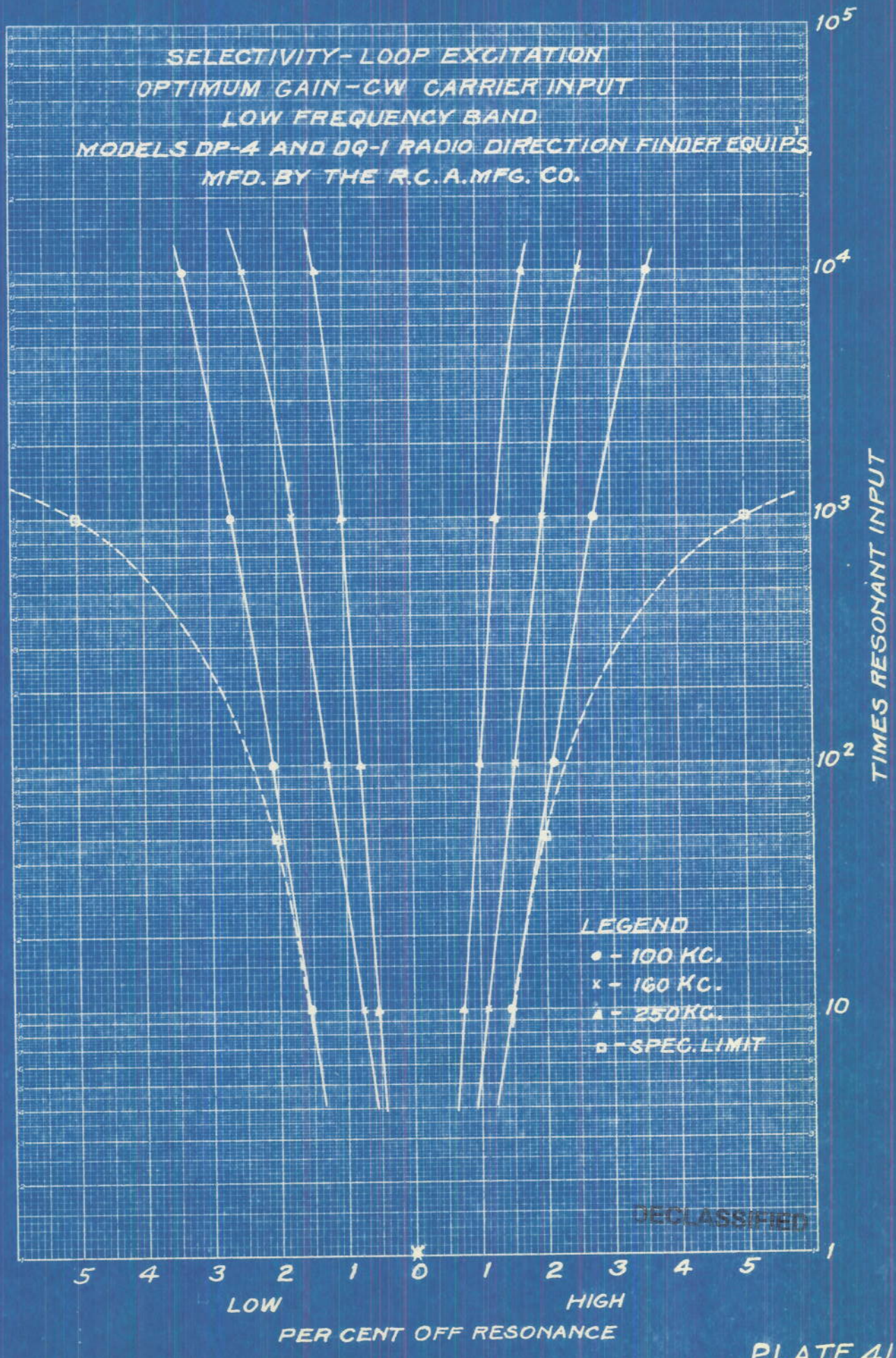
PLATE 39



DECLASSIFIED

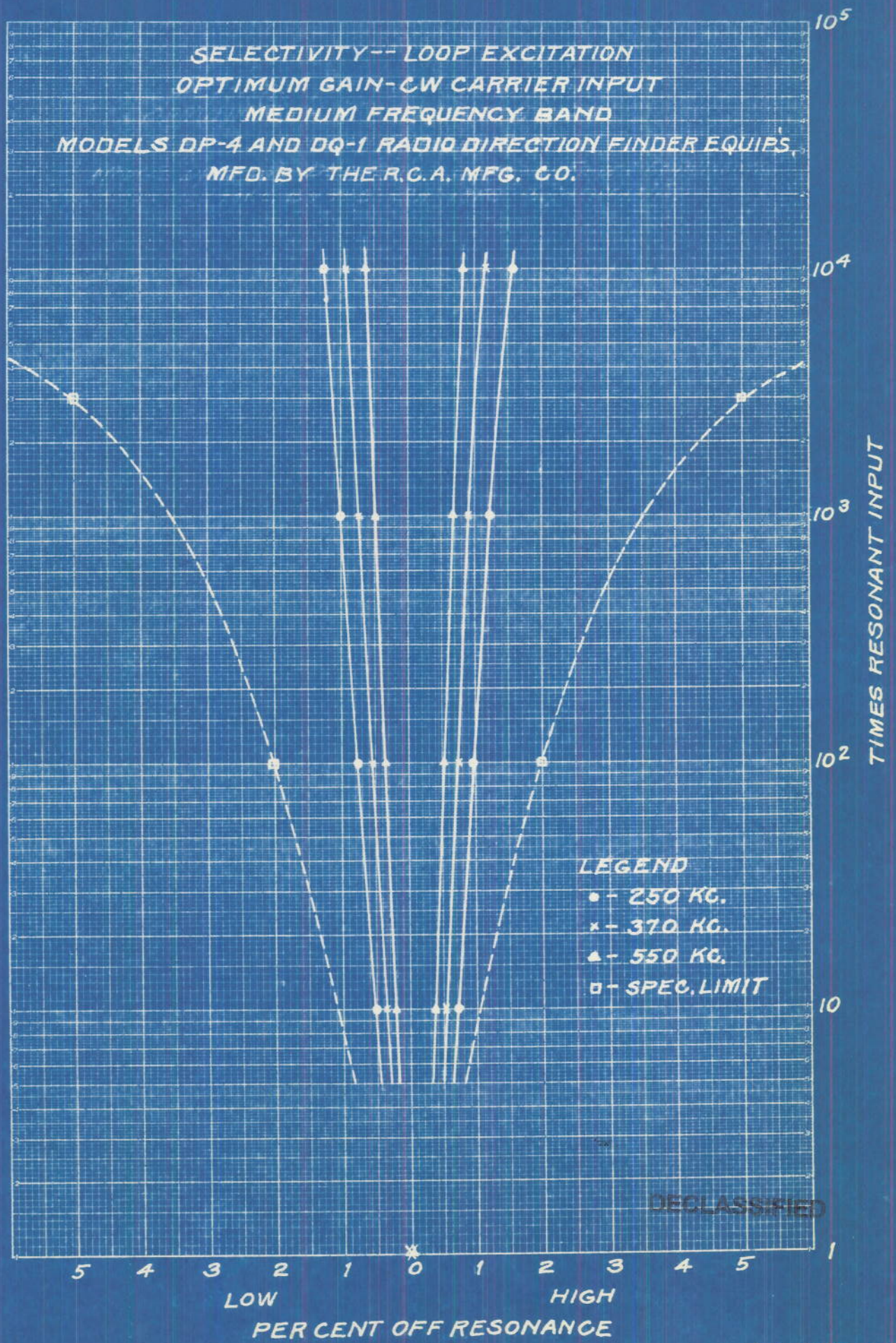
PLATE 40

NO. 31.193. 20 DIVISIONS PER INCH. (125 DIVISIONS) BY TWO 4 1/2-INCH CYCLES RATIO RULING. CODE X BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS



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PLATE 41



DECLASSIFIED

PLATE 42

CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS

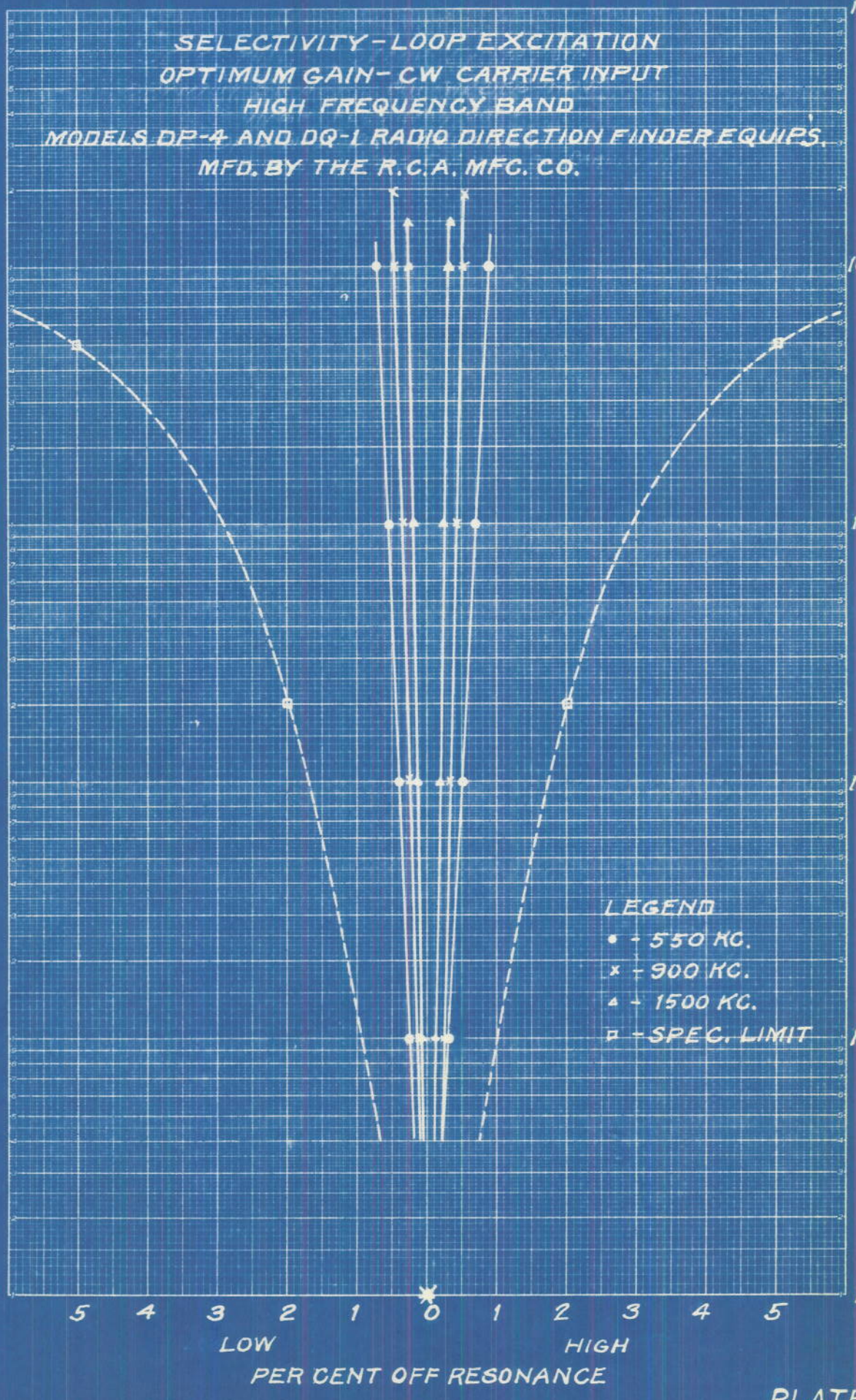
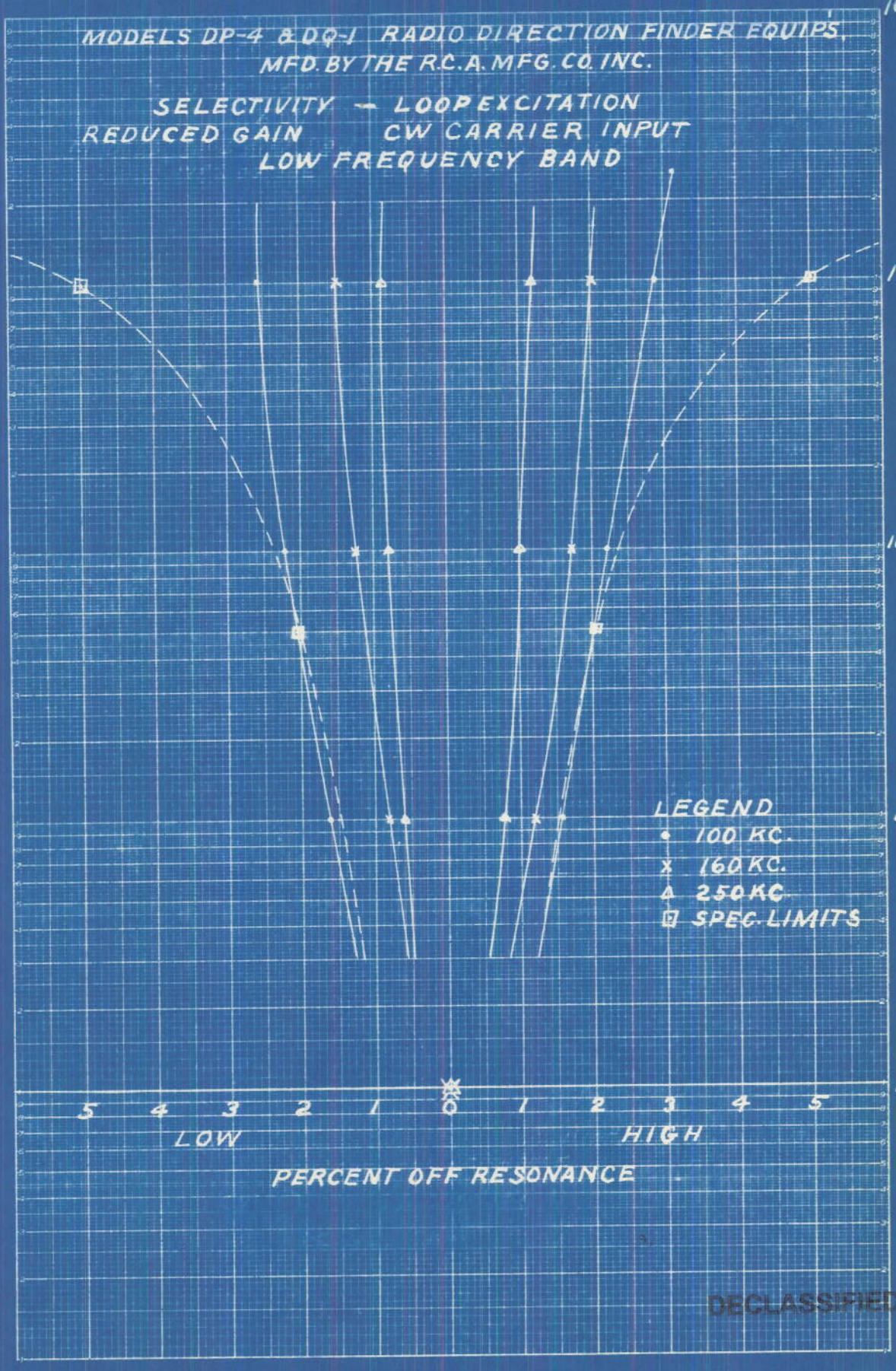
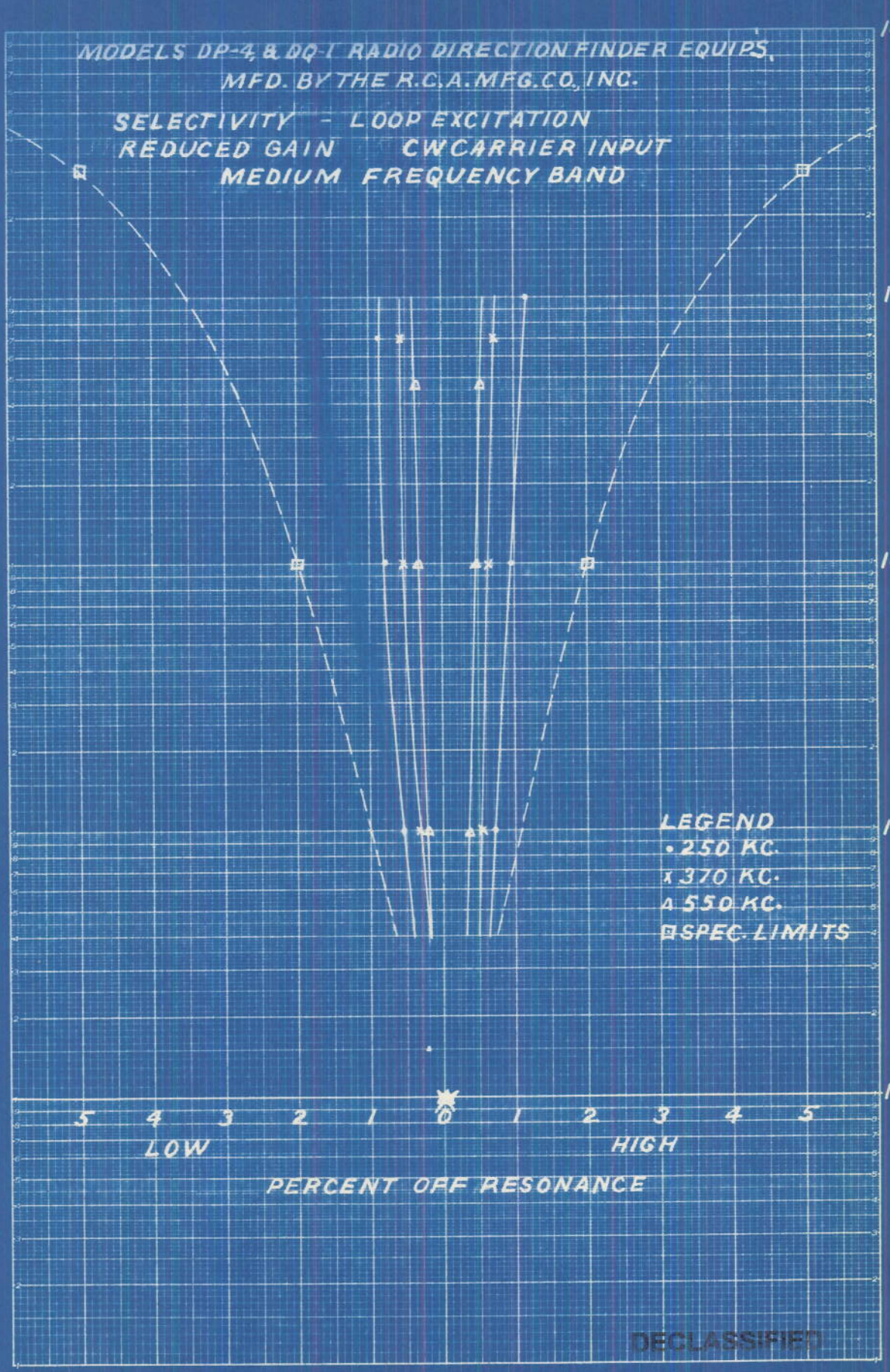


PLATE 43



DECLASSIFIED

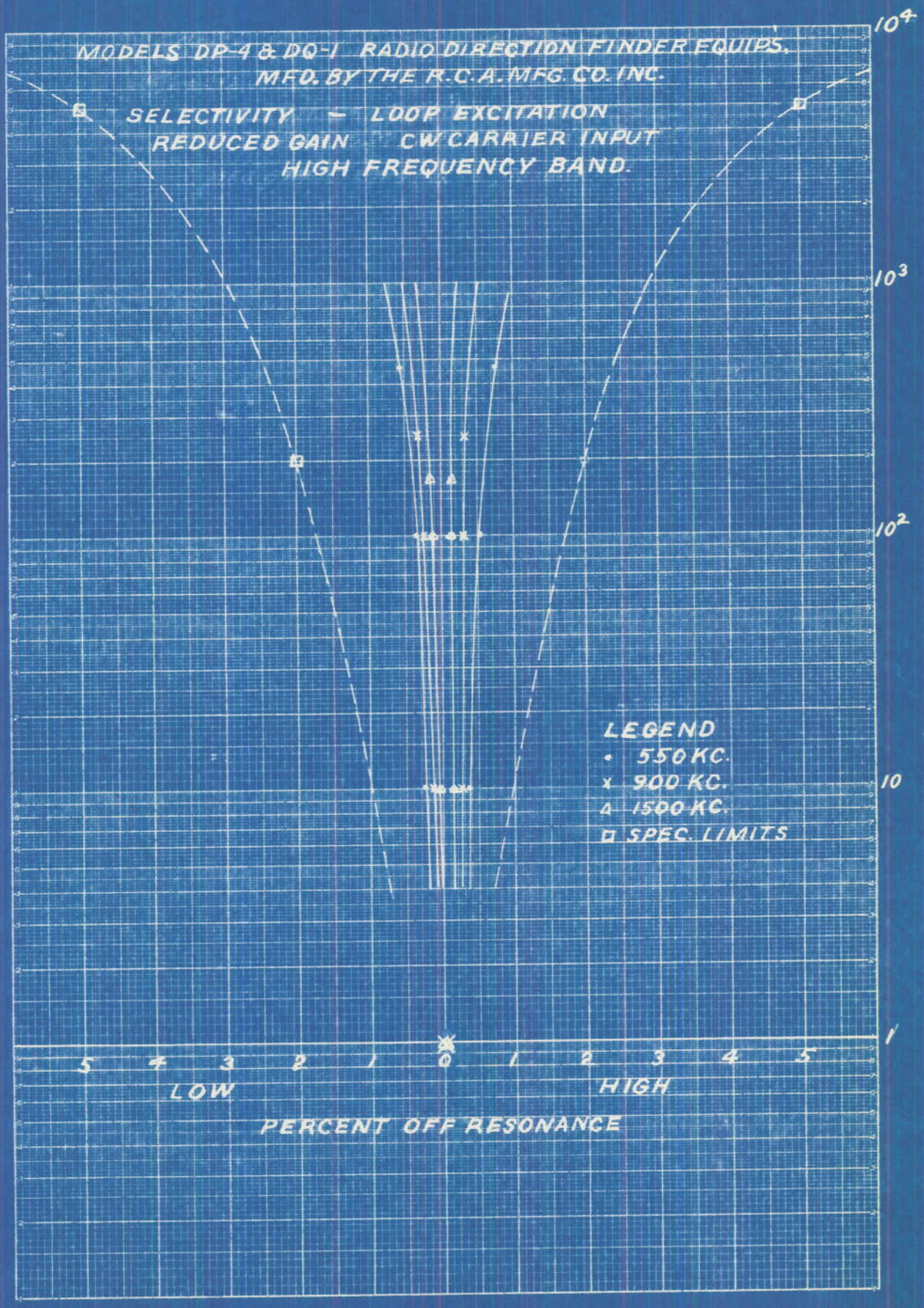
PLATE 44



DECLASSIFIED

PLATE 45

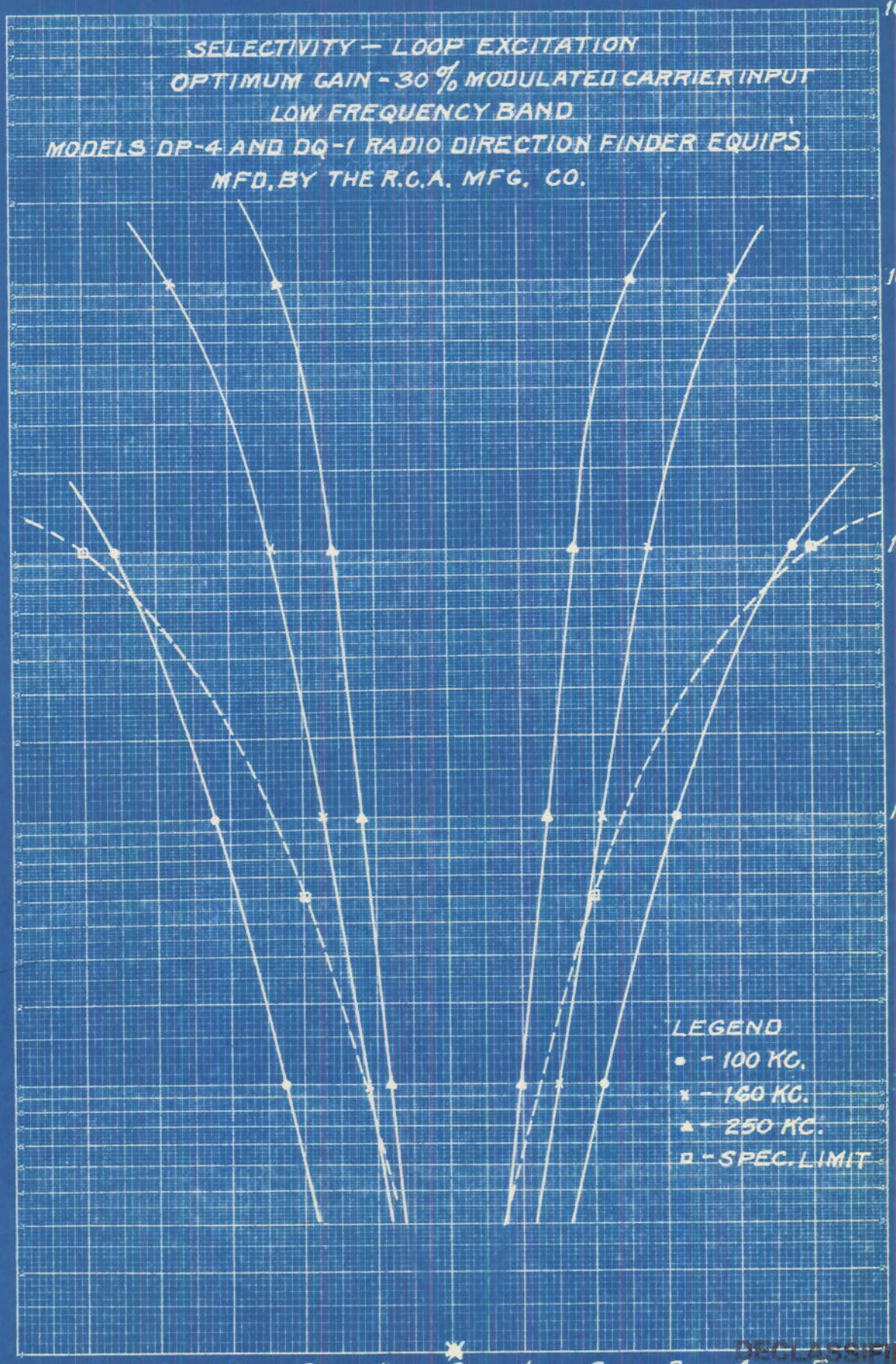
CODEX BOOK C... INC. NORWOOD, MASSACHUSETTS



DECLASSIFIED

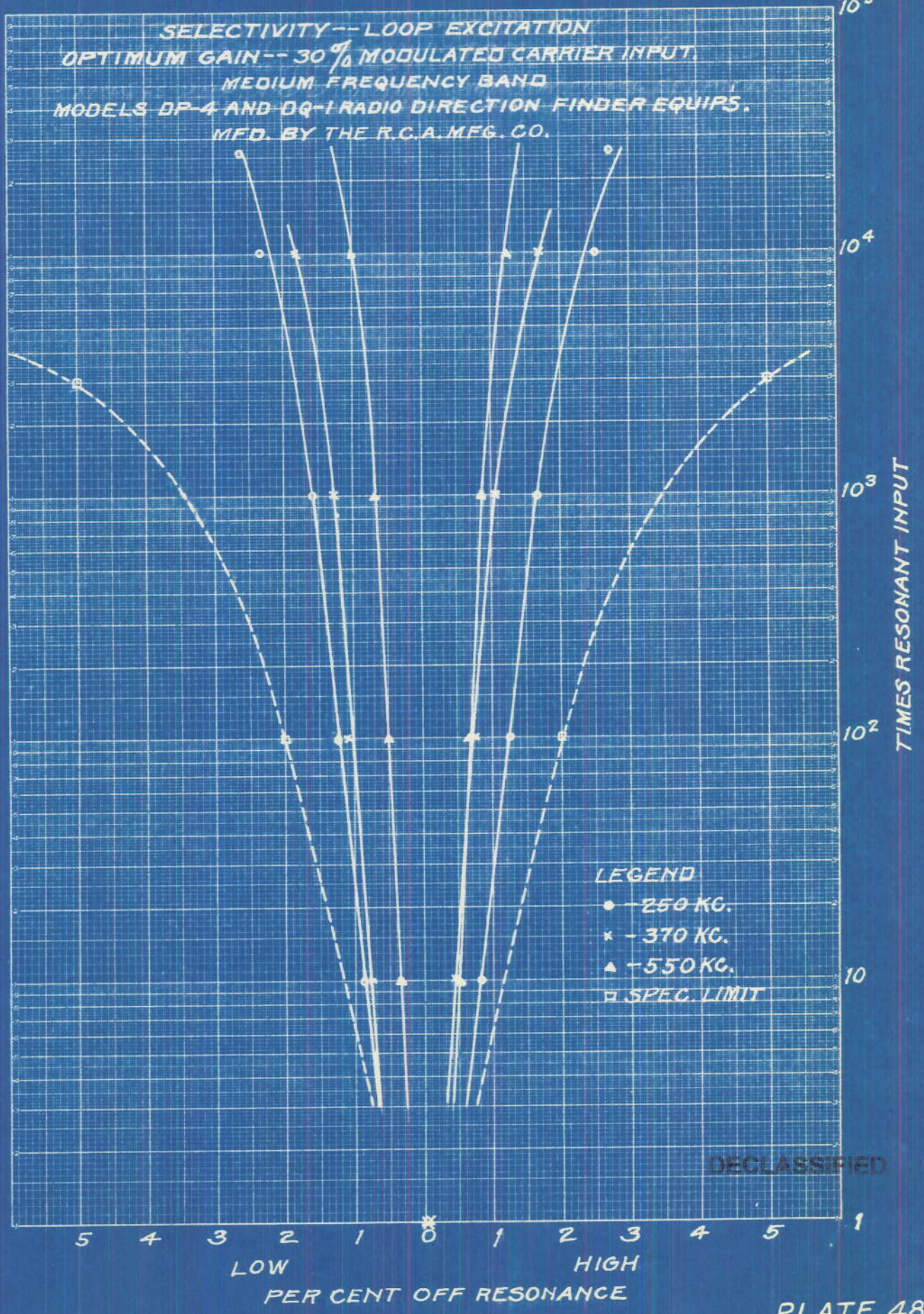
PLATE 46

CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS



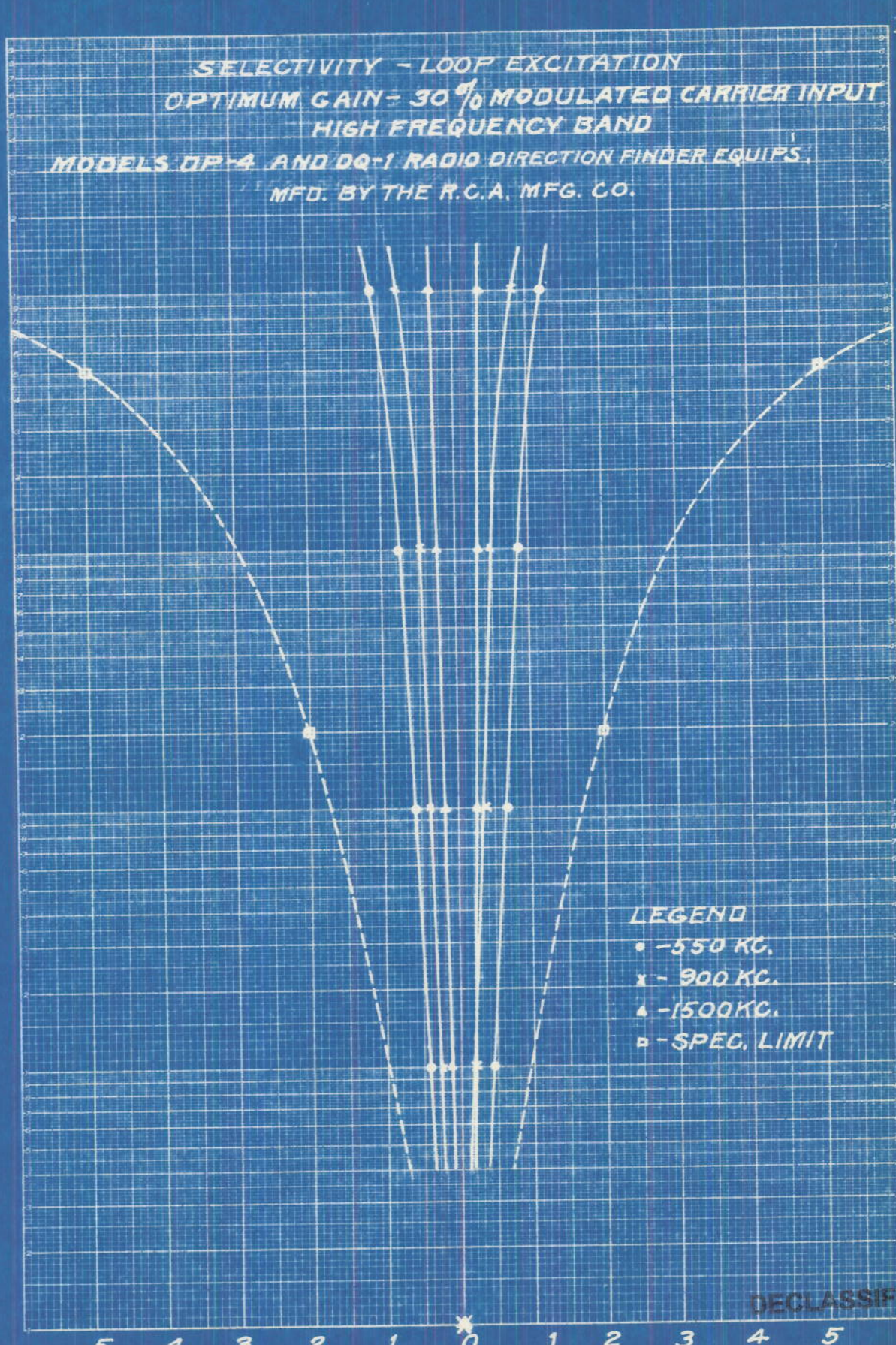
DECLASSIFIED

PLATE 47



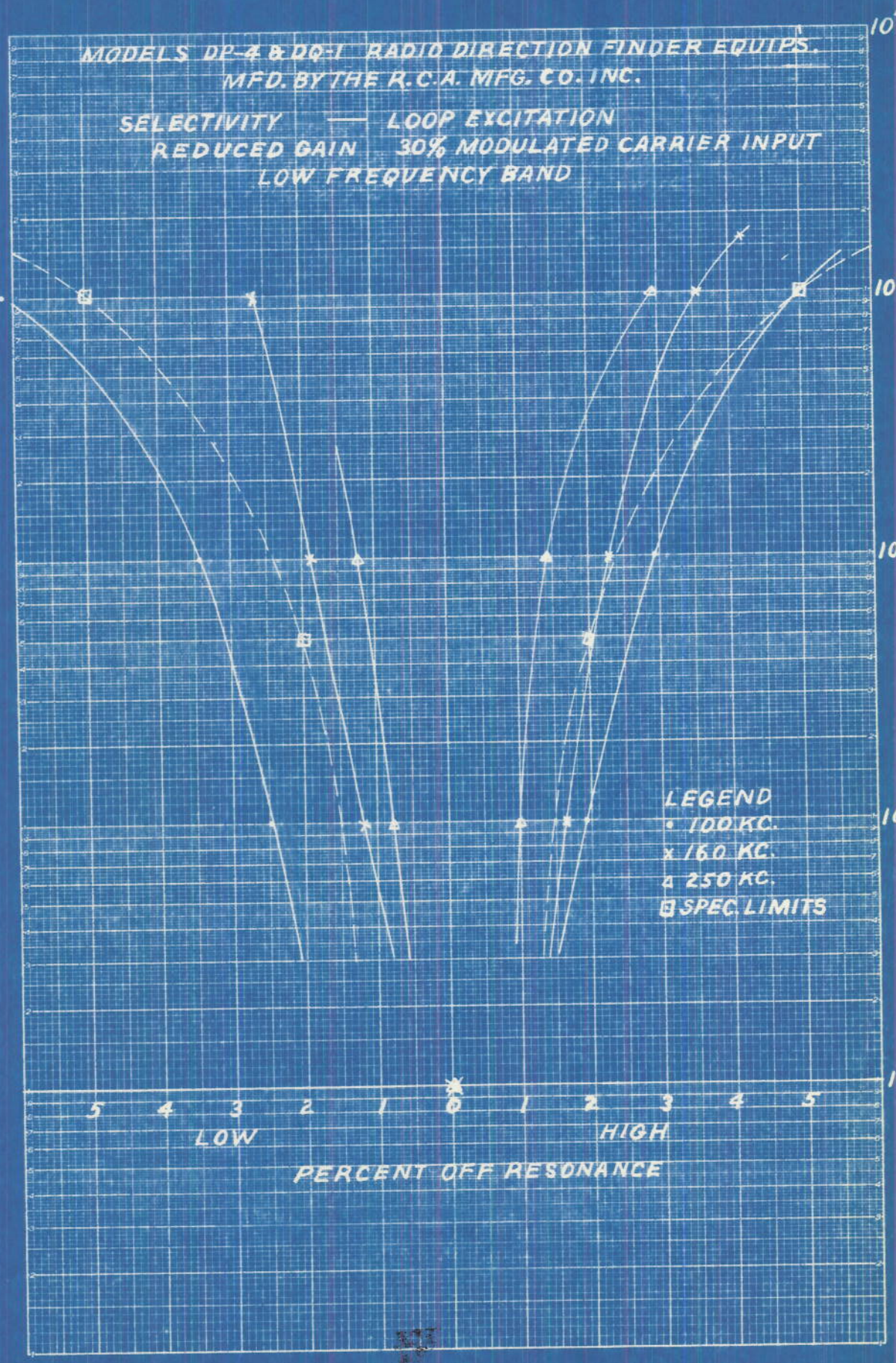
DECLASSIFIED

PLATE 48



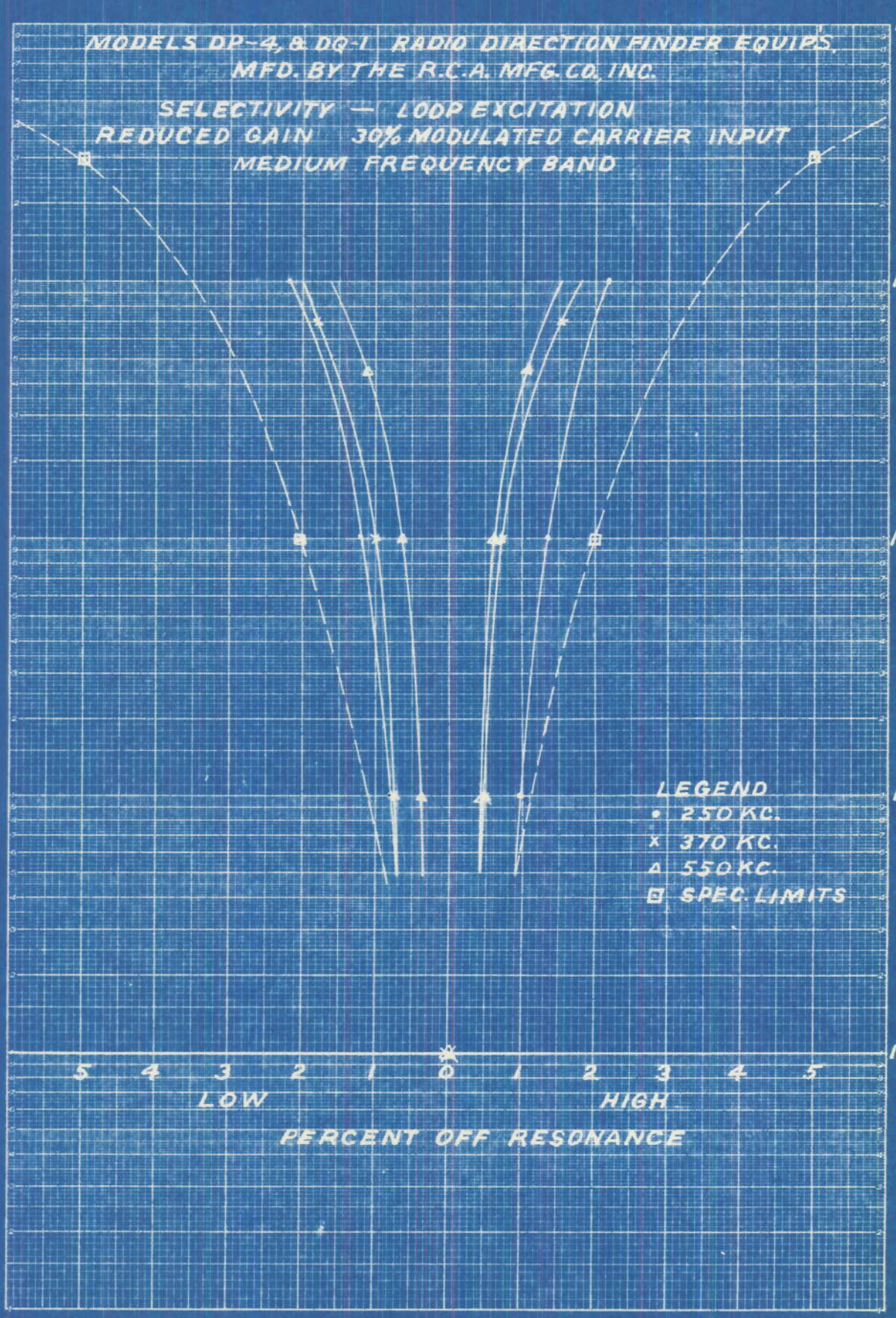
DECLASSIFIED

PLATE 49



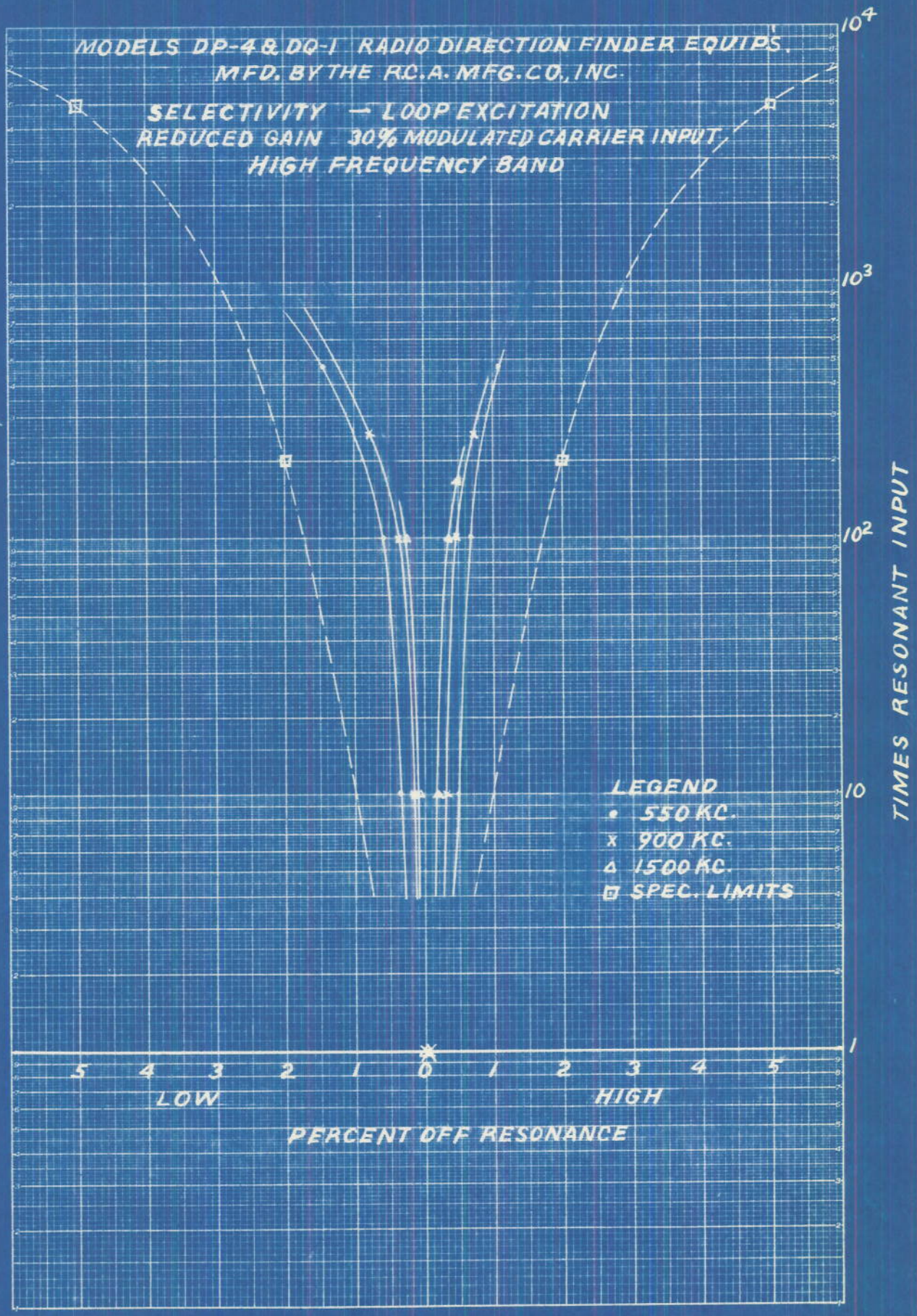
DECLASSIFIED

PLATE 50



DECLASSIFIED

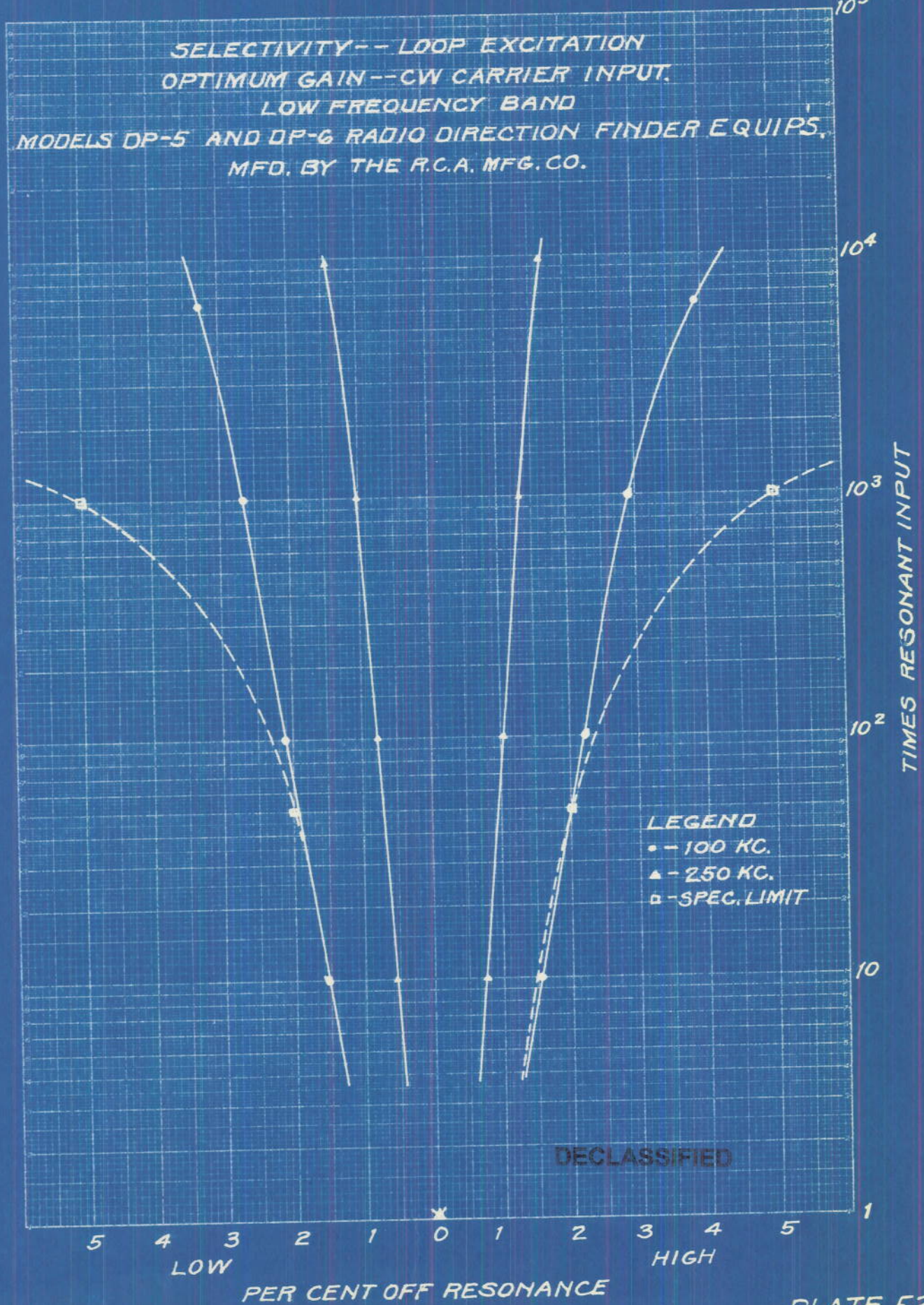
PLATE 51



CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS

DECLASSIFIED

PLATE 52



DECLASSIFIED

PLATE 53

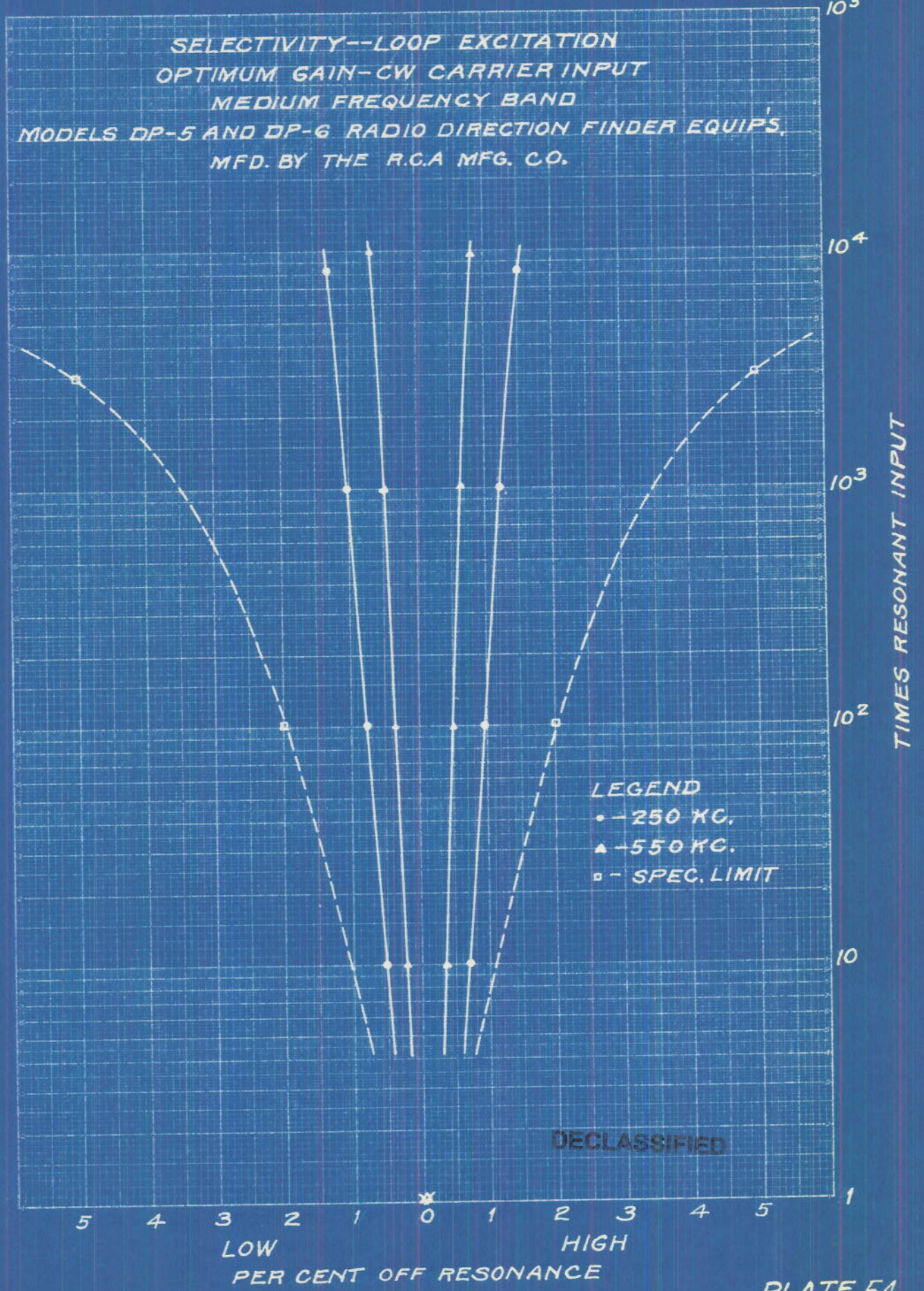

SELECTIVITY--LOOP EXCITATION
OPTIMUM GAIN-CW CARRIER INPUT
MEDIUM FREQUENCY BAND
MODELS DP-5 AND DP-6 RADIO DIRECTION FINDER EQUIPS.
MFD. BY THE R.C.A MFG. CO.
10^5
10^4
10^3
10^2
10
1
TIMES RESONANT INPUT
LEGEND
• - 250 KC.
▲ - 550 KC.
▫ - SPEC. LIMIT
DECLASSIFIED
5 4 3 2 1 0 1 2 3 4 5
LOW
HIGH
PER CENT OFF RESONANCE

PLATE 54

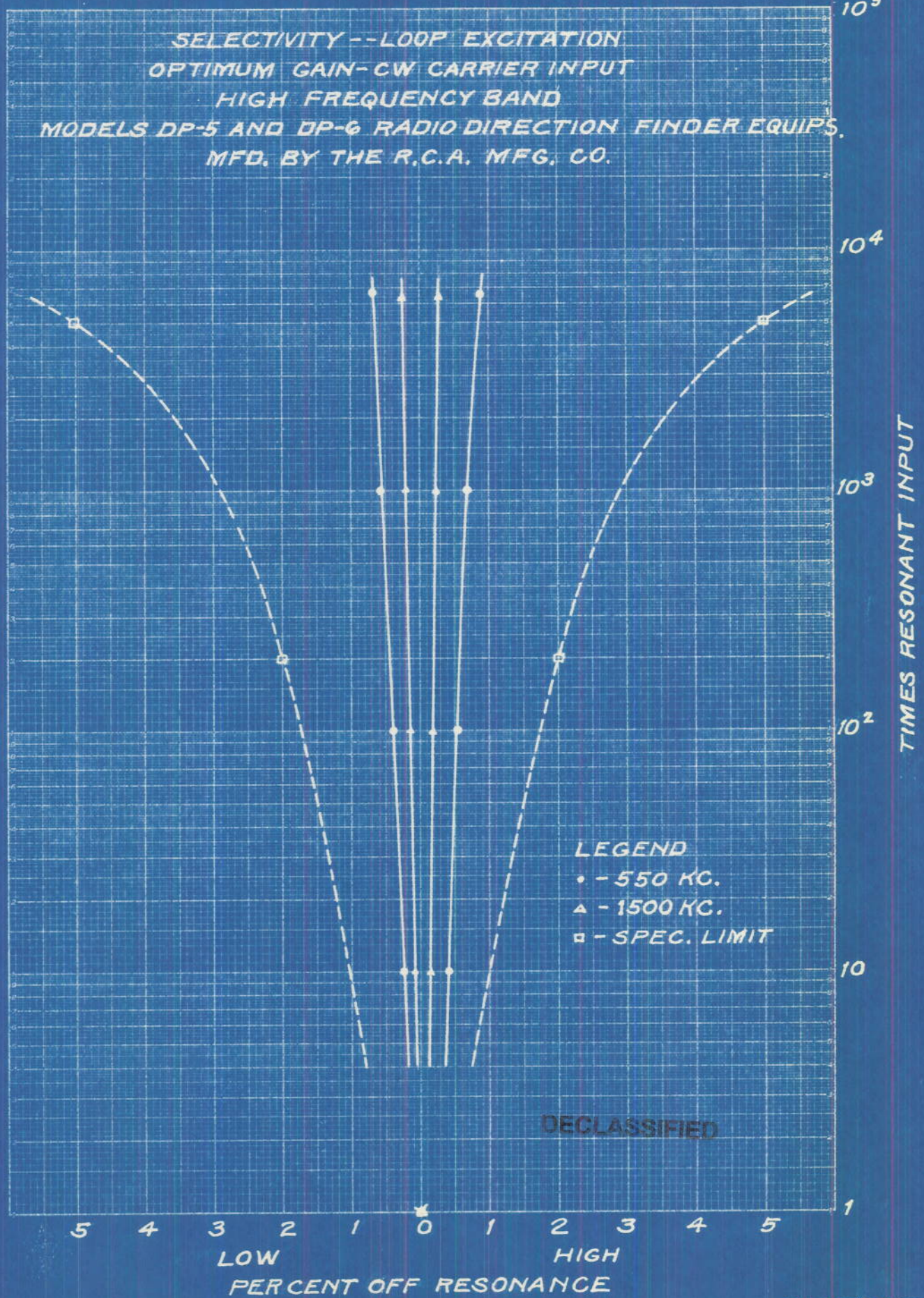
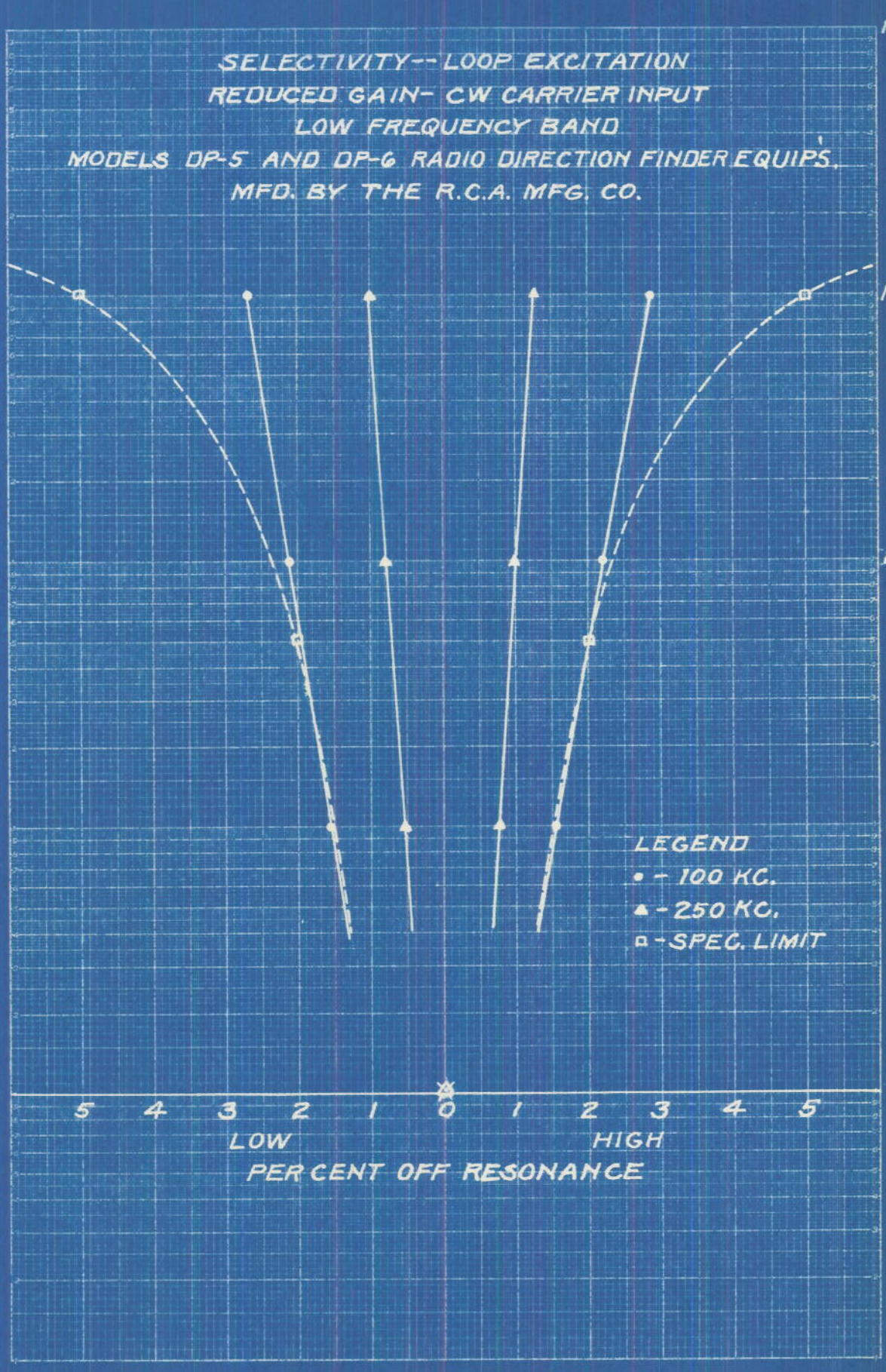
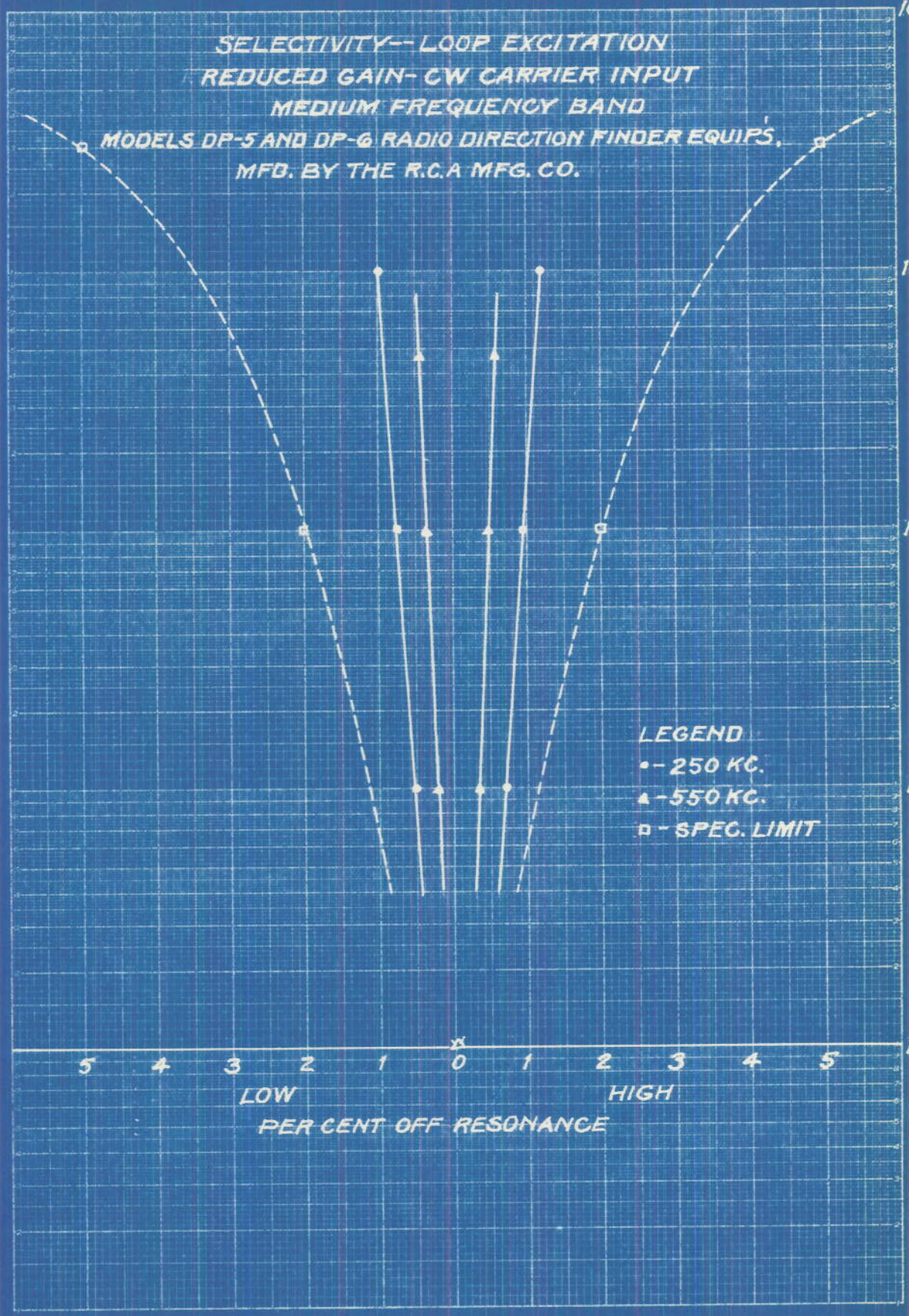

SELECTIVITY -- LOOP EXCITATION
OPTIMUM GAIN - CW CARRIER INPUT
HIGH FREQUENCY BAND
MODELS DP-5 AND DP-6 RADIO DIRECTION FINDER EQUIPS.
MFD. BY THE R.C.A. MFG. CO.
10^5
10^4
10^3
10^2
10
1
TIMES RESONANT INPUT
LEGEND
• - 550 KC.
▲ - 1500 KC.
□ - SPEC. LIMIT
DECLASSIFIED
5 4 3 2 1 0 1 2 3 4 5
LOW
HIGH
PERCENT OFF RESONANCE

PLATE 55



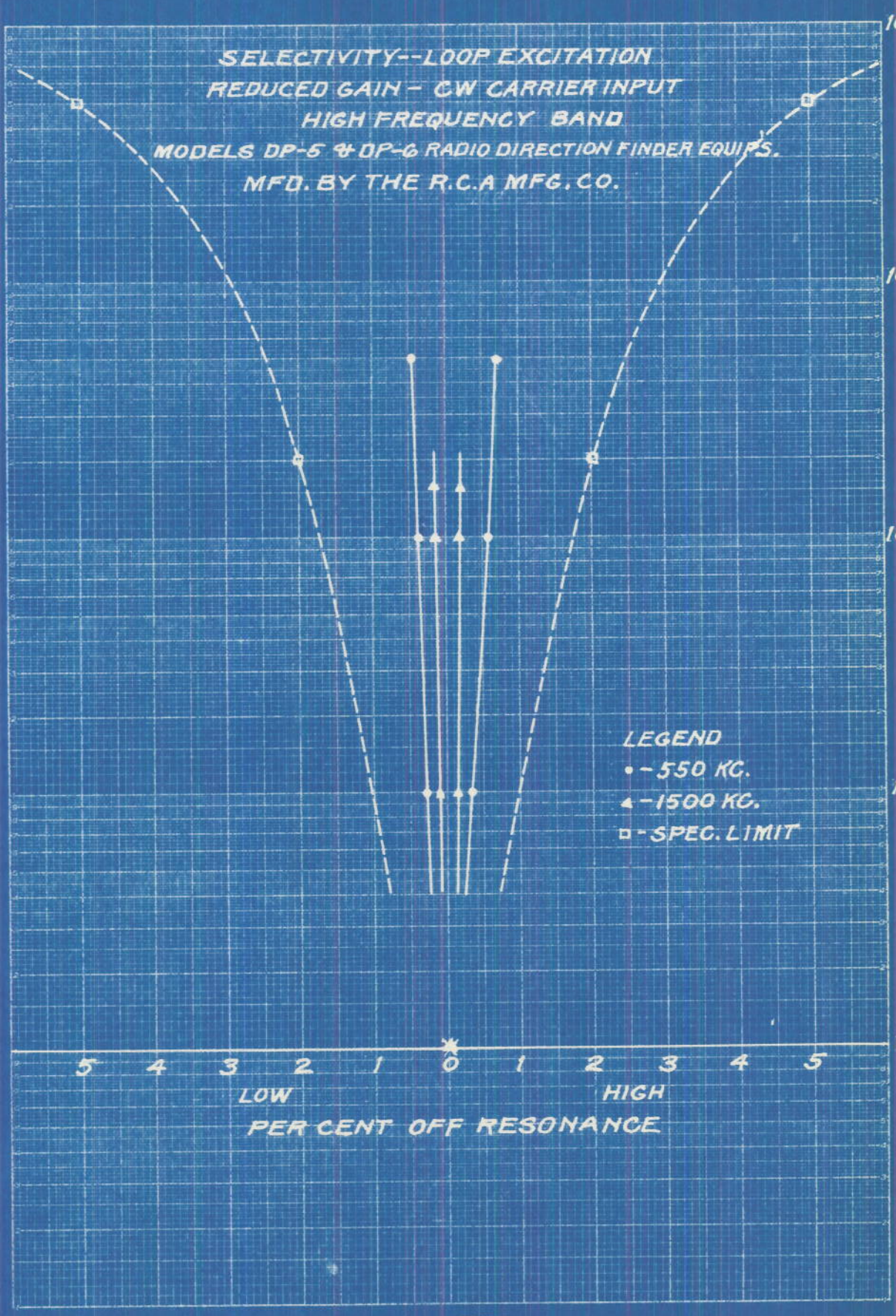
DECLASSIFIED

PLATE 56



DECLASSIFIED

PLATE 57



DECLASSIFIED

PLATE 58

CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS

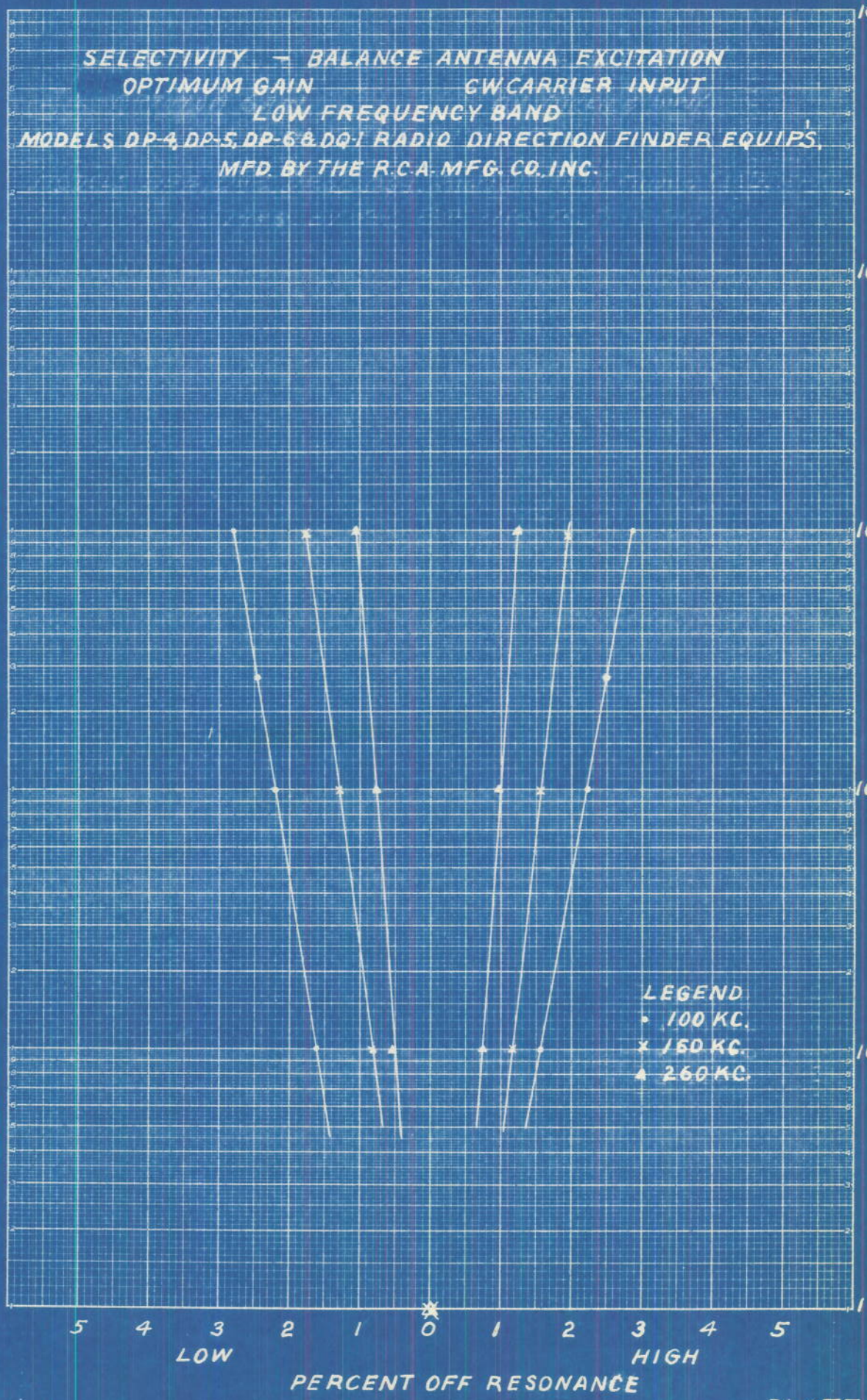
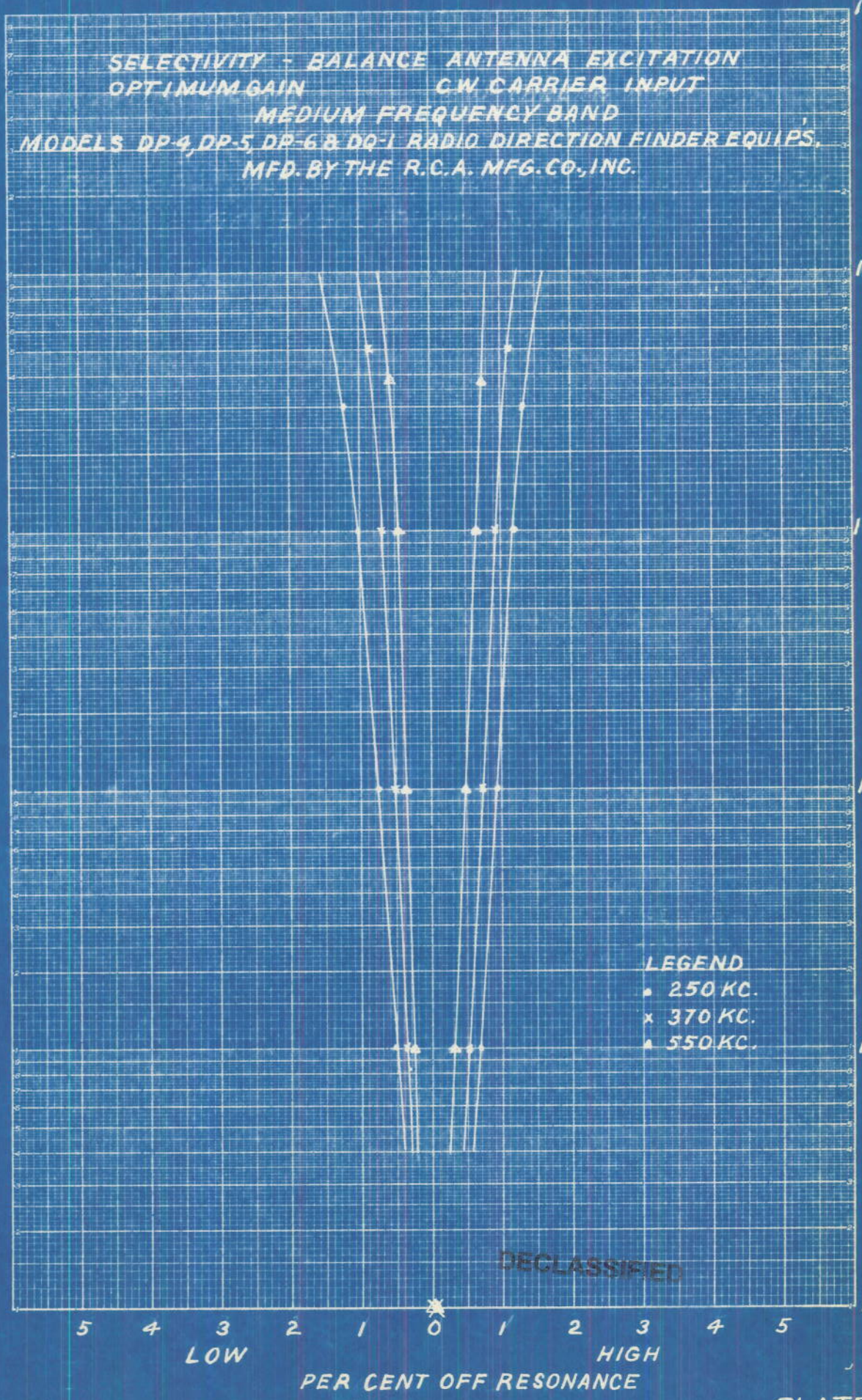


PLATE 59

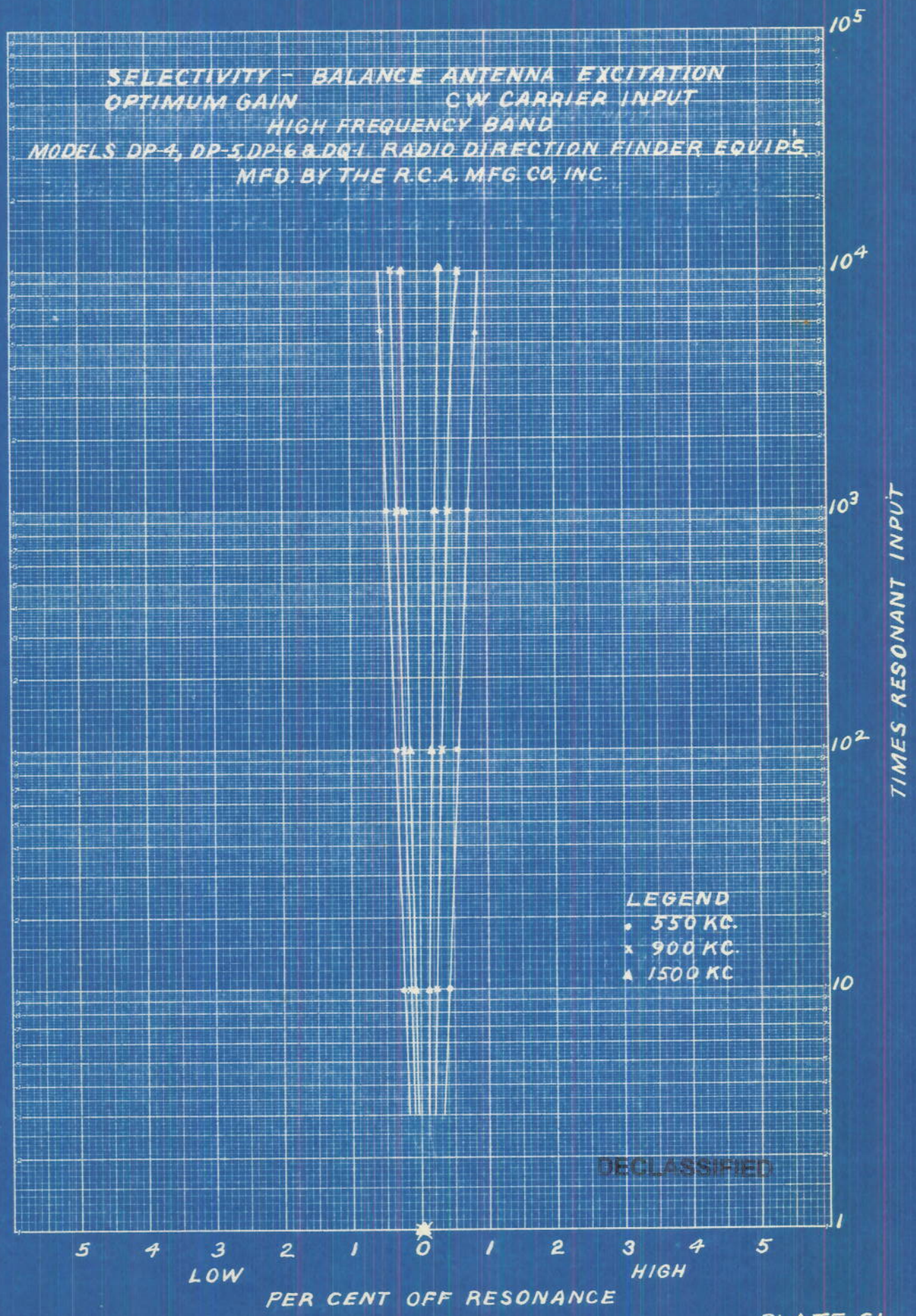
DECLASSIFIED

CODEX BOOK COMPANY, INC., NORWOOD, MASSACHUSETTS



DECLASSIFIED

PLATE 60



DECLASSIFIED

PLATE 61

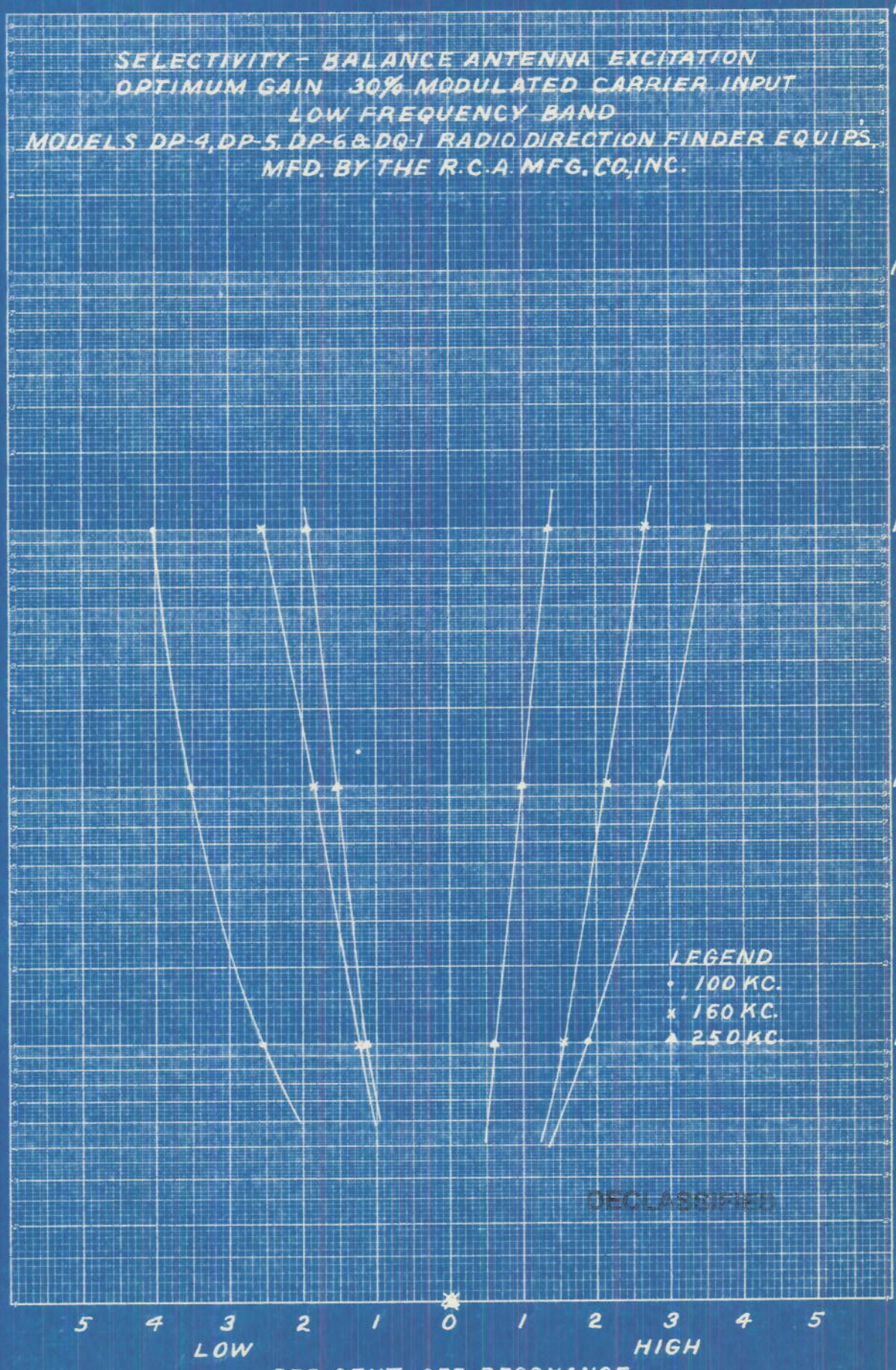

SELECTIVITY - BALANCE ANTENNA EXCITATION
OPTIMUM GAIN 30% MODULATED CARRIER INPUT
LOW FREQUENCY BAND
MODELS DP-4, DP-5, DP-6 & DQ-1 RADIO DIRECTION FINDER EQUIPS.
MFD. BY THE R.C.A. MFG. CO., INC.
10^5
10^4
10^3
10^2
10
1
TIMES RESONANT INPUT
LEGEND
• 100 KC.
x 160 KC.
▲ 250 KC.
DECLASSIFIED
5 4 3 2 1 0 1 2 3 4 5
LOW
HIGH
PER CENT OFF RESONANCE

PLATE 62

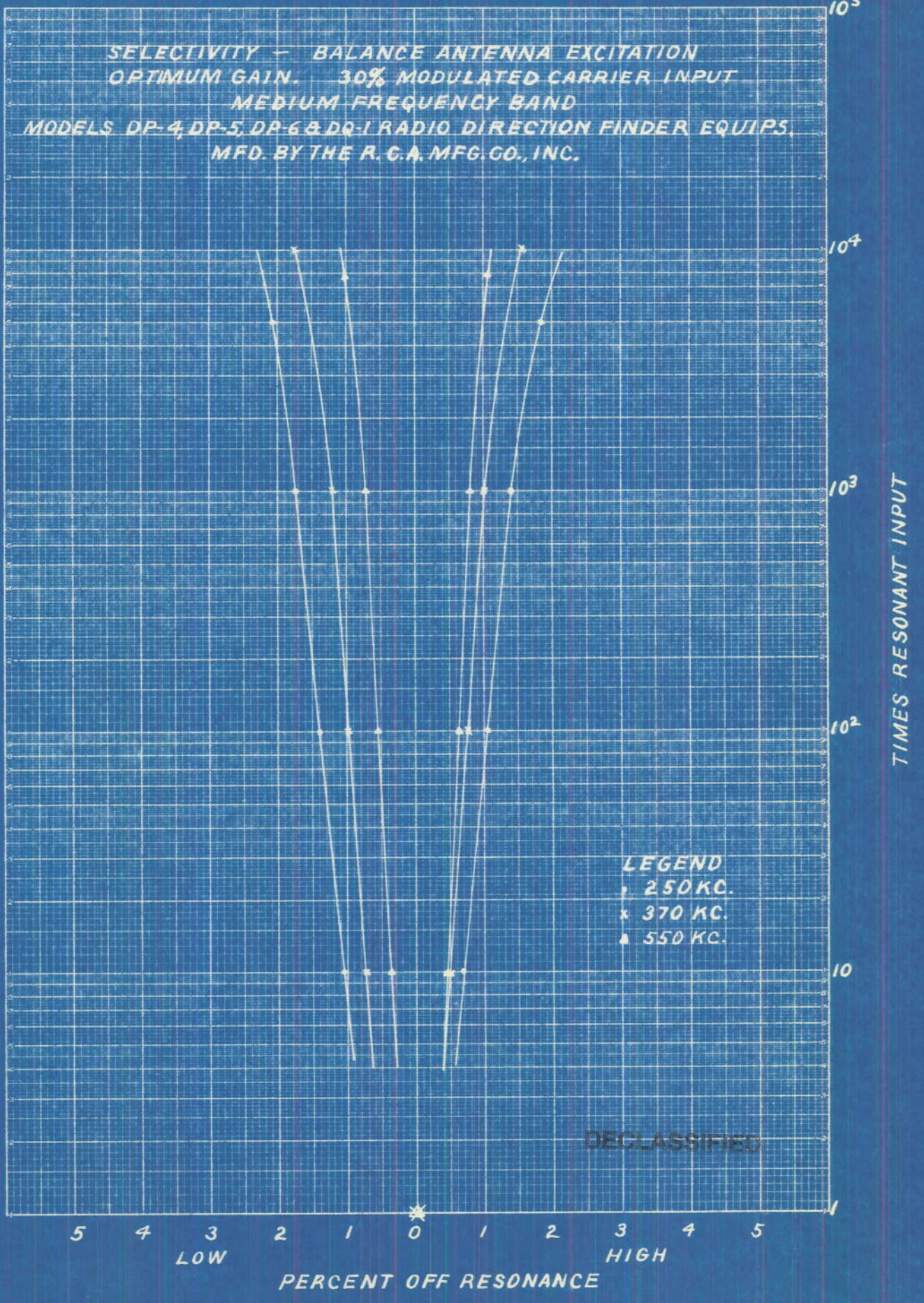
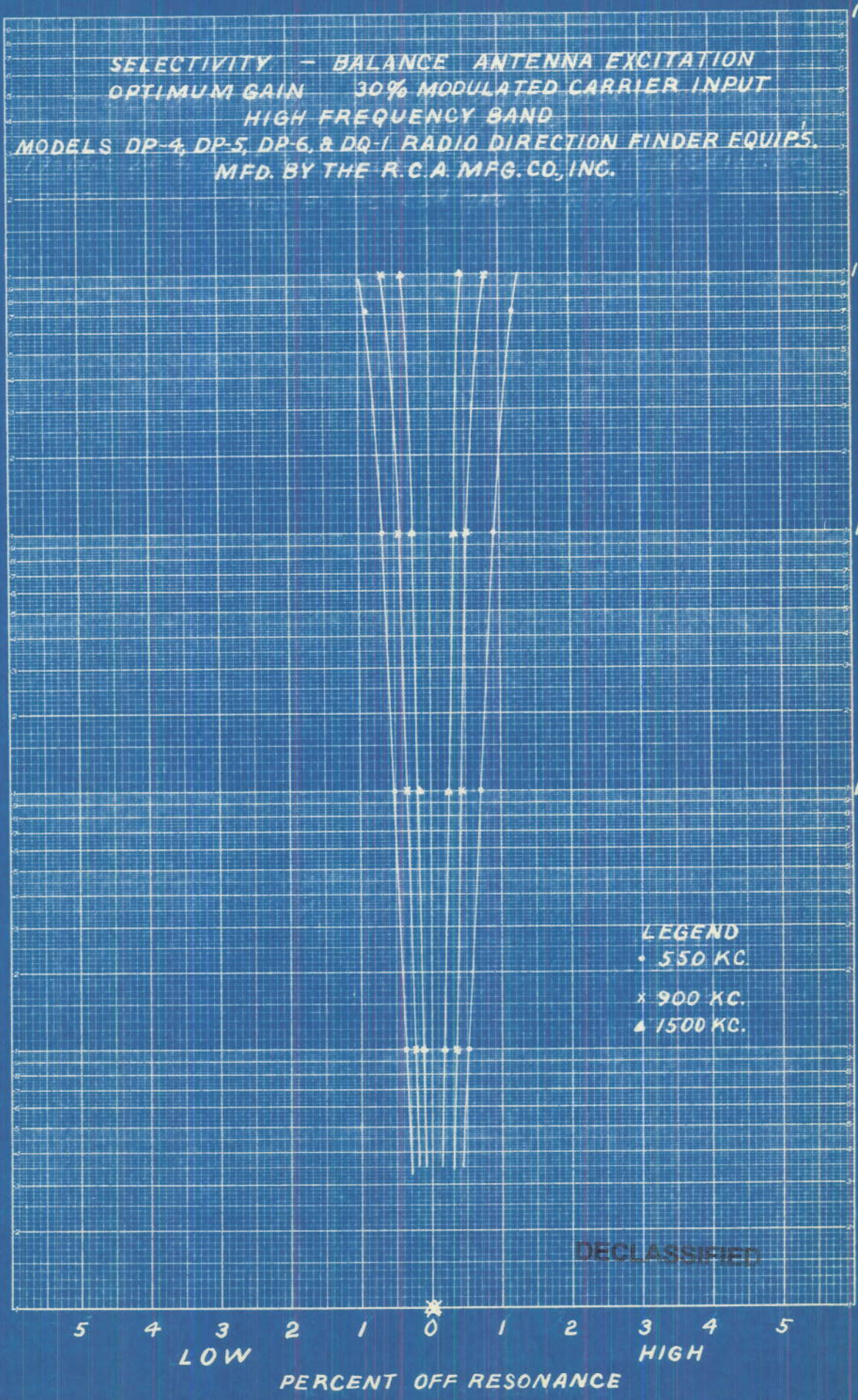

SELECTIVITY — BALANCE ANTENNA EXCITATION
OPTIMUM GAIN. 30% MODULATED CARRIER INPUT
MEDIUM FREQUENCY BAND
MODELS DP-4, DP-5, DP-6 & DQ-1 RADIO DIRECTION FINDER EQUIPS.
MFD. BY THE R.C.A. MFG. CO., INC.
10^5
10^4
10^3
10^2
10
1
TIMES RESONANT INPUT
LEGEND
• 250 KC.
x 370 KC.
▲ 550 KC.
DECLASSIFIED
5 4 3 2 1 0 1 2 3 4 5
LOW
HIGH
PERCENT OFF RESONANCE

PLATE 63

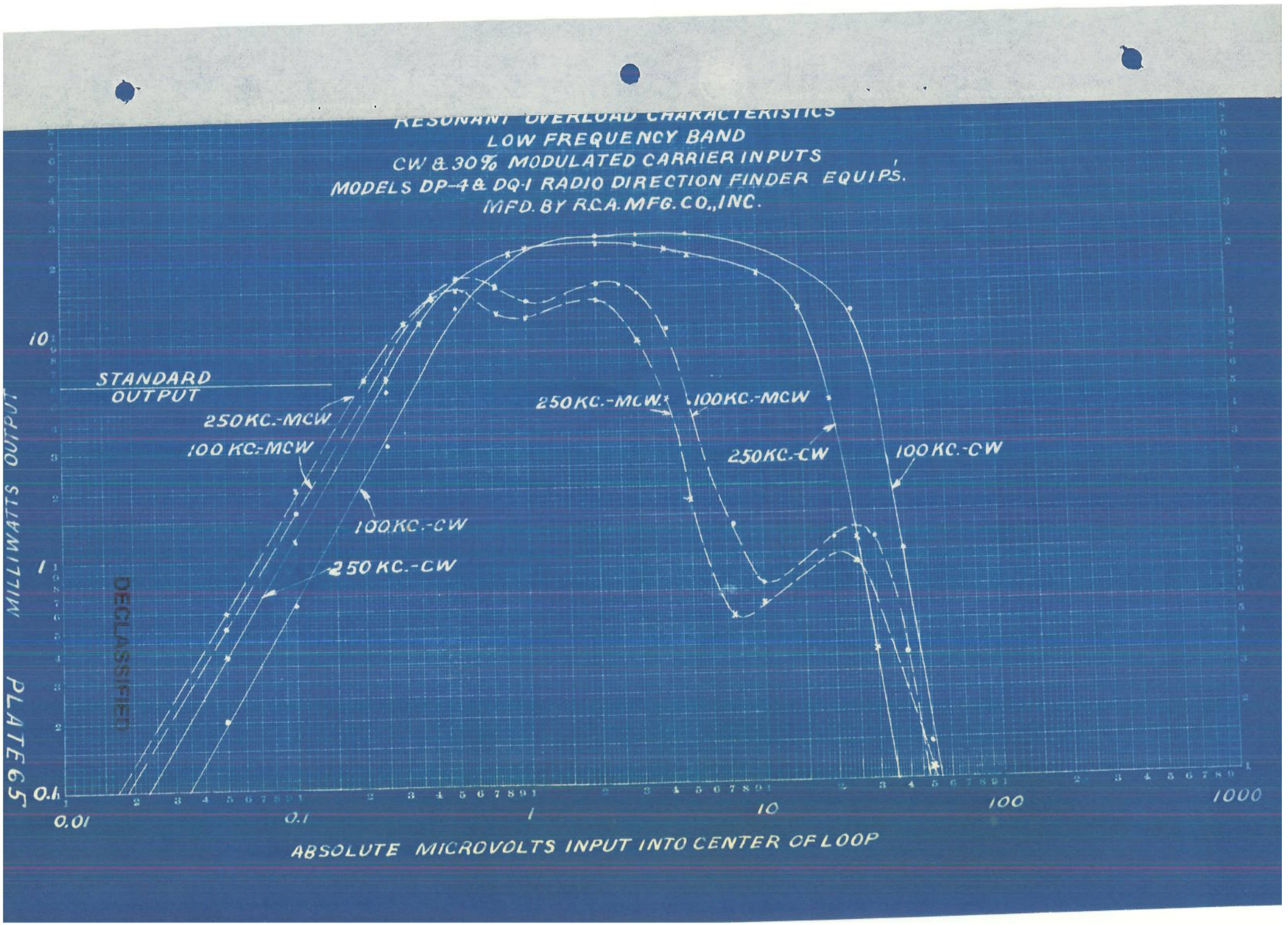
CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS

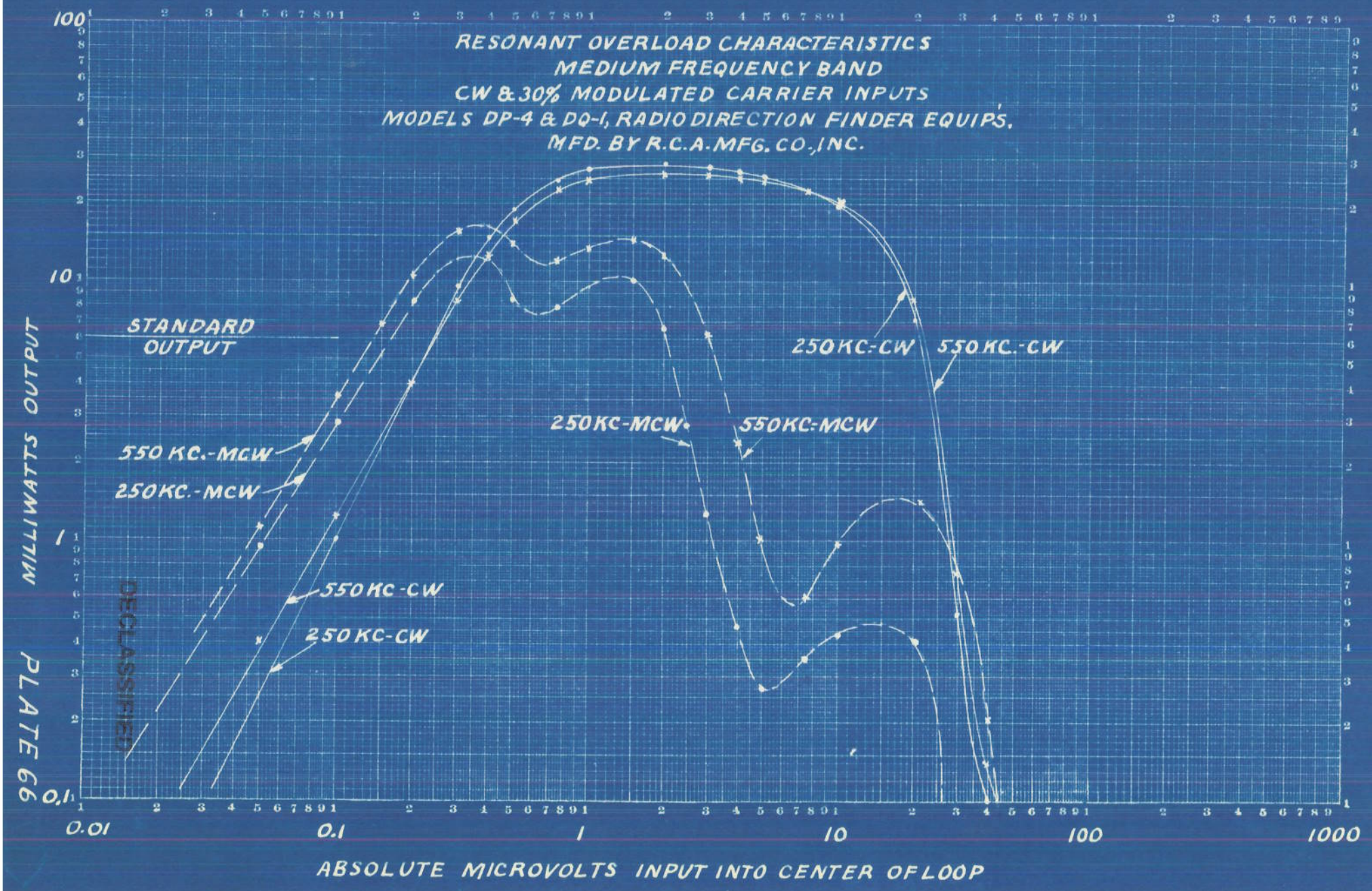
SELECTIVITY - BALANCE ANTENNA EXCITATION
OPTIMUM GAIN 30% MODULATED CARRIER INPUT
HIGH FREQUENCY BAND
MODELS DP-4, DP-5, DP-6, & DQ-1 RADIO DIRECTION FINDER EQUIPS.
MFD. BY THE R.C.A. MFG. CO., INC.



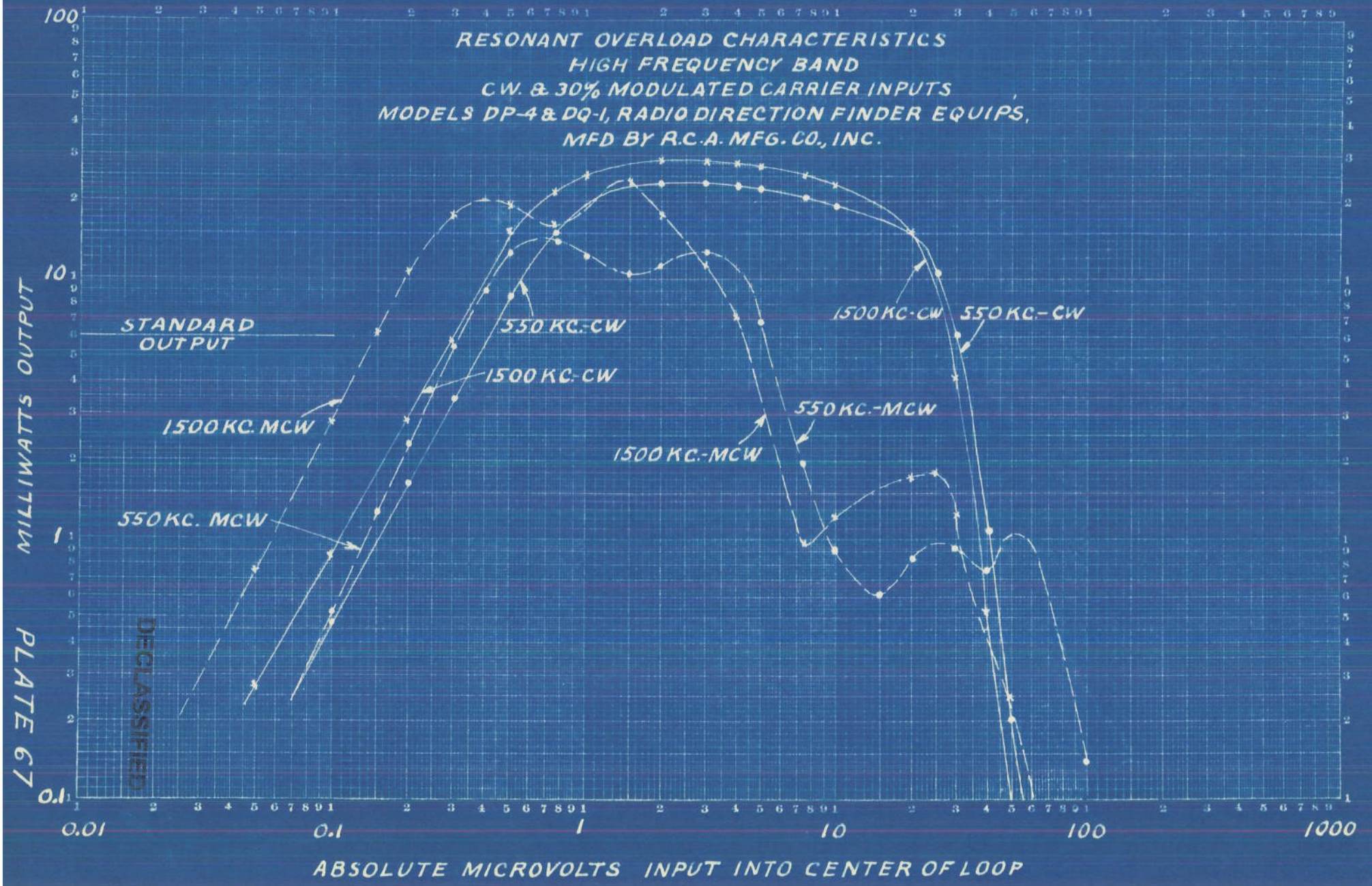
DECLASSIFIED

PLATE 64


RESONANT OVERLOAD CHARACTERISTICS
LOW FREQUENCY BAND
CW & 30% MODULATED CARRIER INPUTS
MODELS DP-4 & DQ-1 RADIO DIRECTION FINDER EQUIPS.
MFD. BY R.C.A. MFG. CO., INC.
STANDARD OUTPUT
250KC.-MCW
100 KC-MCW
100KC.-CW
250 KC.-CW
250KC.-MCW.
100KC.-MCW
250KC.-CW
100KC.-CW
OUTPUT MILLIWATTS
10
1
0.1
0.01
0.1
1
10
100
1000
ABSOLUTE MICROVOLTS INPUT INTO CENTER OF LOOP
DECLASSIFIED
PLATE 65

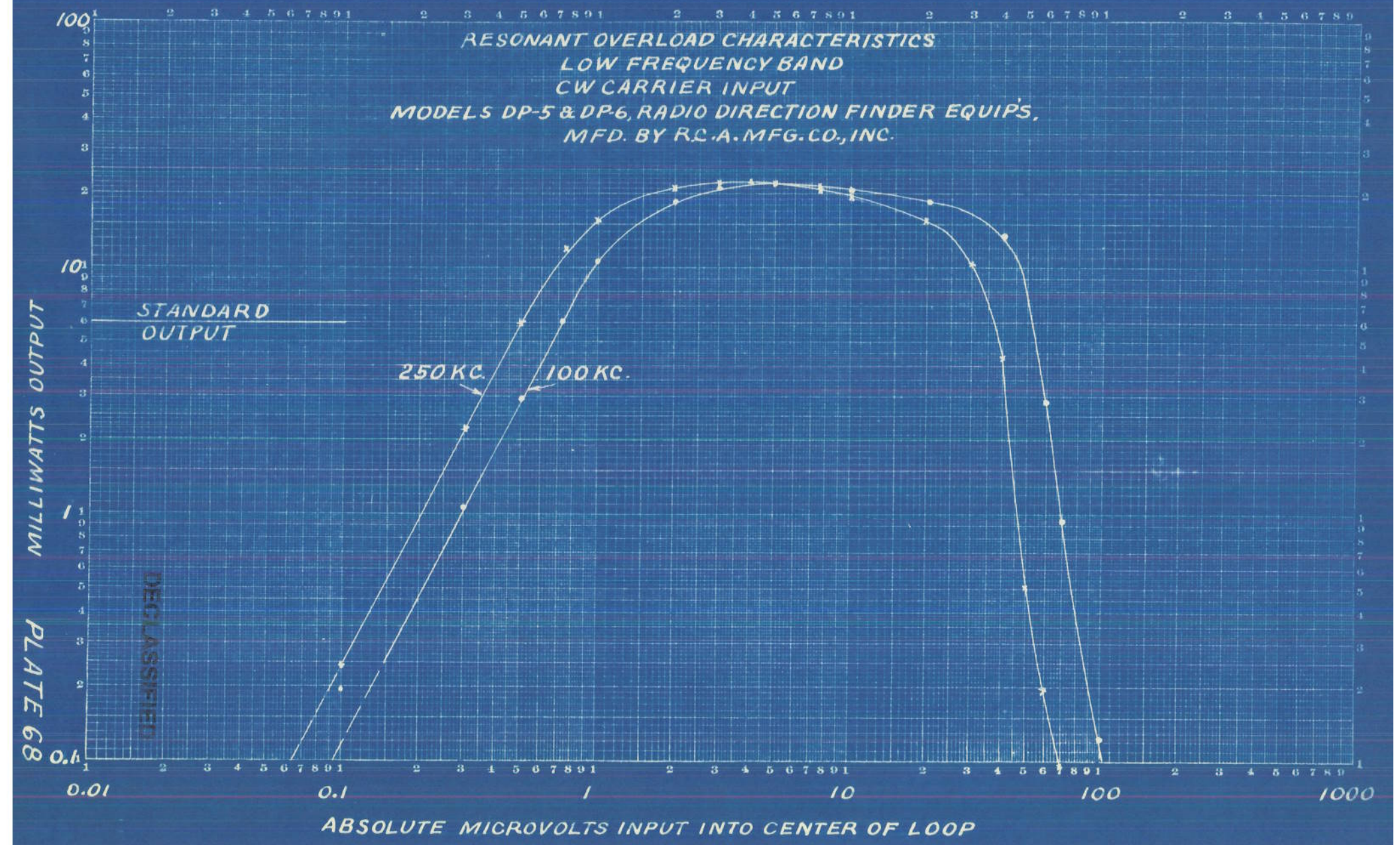


DECLASSIFIED



DECLASSIFIED

NO. 31.156. LOGARITHMIC: 5 X 3 1 15.16 INCH CYCLES.
CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS

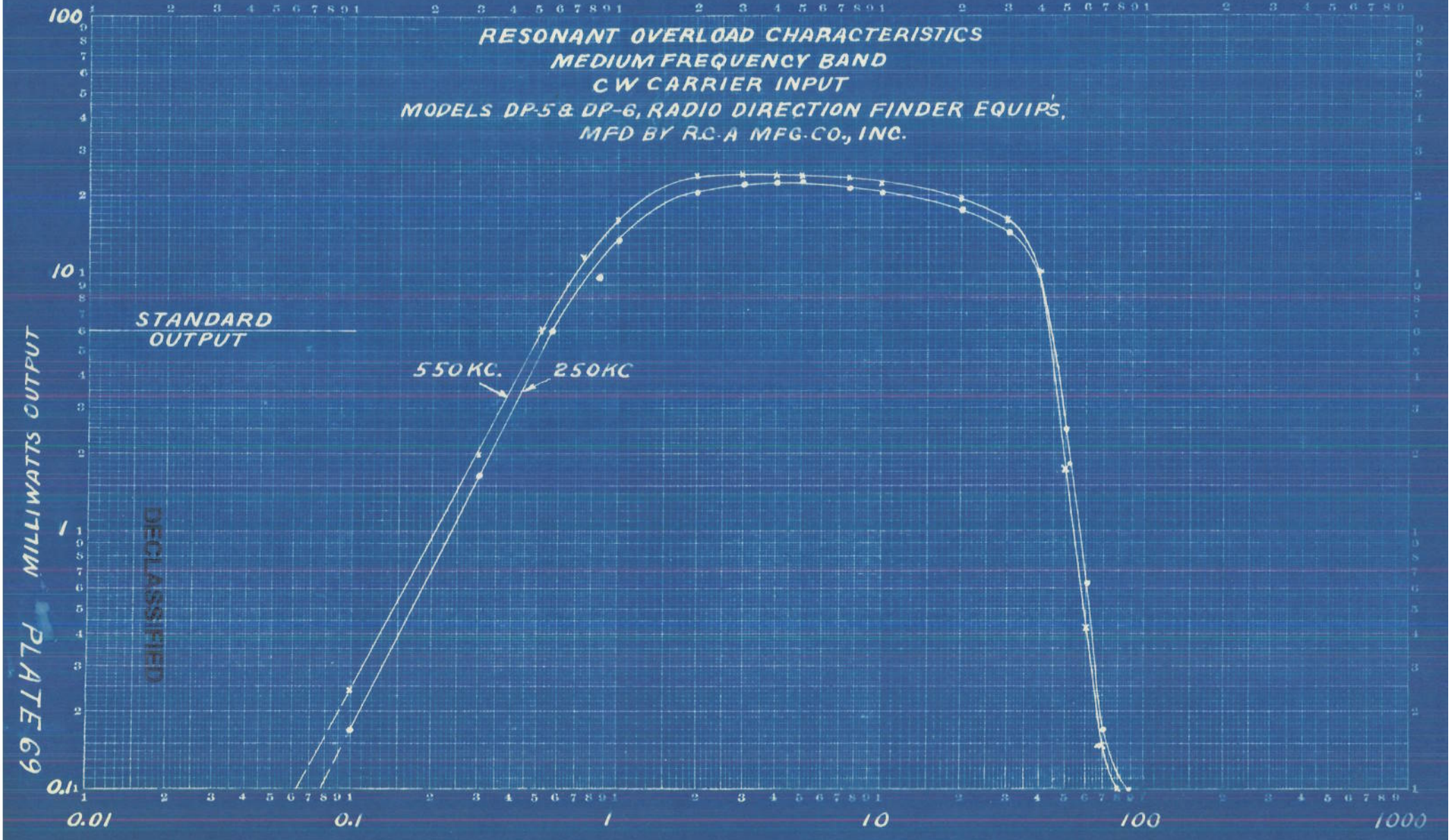


DECLASSIFIED

PLATE 68

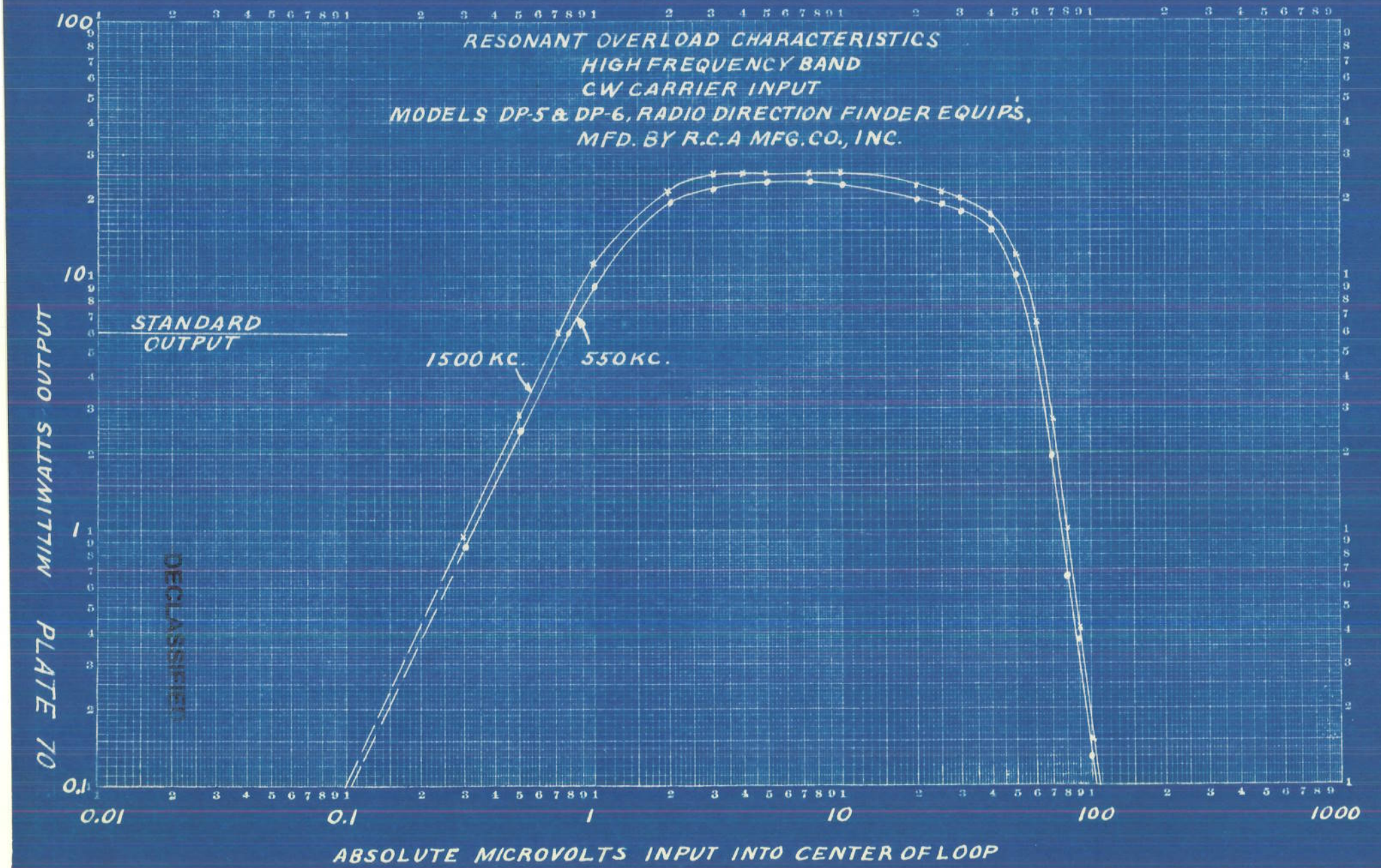
NO. 31,156. LOGARITHMIC: 5 X 3 1-15 16-INCH CYCLES CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS

RESONANT OVERLOAD CHARACTERISTICS
MEDIUM FREQUENCY BAND
CW CARRIER INPUT
MODELS DP-5 & DP-6, RADIO DIRECTION FINDER EQUIPS, MFD BY R.C.A MFG. CO., INC.



DECLASSIFIED

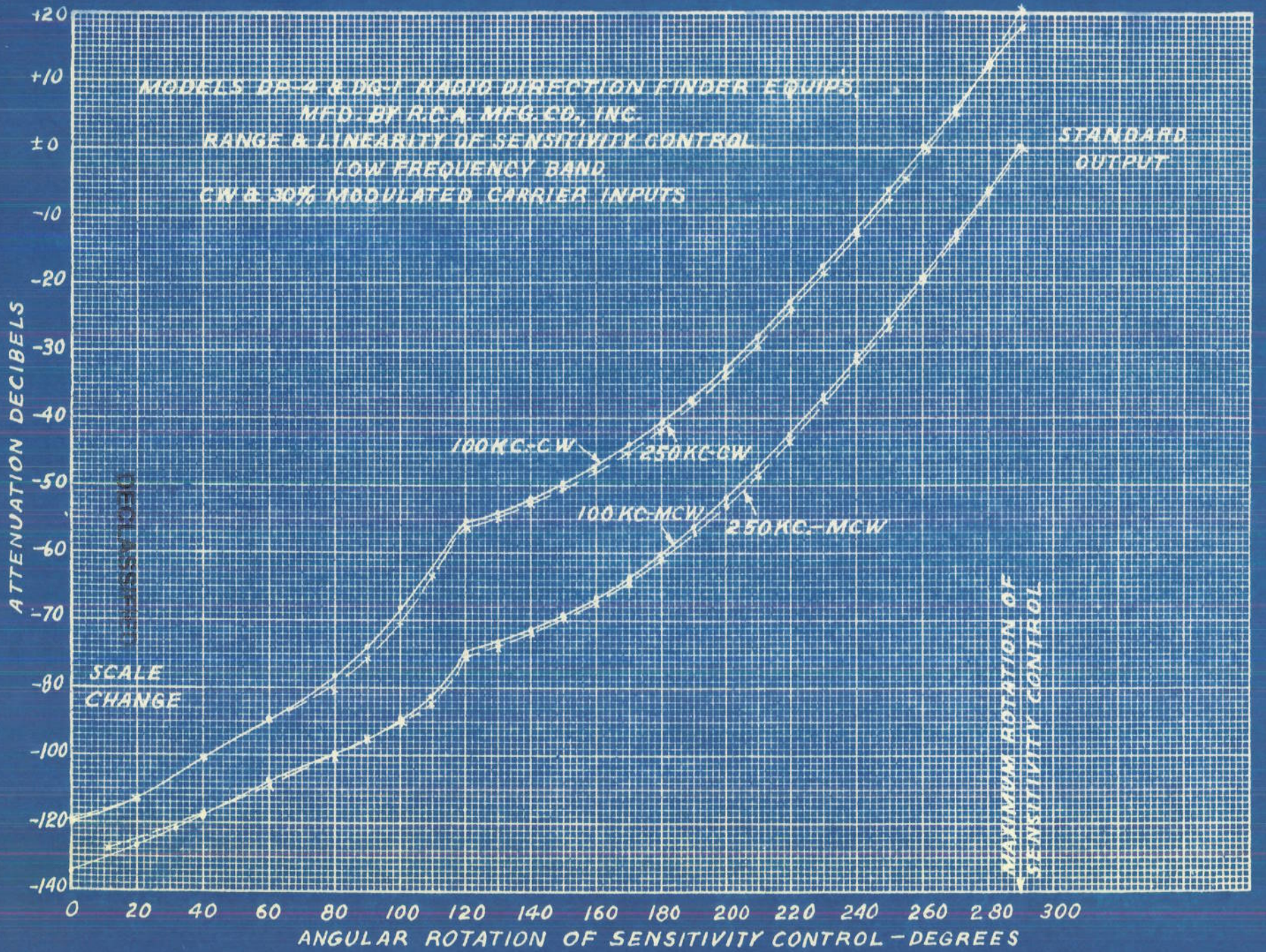
PLATE 69



DECLASSIFIED

IF SHEET IS READ THIS WAY (HORIZONTALLY) THIS MUST BE TOP. IF SHEET IS READ THE OTHER WAY (VERTICALLY) THIS MUST BE LEFT-HAND SIDE.

N. R. L. 31A



DECLASSIFIED

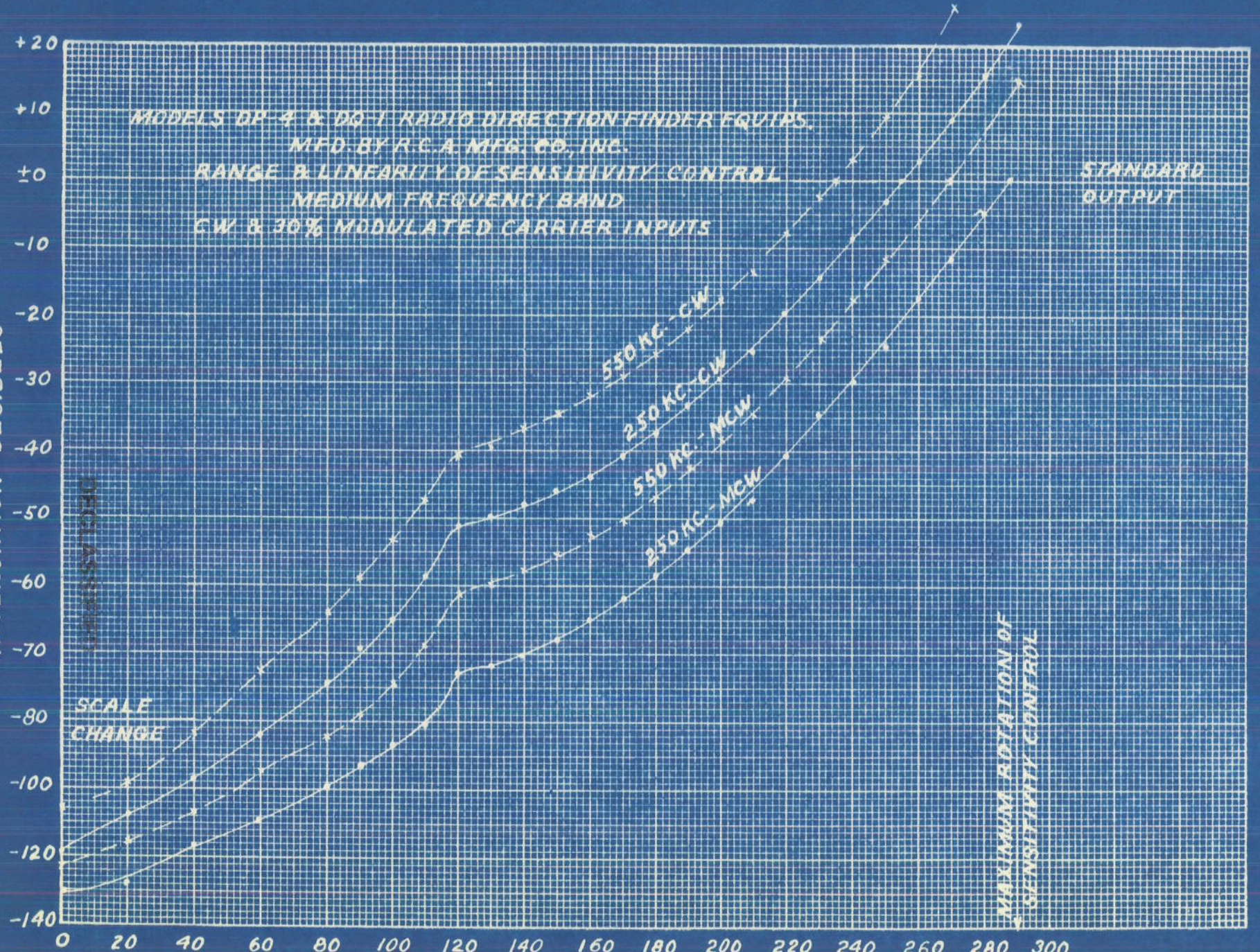
PLATE 71

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

DATE

IF SHEET IS READ THIS WAY (HORIZONTALLY) THIS MUST BE TOP. IF SHEET IS READ THE OTHER WAY (VERTICALLY) THIS MUST BE LEFT-HAND SIDE.

N. R. L. 31A



DECLASSIFIED

PLATE 72

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

DATE

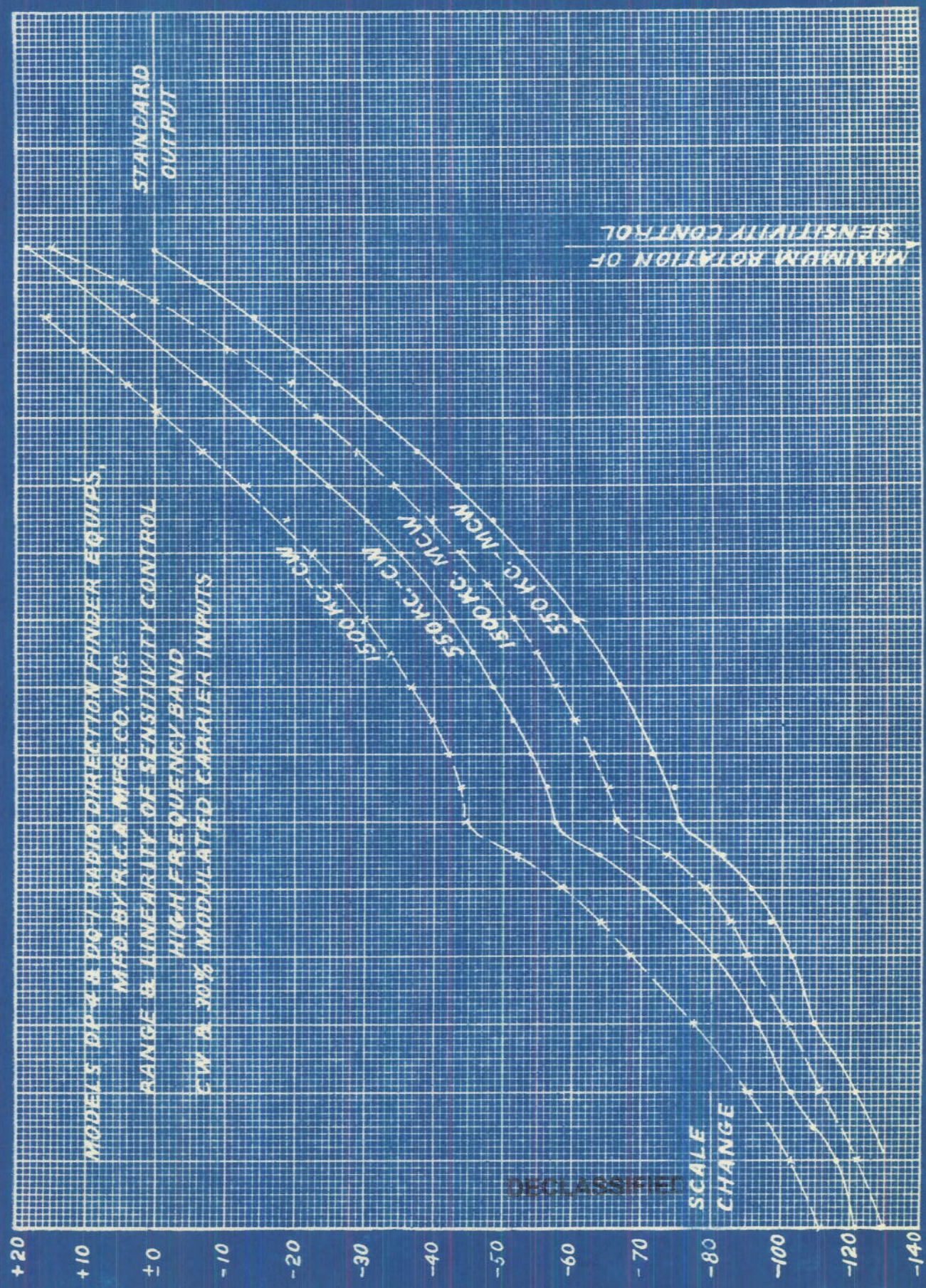


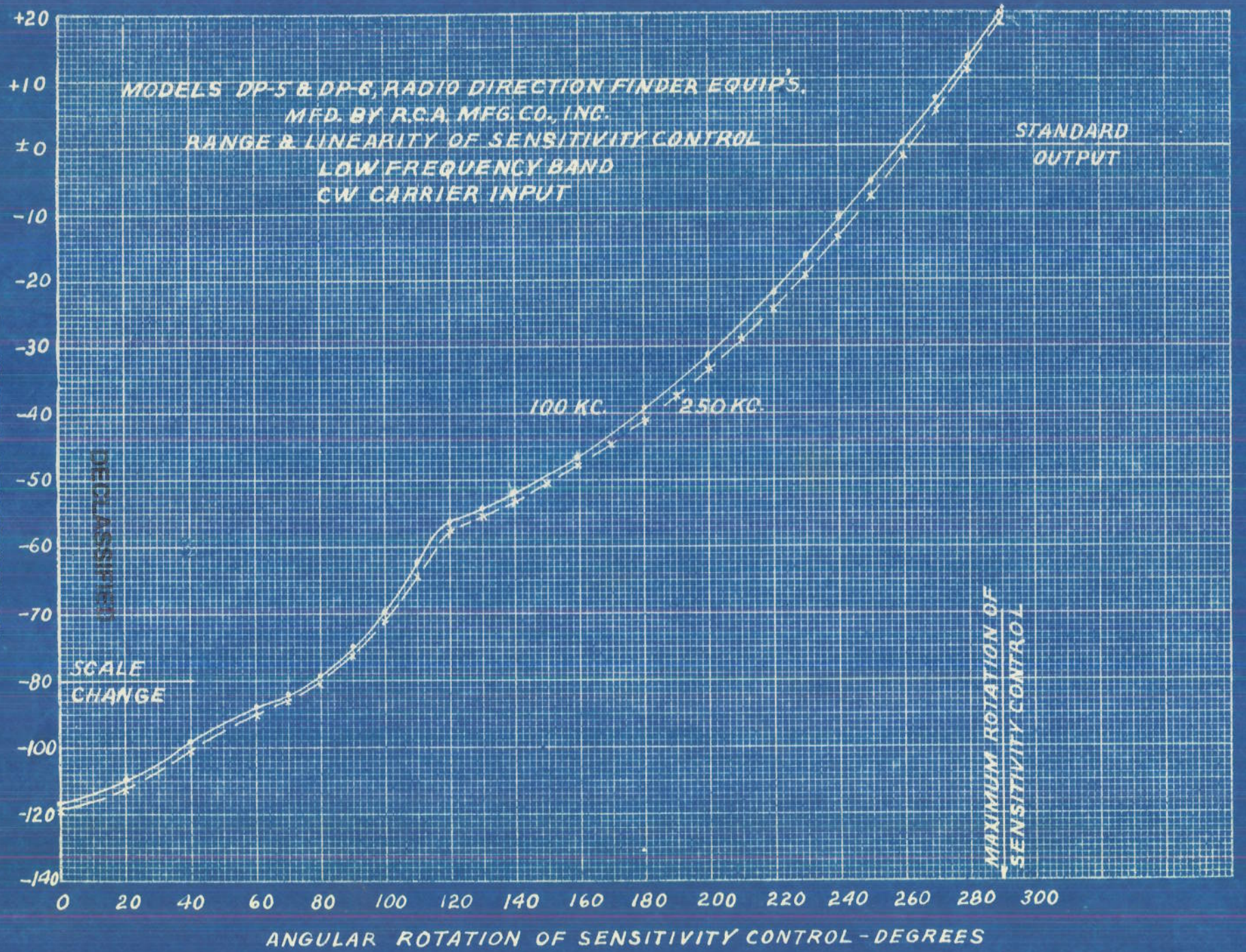
PLATE 73

IF SHEET IS READ THIS WAY (HORIZONTALLY) THIS MUST BE TOP. IF SHEET IS READ THE OTHER WAY (VERTICALLY) THIS MUST BE LEFT-HAND SIDE.

N. R. L. 2811

IF SHEET IS READ THIS WAY (HORIZONTALLY) THIS MUST BE TOP. IF SHEET IS READ THE OTHER WAY (VERTICALLY) THIS MUST BE LEFT-HAND SIDE.

N. R. L. 34A



DECLASSIFIED

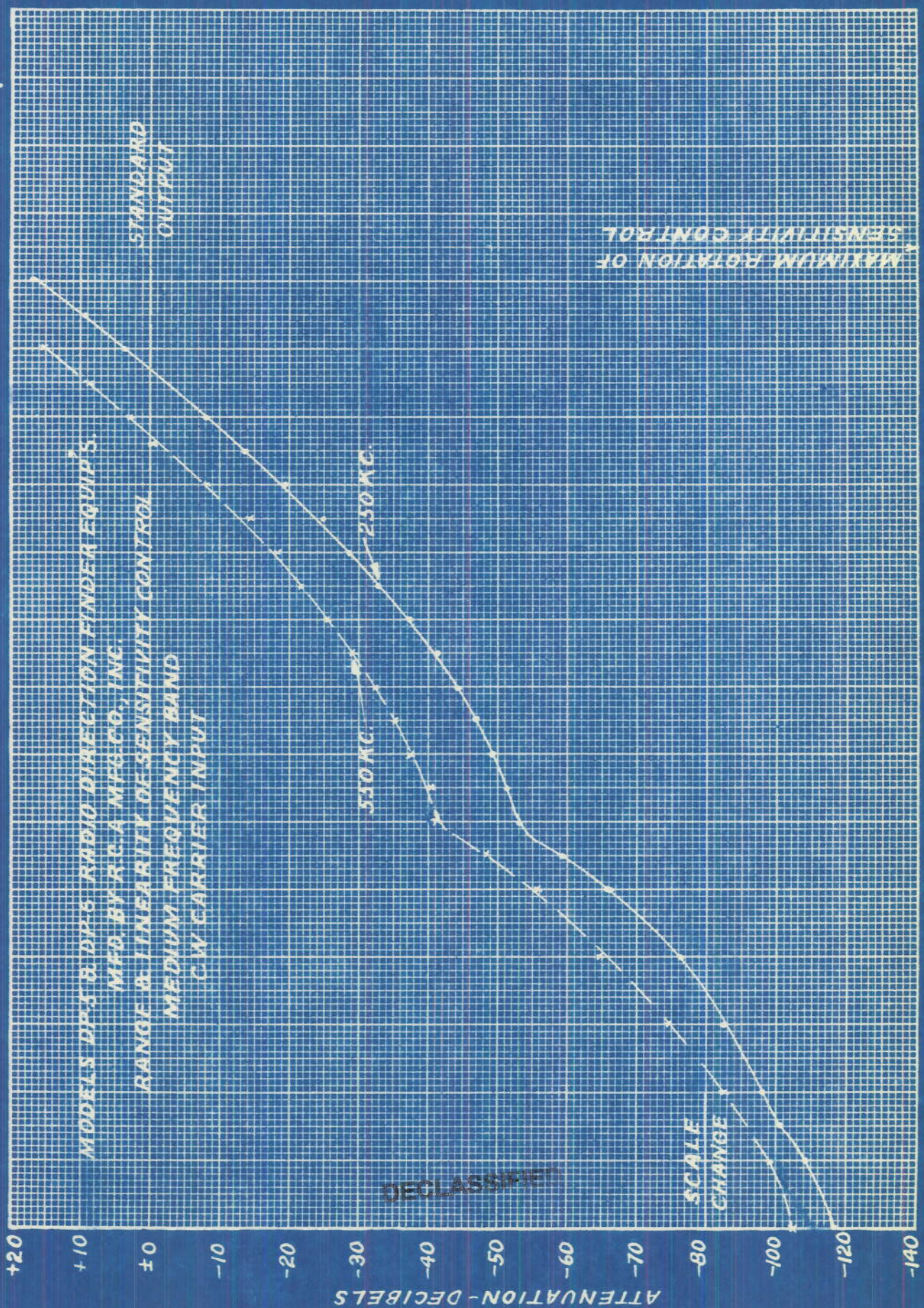
U. S. NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

DATE

PLATE 74

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

DATE



N. R. L. 31A

PLATE 75

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

DATE

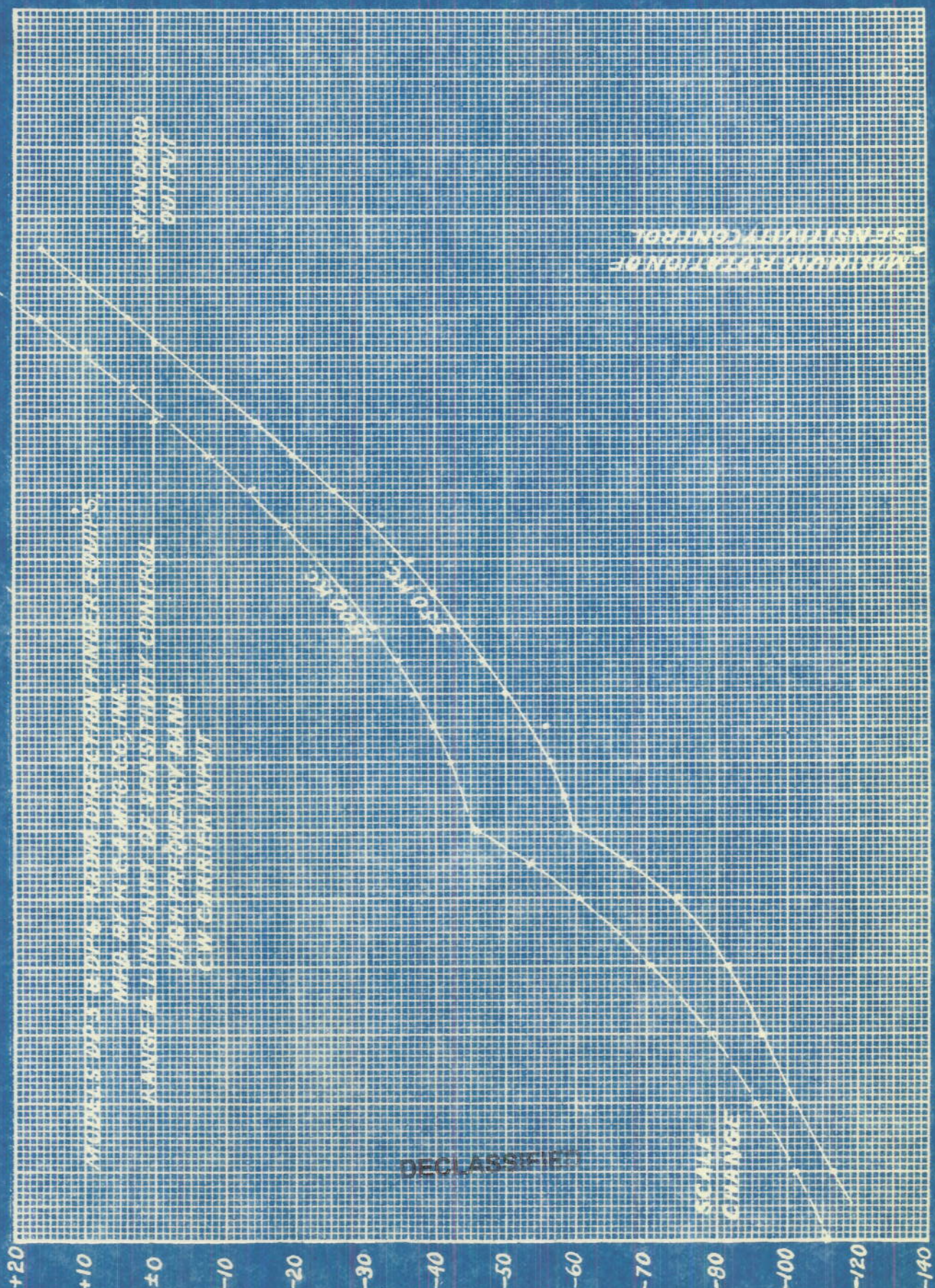


PLATE 76

N. R. L. 34A

IF SHEET IS READ THIS WAY (HORIZONTALLY) THIS MUST BE TOP. IF SHEET IS READ THE OTHER WAY (VERTICALLY) THIS MUST BE LEFT-HAND SIDE.

IF SHEET IS READ THIS WAY (HORIZONTALLY) THIS MUST BE TOP. IF SHEET IS READ THE OTHER WAY (VERTICALLY) THIS MUST BE LEFT-HAND SIDE.

N. R. L. 31A

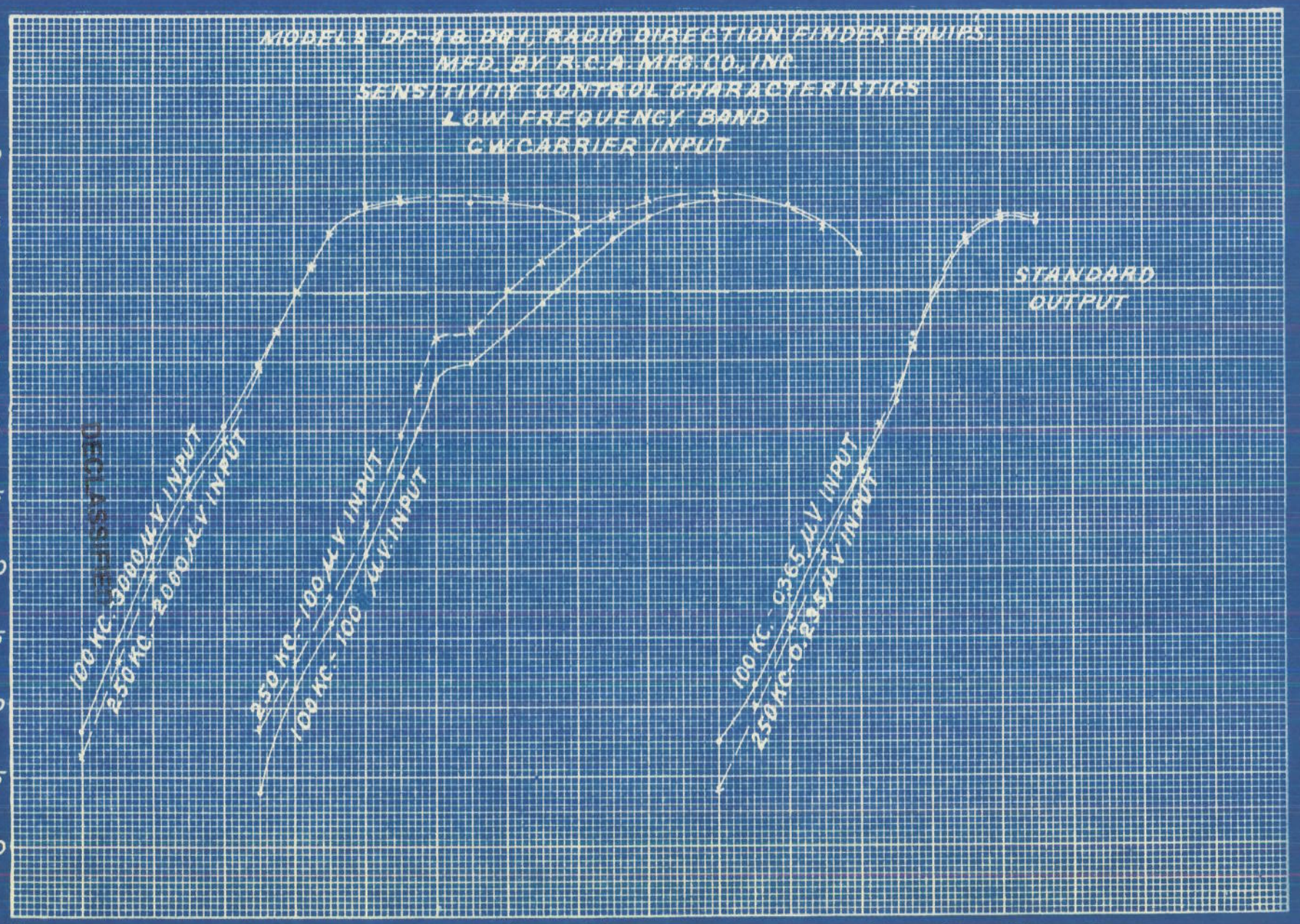


PLATE 77

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

DATE

IF SHEET IS READ THIS WAY (HORIZONTALLY) THIS MUST BE TOP. IF SHEET IS READ THE OTHER WAY (VERTICALLY) THIS MUST BE LEFT-HAND SIDE.

N. R. L. 31A

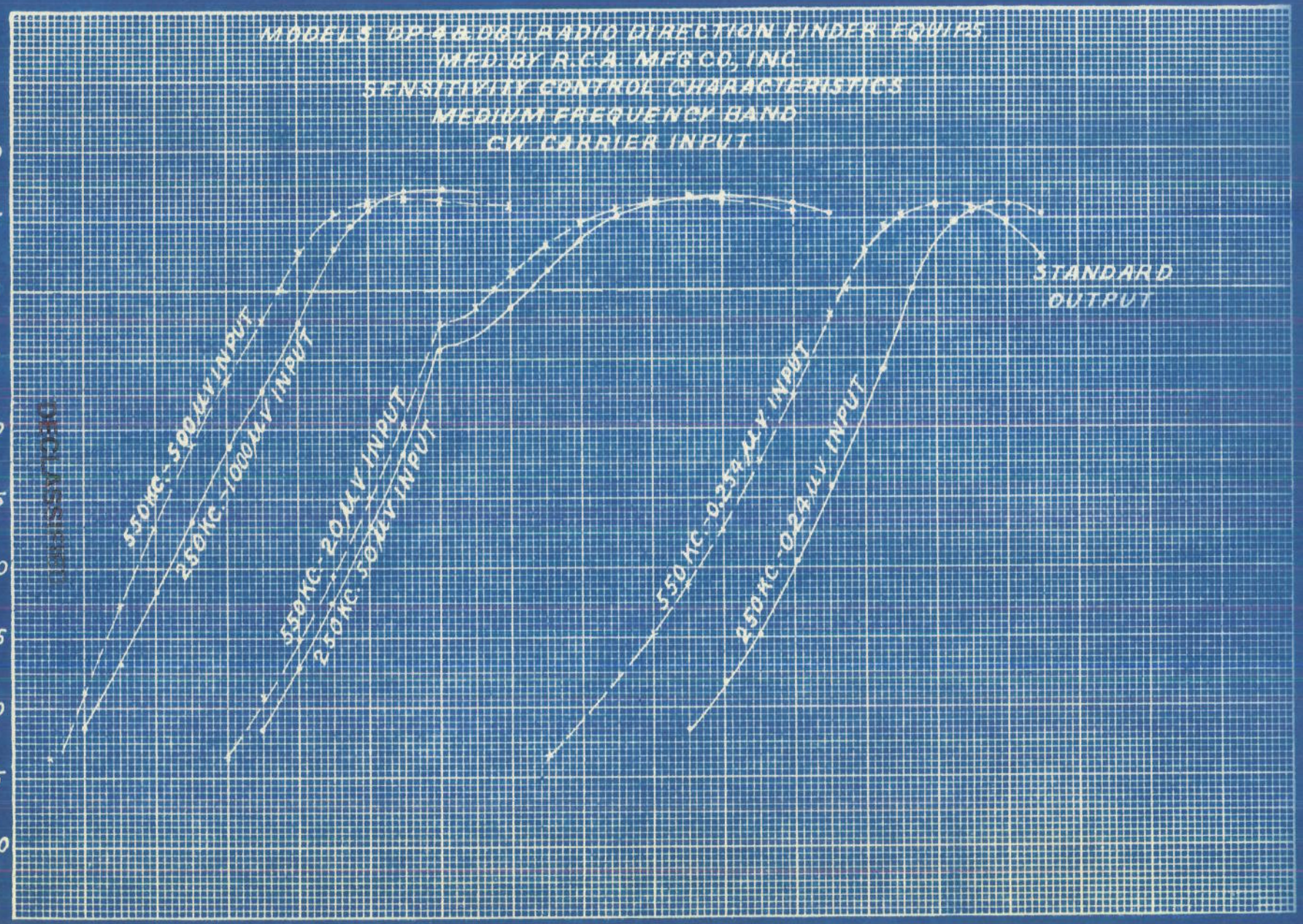


PLATE 78

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

IF SHEET IS READ THIS WAY (HORIZONTALLY) THIS MUST BE TOP. IF SHEET IS READ THE OTHER WAY (VERTICALLY) THIS MUST BE LEFT-HAND SIDE.

N. R. L. 31A

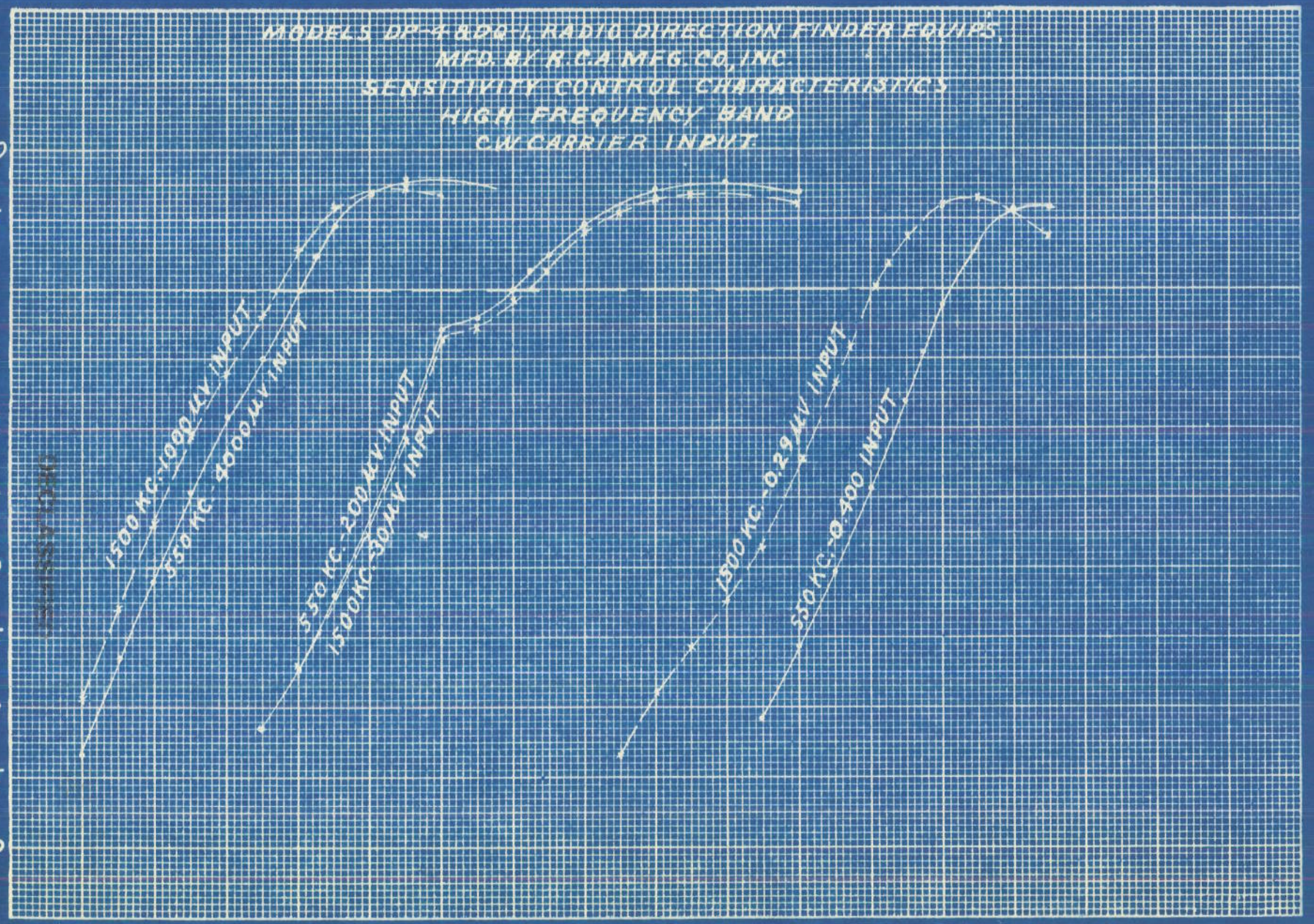
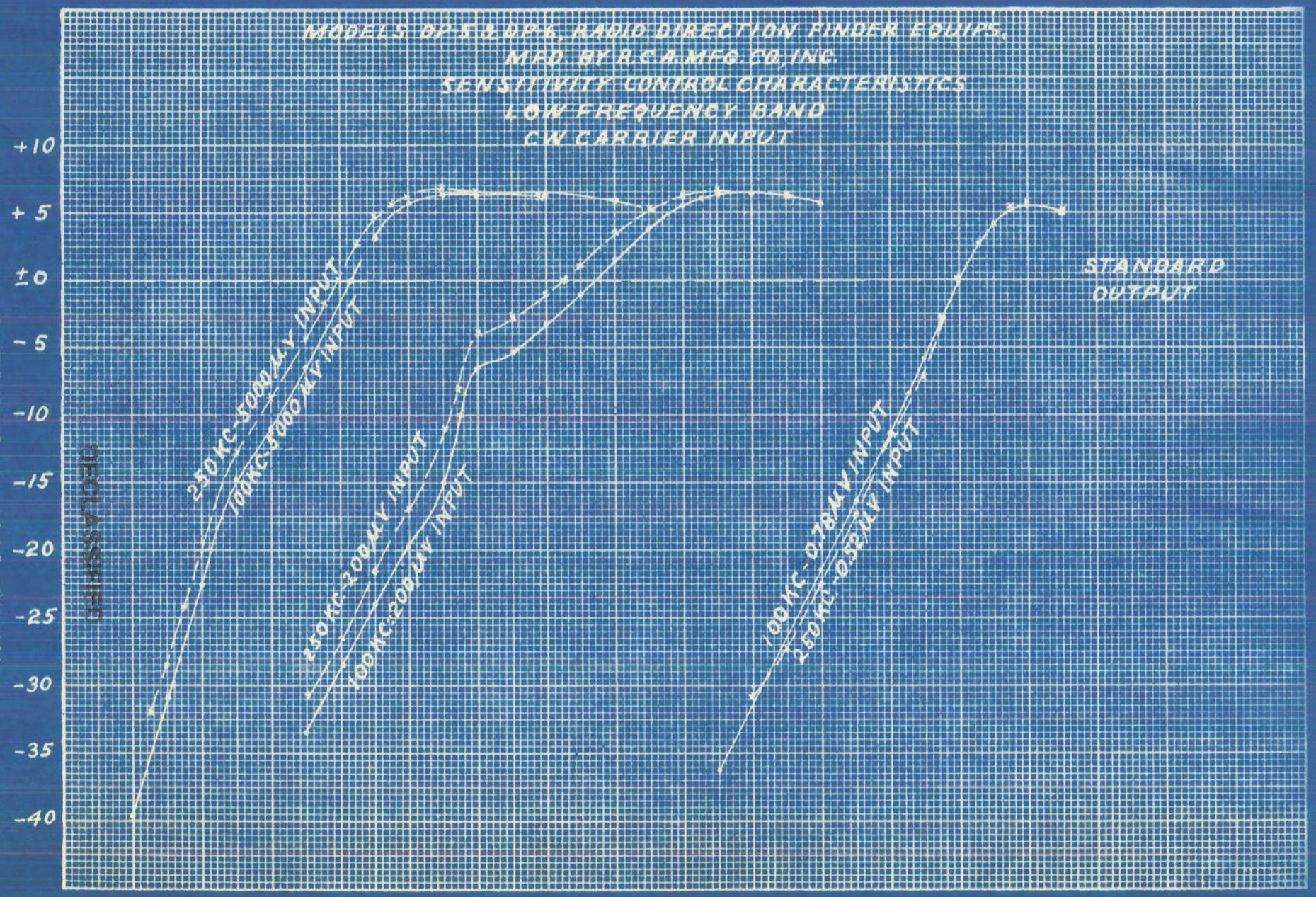


PLATE 79

BELLEVUE, D. C.
DATE

IF SHEET IS READ THIS WAY (HORIZONTALLY) THIS MUST BE TOP. IF SHEET IS READ THE OTHER WAY (VERTICALLY) THIS MUST BE LEFT-HAND SIDE.

N. R. L. 31A



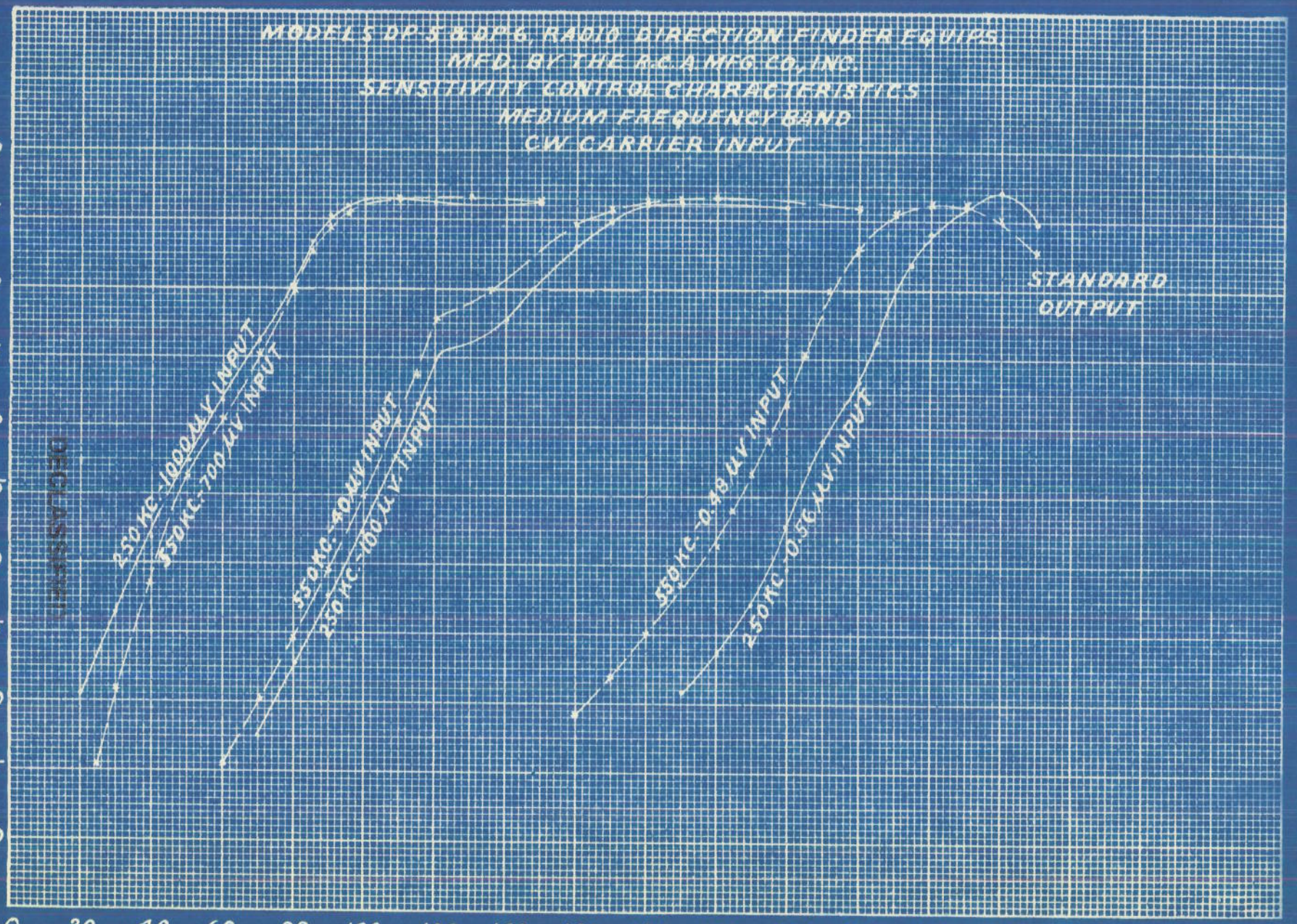
DECLASSIFIED

PLATE 80

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

IF SHEET IS READ THIS WAY (HORIZONTALLY) THIS MUST BE TOP. IF SHEET IS READ THE OTHER WAY (VERTICALLY) THIS MUST BE LEFT-HAND SIDE.

N. R. L. 514



DECLASSIFIED

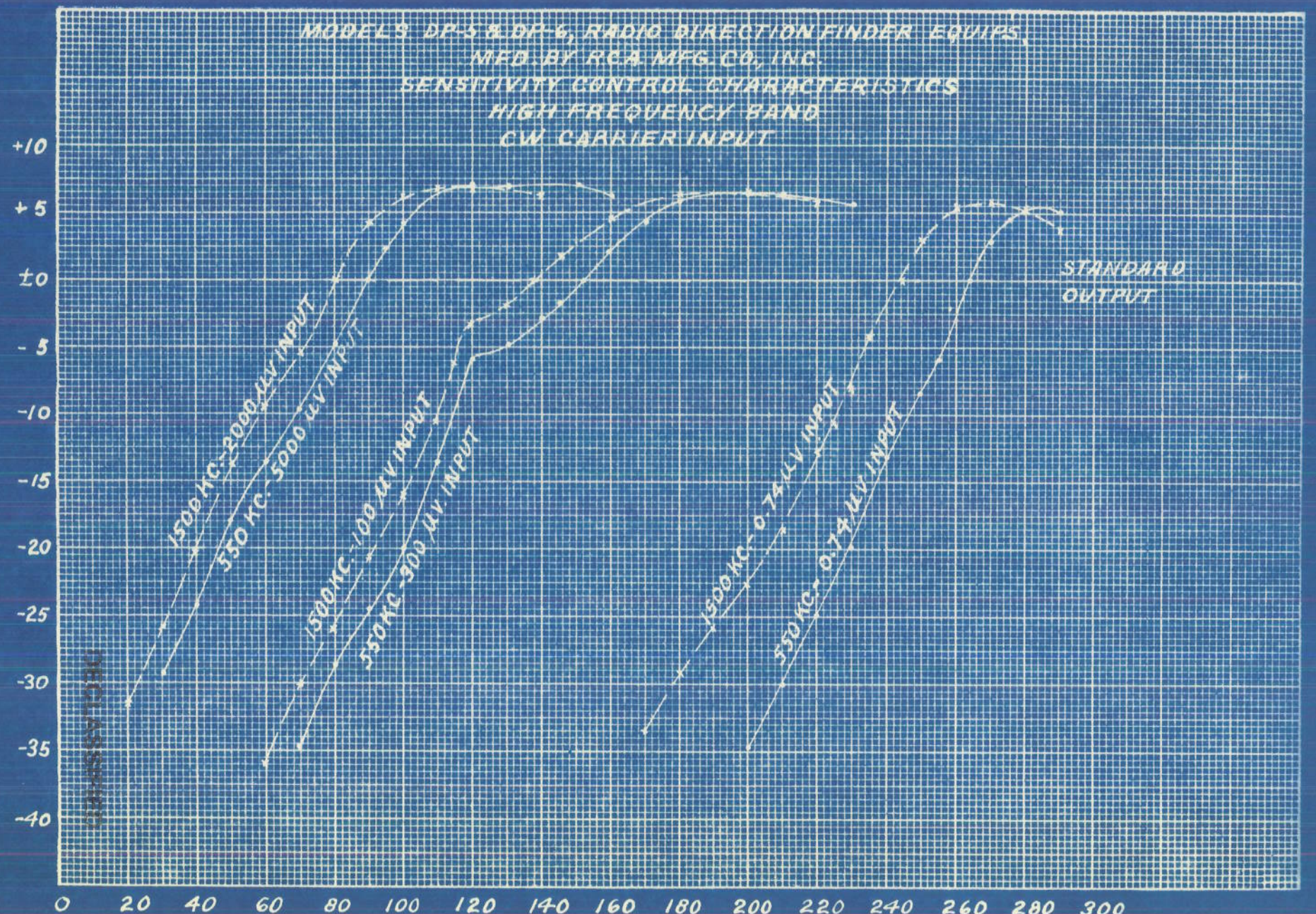
PLATE 81

BELLEVUE, D. C.

DATE

IF SHEET IS READ THIS WAY (HORIZONTALLY) THIS MUST BE TOP. IF SHEET IS READ THE OTHER WAY (VERTICALLY) THIS MUST BE LEFT-HAND SIDE.

N. R. L. 31A

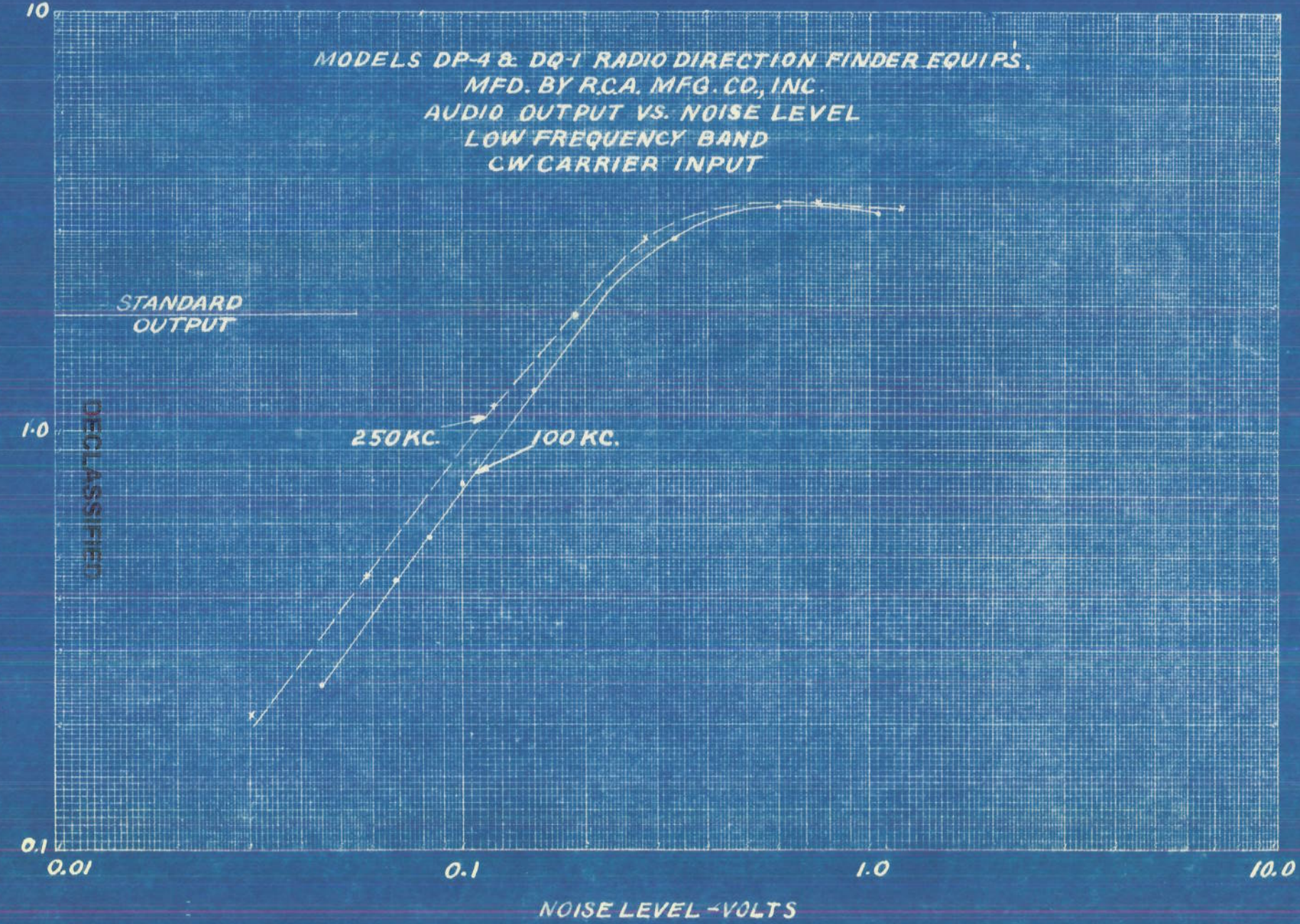


DECLASSIFIED

PLATE 82

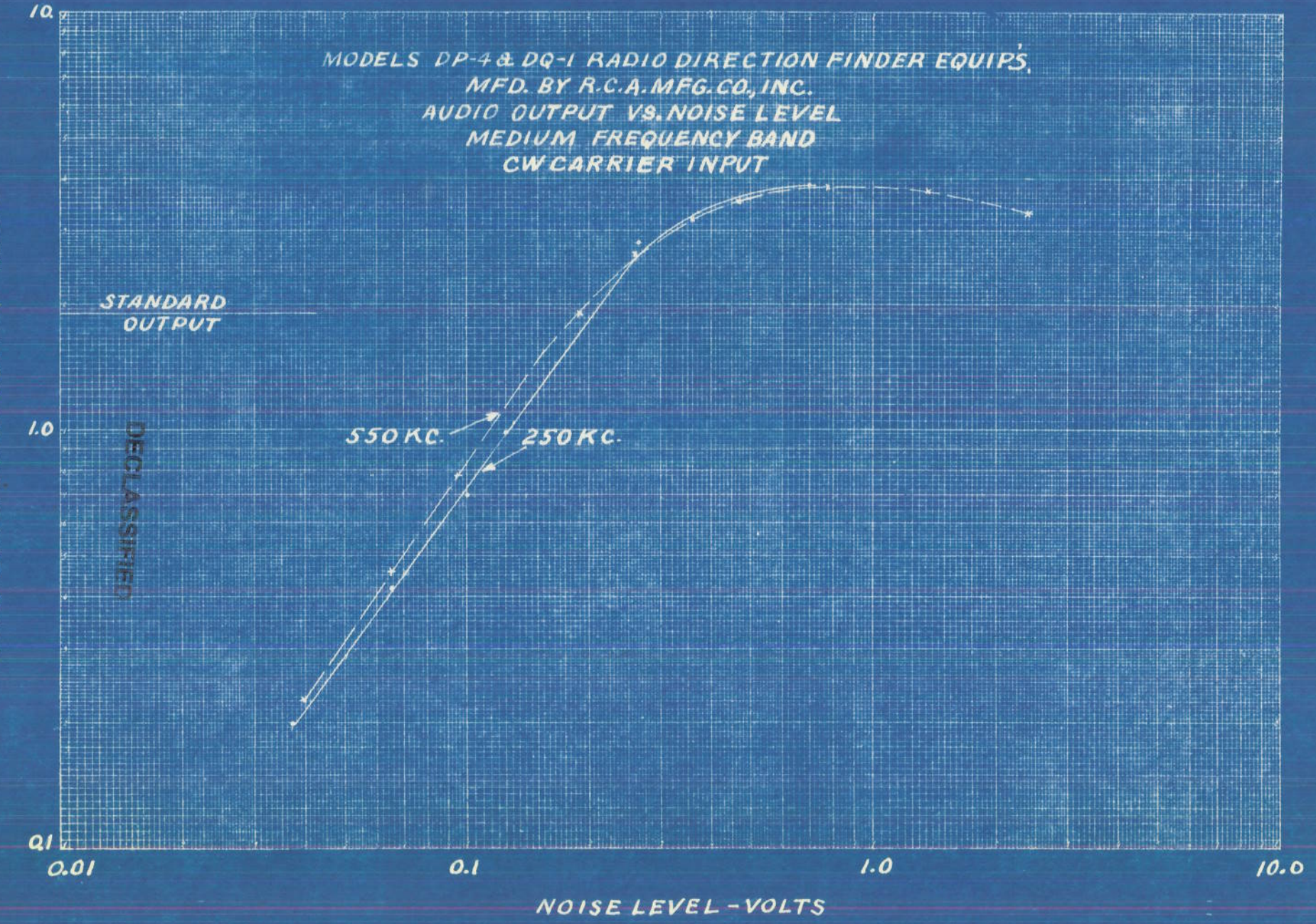
BELLEVUE, D. C.

DATE



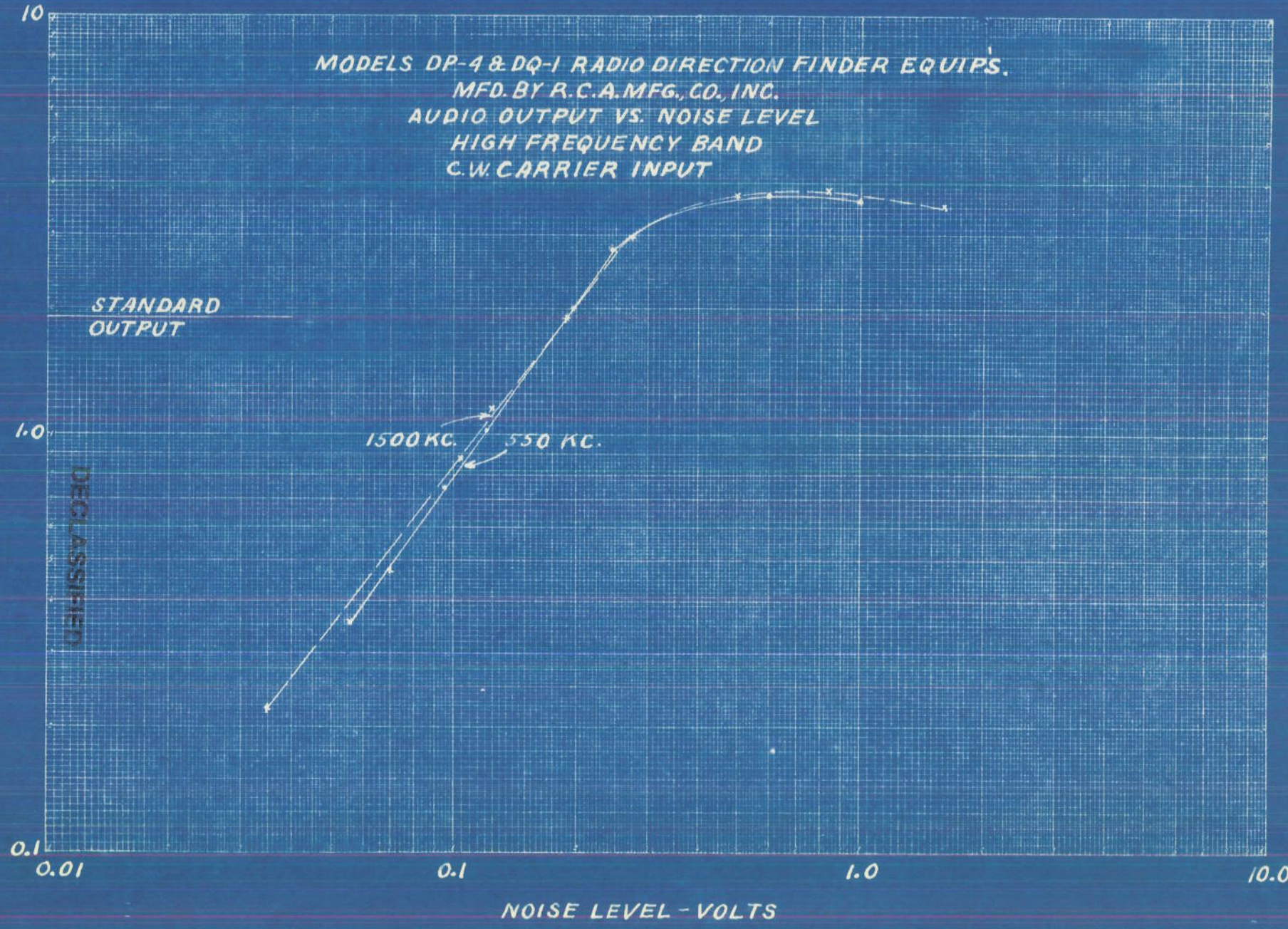
DECLASSIFIED

PLATE 83



DECLASSIFIED

PLATE 84



DECLASSIFIED

PLATE 85

LOGARITHMIC 3 BY 2 3-INCH CYCLES.
CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS

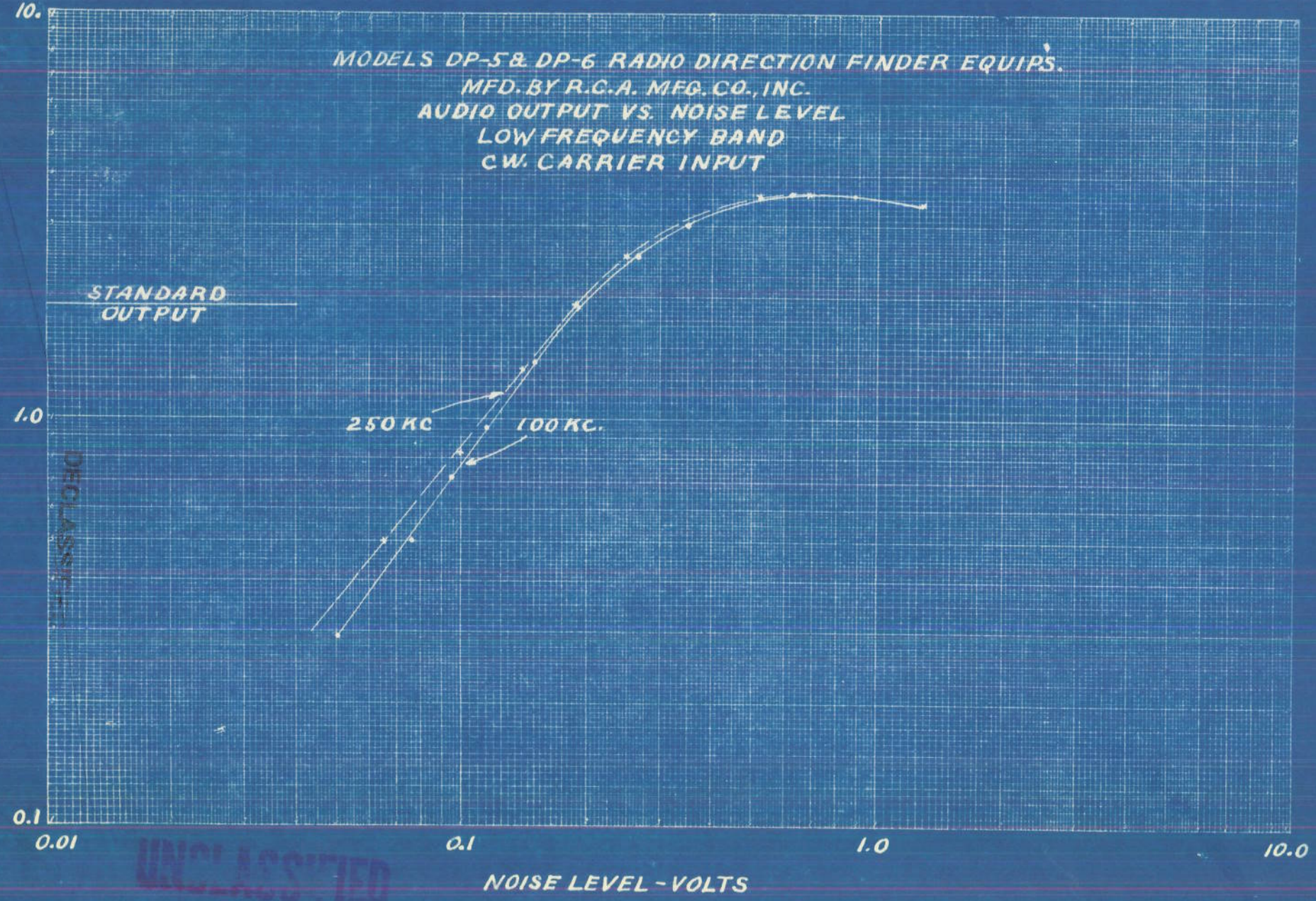
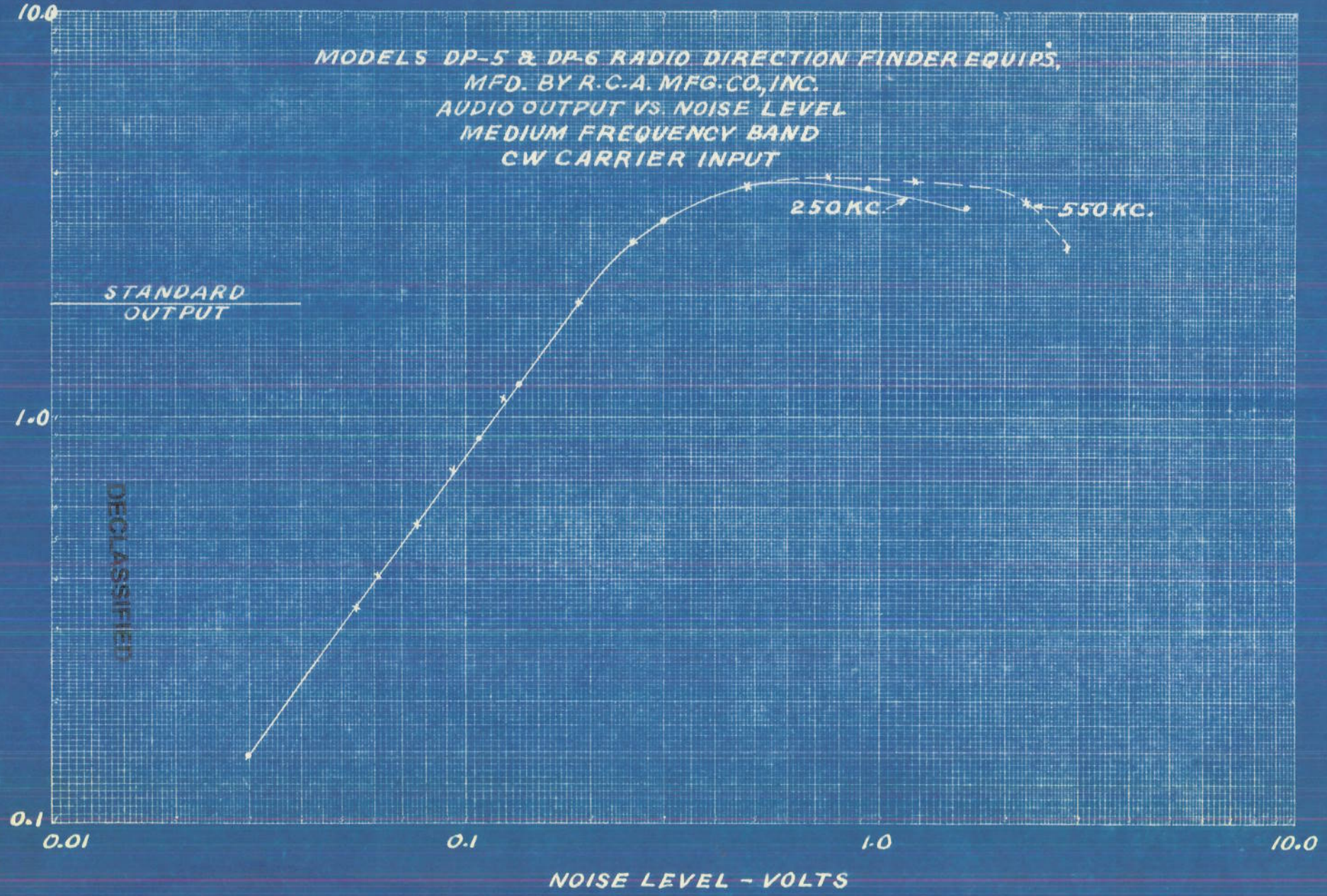


PLATE 86

DECLASSIFIED
UNCLASSIFIED

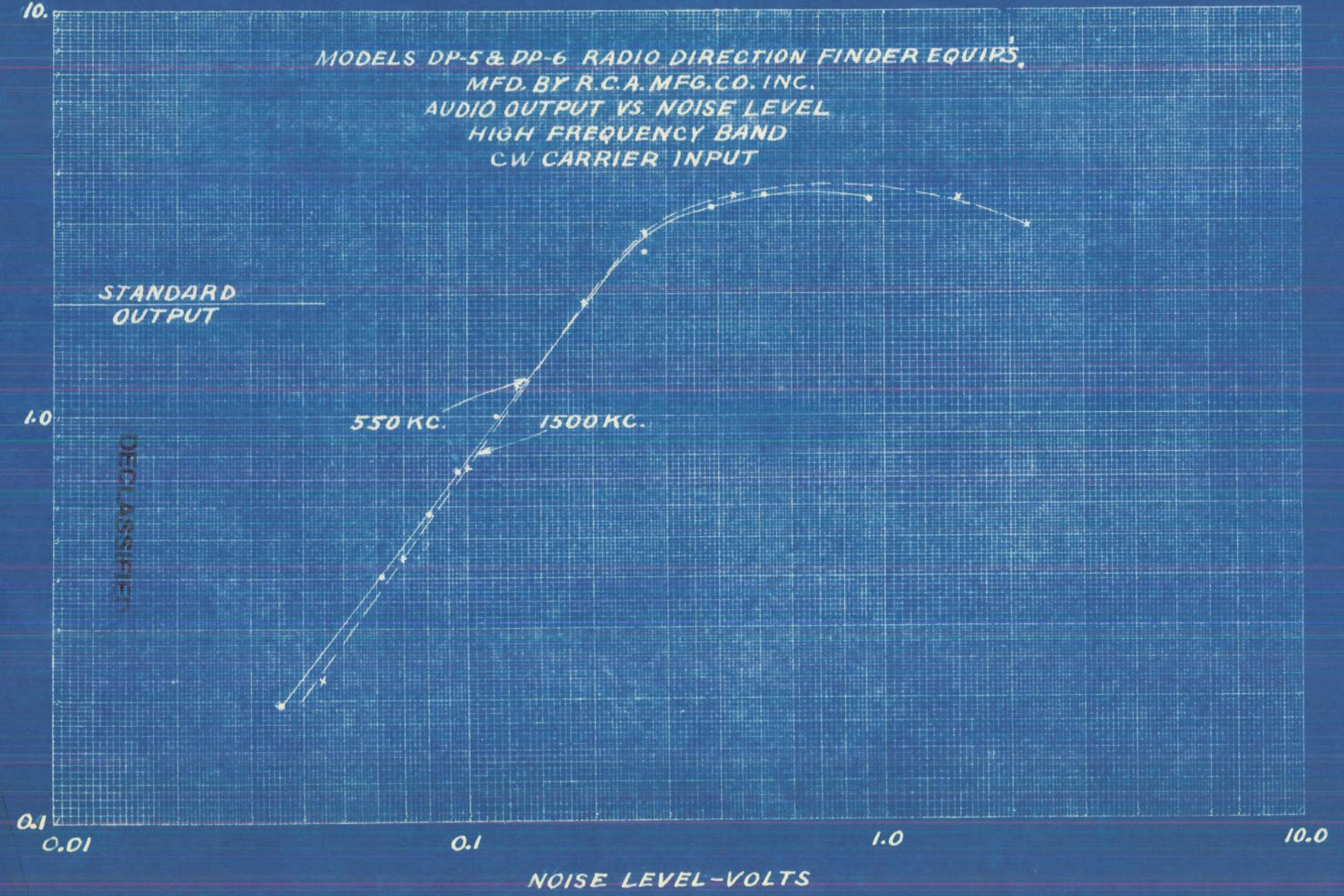
NO. 31,125. LOGARITHMIC: 3 BY 2 3-INCH CYCLES.
CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS.

PLATE 87



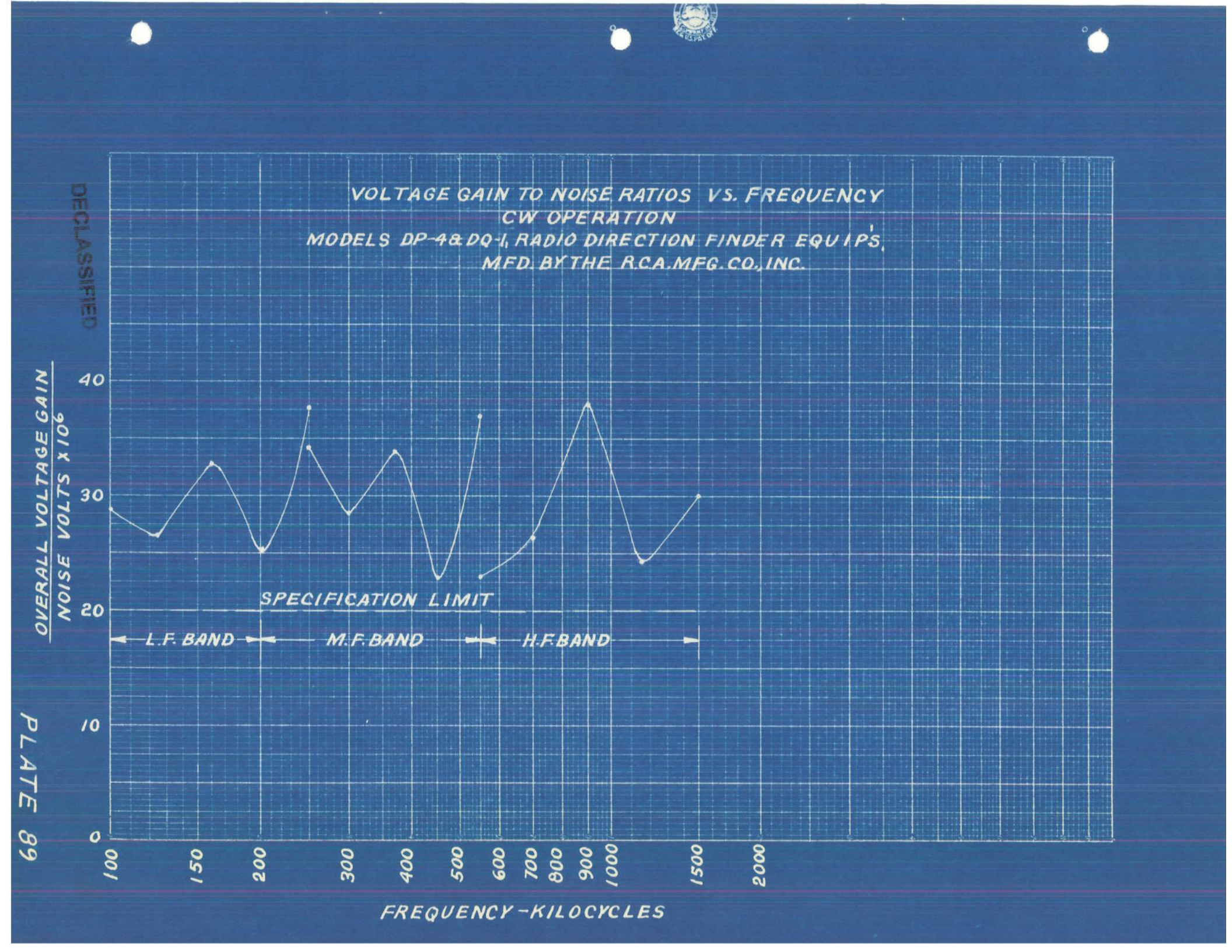
DECLASSIFIED

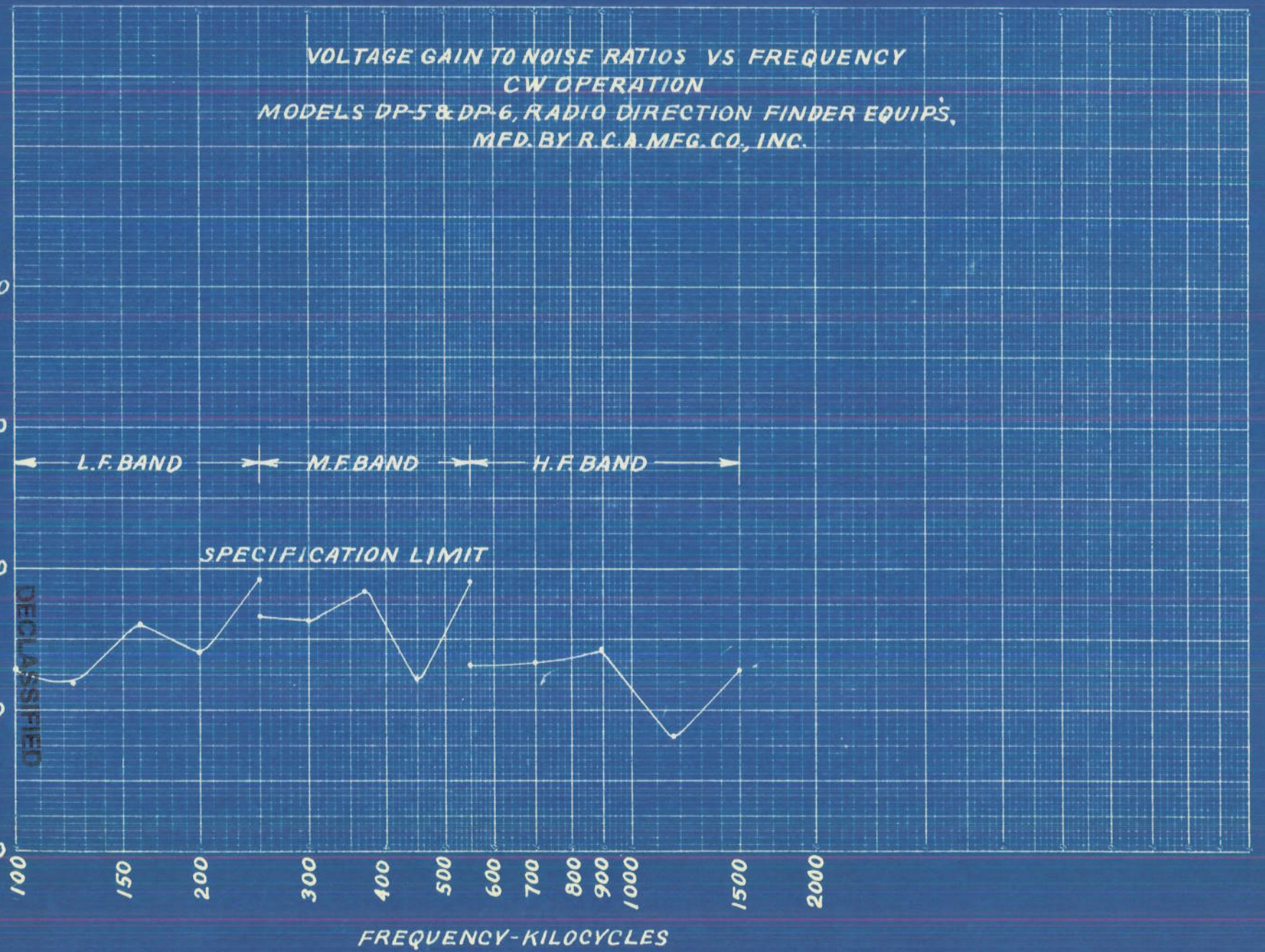
NO. 31,125. LOGARITHMIC: 3 BY 2 3-INCH CYCLES.
CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS.



DECLASSIFIED

PLATE 88

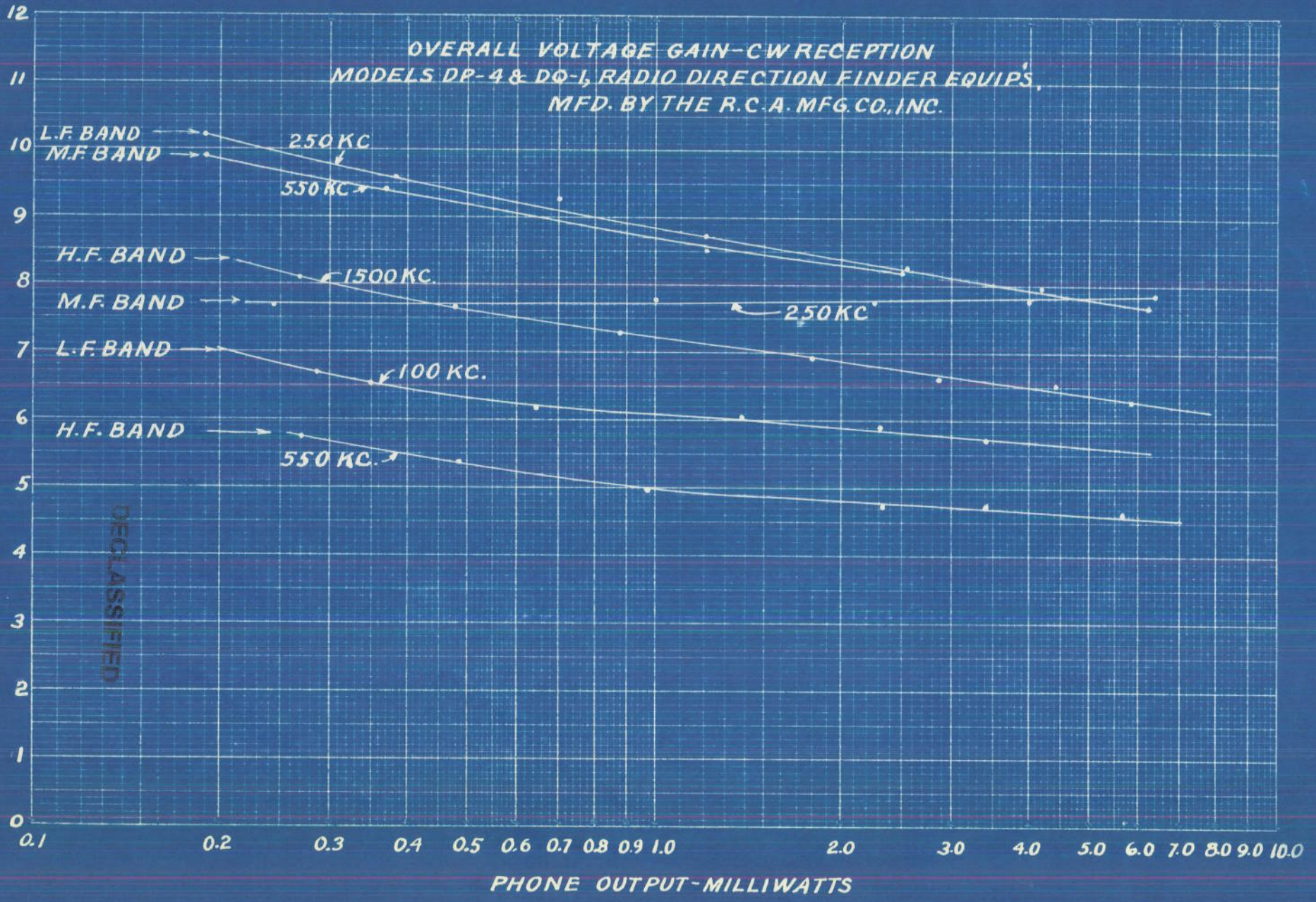

VOLTAGE GAIN TO NOISE RATIOS VS. FREQUENCY
CW OPERATION
MODELS DP-4 & DQ-1, RADIO DIRECTION FINDER EQUIPS.
MFD. BY THE R.C.A. MFG. CO., INC.
DECLASSIFIED
OVERALL VOLTAGE GAIN / NOISE VOLTS X 10⁶
40
30
20
10
0
SPECIFICATION LIMIT
L.F. BAND
M.F. BAND
H.F. BAND
100
150
200
300
400
500
600
700
800
900
1000
1500
2000
FREQUENCY - KILOCYCLES
PLATE 89



DECLASSIFIED

PLATE 90

NO. 31,193. 20 DIVISIONS PER INCH (120 DIVISIONS) BY TWO 4 1/2-INCH CYCLES RATIO RULING. CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS.



DECLASSIFIED

PLATE 91

NO. 31,193. 20 DIVISIONS PER INCH (120 DIVISIONS) BY TWO 4 1/2-INCH CYCLES RATIO RULING. CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS.

OVERALL VOLTAGE GAIN — C W RECEPTION
MODELS DP-5 & DP-6, RADIO DIRECTION FINDER EQUIPS. MFD. BY R.C.A MFG. CO., INC.

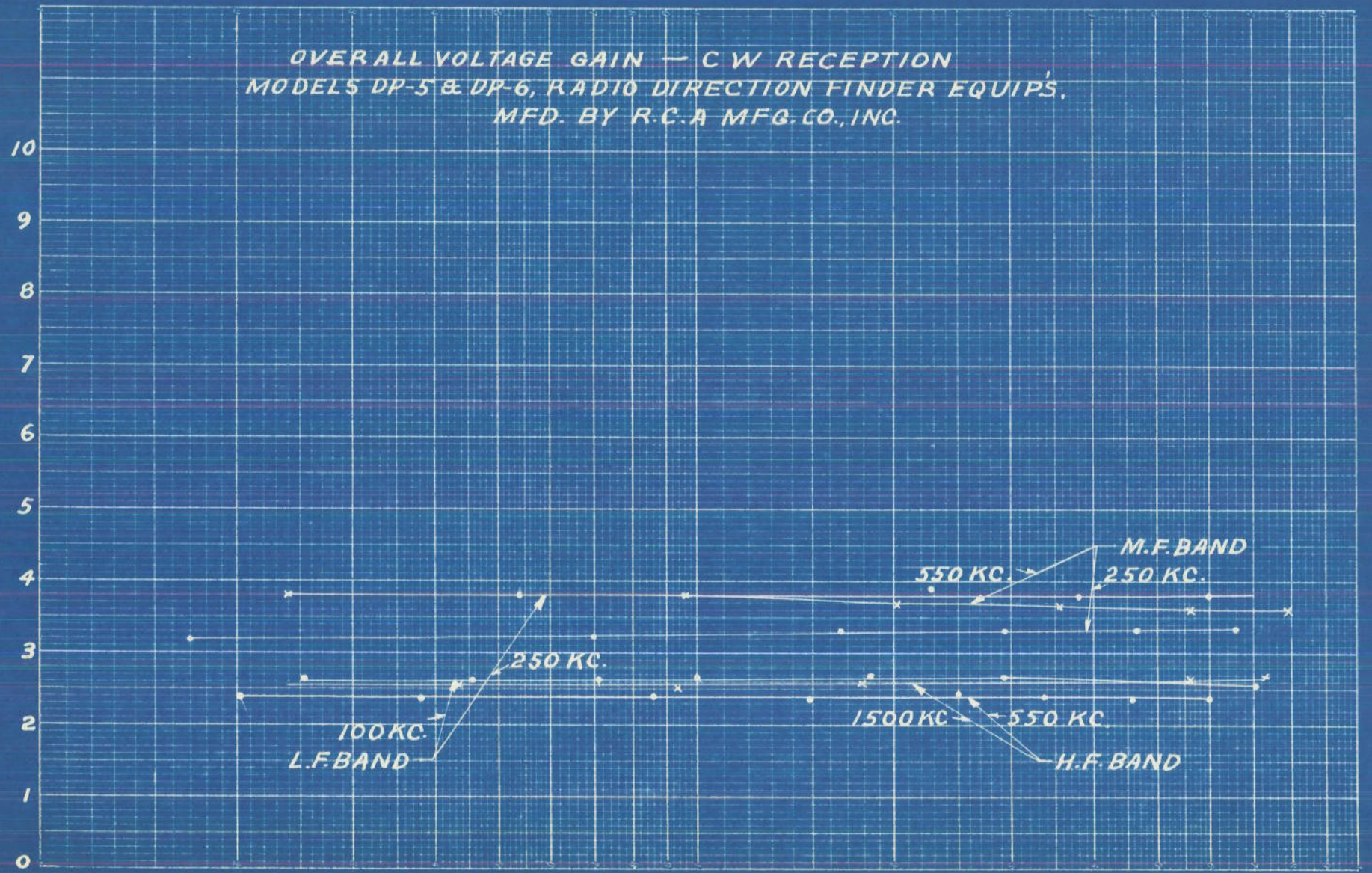


PLATE 92

NO. 3115. 20 DIVISIONS PER INCH (120 DIVISIONS) BY 3 3-INCH CYCLES RATIO RULING. CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS

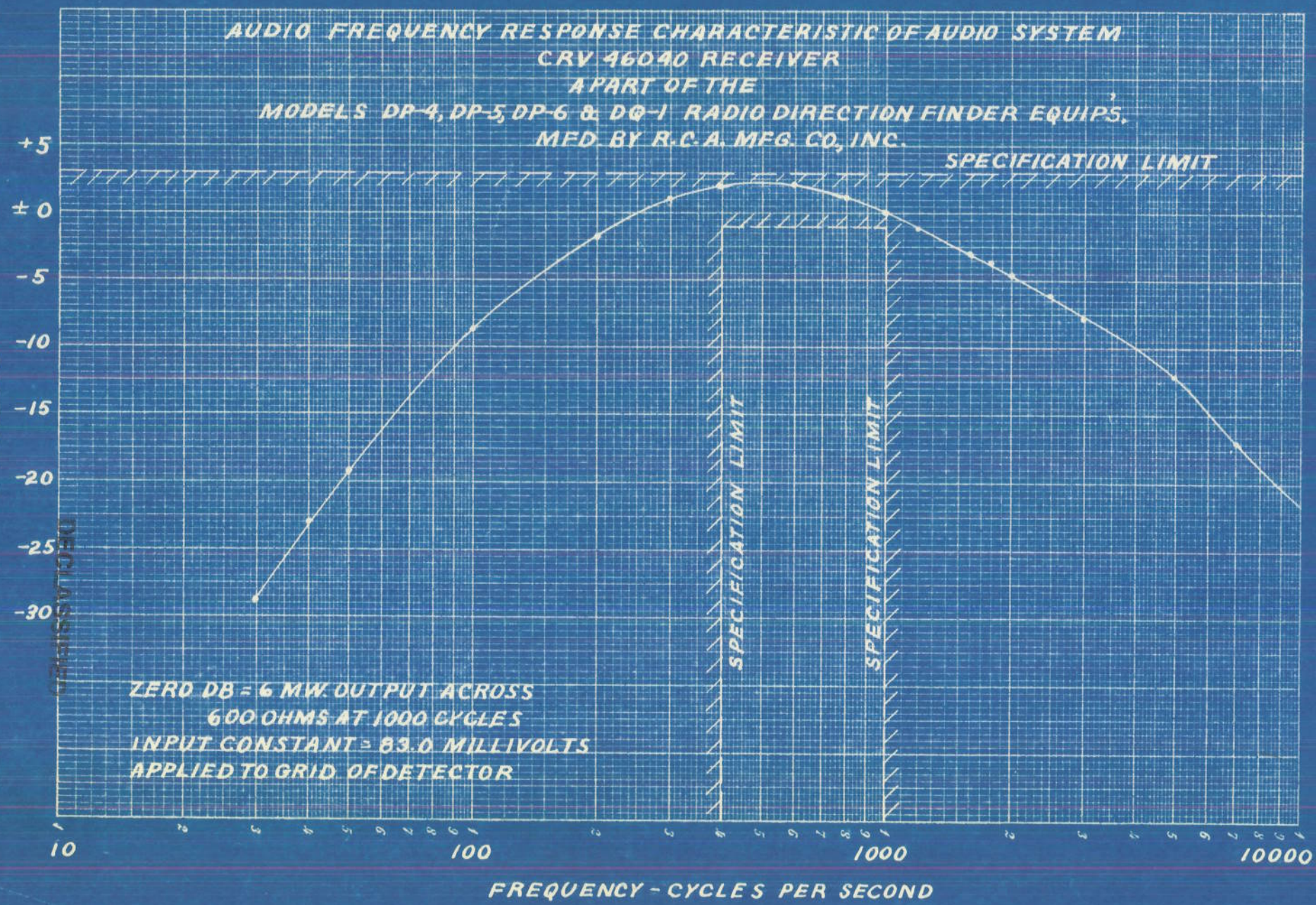
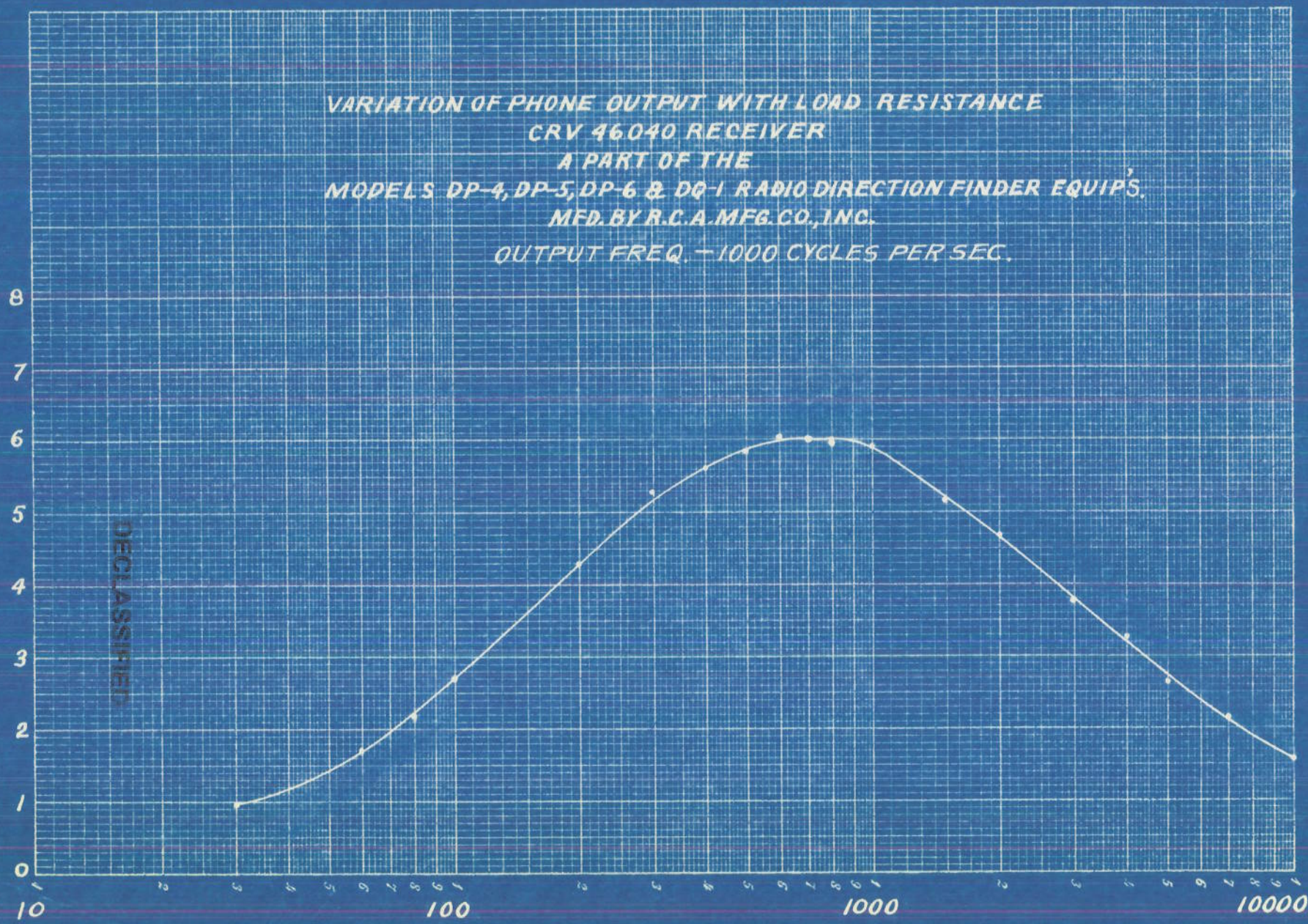


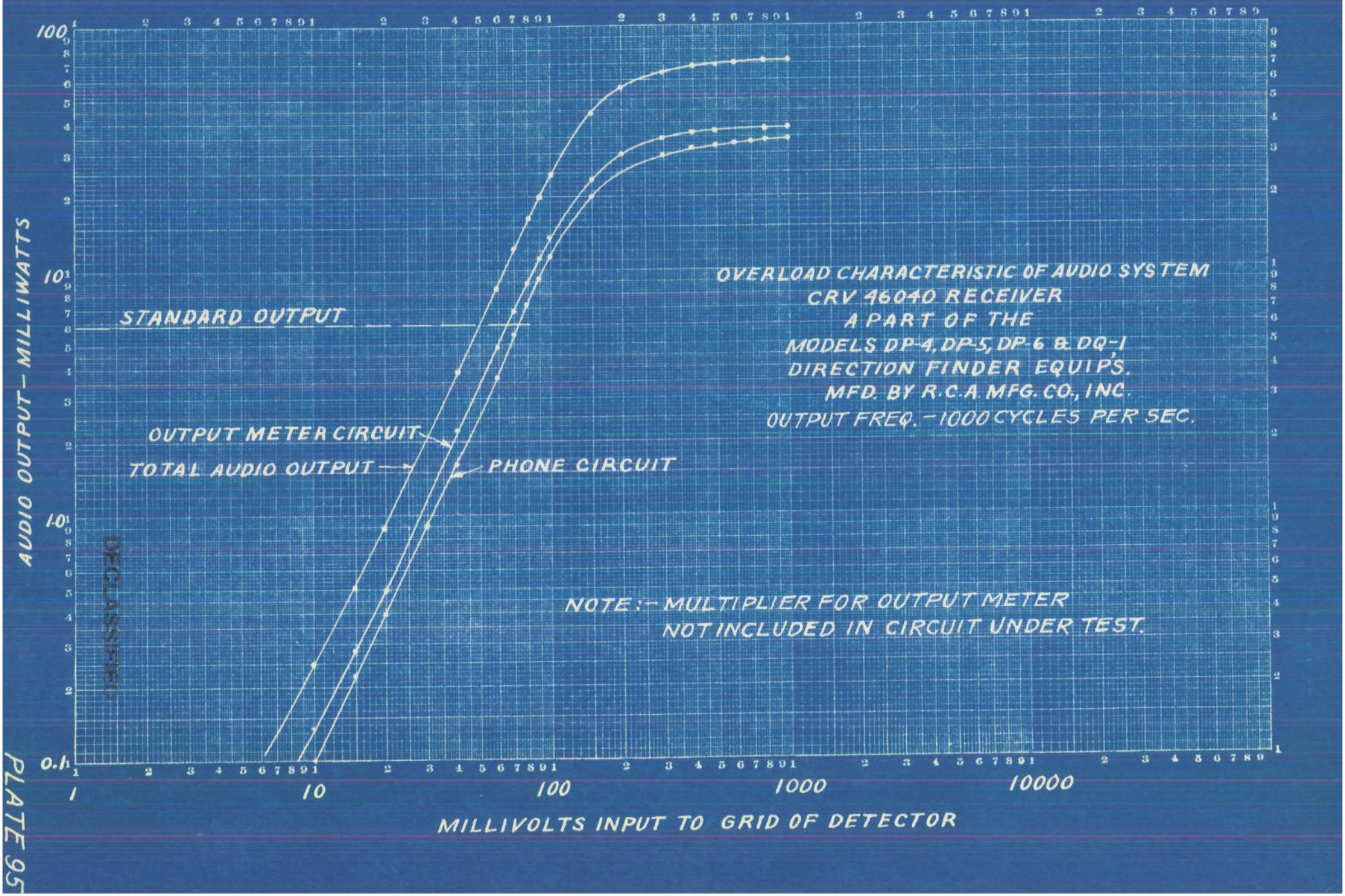
PLATE 93

NO. 3115. 20 DIVISIONS PER INCH (120 DIVISIONS) BY 3 3-INCH CYCLES RATIO RULING.



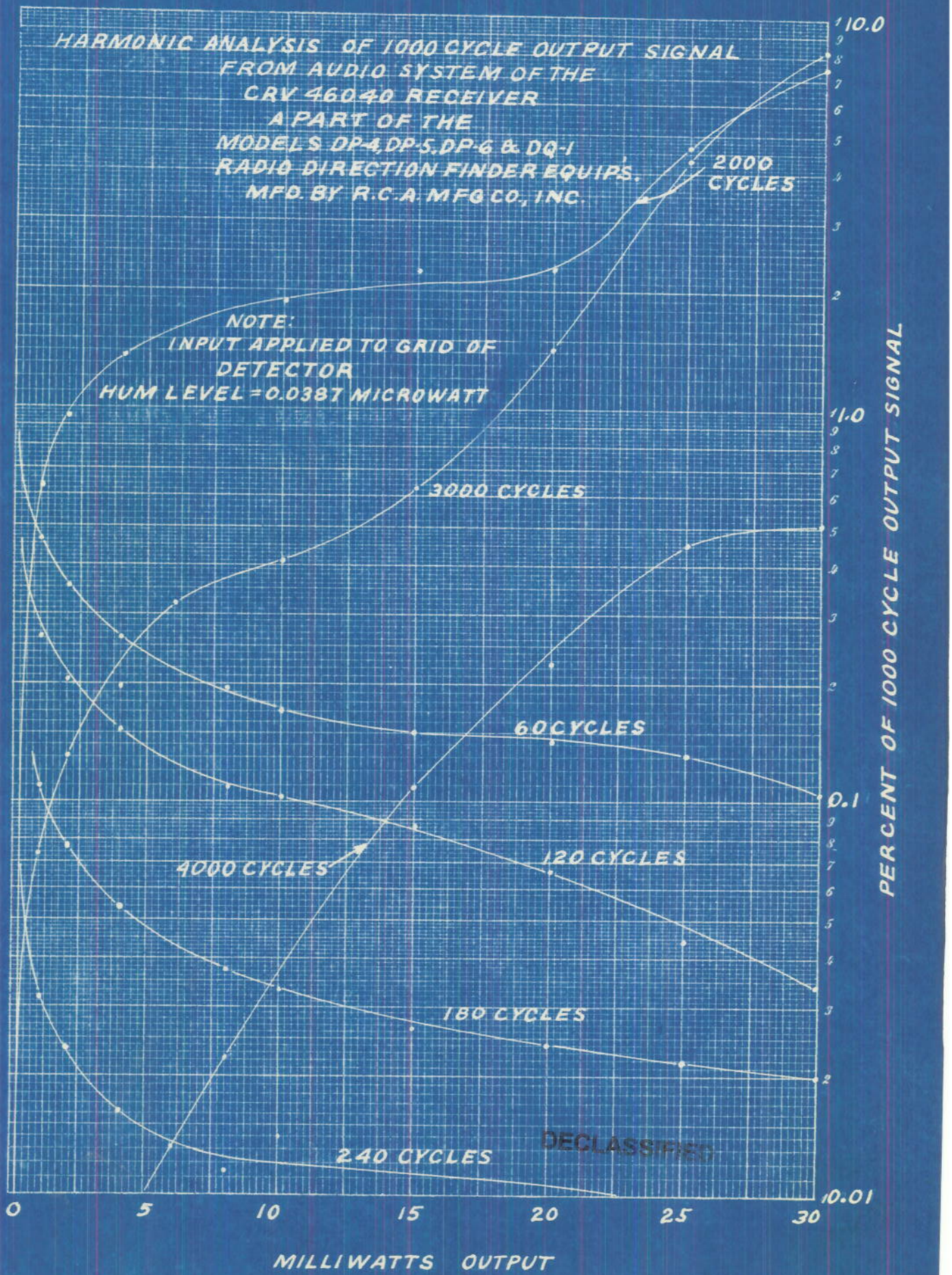
DECLASSIFIED

PLATE 94



DECLASSIFIED

PLATE 95



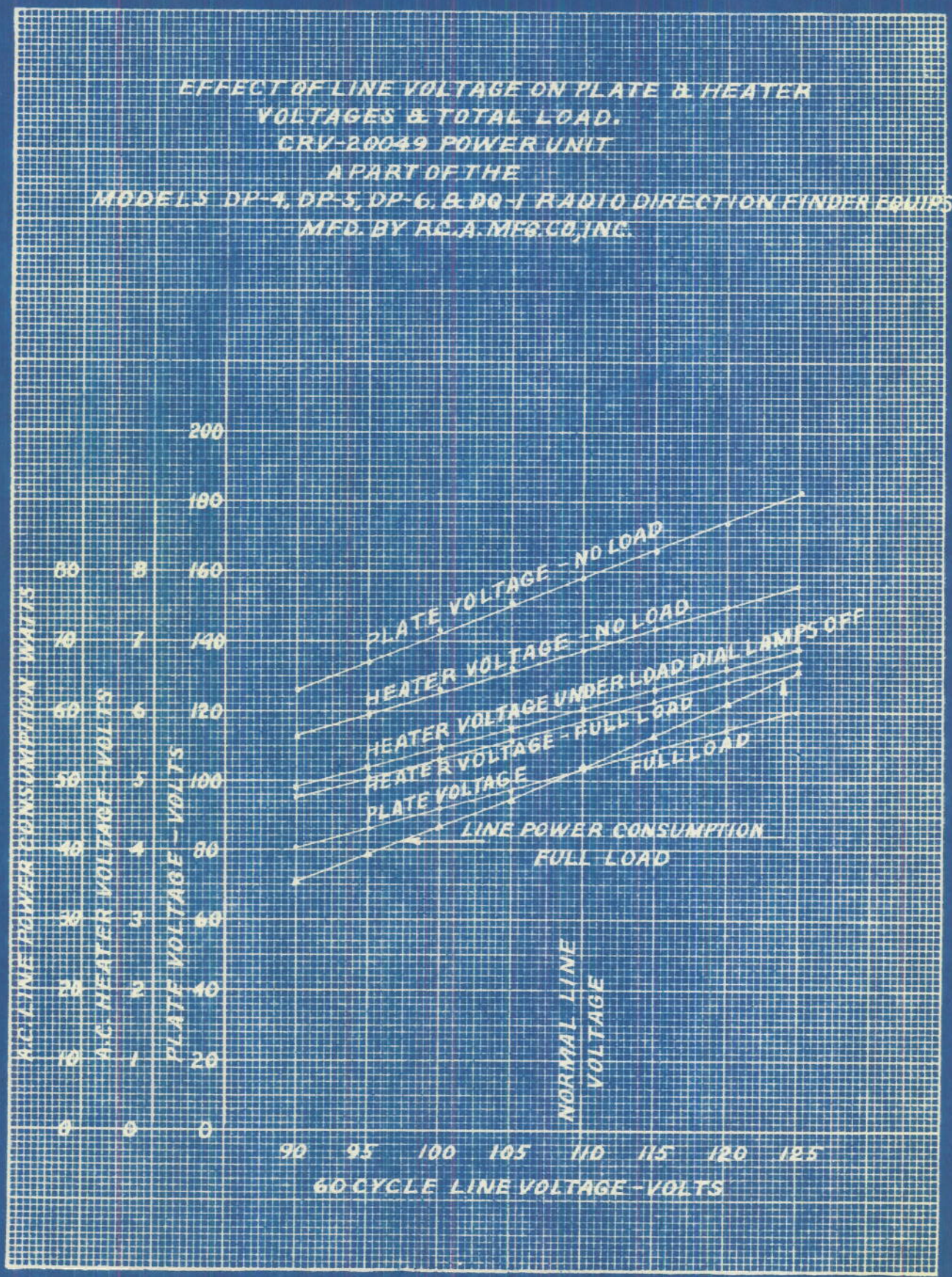
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PLATE 96

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

DATE

EFFECT OF LINE VOLTAGE ON PLATE & HEATER VOLTAGES & TOTAL LOAD.
CRV-20049 POWER UNIT
A PART OF THE
MODELS DP-4, DP-5, DP-6, & DQ-1 RADIO DIRECTION FINDER EQUIPS.
MFD. BY RC.A. MFG. CO, INC.

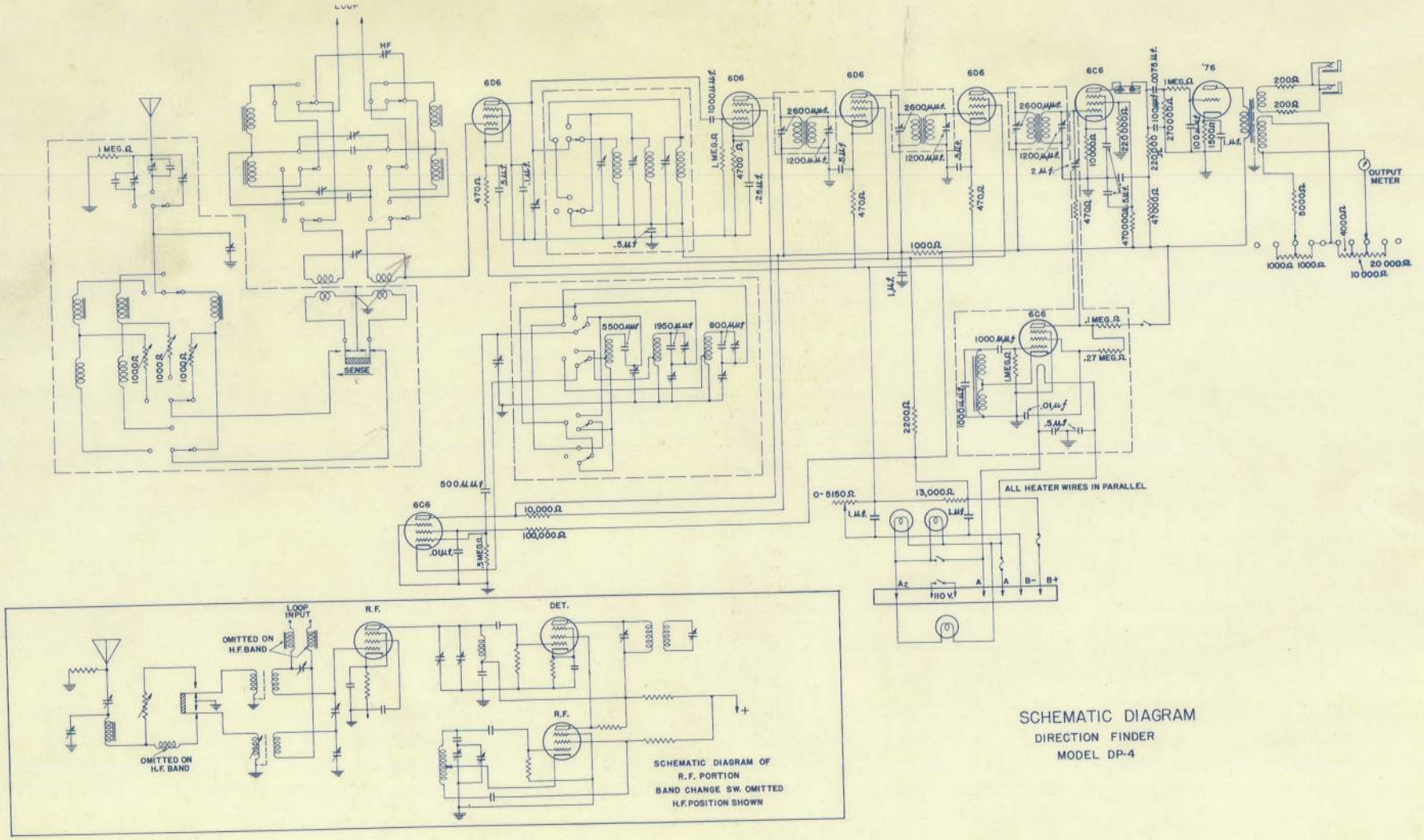


IF SHEET IS READ THIS WAY (HORIZONTALLY) THIS MUST BE TOP. IF SHEET IS READ THE OTHER WAY (VERTICALLY) THIS MUST BE LEFT-HAND SIDE.

N. R. L. 31A

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PLATE 97

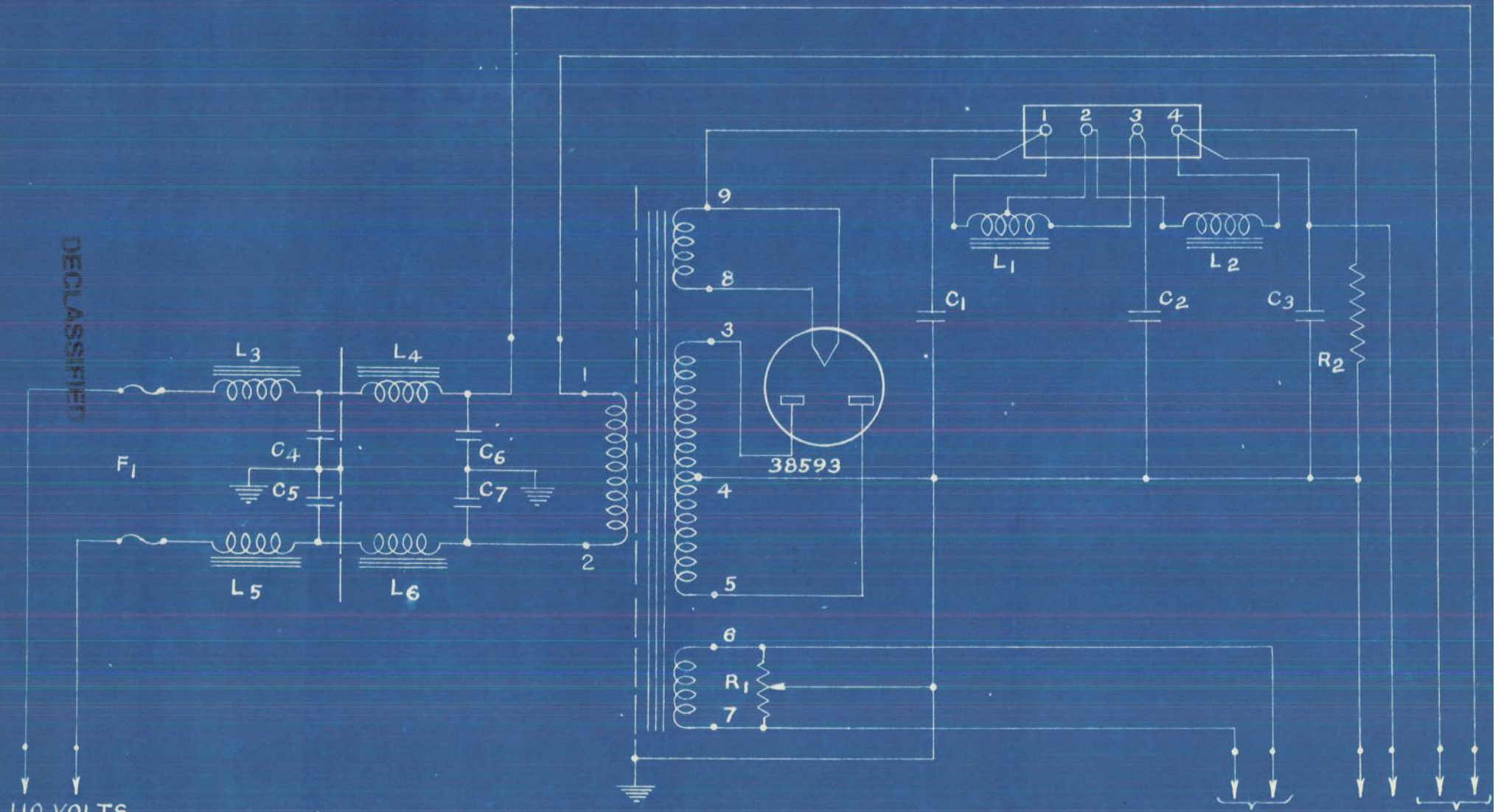


SCHEMATIC DIAGRAM
DIRECTION FINDER
MODEL DP-4

DECLASSIFIED

Plate 98

DECLASSIFIED



SCHEMATIC DIAGRAM
OF
TYPE CRV - 20049

PLATE 90

NO. 31.193. 20 DIVISIONS PER INCH (120 DIVISIONS) BY TWO 4 1/2-INCH CYCLES RATIO RULING.

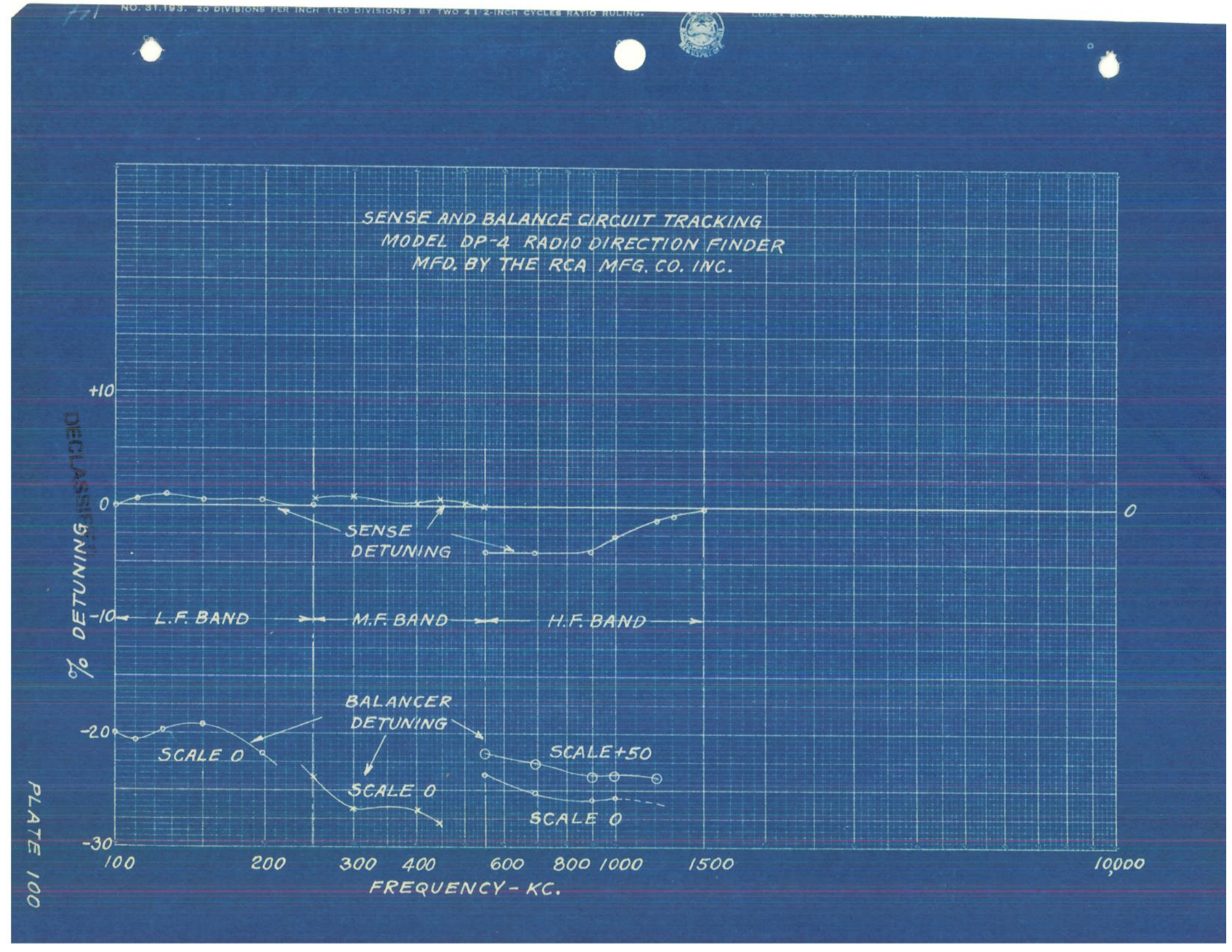
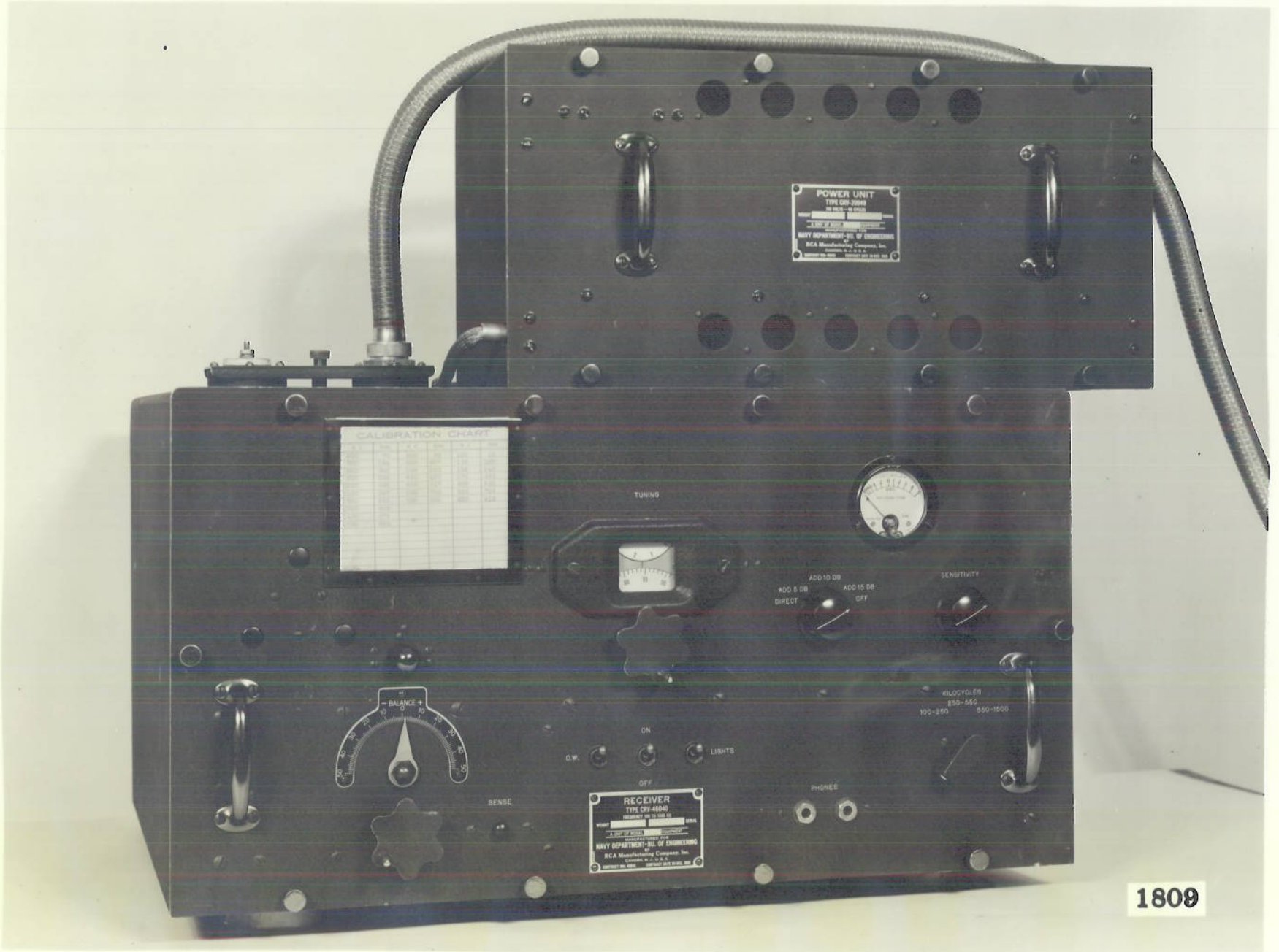
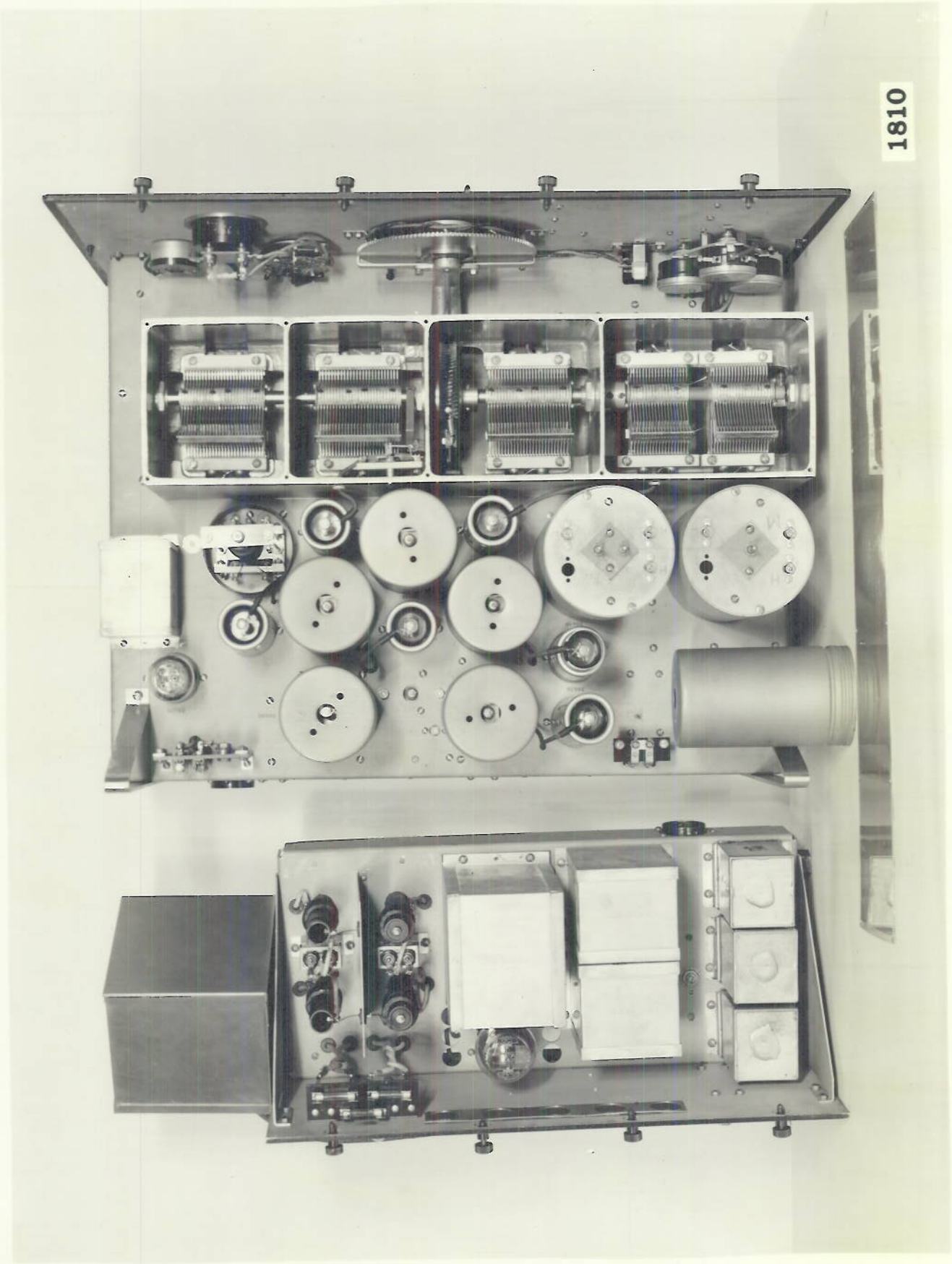


PLATE 100

DECLASSIFIED

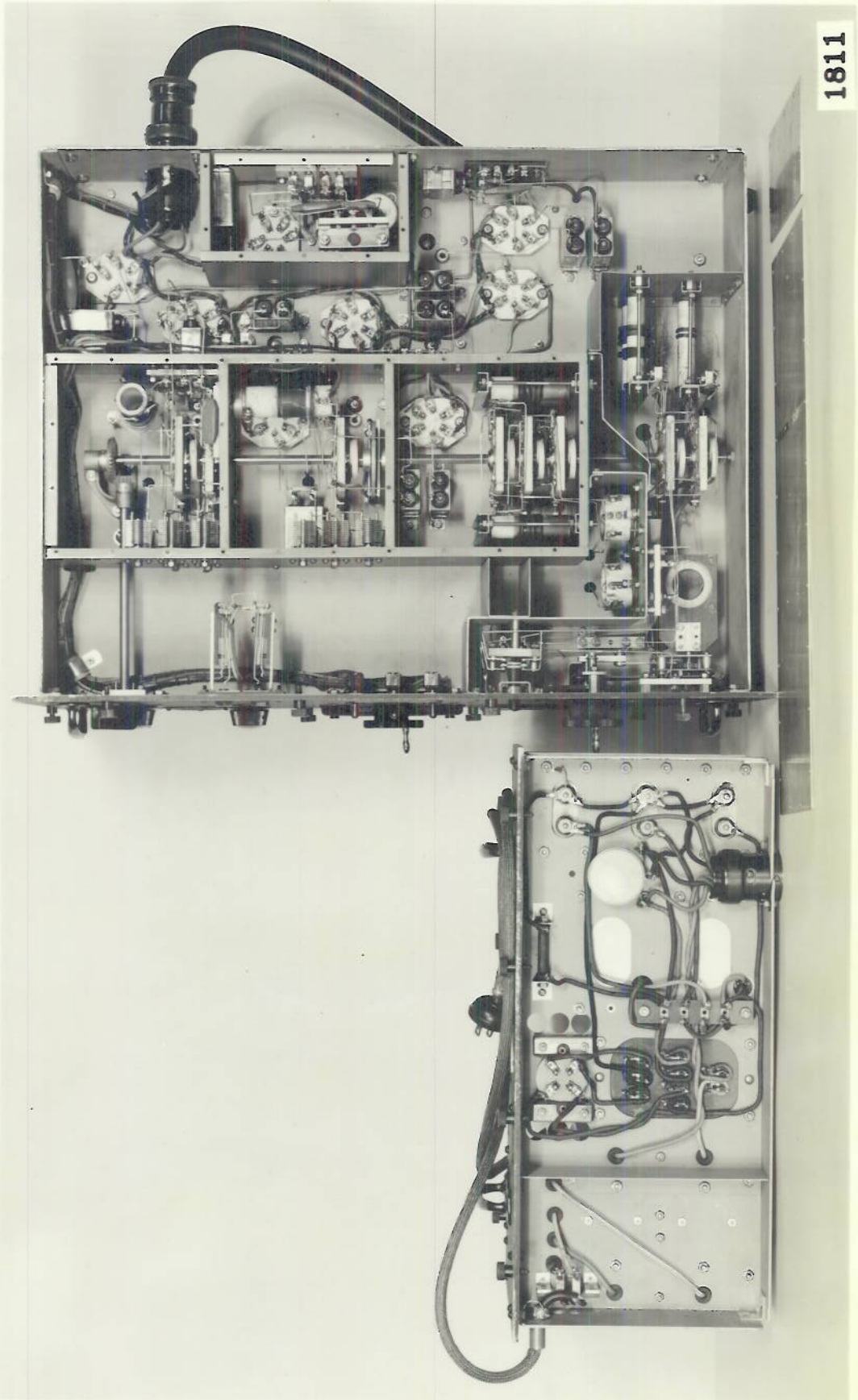
Plate 101





DECLASSIFIED

Plate 102



DECLASSIFIED

Plate 103

DECLASSIFIED



Plate 104



DECLASSIFIED

Plate 105