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DATE 15 March 1942

SUBJECT

Tests of Model CXAR Aircraft Transmitting Equipment

Manufactured by

Bendix Radio Corporation of Baltimore, Maryland

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15 March 1942 NRL Report No. R-1855

NAVY DEPARTMENT

Report On

Tests of Model CXAR Aircraft Transmitting Equipment Manufactured by the Bendix Radio Corporation of Baltimore, Maryland

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION, D.C.

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(b) BuShips Conf. Specifications RE13A 583A
(c) BuShips Conf. Specifications RE13A 583B

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AUTHORIZATION

1. The tests herein reported were authorized by Bureau of Ships letter C-NOs 73237 (1-23-DR1) of 28 January 1941. Additional references pertinent to these tests are listed as references (b) and (c).

OBJECT OF TESTS

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

ABSTRACT OF TESTS

3. The equipment was tested for mechanical construction, electrical performance and its suitability for use in Naval Service. Flight tests were conducted at the Naval Air Station, Anacostia, D. C., and reported in a separate enclosure.

4. The equipment was tested to determine the following characteristics:

(A) Mechanical
  (1) Workmanship
  (2) Ruggedness
  (3) Accessibility
  (4) Weight
  (5) Dimensions
  (6) Operation under conditions of variable temperature and relative humidity
  (7) Effect of shock and vibration

(B) Electrical
  (1) Calibration accuracy
  (2) Power Input
  (3) Power Output
  (4) Power Output vs. bus voltage
  (5) Power Output Tune position
  (6) Overall audio characteristics
    (a) Audio fidelity
    (b) Total harmonic distortion
  (7) Sidetone characteristics
    (a) Frequency
    (b) Fidelity
    (c) Total harmonic distortion
    (d) Voltage output

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(B) (8) Frequency stability
- (a) Temperature
- (b) Humidity
- (c) Channel reset
- (d) Tune-Operate switch
- (e) Vibration
- (f) Voltage input
- (g) Locked key operation
- (h) Roll and pitch
- (i) Power amplifier reaction
- (j) Antenna reaction
- (k) Altitude

(9) Dynamotor characteristics
- (a) Voltage regulation
- (b) Voltage ripple

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CONCLUSIONS

(a) The Model CXAR Equipment is considered suitable for use in Naval Aircraft providing the following minor changes are corrected in the production equipment.

(b) The equipment was previously submitted for test in compliance with reference (b) and reported in reference (a), the transmitter was redesigned and resubmitted for test in compliance with revised specifications, reference (c).

(c) Temperature stability of .001% per degree centigrade for a ten degree change in ambient temperature was obtained over a temperature range from 50° to -30° C. after considerable experimentation with compensating condensers and power amplifier tank condenser design. As the master oscillator circuits utilize phenolic coil forms in place of ceramic insulation, it is expected that stability of .001% will not be obtained with production equipment but will not exceed .003% as specified in reference (c). Production equipment should be checked at reasonable intervals to determine performance as frequency drift in excess of .003% reduces the advantage of frequency channel selection.

(d) The power output is less than that obtained with single channel equipment. CW output power from 9.6 to 55 watts is obtained over the frequency range 3000 to 9050 kc. when working into antenna characteristics from 100 to 300 mmf. and 2 to 40 ohms.

(e) The reduced power is attributed to the limited space available for 4-channel operation which requires four M.O. and P.A. circuits and associated variometers and condensers with reduced space protection for voltage flashovers, particularly for voice operation.

(f) During locked key, temperature and humidity tests, and while operating under vibration, erratic frequency changes ranging from 300 to 700 cycles were prevalent even after the channel changing switch contacts had been changed. This trouble was sometimes cleared for a short time by cleaning the contacts but would reappear after several hours of operation. Shocks made the frequency change 300 to 500 cycles. Several "shocks" were often required to make the frequency set.

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(g) Backlash of the M.O. dial changed the frequency 300 cycles and the reset accuracy was within 100 cycles. Locking the M.O. dial caused the emitted frequency to change 200 to 300 cycles depending upon the direction from which the frequency had been approached.

(h) Erratic frequency instability caused by jarring the equipment or after several hours operation should be kept to a minimum on production equipment.

(i) Ceramic condensers in the h-f channels were found to be secured by string. A more permanent means of mounting should be provided.

(j) Finger spring contacts on the channel switching assembly appear to be weak and should be strengthened.

(k) Instruction books should state clearly the procedure to be followed when cleaning contacts, and how often cleaning should be necessary to insure against failure during flight operations.

(l) Intermittent trouble was experienced with the contacts on the plug-in channels. It was observed that a metal contact similar in appearance to brass had been used for the contacts and switching assembly. Corrosion formed on the contacts causing erratic frequency instability. The contacts were replaced with coin silver which improved operation, but was not entirely satisfactory. The contacts required occasional cleaning for stable performance. It is possible that this trouble may be due in part to the close proximity of the tubes which furnish considerable heat and which may effect the spring pressure of the contact arm. This condition should be observed on the production equipment to insure of continued dependable operation.

(m) The M.O. dials caused excessive frequency shift and were replaced with an improved type dial that practically eliminated backlash.

(n) The tune operate switch was not considered satisfactory and was replaced with another of improved design and proved satisfactory.

(o) The indicator buttons on the remote indicator box do not work properly. These buttons must be adjusted so that their operation is positive at temperatures of -30° centigrade.

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(p) Interaction between the master oscillator, power amplifier and output circuits exists above 7000 kcs. While this was not considered serious on the model, observations should be made at intervals on production equipment to insure that interaction of this nature does not become excessive.

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RECOMMENDATIONS

(a) In order to expedite production, production tests will be made in accordance with specifications, reference (c).

(b) In the production models extreme care should be given frequency stability tests. In the preliminary model considerable experimentation with compensating condensers in the master oscillator circuits was necessary before satisfactory frequency stability was obtained.

(c) Care should be taken to see that the master oscillator, power amplifier, and antenna tuning circuits do not have excessive reaction which would deduct from the advantages of a multi-channel transmitter.

(d) Protective handles having a depth sufficient to protect the component parts of the front panel should be provided. Handles on the preliminary model were not satisfactory.

(e) The remote indicator button operation should be positive.

(f) The calibration chart is not accessible when the transmitter is installed in an airplane. Provision should be made to slide the chart from the top of the transmitter.

(g) When testing production equipment particular care should be given switch contacts and the channel switching assembly. There should be no erratic frequency change caused by slight vibration or shock. Considerable trouble in this regard was experienced with the preliminary model of the equipment.

(h) Radio frequency chokes Nos. L104 and L105 are supported by their pigtail connections. A more secure mounting should be provided.

(i) All wire joints should be crimped and made mechanically secure before soldering. Production equipment should be carefully inspected to see that this requirement is complied with.

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(j) Insulation from wires connected to terminal strips and switches should not be stripped so much as to leave portions of the wire near the connection exposed.

(k) In this equipment both Bristol and Allen set screws have been used. Bristol set screws should be used exclusively.

(l) In the event tinned or base copper wire is used for inductance, the wire should be covered with a protective coating to protect it against corrosion. After limited service use the coils show signs of corrosion. Unprotected silver plated wire would be satisfactory.

(m) Resistors and condensers mounted on the bottom of the chassis should be provided with a support so that they can not be accidentally moved or shifted from their positions. They are supported only by their leads in the model.

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DESCRIPTION OF EQUIPMENT UNDER TEST

5. The subject equipment is manufactured by the Bendix Radio Corporation of Baltimore, Maryland, and is known as the Model CXAR Aircraft Radio Transmitting Equipment. The subject equipment is designated as CXAR Serials 3 and 4.

6. The equipment consists of a four-channel transmitter unit with associated controls and cables. The equipment is provided with its own dynamotor, and the entire equipment operates from a 24-28 volt d.c. power supply. The transmitter is of the M.O.-P.A. type employing an electron coupled oscillator. The work circuit operates on twice the frequency of the master oscillator on all channels.

7. The transmitter is constructed to accommodate four plug-in tuning units. The equipment was furnished with the following plug-in units.

2 channels 540 to 1500 kc.
1 channel 1500 to 3000 kc.
2 channels 3000 to 9050 kc.
1 channel 9050 to 18100 kc.

Any combination of four channels may be used in the transmitter with complete interchangeability.

8. Selection of the desired channel is accomplished electrically by four-position switches on the front panel and on the remote control box. The switch actuates a motor driven switching assembly and is driven from the 28-volt d.c. supply. By means of a handle connected to the channel switching assembly it is possible to remove or replace any channel without power being available. Idle channels may be replaced or removed while another channel is in operation.

9. Fine tuning controls are accessible from the outside of the front exterior of the channels. Course tuning controls in the form of tap switches are inside of the channels.

10. By means of a tune-operate switch the transmitter may be switched to tune position. In this position it is impossible to disable the receiver or to operate the keying relay. In operate position no r-f tubes oscillate when the key is up.

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11. A test key is provided on the transmitter front. The transmitter provides for CW, MCW and Voice emission. Emission selection is accomplished by a switch on the transmitter front panel. When on voice position the dynamotor runs only when the microphone or throttle switch has been operated.

12. The sidetone signal is heard through two jacks located on the front panel.

13. When the key relay is not energized it is possible to operate both associated receivers without interference from the transmitter equipment when in operate position of the tune operate switch.

14. Provisions have been made for operation with either a carbon or dynamic microphone. Changing from one microphone to another is accomplished by changing links located inside the lower right panel.

15. Closing the microphone or throttle switch starts the dynamotor in voice position.

16. The pilot's control box has the following controls mounted on the front face: "Phone-off-Code" toggle switch, indicator button, and four-position channel switch. A built-in telegraph key is mounted on top of the unit. The microphone jack and cable receptacle are on the bottom of the unit.

17. When the transmitter is operated by either the pilot or the operator, a button protrudes from the remote indicator unit indicating the operative channel. A rotating drum channel indicator located on the front panel and coupled directly to the channel changing assembly indicates to the operator the channel in operative position.

18. The position of the local-remote switch on the transmitter panel determines whether the operator or the pilot has control to start and stop the dynamotor, select phone or code emission, or select the frequency channel.

19. When the "Phone-off-Code" switch is in code position, filament and control power is applied to the transmitter and the dynamotor starts. When this switch is in off position no power is drawn from the battery. When the dynamotor is started,

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code emission is secured by closing the test key, the operator's key, or the pilot's key.

20. When the "Phone-off-Code" switch is in phone position, filament and control power is applied to the transmitter. This dynamotor does not start until the microphone control circuit is closed by the pilot or operator.

21. A meter switch is located on the front panel of the transmitter. This switch is spring loaded to normally connect the meter to indicate P.A. grid current. Depressing the switch lever connects the meter to read battery voltage when filament and control voltage has been applied to the transmitter.

22. A meter is provided to indicate plate current of the power amplifier. An r-f meter is provided to indicate antenna current.

23. The design of the transmitter is based on the master oscillator power amplifier principle and uses the following vacuum tubes:

1 Navy Type 6L6G	(Master Oscillator)
1 Navy Type 6L6G	(Speech Amplifier)
2 Navy Type 6L6G	(Modulator)
1 Navy Type 12SL7GT	(Mike Amplifier)
1 Navy Type VR 150/30	(Voltage Regulator)
1 Navy Type 814	(Power Amplifier)

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METHOD OF TESTS

24. A description of the methods used in conducting the tests is as follows:

25. The equipment was checked for size, weight, and mechanical construction. It was then assembled and bench-tested to determine its compliance with the electrical requirements of the specifications, references (b) and (c).

26. All tests were made with a constant 28 volts at the bus unless otherwise specified.

27. The calibration accuracy of the master oscillator was determined in the following manner: By use of the calibration chart accompanying the equipment, the transmitter was tuned to the desired frequency. The output frequency was then measured with the Model LM-1 Crystal Frequency Indicator to determine the difference between the actual frequency and the desired frequency. The calibration accuracy was determined as being the average frequency difference of five trials.

28. The power output measurements were made into typical aircraft antennae of various characteristics to be described later. All other measurements were made into an optimum antenna having a resistance of 8.36 ohms and a capacitance of 300 to 500 μμfd unless otherwise specified.

29. The dummy antennae consisted of an air condenser, Ward Leonard plaque resistors, and an r-f ammeter, respectively, in series. The condenser was connected to the antenna binding posts and the ammeter to the ground post.

30. Power output measurements were made at various frequencies with CW, MCW and Voice operation. The voice power measurements were made with a 400 c.p.s., 75% modulated signal from a General Radio Beat Frequency Oscillator. Power output was calculated from the r-f ammeter current and the measured resistance of the Ward Leonard plaque resistors. Measurements were also made of input current and the input power. Power output measurements were also made with a variable bus voltage.

31. Power output in "Tune" position was determined as follows: A diode rectifier was coupled to the dummy

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antenna load of the transmitter. A milliammeter was placed in series with the output of the rectifier. The transmitter was operated full power CW and the current flowing through the diode rectifier was recorded. The transmitter was switched to tune position, a microammeter was substituted for the milliammeter and the current read. The power in tune position was calculated in decibels from the current ratio.

32. The audio frequency measurements were made with the use of a beat frequency oscillator as a source of modulating frequency, coupled to a mixer unit which controls the microphone voltage and percentage modulation. This in turn was coupled to the microphone input of the transmitter. The output, rectified by a diode detector, was measured with an output voltmeter. The percentage modulation was measured on an NRL percentage modulation meter. Fidelity measurements were made at both full power and with 35 watts output, where available, as follows: The microphone voltage was adjusted by means of the mixer to give the desired modulation at 400 c.p.s. and this value of microphone voltage kept constant throughout the tests. The frequency was then varied from 100 to 15,000 c.p.s. and the output voltage recorded at each step. The percentage modulation was also measured during the 35-watt output test.

33. The total audio frequency distortion was taken with the same apparatus as above, except that the rectified output was coupled to a wave analyzer. With the percentage modulation constant at 75%, runs were made at 35 watts output with modulation frequencies ranging from 200 to 4,000 c.p.s. Under these conditions the output voltage as observed on the General Radio wave analyzer was recorded at successive harmonics of the fundamental modulation frequency. The total RMS harmonic content was determined from these values.

34. The sidetone frequency was measured by connecting a pair of headphones across the sidetone output and beating the sidetone signal against that of an audio beat frequency oscillator. The sidetone output voltage was also measured with a 300-ohm load across the sidetone output. The total harmonic distortion of the sidetone output was determined by the same method described above for distortion measurements. The sidetone impedance across the various taps of the sidetone output was found by the resistance substitution method.

35. To determine the frequency stability with variable temperature, the transmitter was installed in

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a temperature control box. The temperature was varied in 10° steps from +60° to -30° Centigrade and frequency measurements recorded at each step. The relative humidity was maintained at less than 50% throughout the test. The procedure was as follows: The transmitter was turned on, temperature raised to +60° C. and allowed to stabilize for 30 minutes. At the end of this time the frequency was recorded by means of the LK frequency drift indicator. The temperature was lowered 10° and the frequency again measured after a 30-minute stabilization period. This was repeated in 10° steps until -30° C. was reached. During the entire run the transmitter remained in a locked key condition with maximum CW output.

36. Frequency stability with variable relative humidity, and a constant temperature maintained at 50° C. was determined with the equipment, including the dummy antenna, in a temperature control room. The first step was to stabilize the equipment in a locked key condition for 15 minutes at 30% relative humidity. At the end of this time the frequency, as observed on the LK frequency indicator, was recorded. The power output was also recorded. Secondly, the humidity was raised to 95%, 30 minutes was allowed for stabilization, then the frequency and power were recorded. With the humidity again lowered to 30%, the equipment was stabilized for 30 minutes. At the end of this time, frequency and power output were recorded. The frequency and power output changes any time during the second and third run were taken with reference to the end of the first run.

37. Frequency change due to channel reset was found in the following manner: After the transmitter had stabilized the output frequency was measured on an LK Frequency Drift Indicator. Then, by means of the channel selector switch, the equipment was switched to an unused channel, then back to the operative channel. The key was opened momentarily during the change. The frequency was again recorded ten seconds after the key had been closed. This procedure was repeated five times. In each case the frequency change was determined as the deviation from the preceding reset. The average of the five resets was recorded.

38. Frequency stability vs. tune-operate switch was determined as follows: The equipment was permitted to stabilize while operating in a full power locked key condition. After stabilization the output frequency was measured on a Model LM-1 Crystal Frequency Indicator. The output of an audio oscillator was zero beat against the audio note from the Crystal Frequency Indicator.

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The tune-operate switch was placed in tune position and the audio oscillator again zero beat with the Crystal Frequency Indicator. The frequency change was then read directly from the audio oscillator.

39. Another test was made in which all stages were detuned. With the tune-operate switch in tune position, the M.O. was set to a given frequency with the Crystal Frequency Indicator. The tune-operate switch was then switched to operate and the remaining stages resonated to the M.O. frequency. In a manner similar to that outlined above, the M.O. frequency change caused by the operation was measured.

40. In order to determine the frequency stability with vibration, the transmitter was mounted on a vibration table capable of an excursion of approximately .016 inch and a frequency of 10 to 55 cycles per second. The transmitter was given a 15-minute warm-up followed by a 15-minute full power key locked operation, during which the frequency was recorded with the LK frequency indicator. All power was turned off on the transmitter, vibration was started and maintained for one hour. The vibration frequency was variable during this time. The filaments were turned on during the last fifteen minutes of vibration, after which the key was closed and the frequency again observed over a fifteen minute period. The difference in frequency at the end of each fifteen minute key locked run determined the frequency set.

41. The frequency change, with a change in bus voltage, was determined as follows: The equipment was turned on and allowed to stabilize at 28 volts input. The voltage was then lowered in one-volt steps to 23 volts and returned, in steps of one volt, to 28 volts. The frequency was recorded at the end of each step as observed on the LK frequency drift indicator. The power output was also recorded. A run was also made with a voltage variation of 30 to 20 volts to determine the power output under extreme conditions of operation.

42. To determine the frequency drift during a one-half hour locked key warm-up period the equipment was placed in a temperature control room at a constant temperature of 50° C. and percentage relative humidity less than 30%. The equipment was turned on and the key closed after a one minute warm-up. Frequency measurements were made every five minutes after the first five-minute warm-up period by means of the LK frequency drift indicator. Throughout the test, locked key and full CW power were maintained.

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43. The roll and pitch measurements were made by mounting the equipment on a platform capable of being tilted 45° from horizontal. Roll measurements were made by tilting the equipment left and right 45° from horizontal. Pitch measurements were made by tilting the equipment forward and back 45° from horizontal. The equipment was given at least 45-minute filament and plate warm-up, after which it was moved through the specified plane at rates ranging from 4 to 10 cycles per minute for a period of 30 minutes. The frequency was recorded as observed on an LK frequency drift indicator in all tests.

44. To determine the change in frequency due to P.A. reaction, the transmitter in each case was tuned to its optimum output for a given frequency. The transmitter frequency was then recorded from the LK Drift Frequency Indicator. The P.A. plate current was also recorded. The second step was to increase the plate current 25% by detuning the P.A. The resultant frequency change was recorded. The final step was to decrease the P.A. plate current 25% in a like manner and record the frequency changes.

45. Frequency stability vs. change in altitude was determined in the following manner. The equipment was installed in the temperature control room. The temperature was lowered to -23° Centigrade. The transmitter was placed in operation and allowed to stabilize for one-half hour, at the end of which time the frequency was recorded from the LK Frequency Drift Indicator. The atmospheric pressure was lowered to 14.0 inches of mercury or the equivalent of 20,000 feet altitude. The frequency was again recorded. The atmospheric pressure was again restored to normal and the frequency noted.

46. The acceleration test was made as follows: The transmitter was mounted on an accelerometer platform and dropped at rates of 5.89 to 6.32 g. The tests were made with the transmitter in the vertical position, 90° forward from the vertical, and 90° to the side of vertical with respect to normal operating position. Locked key runs before and after the drops gave a means of comparing operation changes, if any.

DATA RECORDED DURING TESTS

47. Data recorded during the tests in the form of tables and plates are appended to this report. A discussion of this information will be found in "Results of Tests."

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DISCUSSION OF PROBABLE ERRORS

48. Following is a list of the apparatus used in conducting the tests with the margin of error according to the manufacturer's guarantee:

Manufacturer	Instrument	Type	Serial No.	Accuracy
Radio Research Company	Frequency drift indicator	LK	4	±0.005%
Radio Research Company	Frequency drift indicator	LK-1	1	±0.005%
Radio Research Company	Crystal frequency indicator	LM-1	5	±0.001%
General Radio Corporation	Beat frequency oscillator	713-B	499	±2.0%
General Radio Corporation	Wave Analyzer	736-A	118	±5.0%
General Radio Corporation	Output Voltmeter	483-C	15	±10.0%
General Radio Corporation	Cathode ray oscilloscope	TMV-122-B	42222	
Weston	Radio frequency ammeter	425	95385	±2.0%
Weston	Radio frequency ammeter	425	28854	±2.0%
Weston	D.C. Voltmeter	45	45050	±1.0%
Weston	D.C. microammeter	301	463759	±2.0%
Westinghouse	D.C. milliammeter	CAY-22063	--	±2.0%
Naval Research Laboratory	Diode rectifier			±2.0%
Naval Research Laboratory	Microphone Mixer Unit			±2.0%
Naval Research Laboratory	Modulation Meter			±2.0%

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Manufacturer	Instrument	Type	Serial No.	Accuracy
Naval Research Laboratory	Vibrating Table			±5.0%
Naval Aircraft Factory	Accelerometer			±10.0%
Frigidaire	Temperature Control box			±10.0%
York	Temperature Control Room			±5.0%

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RESULTS OF TESTS

The results of the tests of subject equipment will be discussed with regards to its compliance with the specifications, reference (c). The numbers of the sub-paragraphs are in agreement with those of the specifications.

I. INTRODUCTION

1-1 The complete transmitter installation as supplied by the contractor consists of the following items:

(1) Transmitter with tubes and mounting.

(2) Dynamotor and mounting.

(3) Pilot's control box.

(4) Operator's indicator box.

(5) Two plug-in tuning units (range 3000 - 9050 kc. each). Three were furnished with CXAR-4.

(6) One plug-in tuning unit (range 540 - 1500 kc.) Two were furnished with CXAR-4.

(7) One plug-in tuning unit (range 1500 - 3000 kc.) Furnished with revised model CXAR-3 near conclusion of tests.

(8) Five transmitter instruction books. Two preliminary instruction books were supplied.

(9) Cables and plugs for the above.

(10) Slip covers for transmitter and dynamotor are required by specifications. No cover was supplied for dynamotor.

(11) Operating spares and box to contain transmitter spares. Neither spares nor box were supplied.

(12) Two copies of manufacturers type test.

1-3 Operating spares and appropriate box were not furnished with the equipment.

(1) Spare resistors, capacitors and R. F. chokes were not supplied with the equipment.

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1-3 (2) One complete set of spare vacuum tubes was furnished with the equipment.

(3) Four sets of fuse renewals were not supplied with the equipment.

(4) Spare brushes were not supplied with the equipment.

(5) A suitable spare parts box was not furnished with the equipment,

1-5 The weight of the first seven (7) items listed above is 98.8 pounds. This is the weight of the complete equipment exclusive of cables, spare tubes and instruction books. The total weight of the cables is 10.7 pounds. The weight of the equipment is within the specification limit of 104 pounds. However, these measurements were made before final changes were made in the equipment. Therefore, the weights may have been changed by a slight amount. Weights are given in Table No. 1.

1-11 The preliminary instruction book in its present form is inadequate. It contains only a material list and schematic diagrams of the equipment.

II

GENERAL REQUIREMENTS

2-1 Note 2. On the schematic circuit diagram, instead of showing the value of each resistance, capacitance,or choke coil near the item concerned, a designating number is used. It is necessary to refer to the material list in the instruction book to identify it with its proper value.

2-2 (1) All rotor type switches are of the self-positioning type. Early in the tests, mechanical trouble was encountered with the tune-operate switch. This switch was replaced by the manufacturer with another of approved design which proved satisfactory throughout the remainder of the tests. Considerable trouble was had with poor contact of the contact points on the channel units and in the channel

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2-2 (1) switching assembly. The contacts are of the pressure type and are not self-cleaning. The original contacts were not made of coin silver; however, they were replaced by the manufacturer with coin silver early in the tests. A corrosion that formed on the contacts was believed to be caused by sulphur dioxide given off by sulphur dielectric condensers used in the antenna circuit of the high frequency channels. The condensers were replaced with condensers having a mica dielectric. It is believed that the switches could be improved by incorporating a wiper action that would afford self-cleaning and a more positive contact. Dirty contacts caused erratic frequency instability during the tests.

(2) There are no push button switches in the subject equipment. All toggle switches are so arranged that the unit may be easily removed and replaced without removal of other units.

2-3 The use of pressure and friction contacts is discussed in paragraph 2-2 (1).

2-4 (1) The smallest number and types of vacuum tubes have been used in this equipment to meet the specification requirements. Vacuum tubes are operated within the manufacturer's ratings. Tubes are not used in parallel. The P.A. tube is a single type 814.

(2) Pilot lights are not used in this equipment.

2-5 (1) All vacuum tubes and other delicate devices are mounted so as to protect them from damage and improper functioning due to shock or vibration. No provisions have been made for securing the tubes in their sockets. However, no failure resulting from loose tubes occurred during tests.

(2) All vacuum tube sockets are of the single unit type.

2-6 (1) The component parts of the equipment are so marked as to conform to specification requirements for about 70% of the parts. All major components are marked but many of the smaller parts are not marked. It is possible

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2-6 (1) that in a production model the parts could be more easily marked for identification. The tube mountings and receptacles are properly marked for identification.

(3) Standard component parts are used wherever possible in the equipment. The use of component parts of a special manufacturer are kept to a minimum.

(4) All assembled component items are so mounted in the major assemblies as to permit the replacement of those likely to become defective, without extensive disassembly. Rivets are not used in the mounting of any unit of the equipment which are likely to be subjected to replacement.

(5) All panels are suitably drilled and adjacent equipment suitably mounted to permit the substitution of replacement meters of the same nominal size. All indicating instruments, exclusive of self-contained thermocouple instruments, are protected against damage due to stray radio-frequency potentials by the use of suitable by-pass units.

(6) Relays are accessible for examination and adjustment. Keying relays provide satisfactory keying up to twenty-five (25) words per minute. Relay contacts are securely attached.

(7) Variable coils employing rollers or slides in contact with coils are not incorporated in the equipment.

(8) No special tools are required for adjustment of the transmitter controls. Allen wrenches are provided to adjust set screws used to secure control knobs and gears in the channel switching assembly of this equipment. The wrenches are securely attached to a convenient point on the chassis. No other special tools are required for routine operation of the equipment.

(9) All rotatable devices, including control knobs, are secured to their respective shafts in a suitable manner. Friction is not used

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2-6 (9) as a means of locking. Adjustable couplings are not used in this equipment. Pins are used as a means of securing wherever practicable. Where set screws are used two screws are employed.

(10) No damage resulted to the equipment when subjected to vibration and drop tests discussed elsewhere in this report.

(a) All machine screws are secured where practicable with lock washers. Binder head screws are used wherever practicable. Varnish or cement is not used for staking purposes in this equipment.

(b) Not all wires connected to terminals, etc., are securely fastened by crimping and in some cases depend on solder for mechanical strength.

(c) Solder connections are used in the electrical and radio frequency wiring wherever practicable. Non-corrosive soldering flux is used for all soldered connections.

(11) (a) A platform capable of orientation from the vertical and up to and including 180 degrees was not available for these tests.

(b) The equipment withstood three acceleration tests on the laboratory accelerometer. The acceleration varied between 5.89 and 6.32 g in its normal position and 90 degrees from normal. For an undetermined reason the transmitter would not operate during the first five minutes after power was applied following the drop tests. The frequency difference between two one-half hour locked key runs made immediately before and immediately following the tests was +1020 cycles, or .014%, at 3000 kc. No damage resulted to any component part of the equipment during these tests.

(c) Suitable shock-proof mountings have been provided for the equipment.

(d) The transmitter cannot be placed on its face without the weight being subjected to the

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2-6 (11) (d) control knobs and ends of toggle switches. "Snatch-handles" are provided but are not of sufficient depth to afford needed protection for the transmitter controls. The channel assemblies when removed from the transmitter may be placed on their face or any side without likelihood of being damaged.

(12) The major units of the equipment are housed in suitable grounded metal cabinets finished externally in durable black enameled wrinkle finish. Aluminum alloy surfaces and all other parts are protected against corrosion consistent with good engineering practice.

(13) (a) All exposed surfaces, in so far as is practicable, have been made resistant to the corrosive action of moist sea atmosphere or have been suitably protected therefrom.

(b) Bright screws have been used on the channels to secure the dial controls. These screws need never be removed for routine operation and should therefore be painted black.

(c) In general all caps, catches and screw heads, except stainless steel which are manipulated or removed in normal process of installation and servicing, have a dull nickel or chromium finish.

(14) All connecting cases and plugs are designed in conformance with the specifications to permit operation under adverse conditions of salt spray, humidity and changes in temperature accompanied by condensation.

The high voltage fixed connections associated with the antenna system are not mounted on stand-off insulators to obviate the danger of salt water or moisture rendering the equipment inoperative. A flat Mycalex panel inset is used to support the connector.

The connection plugs can be removed with heavy gloves. However, it would be difficult to operate all the tuning controls while wearing heavy gloves.

The external connection provided for the keying relay is not recessed in the cabinet.

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2-6 (15) (a) Access to the individual units for purpose of inspection, repair and tube replacement is accomplished in a convenient manner through the top access door and by removal of the side, back and top panels.

(b) The shielding is splashproof to 45° from the vertical. There are no louvres on the top of the transmitter case. The tube access door on top of the transmitter case is secured by means of snap fasteners capable of operation with heavy gloves. However, all the tubes can not be reached through this door. The side and/or rear panels must be removed to reach them. This is accomplished by removing binder-head screws with a screw driver.

2-7 Except for antenna connections, satisfactory provision has been made to prevent personnel from accidentally coming in contact with voltages in excess of 40 volts.

(1) The equipment is so designed that no damage will result to the equipment or tubes due to normal operation involving changing power, frequency, tubes or type of emission.

(2) All metal control shafts are suitably grounded for protection of personnel. There has been no evidence of any control knob or handle giving unpleasant shocks or burns when touched due to possible existence of stray high frequency fields.

(3) Suitable provision has been made to protect the equipment or its components against damage due to power being turned on, or keying the transmitter before the tubes have had sufficient time to warm up, or if the input voltage should rise or fall off abruptly.

(4) The equipment is adequately provided with fuses in the high and low voltage supply circuits. Spare fuses, suitably marked and conveniently located, are also provided.

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2-7 (5) During the course of the tests, no trouble was experienced with shorts or flash-overs due to poorly designed connections or jacks.

(6) Inflammable material, which will ignite or explode from an electrical spark or heating, and which if so ignited will continue to burn, is not used in this equipment.

2-8 (1) During tests the equipment operated without injury in continuous and intermittent service in degrees of relative humidity and temperature varying between 5 to 100% and -30 to 60° centigrade respectively. No electrical failures were experienced due to temperature or humidity. However, the indicator buttons on the remote indicator box would not function properly at low temperatures. No other mechanical failures were noted due to temperature or humidity.

(2) No failures to any part due to overload were experienced during tests on this equipment.

(3) The transmitter operated several times in continuous locked key full power CW condition for as long as 12 hours with variable temperature without damage, overheating, or showing signs of corona, flashover, or brush discharge. The equipment operated full power at keying speeds up to 25 words per minute in a satisfactory manner.

2-9 (1) All connections within the equipment are suitably supported to minimize changes in frequency, output or breakage due to severe vibration under flight conditions. The vibration test is discussed elsewhere in this report. (See paragraph 3-19 (3)).

(2) No attempt has been made to color code the wire used within the transmitting equipment.

2-10 (1) Wood is not used in the construction of this equipment.

(2) The use of iron or steel which is subject to corrosion is kept to a minimum in this equipment.

(3) Mycalex and similar material used in this equipment is suitably glazed in accordance with specifications.

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2-11 (2) Electrolytic capacitors are not employed in this equipment.

2-12 A sulphur dielectric condenser used in the antenna circuit of a high frequency channel of this equipment, did, on one occasion, melt and run out of its container at 60° C. This condenser failed later when subjected to humidity. At temperatures less than 60° this same condenser and one similar to it in the other channel gave off sulphur dioxide which was attributed to have caused a highly resistive corrosion to form on the channel switch contacts. This resulted in a very erratic frequency instability. The condensers have been replaced with mica condensers. No further failure of this nature was encountered during the remainder of the tests.

2-13 A slip cover is provided for the transmitter. The model designation is plainly stenciled on the cover. No cover was furnished for the dynamotor.

III

TRANSMITTER AND TRANSMITTER CONTROLS

3-1 The transmitter is of the M.O.-P.A. type, employing an electron coupled oscillator. The work circuit operates on twice the frequency of the frequency determining circuit.

3-2 Frequency Channels

The transmitter is constructed to accomodate four plug-in tuning units whose frequency range is as follows:

(a) 540-1500 Kcs.

(b) 1500-3000 Kcs.

(c) 3000-9050 Kcs.

(d) 9050-15300 Kcs.

It is possible to use any combination of the tuning units, with complete mechanical

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3-2 interchangeability, thereby providing a four-channel transmitter. Channels (b) and (d) were not furnished when initial tests were made on the equipment. Tests on these channels are therefore incomplete.

3-3 Channel Selection:

By electrical means requiring not over ten (10) seconds, it is possible to shift from one channel to another. It is not necessary to readjust any controls as a result of having shifted channels after having been properly tuned. It is possible to remove or replace any unit without power being available, and to operate one tuning unit without damage even though another tuning unit has been withdrawn. Channel selection is made by means of channel selection switches on the transmitter panel and on the pilot's control box. The operator has control at all times. The pilot has control only at the discretion of the operator. Channel selection is made manually when the power is off, or if the channel switching motor should fail, by means of a collapsible handle connected to the switching assembly. This control is located on the right side panel. Idle channels may be removed or replaced while the power is on the channel in operating position. An indicating device on the front panel indicates the channel in operating position at all times even if the power is off. Indicating buttons on the remote indicator box serve to indicate to the pilot the channel in operating position. These buttons work only when power is on.

3-4 Frequency Presetting

It is possible to preset to any frequency in the tuning unit, without use of tools, completely pretuning to any frequency in the specified range. With the aid of an external crystal frequency indicator not included as a part of this equipment, it is possible to set the H. C. when on tune position during periods of radio silence, then to complete the tuning,

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3-4 when on operate position, radiating into the prescribed antenna without changing the M.C. The maximum frequency change due to this operation was 1250 cycles at 9000 Kc. The maximum change allowed by specifications is 1500 cycles. Results of this test are contained in Table No. 38(2).

3-5 C.F.I. Post

The C.F.I. post is properly engraved "C.F.I."

3-6 Channel Interaction

The equipment was not available for this test after final changes had been made in it.

3-7 Location of Tuning Control

The equipment is designed for maximum convenience of tuning. In the first model of the subject equipment, the multiplicity of tap switches, the method of changing these taps, and the time required to change frequency was much greater than deemed satisfactory in the Naval Service. In the resubmitted model the tap switches have been greatly simplified. They are located on the side of each channel. The channel must be removed to adjust the taps. No special tools are required to change taps; they are so arranged that for a given frequency the tap position number is the same for all circuits. Their frequency ranges are clearly labeled. Time required to change frequency is reduced to a minimum. The five tuning controls are located on the front exterior.

3-8 Marking of Tuning Controls

(1) The taps, including those on the frequency determining circuit of the master oscillator, are marked in terms of output frequency.

(2) A scale reading 0-50 divisions is used to indicate antenna coupling. An increase in numerals increases the coupling. There is no arrow to indicate the direction of increased coupling.

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3-8 (4) The antenna loading inductance decreases with increased dial readings. The scale reads from 0 to 100 divisions.

(5) The tuning controls are properly identified with name or function engraved nearby. Letters are used to designate clearly the controls except the M.O. taps which have the approximate frequency range indicated.

3-9 (1) A typical calibration chart is secured to the top shield of the transmitter so that it is easily removable. Both sides of the chart are utilized to carry typical operating data for the units. This data includes dial and r-f switch settings for as many frequencies as space permits.

(2) The front panel of each tuning unit carries a calibration chart to be filled in by the operator. Model CXAR-4 had cardboard calibration charts attached to the channel. The revised model CXAR-3 used a single chart made of a material similar in appearance to celluloid. Pencil marks could easily be erased from this chart and a new calibration entered.

3-10 Antennae

(1) The equipment when used above 1500 Kcs. is suitable for operation into the typical antennae whose characteristics are summarized in the specifications.

(2) In addition, when used above 1500 Kc., the equipment is capable of operation into an antenna approximating a 14-foot fixed antenna having 50 μμf capacity and one ohm resistance at 3000 Kc., and into an antenna whose natural frequency is approximately 7 mcs.

(3) The equipment is suitable for operation into trailing wire antennae up to 300 feet in length, reeling out the proper length to resonate.

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5-10 (4) With the transmitter properly tuned and in operation, no damage will result to any part, including vacuum tubes, if the antenna becomes short circuited, open circuited, or grounded. This shall not be interpreted to permit tuning into an open, shorted, or grounded antenna.

3-11 Power Output

Power output measurements were made with various antenna values ranging from 1 to 40 ohms resistance and 100 to 500 μμf capacity. The measurements were made for cw, mcw and phone power output. These measurements were made before the new specifications, reference (c), were available. Therefore direct comparison to the antenna characteristics listed therein cannot be made. However, generally speaking, the equipment meets the revised specifications, reference (c), for power output. The maximum power output varied between 12.2 and 55 watts cw, and 11.7 and 54 watts phone carrier for output frequencies of 540 and 9050 Kc. respectively. Results of this test are contained in Tables 4 to 8, inclusive.

3-12 Tune Operate Switch

This switch is located on the transmitter front panel and has tune and operate (or full power) positions respectively:

(1) In the tune position it is impossible to disable the receiver or to operate the keying relay. In tune position the power is in every case more than 45 db down from full power output. The values varied between 46.6 and 62.7 db depending upon the output frequency. The results of this test are given in Table No. 11.

(2) In the full power position no r-f tubes oscillate when the key is up. Full plate power is applied to enable tuning of the P.A. and antenna and subsequent normal full power operation.

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3-13 Test Key

A test key is provided on the front panel. It is of the three position toggle switch type. In up position the key is locked. Center position is key open, and the bottom position is non-locking, making it possible to key the transmitter. This arrangement is considered satisfactory.

3-14 (a) During periods when the charging generator is not supplying the battery with power, or when the engine fails and the terminal voltage drops to 22 volts, the transmitter can be tuned and will operate at reduced power output. The dynamotor, keying relay and band change motor all work satisfactorily at voltages down to 15 volts. The indicator buttons on the pilot's control box work intermittently at 23.5 volts. These buttons do not work satisfactorily at less than 24 volts. Buttons B and C on the remote indicator box work satisfactorily at voltages as low as 20 volts. Button D will not work at voltages lower than 23 volts. Button A would not work at any voltage. However, the indicator buttons would not be essential for tuning or emergency operation at reduced voltage.

(b) No additional heater adjustment is supplied.

3-15 Emission Selection

A switch is provided on the transmitter panel to change from cw to mcw emission. Furthermore, there is a standby position which, when on, removes the high voltage from the tubes and permits the dynamotor to stop and the filaments to remain on. Voice control may be had when in cw, mcw, or standby positions either by closing the throttle or microphone switch.

3-16 Audio Characteristics

(1) When properly tuned and set on the voice position the overall audio frequency characteristics as measured between the output of

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3-16 (1) the microphone transformer and the transmitter output, when operating at full power with up to 75 percent modulation, did not vary more than 6 dbs between extremes over the frequency range of 400 to 3000 cycles. The maximum variation experienced occurred with re-submitted CXAR-4 at 600 Kcs. and was 6 db. Tests on CXAR-4 were made with values of modulation less than 75% because at that time the equipment was not capable of 75% modulation. Tests made on the re-submitted model, CXAR-3, were made at 75% modulation. The equipment under all conditions met the specification requirements for fidelity. Results of these tests are shown in Tables No. 12 through 21 and Plates 2 through 13.

(2) The total audio frequency distortion did not exceed 15% r.m.s. at full power when measured at 1000 cycles. The measurements were made at 75% modulation. The highest value recorded at 1000 cycles was 8.26%. At 400 cycles the maximum distortion was 15.3%. Specification requirements are met for audio frequency distortion. Results of these tests are contained in Tables No. 20, 21, and 22, and Plates 10 through 14.

(3) The transmitter is capable of 75% modulation with a microphone output of one (1) volt from the carbon microphone. Actually, 78% modulation at 1000 cycles was had with 0.45 volts r.m.s. from the microphone. When using the dynamic microphone, 0.016 volts r.m.s. was required for 78% modulation when measured at 1000 cycles. The equipment meets the requirements of the specification. Results of this test are shown in Tables No. 20 and 21 and Plates 10 through 13.

(5) Harmonics, key clicks, lilt and other objectionable radiations have been reduced to a minimum consistent with the limitations of the specifications. There is in this equipment a slight feedback above 7000 Kc. However, this does not seriously effect the emitted signal.

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3-17 Sidetone

(1) Selection of the type emission automatically changes to the proper sidetone signal which is furnished to two jacks located on the front panel marked "Operators Sidetone" and "Pilots Sidetone" through separate key relay contacts.

(2) The code sidetone frequency is approximately 1060 cycles.

(3) The impedance of the sidetone winding is the lowest practicable value. The sidetone winding impedance varied from an infinitely small value to 22 ohms on tap seven of the sidetone switch. Results of these measurements are shown in Table No. 23.

(4) The specifications require that the output of each sidetone winding shall be adjustable from 0.1 volt or less to approximately 8 volts as measured across a load of 2000 ohms for modulated signals with 75% modulation at 1000 cycles. Measurements were made in accordance with the above-mentioned requirements, except that the load was 300 ohms. The voltage varied between 0.251 and 7.34 volts in six steps. The minimum and maximum value does not meet the specification requirements. Furthermore, there is but one sidetone winding from which the output is fed simultaneously to both jacks. This is in violation of the specifications which require that there be two windings. Results of this test are shown in Table No. 23.

(5) As stated above, there is only one sidetone adjustment. Therefore, the voice and code sidetone can not be set to different levels as required by the specifications. The adjustment control is located inside and accessible only from the inside of the transmitter. One or more channels (depending upon the side of the screw driver used to turn the control) must be removed to gain access to the control.

(6) The design of the transmitter is such that feed-back howl or modulating the transmitter

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3-17 (6) when on C.W. or radiating the sidetone, interphone, or receiver output does not exist.

(7) Accidental shorting of the sidetone circuit will not damage the equipment.

3-18 Break-in Operation

(1) When the key relay is not energized it is possible to operate both associated receivers without interference from the transmitting equipment when in the operate position of the tune operate switch.

(2) Relay contacts are provided which disconnect the antenna lead-in from the receiver and which ground the receiver antenna input circuit when the key is closed to transmit. The capacitance of the receiver input leads to ground are a practical minimum.

3-19 Frequency Stability

(1) Tests were not made exactly in accordance with the new specifications (Edition B, 15 January, 1942) inasmuch as these tests were made before they were written. Operating conditions and procedure are discussed in detail elsewhere in the report.

(2) Humidity

The maximum frequency change encountered due to humidity was .0394%. This change occurred at 9000 Kc. Specification requirements limiting the frequency change to 0.12% below 3000 Kc. and 0.06% above 3000 Kc. are met in all cases. Power output was found to change as much as 20.9% for the intermediate frequency channels. This value is in excess of the 20% allowed by the specifications. However, due to the fact that the antenna load was exposed to the humidity change, the error in measurement may have been equal to or in excess of the amount by which the change in power output exceeded the specifications. More recent tests made by the manufacturer subsequent to final changes in the equipment

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3-19 (2) have shown that specification requirements for change in power output can be met. Results of these tests are shown in Tables 28, 29, 30, 31 and 32, and Plates 23, 24, 25, 26 and 27.

(3) Vibration

The equipment met the specification requirements of 0.04% maximum frequency change due to vibration at frequencies below 3000 Kc. and 0.02% at frequencies above 3000 Kcs. The maximum change in frequency was 0.0066% for an output frequency of 9000 Kc. Results of these tests are shown in Table No. 39.

(4) Temperature

The variation in emitted frequency per degree centigrade met the specification requirements in all cases. The maximum frequency variation due to temperature change in the intermediate frequency channels was 0.00397% and occurred at 40° centigrade while operating on 600 Kc. The maximum frequency change for the high frequency channels was 0.0022% and occurred at -20° centigrade while operating on 3000 Kc. The specifications require that the average variation in emitted frequency per degree centigrade shall not exceed 0.006% for frequencies below 3000 Kc. and 0.003% for frequencies above 3000 Kc. Results of these tests are shown in Tables No. 24 through 31, and Plates 15 through 22.

(5) M.O. Reset Accuracy

The requirements outlined in this paragraph were not included in the first edition of these specifications. No tests were made on M.O. Reset Accuracy.

(6) Channel Reset

After properly pretuning the transmitter, changing channels did not result in shifting the output frequency more than the specified 300 cycles for frequencies above 3000 Kc. and 600 cycles for frequencies below 3000 Kc.

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3-19 (6) The maximum change occurring for any channel was 32 cycles. Results of this test are contained in Table No. 37.

(7) Tune-Operate

The frequency difference between M.O. output frequency in tune position with all other stages detuned, and the M.O. output frequency in operate position with all other stages resonated is less than the allowed 1500 cycles at frequencies above 3000 Kc. and less than 3000 cycles at frequencies below 3000 Kc. The greatest deviation occurred at 9000 Kc. and was 1250 cycles.

Frequency change caused by changing from operate to tune position when all stages were resonated to the M.O. frequency was 1350 cycles at 9000 Kc. There were no requirements in the specifications for this test.

Results of these tests are contained in Table No. 38.

(8) Voltage Input

With input voltage of 28 volts, a change to 24 volts caused the emitted frequency to change to 0.0144% at 9000 Kc. The specifications permit a change of .02% for frequencies above 3000 Kc. and .04% for frequencies below 3000 Kc. Results of this test are contained in Tables 40 and 41 and Plate 28.

(9) Locked Key Operation

Specifications state that after a 15-minute filament warm-up period with the ambient temperature maintained between 25 and 35 degrees centigrade and with the transmitter operated with key locked at full power for a period of 15 minutes, the frequency shall not vary more than 0.02% with locked key for frequencies above 3000 Kc. For frequency ranges below 3000 Kc. this tolerance shall be doubled. Tests were made in accordance with the first edition of these specifications. The method of test is described in Methods of Test.

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3-19 (9) Frequency variation was determined as the difference in frequency with reference to any time between the end of the first five minutes and at the end of thirty minutes locked key operation. The greatest change recorded during these test was 0.0183% for an output frequency of 9000 Kc. The greater part of the frequency change occurs during the first ten minutes of operation. Tests made according to the new specifications are therefore more lenient than those specified in the first edition. Upon the basis of these tests it is believed that the equipment would easily meet the revised specifications as quoted above. Results of these tests are shown in Table No. 42 and Plates 29 to 33, inclusive.

(10) Roll and Pitch

The change in frequency due to the transmitter being inclined at an angle up to 45 degrees from the horizontal, in pitch and roll attitude, did not exceed the specified 0.005% of the frequency as measured with the transmitter in the level position. For frequency ranges below 3000 Kc. the allowed frequency change is 0.015%. The greatest frequency change experienced during these tests was 0.0029%. This change was measured for roll at 6000 Kc. Results of this test are shown in Tables No. 43, 44, and 45 and Plates 34, 35 and 36.

(11) Change of Master Oscillator Tubes

The average variation in frequency from the mean frequency was 0.0045% due to changing M. O. tubes picked at random from a group of tubes. The average deviation from the mean is defined as the sum of all deviations divided by the number of tubes. Similarly, changing the P. A. tube caused the emitted frequency to vary 0.0055% from the average. Measurements were made at 9000 Kc. output frequency. These figures meet the requirements of 0.025% and 0.015% maximum variation for the change of M.O. and P.A. tubes respectively. For frequencies below 3000 Kc. the above tolerances shall be doubled.

(12) Altitude

The frequency change due to change in atmospheric pressure from normal to 14 inches of

3-19 (12) mercury (approximately 20,000 feet) while operating in a -23° C. ambient was only ten cycles. When the pressure was restored to 30 inches of mercury, the frequency changed 0.007%. Operation at this altitude (approximately 20,000 feet) and temperature (-23° C.) was satisfactory in all respects. This test was not required by the specifications. Results of this test are given in Table No. 48 and Plate 37.

(13) Power Amplifier and Antenna Reaction: The change in M.O. frequency due to detuning the P.A. by an amount resulting in a 25% change in plate current was 1700 cycles or .0189% while operating at 9000 kc. Similarly the antenna reaction changed the M.O. frequency 495 cycles or .0055%. Results of this test are given in Tables 46 and 47.

3-20 (1) Microphone and Throttle Switch Circuit: The equipment is adapted to the use of a carbon microphone capable of one (1) volt, 1000-cycle output at approximately 75 ohms impedance, or a magnetic microphone which is 50 db down, and whose impedance at 1000 cycles is 100+j270 ohms, and whose output is 50 millivolts into an open circuit and 25 millivolts into a 700-ohm load. The equipment contains the necessary amplification for the magnetic microphone. Change from one microphone to another is an installational adjustment and entails a minimum amount of time practicable. Changing the circuit is accomplished in a few minutes by removing the side panel to gain access to the two links which must be changed in order to use the other microphone.

(2) The microphone jack is located on the front of the transmitter and is of the non-locking type.

(3) The throttle switch does not meet the specifications inasmuch as it is of the non-locking type. It is located on the transmitter face. The throttle switch closes the microphone control circuit to ground.

(4) Closing the microphone or throttle switch starts the dynamotor in voice operation.

3-21 Keying Circuits: The key jack is located on the front of the transmitter and is of the locking type. Closing the key operates the key relay.

3-22 (1) Transmitter Layout: The overall dimensions of the transmitter do not exceed the following specified dimensions.

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3-22 (1) (1) Width 23-3/8 inches
(2) Height 10-7/8 inches
(3) Depth 13-9/16 inches

including protrusions but not including plugs. Dimensions are given in Table No. 1.

(2) The specified receptacles, antenna, ground, and receiver input connections are located on the left end of the transmitter. Markings on or near the various binding posts indicate their use, namely: Ground, Receiver, and Antenna.

(3) Two sidetone jacks, microphone jack, throttle jack and key jack are located on the transmitter face. All except the microphone jack are of the locking type.

(4) The test key is located on the left of the transmitter face.

(5) The "C.W.-M.C.W.," "phone-off-code," channel selector, and battery - P.A. grid current meter are located on the right side of the front panel of the transmitter. The "local-remote" and "tune-operate" switches are located on the left side of the front panel of the transmitter.

(6) Four plug-in tuning units are inserted through openings in the transmitter and are securely attached in place by means of two thumb screws which can be removed without use of tools.

(7) Conveniently located handles are located on the transmitter front, which should also serve as rests for the transmitter when on its face for servicing. However, the handles are not of sufficient depth to afford protection for all the switches and tuning controls. An additional 1/4 inch in depth is needed to meet this requirement.

(8) Bristo set screw wrenches are conveniently located and attached inside the transmitter case.

(9) A properly marked C.F.I. post is provided on the transmitter face.

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3-22 (10) The transmitter frame is constructed of aluminum angle. Top, rear, bottom, left and right shields are removable and are secured to the frame with binder head screws.

(11) The rear, left and right shields are louvred. The bottom shield is perforated. The equipment does not meet the specification requirement that the transmitter shall be splash-proof from 45 degrees up to the vertical. It is necessary that there be ventilation in the equipment to prevent overheating. The equipment is considered satisfactory in this respect.

(12) The two male mounting tracks are fastened to the bottom side of the transmitter with rubber shock mounts. The two female mounting tracks are to be secured to the airplane construction. The mounting tracks are 17-3/4 inches center to center, left to right, as required by the specifications.

(a) Each female mounting track has two rows of five No. 8 flat head mounting holes, 2-1/8 inches between centers, front to rear, and the rows are spaced 3/4 inch between centers left to right.

(b) The centers of the rear mounting holes are 5/8 inch from the extreme rear of the transmitter frame. The center of the right mounting track is 1-5/8 inches from the right hand end of the transmitter frame. These mountings are such that the equipment is interchangeable with GP-6 equipment.

The foregoing features are in accordance with the specification requirements.

(13) Three receptacles are located, in accordance with the specification requirements, on the left face of the transmitter near the bottom edge. Reading from front to rear, they receive plugs for the following cables: transmitter to dynamotor, transmitter to pilot's control box, and transmitter to indicator box.

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3-23 (1) Pilot's Control Box: Measurements of this unit, exclusive of controls, are as follows:

	Height	Depth	Width
Actual	5-11/16"	2-1/4"	2-5/8"
Specifications	5-7/8"	2-1/4"	2-5/8"

The dimensions of the control box meet the specified limits.

(2) The following controls as required by the specifications are mounted on the front face of the pilot's control box:

(a) "Phone-off-code" toggle switch.
(b) Indicator button.
(c) 4-position channel switch.

(3) A built-in telegraph key is mounted on the top face of the unit.

(4) On the bottom face of the unit there are mounted a microphone jack and a receptacle for the cable from pilot box to the transmitter.

(5) The rear face of the unit is to be attached to the plane with four No. 8 screws. The pilot's box is secured to the rear face with three non-losable screws with knurled heads.

(6) When the transmitter local-remote switch is in the remote position, the pilot's "phone-off-code" switch is operative. When the switch is placed in the code position, filament voltage is applied and the transmitter dynamotor starts. When this switch is in the phone position, filament voltage is applied and the dynamotor starts when the microphone control switch or the throttle switch is closed on the pilot's box or the transmitter.

(7) The pilot's box indicator button protrudes from the panel only when the "phone-code" switch is closed on phone or code, and the transmitter "local-remote" switch is on remote position. It thus indicates to the pilot when he has control and when the transmitter is operative.

(8) The pilot's box channel selector switch is operative when the transmitter local-remote switch is in the remote position. This switch selects the desired channel in the transmitter.

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3-23 (9) The telegraph key controls the key relay when the transmitter is operated by the pilot or the operator.

(10) The microphone inserted in the microphone jack is operative when the transmitter is started by the pilot or the operator. All specification requirements are met for the pilot's control unit.

3-24 Operator's Remote Indicator Unit

(1) Dimensions of the remote indicator box, exclusive of screws and receptacle, are as follows:

Actual	Specifications
2-3/4 inches high	2-3/4 inches high
1-11/16 inches deep	1-11/16 inches deep
2-5/16 inches wide	2-5/16 inches wide

(2) Four indicator buttons are mounted on the front face of the unit.

(3) On the bottom face of the unit a receptacle is mounted for the cable from the indicator unit to the transmitter.

(4) The rear face of the unit is to be secured to the plane with three No. 8 machine screws. The indicator unit is secured to its rear face with two non-losable screws with knurled heads.

(5) When the transmitter is operated by either the pilot or the operator, a button protrudes from the panel indicating the operative channel. If power is removed from the transmitter, no buttons protrude through the panel.

Indicator button A on CXAR-4 was inoperative throughout the tests. It was found that button D would not work satisfactorily at voltages less than 23 volts. It is understood that the manufacturer has taken steps to improve the design of the indicators. The operator's remote indicator unit meets specification requirements except for size and freedom from mechanical trouble.

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3-26 Transmitter Local Control Circuits:

(1) When the transmitter "local-remote" switch is in the local position, the operator has control of:

(a) Starting and stopping the transmitter.
(b) Selection of phone or code emission.
(c) Selection of the r-f channel.

When the "local-remote" switch is in the remote position, these functions are transferred to the pilot. However, inasmuch as the operator has control of the local-remote switch, he could at any time assume control of the transmitter by changing the switch position.

(2) When the operator has control he may place the "phone-off-code" switch in the code position. This applies filament and control power to the transmitter and starts the dynamotor. When this switch is in the off position, no power is drawn from the battery. When the dynamotor is started, code emission is secured by closing the test key, the operator's key, or the pilot's telegraph key, thus closing the keying relay.

(3) When the "phone-off-code" switch is in the phone position, filament and control power are applied to the transmitter. The dynamotor will not start until the microphone control circuit is closed by the pilot or the operator operating their microphone switch or closing the throttle switch. Closing the microphone control circuit starts the dynamotor, arranges the audio circuit for phone operation and closes the keying relay cuasing the phone carrier emission.

(4) When filament power is applied in either phone or code operation, the operator may select the desired r-f channel by operation of the channel selector switch. A rotating drum channel indicator is secured to the front panel of the transmitter. This indicator is mechanically connected to the channel switch so as to indicate the position of this switch in either local or remote control. A manual channel switch control is accessible from the right end of the transmitter. This control operates the channel switch if power is not available from the battery.

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3-26 (5) An emission selector switch selects either cw or mcw emission during code operation. This switch is mounted to the transmitter front panel and is controlled by the operator only.

(6) A meter switch is provided on the transmitter front panel. This switch is spring loaded to normally connect the meter to indicate P.A. grid current. When the switch lever is depressed the meter indicates battery voltage when filament and control voltage has been applied to the transmitter.

(7) A tune-operate switch is provided on the transmitter front panel. When it is in tune position, plate voltage is removed from the P.A. to prevent carrier emission during the tuning period, plate voltage is removed from the modulator and audio driver stages to prevent sidetone emission and modulator over-voltage stresses. When the "tune-operate" switch is in the operate position, the above voltages are applied through the contacts of the keying relay where necessary for control purposes.

(8) A sidetone signal is available at the operator's and pilot's sidetone jacks mounted on the transmitter front panel. The circuits to these two jacks are individually broken by contacts on the keying relay when this relay is de-energized. No sidetone signal is available when the "tune-operate" switch is in the tune position. When code operation is secured, the sidetone signal is an audio tone of approximately 1000 cycles. When voice operation is secured, the sidetone signal reproduces the microphone signal originating in either the pilot's or the operator's microphone.

IV.

DYNAMOTOR

4-1 The transmitter dynamotor unit contains its starting relay and fuses, and functions also as the transmitter junction box. The dynamotor, including receptacles and its mounting, has the following dimensions:

Actual	Specifications
8-3/8 inches high	8-7/16 inches high
10-9/16 inches long	10-5/8 inches long
6-5/16 inches wide	8-1/4 inches wide

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4-2 The dynamotor withstood operation under all types of transmitter emission in a locked key condition, continuously operated for periods up to twelve hours on numerous occasions. The only dynamotor failure experienced throughout the tests occurred shortly after tests were initiated. This failure was attributed to a mechanical defect during process of manufacture resulting in a shorted turn in the 28-volt winding. The dynamotor is, therefore, capable of continuous duty under service conditions of operation without damage. The temperature rise did not reach a point to damaging part of the machine when loaded with the maximum load encountered, and with this maximum maintained for a period of 30 minutes, with an input voltage of 28 volts at the bus. Oiling and maintenance instructions are not stamped inside the dynamotor and covers as required by the specifications.

4-4 During the tests on subject equipment the dynamotor performed satisfactorily in excess of 500 hours, without adjustments or additions of lubricants.

4-5 The brushes are conveniently accessible for inspection and replacement without extensive disassembly. The brush holders are set and locked into position to insure optimum commutation. The method of setting and locking the brush holders is such that the original position can not be changed or shifted during overhaul. The design is such that there are no springs, pigtail connections, etc., exposed to the outside.

4-6 The filtering and shielding of this equipment is such that no serious interference was noticed in the associated receiving equipment. Satisfactory performance was had throughout the temperature range of +60° to -52° C.

At any load normally encountered under service conditions the ripple was not in excess of 3 per cent as measured between the average output voltage and r-m-s ripple voltage. The transmitter was operated full load cw and the

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4-6 measurements taken on the load side of all filter circuits. The subject equipment was not available for final test. Dynamotor ripple as taken from data submitted by the manufacturer was 0.4%. Dynamotor test data is contained in Tables Nos. 3 and 49.

4-7 Fuses: The 28-volt and high voltage circuits to the transmitter are separately fused and located in this unit with spare fuses conveniently located nearby.

CABLES, PLUGS AND LINKAGES

5-1 All cables used for interconnecting the various units of the equipment are of the internal shielded type with a tough rubber outer jacket.

5-2 The cables meet all specified requirements except as to length. Measurements are as follows:

Cable Assembly	Length	Specifications
(a) Airplane junction box to dynamotor	94"	120"
(b) Transmitter to dynamotor	70"	120"
(c) Transmitter to control box	130"	180"
(d) Transmitter to remote indicator box	56"	120"

Detailed cabling drawings showing numbering and color coding details were not furnished with the equipment.

5-3 Connector plugs are of the die-cast construction, straight or angle type as specified. Plugs are designed to fit only in the correct position and arranged so that shocks or short circuits will not result even if the plug comes in contact

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5-3

with a flat metal surface. Attachment plugs are suitable for accommodating a ground wire in the cable. The connecting plug housing and cable shielding are grounded. The shells have a finish similar to the natural color of the metal.

CONCLUSIONS

(a) The Model CXAR Equipment is considered suitable for use in Naval Aircraft providing the following minor changes are corrected in the production equipment.

(b) The equipment was previously submitted for test in compliance with reference (b) and reported in reference (a), the transmitter was redesigned and resubmitted for test in compliance with revised specifications, reference (c).

(c) Temperature stability of .001% per degree centigrade for a ten degree change in ambient temperature was obtained over a temperature range from 50° to -30° C. after considerable experimentation with compensating condensers and power amplifier tank condenser design. As the master oscillator circuits utilize phenolic coil forms in place of ceramic insulation, it is expected that stability of .001% will not be obtained with production equipment but will not exceed .003% as specified in reference (c). Production equipment should be checked at reasonable intervals to determine performance as frequency drift in excess of .003% reduces the advantage of frequency channel selection.

(d) The power output is less than that obtained with single channel equipment. CW output power from 9.6 to 55 watts is obtained over the frequency range 3000 to 9050 kc. when working into antenna characteristics from 100 to 300 mmf. and 2 to 40 ohms.

(e) The reduced power is attributed to the limited space available for 4-channel operation which requires four M.O. and P.A. circuits and associated variometers and condensers with reduced space protection for voltage flashovers, particularly for voice operation.

(f) During locked key, temperature and humidity tests, and while operating under vibration, erratic frequency changes ranging from 300 to 700 cycles were prevalent even after the channel changing switch contacts had been changed. This trouble was sometimes cleared for a short time by cleaning the contacts but would reappear after several hours of operation. Shocks made the frequency change 300 to 500 cycles. Several "shocks" were often required to make the frequency set.

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(g) Backlash of the M.O. dial changed the frequency 500 cycles and the reset accuracy was within 100 cycles. Locking the M.O. dial caused the emitted frequency to change 200 to 300 cycles depending upon the direction from which the frequency had been approached.

(h) Erratic frequency instability caused by jarring the equipment or after several hours operation should be kept to a minimum on production equipment.

(i) Ceramic condensers in the h-f channels were found to be secured by string. A more permanent means of mounting should be provided.

(j) Finger spring contacts on the channel switching assembly appear to be weak and should be strengthened.

(k) Instruction books should state clearly the procedure to be followed when cleaning contacts, and how often cleaning should be necessary to insure against failure during flight operations.

(l) Intermittent trouble was experienced with the contacts on the plug-in channels. It was observed that a metal contact similar in appearance to brass had been used for the contacts and switching assembly. Corrosion formed on the contacts causing erratic frequency instability. The contacts were replaced with coin silver which improved operation, but was not entirely satisfactory. The contacts required occasional cleaning for stable performance. It is possible that this trouble may be due in part to the close proximity of the tubes which furnish considerable heat and which may effect the spring pressure of the contact arm. This condition should be observed on the production equipment to insure of continued dependable operation.

(m) The M.O. dials caused excessive frequency shift and were replaced with an improved type dial that practically eliminated backlash.

(n) The tune operate switch was not considered satisfactory and was replaced with another of improved design which proved satisfactory.

(o) The indicator buttons on the remote indicator box do not work properly. These buttons must be adjusted

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so that their operation is positive at temperatures of -30° Centigrade.

(p) Interaction between the master oscillator, power amplifier and output circuits exists above 7000 kcs. While this was not considered serious on the model, observations should be made at intervals on production equipment to insure that interaction of this nature does not become excessive.

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TABLE NO. 1

Model CXAR - 3 and 4

Weights and Dimensions

Unit	Width		Height		Depth		Weight*	
	Actual	Specified	Actual	Specified	Actual	Specified	Actual	Specified
Transmitter	21 9/16"	23 3/8"	10 13/16"	10 7/8"	13 9/16"	13 9/16"	72.6 lbs.	-
Pilot's Control box	2 5/8	2 5/8	5 11/16	5 7/8	2 1/4	2 1/4	1.0 lbs.	-
Remote Indicator box	2 5/16	2 5/16	2 3/4	2 3/4	1 11/16	1 11/16	0.5 lbs.	-
Dynamotor	6 5/16	8 7/16	8 3/16	8 7/16	10 9/16	10 5/8	25.7 lbs.	-
					Total Weight		98.8 lbs.	104 lbs.

Cables

Cable	Length		Weight*
	Actual	Specified	
Airplane Junction Box to Transmitter	94 in.	120	2.4 lbs.
Transmitter to Dynamotor	70 in.	120	2.2 lbs.
Transmitter to Control Box	130 in.	180	4.7 lbs.
Transmitter to Remote Indicator	56 in.	120	1.4 lbs.
	Total Weight		10.7 lbs.

*Weights as tabulated were measured before final changes had been made in the equipment.

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TABLE NO. 2

Model CXAR - 3
M.O. Calibration Accuracy

Channel	Frequency Range kc.	Calibration Frequency kc.	Actual Frequency kc.	Frequency Difference Cycles	Frequency Difference %
A	540/1500	540	539.2	+800	0.148
A	540/1500	1500	1500.58	-580	0.039
G	1500/3000	1500	1525.8	+25800	1.72
G	1500/3000	3000	2999.68	-315	0.01
C	3000/9050	3000	3053.5	+53500	1.78
C	3000/9050	9050	9452.0	+102000	1.13
J	9050/15800	9050	9032.0	+18000	0.2
E	3000/9050	3000	2998.4	-1600	0.053
E	3000/9050	9050	9172.0	+122000	1.35

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TABLE NO. 3

Model CXAR - 4
(Test Data Submitted by Manufacturer)

Power Input

Measurements made with 28 Volts at Bus.
Transmitter Tuned to 3000 Kc. P.A. loaded to 120 M.A.

Operation	Amperes	Watts
Phone (normal modulation)	19.0	533.0
Phone Carrier	18.5	517.0
MCW key closed	19.6	548.0
CW key closed	17.6	493.0
CW key open	9.3	260.0
CW tune position	11.2	312.0
Starting current	50.0	1400.0
Filament current	4.5	126.0
380 volt supply CW key open	0.008	3.04
CW key closed	0.150	57.0
MCW key closed	0.395	150.0
Phone carrier	0.225	85.5
MCW key open	0.110	41.8
Phone modulated	0.370	140.6
1000 volts supply CW key open	0.005	5.0
CW key closed	0.134	134.0
MCW key open	0.005	5.0
MCW key closed	0.120	120.0
Phone carrier	0.130	130.0
Phone modulated	0.125	125.0

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TABLE NO. 4

Model CXAR - 3

Power Output
(28 Volts Primary Supply Voltage)

Channel	Frequency Kc.	Antenna Ohms	Antenna μμf	Output Watts CW	Output Watts Phone Carrier
540/1500 Kc.	540	13.3	300	12.23	11.73
		8.36	200	*	*
		40.8	150	*	*
		1.99	100	*	*
	1500	13.3	300	42.6	40.3
		8.36	200	22.7	21.8
		40.8	150	45.8	44.1
		1.99	100	4.18	4.18
1500/3000 Kc.	1500	13.3	300	37.0	35.8
		8.36	200	33.0	31.7
		40.8	150	30.2	30.2
		1.99	100	5.4	5.22
	3000	13.3	300	11.9	11.9
		8.36	200	13.18	13.18
		40.8	150	12.17	12.17
		1.99	100	8.75	8.38
3000/9050 Kc.	3000	13.3	300	43.0	42.1
		8.36	200	44.8	43.4
		40.8	150	28.1	27.4
		1.99	100	10.3	10.35
	9050	13.3	300	45.5	44.0
		8.36	200	28.0	27.07
		40.8	150	55.0	54.0
		1.99	100	9.62	9.2
9050/15800 Kc.	9050	13.3	300	42.6	42.1
		8.36	200	30.1	28.6
		40.8	150	12.34	12.34
		1.99	100	9.2	8.95

*Transmitter could not be tuned into antenna having these characteristics at this frequency.

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TABLE NO. 5

Model CXAR - 4

Power Output
Channel A Position A

Frequency Kc.	Antenna Ohms	Antenna µµf	Power Output CW	Power Output MCW
540	40	100	*	*
		300	15.4	19.6
		500	22.5	26.3
	6	100	*	*
		300	18.4	**
		500	27.8	33.7
1500	40	100	35.3	36.9
		300	40.0	40.9
		500	13.0	15.4
	6	100	10.8	11.9
		300	13.2	13.7
		500	2.94	3.84

*Transmitter could not be tuned to antenna having these characteristics at this frequency.

**Antenna load capacitor arced over.

The above tests were made before final changes were made in the equipment.

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TABLE NO. 6

Model CXAR - 4

Power Output
Channel C Position C

Frequency Kc.	Antenna Ohms	Antenna μμf	Power Output CW	Power Output MCW
3000	40	100	37.7	42.5
		300	26.9	29.6
		500	17.4	22.5
	6	100	25.2	27.8
		300	45.1	52.0
		500	43.1	50.4
	2	100	10.3	10.6
		300	31.9	33.7
		500	19.35	22.0
	1	100	13.1	13.8
		300	18.6	22.1
		500	5.3	6.25
9050	40	100	43.3	46.7
		300	48.4	52.0
		500	49.4	52.0
	6	100	16.95	17.6
		300	29.0	30.1
		500	31.5	35.4
	2	100	7.6	8.0
		300	14.4	14.8
		500	16.4	17.1
	1	100	4.0	4.33
		300	7.85	8.07
		500	8.59	9.2

These tests were made before final changes were made in the equipment.

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TABLE NO. 8

Model CXAR - 4
Power Output
Channel E Position B

Frequency Kc.	Antenna Ohms	Antenna µµf	Power Output CW	Power Output MCW
3000	40	100	36.8	45.0
		300	29.6	34.6
		500	23.1	26.3
	6	100	25.3	26.5
		300	48.0	50.4
		500	34.0	39.7
	2	100	9.7	10.5
		300	30.0	35.3
		500	15.6	17.1
	1	100	4.41	4.45
		300	19.75	20.5
		500	9.35	10.3
9050	40	100	43.3	45.0
		300	48.5	52.0
		500	49.3	50.2
	6	100	13.9	14.4
		300	26.3	26.7
		500	28.8	29.6
	2	100	7.23	7.78
		300	14.1	14.7
		500	15.0	15.7
	1	100	3.65	3.93
		200	7.29	7.9
		300	8.64	8.93

These tests were made prior to final changes in the equipment.

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TABLE NO. 9

Model CXAR - 3
Power Output vs. Bus Voltage
CW Operation
(Antenna Resistance 8.36 Ohms)

Channel	Frequency Kc.	Bus Voltage	P.A. Plate Current	Antenna Watts
A	540	28	50	13.02
A	540	23	42	10.01
A	1500	28	119	28.6
A	1500	23	100	18.75
G	1500	28	122	14.1
G	1500	23	102	8.36
G	3000	28	122	20.0
G	3000	23	102	12.0
C	3000	28	120	24.2
C	3000	23	100	14.1
C	9050	28	120	22.7
C	9050	23	102	14.1
J	9050	28	70	28.6
J	9050	23	60	18.75

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TABLE NO. 10

Model CXAR - 4
Power Output vs. Bus Voltage
CW Operation

Channel	Frequency Kc.	Bus Voltage Volts	Output Watts	% Change Output 28 - 23V
A	600	30.0	22.2	0.653%
		28.0	19.6	
		26.0	16.3	
		24.0	13.7	
		22.0	11.6	
		21.0	4.7	
		20.5	3.0	
		20.0	0.0	
B	1440	30.0	21.3	0.025%
		28.0	18.8	
		26.0	11.1	
		24.0	8.7	
		23.0	4.7	
		20.0	2.09	
C	9000	30.0	31.3	0.438%
		28.0	24.7	
		26.0	21.3	
		24.0	17.3	
		22.0	4.2	
		20.0	1.34	

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TABLE NO. 11

Model CXAR - 3
Power Output
Tune Position

Antenna Resistance 8.36 Ohms

Channel	Frequency Range	Frequency Kc.	Antenna Current	Diode Current I Operate	Diode Current I Tune	Current Ratio	DB
A	540-1500	1500	1.62 a.	1.25 ma.	1 µa.	1250	62
A	540-1500	600	1.63 a.	1.2 ma.	3 µa.	400	52
G	1500-3000	3000	1.41 a.	1.2 ma.	1 µa.	1200	61.6
G	1500-3000	1500	1.19 a.	.9 ma.	1 µa.	900	59.1
C	3000-9050	3000	1.78 a.	1.48 ma.	2 µa.	740	57.4
C	3000-9050	9000*	1.71 a.	1.6 ma.	7.5 µa.	233	46.6
J	9050-15800	9000*	1.41 a.	1.37 ma.	1 µa.	1370	62.7

*Measurements made across resistance only.

Specifications: In the tune position the power output shall be at least 45 db down from full power output.

[redacted]

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[redacted]

TABLE NO. 12

Model CXAR - 4
Audio Characteristics
Fidelity

Channel A Position A 600 Kc.
Antenna: Resistance 8.36 Ohms Capacity 300 μμf
P.A. Plate I 88 MA. Mike Voltage .4 Volts
With 400 Cycles, Modulation 40%, Power Output 18.8 Watts

Modulation Frequency-Cycles	Decibels
100	-10.2
200	- 2.8
300	- 1.15
400	0.0
600	1.4
800	1.7
1000	2.15
1250	1.75
1500	1.6
2000	0.9
2500	0.0
3000	- 0.9
4000	- 3.45
6000	- 8.9
8000	-14.4
10000	-19.2
15000	-20.95

Maximum variation between 400 and 3000 cycles is 3.05 db.

Specifications: 6 db. allowed variation.

[redacted]

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TABLE NO. 13

Model CXAR - 4
Audio Characteristics
Fidelity

Channel A Position A 600 Kc.
Antenna: Resistance 8.36 Ohms Capacity 300 μμf
P.A. Plate I 50 MA. Mike Voltage .4 Volts
With 400 Cycles, Modulation 55%, Power Output 10.1 Watts

Modulation Frequency-Cycles	Decibels
100	-11.38
200	- 4.1
300	- 1.2
400	0.0
600	1.2
800	1.45
1000	1.2
1250	0.8
1500	0.0
2000	- 1.4
3000	- 4.6
4000	- 8.0
6000	-14.0
8000	-18.8
10000	-20.9
15000	-22.48

Maximum variation between 400 and 3000 cycles is 6 db.

Specifications: 6 db. allowed variation.

[redacted]

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TABLE NO. 14

Model CXAR - 4
Audio Characteristics
Fidelity

Channel A Position A 1440 Kc.
Antenna: Resistance 6 Ohms Capacity 300 μμf
P.A. Plate I 100 MA. Mike Voltage .4 Volts
With 400 Cycles, Modulation 40%, Power Output 13.44 Watts

Modulation Frequency-Cycles	Decibels
100	-10.8
200	- 4.0
300	- 1.3
400(Reference point)	0.0
600	1.0
800	1.3
1000	1.4
1250	1.3
1500	0.89
2000	0.0
3000	- 2.5
4000	- 5.6
6000	- 8.9
8000	-13.0
10000	-16.5
15000	-24.9

Maximum variation between 400 and 3000 cycles is 3.9 db.

Specifications: 6db. allowed variation.

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TABLE NO. 15

Model CXAR - 4
Audio Characteristics
Fidelity

Channel A Position A 1440 Kc.
Antenna: Resistance 6 Ohms Capacity 300 μμf
P.A. Plate I = 100 MA. Mike Voltage = .52 Volts
With 400 Cycles, Modulation = 57.2%, Power Output = 18.6 Watts

Modulation Frequency-Cycles	Decibels
100	-15.9
200	- 3.1
300	- 1.0
400	0.0
600	0.4
800	0.6
1000	0.5
1250	0.2
1500	0.0
2000	- 1.9
3000	- 2.9
4000	- 5.0
6000	- 9.1
8000	-12.6
10000	-16.5
15000	-26.0

Maximum variation between 400 and 3000 cycles is 3.5 db.

Specifications: 6 db. allowed variation.

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TABLE NO. 16

Model CXAR - 4
Audio Characteristics
Fidelity

Channel E Position D 3000 Kc.
Antenna: Resistance 6 Ohms Capacity 300 µµf
P.A. Plate I = 120 MA. Mike Voltage = .4 Volts
With 400 Cycles, Modulation 37%, Power Output 34.6 Volts

Modulation Frequency-Cycles	Decibels
100	-12.02
200	- 4.04
300	- 1.22
400	0.0
600	0.98
800	1.22
1000	1.52
1250	1.44
1500	1.22
2000	0.89
3000	- 0.58
4000	- 2.28
6000	- 6.0
8000	- 9.18
10000	-11.72
15000	-16.48

Maximum variation between 400 and 3000 cycles is 2.1 db.

Specifications: 6 db. allowed variation.

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TABLE NO. 17

Model CXAR - 4
Audio Characteristics
Fidelity

Channel E Position D 3000 Kc.
Antenna: Resistance 6 Ohms Capacity 300 μμf
P.A. Plate I 50 MA. Mike Voltage .4 Volts
With 400 Cycles, Modulation 47%, Power Output 6.61 Watts

Modulation Frequency-Cycles	Decibels
100	-10.5
200	- 2.86
300	- 0.89
400	0.0
600	0.828
800	0.828
1000	0.828
1250	0.66
1500	0.26
2000	- 0.5
3000	- 2.4
4000	- 2.68
6000	- 9.6
8000	-12.0
10000	-14.8
15000	-20.0

Maximum variation between 400 and 3000 cycles is 3.23 db.

Specifications: 6 db. allowed variation.

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TABLE NO. 18

Model CXAR - 4
Audio Characteristics
Fidelity

Channel E Position D 9000 Kc.
Antenna: Resistance 8.36 Ohms, Capacity 300 µµf
P.A. Plate I 120 MA. Mike Voltage .4 Volts
With 400 Cycles, Modulation 27%, Power Output 17.5 Watts

Modulation Frequency-Cycles	Decibels
100	-12.0
200	- 3.75
300	- 0.9
400	0.0
600	1.1
800	1.6
1000	1.9
1250	1.9
1500	1.6
2000	1.2
2500	0.7
3000	0.35
4000	- 2.1
6000	- 6.0
8000	- 9.13
10000	- 9.1
15000	-18.0

Maximum variation between 400 and 3000 cycles is 1.9 db.

Specifications: 6 db. allowed variation.

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TABLE NO. 19

Model CXAR - 4
Audio Characteristics
Fidelity

Channel E Position D 9000 Kc.
Antenna: Resistance 8.36 Ohms Capacity 300 μμf
P.A. Plate I 50 MA. Mike Voltage .4 Volts
With 400 Cycles, Modulation 52.4%, Power Output 6.02 Watts

Modulation Frequency-Cycles	Decibels
100	-13.56
200	- 4.4
300	- 1.6
400	0.0
600	0.5
800	0.9
1000	0.7
1250	0.2
2000	- 1.4
2500	- 2.5
3000	- 3.75
4000	- 6.0
6000	-10.4
8000	-14.0
10000	-16.5
15000	-22.5

Maximum variation between 400 and 3000 cycles is 4.65 db.

Specifications: 6 db. allowed variation.

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TABLE NO. 20

Model CXAR - 3

Audio Frequency Response and Distortion

DYNAMIC MICROPHONE

Output Frequency 3000 Kc.

Antenna: Resistance 8.36 Ohms Capacity 100 μμf
Carrier Current 1.78 Amperes
Modulated Carrier Current 1.99 Amperes

(Microphone Input Held Constant at .016 Volts R. M. S.)

OVERALL

Frequency Cycles	400.0	600.00	1000.0	1500.0	2000.00	3000	4000
Frequency Response db.	0	1.73	2.4	2.2	1.87	0.98	-0.2
% Modulation	59.0	72.00	78.0	76.0	73.00	66.0	57.0
% T.H.D	15.3	9.86	5.2	3.46	2.63	2.0	1.8
Carrier Hum db			-44.3				

SIDETONE OUTPUT

Sidetone switch position 5. Load impedance 300 ohms.
Output 55 M.W. at 1000 cycles. Microphone input .016 Volts R.M.S.

Frequency Cycles	400	600	1000	1500	2000	3000	4000
Frequency Response db.	0	.98	.29	1.44	1.29	1.29	1.21
Output Volts R.M.S.	3.4	3.8	3.95	4.0	3.95	3.95	3.92
% Total Harmonic Distortion	8.22		7.8				9.75

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TABLE NO. 21

Model CXAR - 3

Audio Frequency Response and Distortion

CARBON MICROPHONE

Output Frequency 3000 Kc.

Antenna: Resistance 8.36 Ohms Capacity 100 μμf
Carrier Current 1.56 Amperes
Modulated Carrier Current 1.79 Amperes

(Microphone input held constant at .45 Volts R. M. S.)

OVERALL

Frequency Cycles	400	600	1000	1500	2000	3000	4000
Frequency Response db.	0	1.8	3.0	3.3	3.3	2.5	1.45
% Modulation	55	67	78.0	80	80	73	65
% T.H.D.	14.2	10.63	8.26	7.12	6.45	5.72	4.8
Carrier Hum db.			-39.8				

SIDETONE OUTPUT

Sidetone switch position 5. Load impedance 300 ohms.
Output 85 M.W. at 1000 cycles. Microphone input .66 Volts R.M.S.

Frequency Cycles	400	600	1000	1500	2000	3000	4000
Frequency Response db.	0	.84	1.24	1.42	1.58	1.82	2.04
Output Volts	4.5	4.95	5.2	5.3	5.4	5.55	5.7
% Total Harmonic Distortion	6.06	4.36	8.63	5.53	5.77	6.14	6.18
Carrier Hum db.			-46				

Specifications:
Overall audio frequency response - maximum variation not to exceed 6 db. between 400 and 3000 cycles.
Total audio frequency distortion shall not exceed 15% r.m.s. when measured at 1000 cycles modulated 75%.
The carrier shall be capable of 75% modulation with one (1) volt output from the carbon microphone.

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TABLE NO. 22

Model CXAR - 4
Audio Characteristics
Total Harmonic Distortion

Channel A Position A 600 Kc.
Antenna Resistance 8.36 Ohms, Capacity 300 μμf
P.A. Plate I 90 MA. Mike Voltage .4 Volts
At 400 Cycles, Modulation 32.1% Power Output 20.5 Watts

Modulation Frequency c.p.s.	DB	Percent Total Harmonic Distortion	Percent Modulation
200	-4.3	7.0	21.5
300	- .8	6.5	27.3
400	0.0	6.0	32.1
600	1.15	6.0	39.9
800	1.0	5.5	43.3
1000	1.85	6.0	42.1
1500	1.7	6.0	42.0
2000	1.35	6.0	40.2
3000	- .35	6.0	34.6
4000	-2.85	6.5	25.9

Specifications: T.H.D. shall not exceed 15% when measured at 1000 cycles and 75% modulation.

Note: These measurements were made before the final changes were made in the equipment. It was not capable of 75% modulation.

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TABLE NO. 23

Model CXAR - 3

Sidetone Output With Carbon Microphone
Microphone Input .45 Volts R.M.S. at 1000 Cycles

Output Frequency 3000 KC

Antenna: Resistance 8.36 Ohms
Capacity 100 μμf

Sidetone Load Impedance 300 Ohms

Sidetone Switch Position	Sidetone Output Volts 1000 Cycle Phone	MCW	CW	1000 Cycle Phone* Sidetone Z (Ohms)
1	0.251	0.4	0.388	
2	0.49	0.83	0.83	0.3
3	1.01	1.64	1.64	0.75
4	1.97	2.84	3.33	2.4
5	3.83	6.4	6.5	7.0
6	7.34	12.5	12.1	22.0

*The sidetone impedance was determined to be that impedance which gave an output voltage equal to one-half the output voltage secured with open circuit.

Specifications: The impedance of the sidetone winding shall be of the lowest value practicable.

[redacted]

[redacted]

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TABLE NO. 24

Model CXAR - 4
Frequency Stability vs. Temperature
Channel A Position A 600 Kc.

Antenna: Resistance 6 Ohms, Capacity 300 μμf
Relative Humidity less than 50%

Temperature ° C.	Beat Frequency Cycles	Frequency Change Cycles	Percent Frequency Change/°C	R F Output Watts
60	744			1.95
50	730	-14	0.00023	19.5
40	492	-238	0.00397	19.5
30	478	-14	0.00023	19.5
20	387	-91	0.00152	19.6
10	409	22	0.00037	19.6
0	393	-16	0.00027	19.8
-10	397	4	0.00007	19.8
-20	250	-147	0.00245	19.8
-30	350	100	0.00167	19.5

Specifications: Frequency change not to exceed .006% per degree Centigrade for each fifteen degrees change in ambient.

Note: At the time these tests were made specifications allowed 0.025% frequency change per degree Centigrade for each ten degrees change in ambient.

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TABLE NO. 25

Model CXAR - 4
Frequency Stability vs. Temperature
Channel A Position A 1500 Kc.

Antenna: Resistance 6 Ohms, Capacity 100 μμf
Relative Humidity less than 50%

Temperature ° C.	Beat Frequency Cycles	Frequency Change Cycles/10°C.	Percent Frequency Change/°C.	R F Output Watts
60	272			10.1
50	305	33	0.00022	10.1
40	521	216	0.00144	10.4
30	570	49	0.00033	10.1
20	678	108	0.00072	10.1
10	658	-20	0.00013	10.4
0	768	110	0.00073	10.4
-10	1000	232	0.00155	10.6
-20	1115	115	0.00077	10.4
-30	1195	114	0.00076	10.1

Specifications: Frequency change not to exceed 0.006% per degree Centigrade for each fifteen degrees change in ambient.

Note: At the time these tests were made specifications allowed 0.025% frequency change per degree Centigrade for each ten degrees change in ambient.

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TABLE NO. 26

Model CXAR - 4
Frequency Stability vs. Temperature
Channel C Position C 3000[redacted]Kc.

Antenna: Resistance 8.36 Ohms, Capacity 300 μμf
Relative Humidity less than 50%

Temperature ° C.	Beat Frequency Cycles	Frequency Change Cycles/10°C.	Percent Frequency Change/°C.	R F Output Watts
60	1325			33.4
50	1800	475	0.00158	33.4
40	2050	250	0.00083	33.4
30	2300	250	0.00083	33.4
20	2550	250	0.00083	33.4
10	2725	175	0.00058	33.4
0	2925	200	0.00067	33.4
-10	3150	225	0.00075	33.4
-20	3350	200	0.00067	36.8
-30	3450	100	0.00033	36.8

Specifications: Frequency change not to exceed 0.003% per degree Centigrade for each fifteen degrees change in ambient.

Note: At the time these tests were made specifications allowed 0.001% frequency change per degree Centigrade for each ten degrees change in ambient.

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TABLE NO. 27

Model CXAR - 4
Frequency Stability vs. Temperature
Channel C Position C 9000 Kc.

Relative Humidity less than 50%

Temperature °C.	Beat Frequency Cycles	Frequency Change Cycles/10°C.	Percent Frequency Change/°C.	R F Output Watts
60	3150			
50	3900	750	0.00083	18.8
40	4250	350	0.0004	18.8
30	4700	450	0.0005	18.8
20	4800	100	0.00011	18.8
10	4300	-500	0.000556	18.8
0	3800	-500	0.000556	18.8
-10	1900	-1900	0.00211	18.8
-20	1100	- 800	0.00089	21.4
-30	350	- 750	0.000833	21.4

Specifications: Frequency change not to exceed 0.003% per degree Centigrade for each fifteen degrees change in ambient.

Note: At the time these tests were made specifications allowed 0.001% frequency change per degree Centigrade for each ten degrees change in ambient.

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[redacted]

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TABLE NO. 28

Model CXAR - 4
Frequency Stability vs. Temperature
Channel D Position D 3000 Kc.

Relative Humidity less than 50%

Temp-ature ° C.	Beat Frequency Cycles	Frequency Change Cycles/10°C.	Percent Frequency Change/°C.	R F Output Watts
60	1225			33
50	1850	625	0.00208	33
40	2260	410	0.00137	33
30	2525	265	0.00089	33
20	2610	85	0.000283	33
10	2720	110	0.00037	33
0	2760	40	0.00013	33
-10	2780	20	0.00007	33
-20	2650	-130	0.00043	33
-30	2500	-150	0.0005	33

Specifications: Frequency change not to exceed 0.003% per degree Centigrade for each fifteen degrees change in ambient.

Note: At the time these tests were made specifications allowed 0.001% frequency change per degree Centigrade for each ten degrees change in ambient.

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TABLE NO. 29

Model CXAR - 4
Frequency Stability vs. Temperature
Channel D Position D 5500 Kc.

Antenna: Resistance 8.36 Ohms, Capacity 100 μμf
Relative Humidity less than 50%

Temp-ature °C.	Beat Frequency Cycles	Frequency Change Cycles/10°C.	Percent Frequency Change/°C.	R F Output Watts
60	2000			
50	2500	500	0.00091	27
40	2650	150	0.000273	27
30	2680	30	0.000054	27
20	2525	-155	0.000282	27
10	2350	-175	0.000318	27
0	2000	-350	0.000637	27
-10	1500	-500	0.00091	27
-20	975	-525	0.000955	27
-30	0	-975	0.00177	27

Specifications: Frequency change not to exceed 0.003% per degree Centigrade for each fifteen degrees change in ambient.

Note: At the time these tests were made specifications allowed 0.001% frequency change per degree Centigrade for each ten degrees change in ambient.

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TABLE NO. 30

Model CXAR - 4
Frequency Stability vs. Temperature
Channel D Position D 9000 Kc.

Antenna: Resistance 8.36 Ohms, Capacity 300 μμf
Relative Humidity less than 50%

Temp-ature ° C.	Beat Frequency Cycles	Frequency Change Cycles/10°C.	Percent Frequency Change/°C.	R F Output Watts
60	1475			21.8
50	3225	1750	0.00194	21.8
40	4175	950	0.00106	21.8
30	5175	1000	0.00111	21.8
20	5900	725	0.000806	21.8
10	6390	490	0.000544	21.8
0	7050	660	0.000733	21.8
-10	7175	125	0.000139	21.8
-20	7325	150	0.000167	21.8
-30	6875	-450	0.0005	21.8

Specifications: Frequency change not to exceed 0.003% per degree Centigrade for each fifteen degrees change in ambient.

Note: At the time these tests were made the specifications allowed 0.001% frequency change per degree Centigrade for each ten degrees change in ambient.

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TABLE NO. 31

Model CXAR - 4
Frequency Stability vs. Temperature
Channel E Position D 3000 Kc.

Antenna: Resistance 8.36 Ohms, Capacity 300 μμf
Relative Humidity less than 50%

Temp-ature °C.	Beat Frequency Cycles	Frequency Change Cycles/10°C.	Percent Frequency Change/°C.	R.F Output Watts
60	1160			29.6
50	1140	-20	0.000067	30.1
40	1705	565	0.00188	31.4
30	2000	295	0.00098	32.4
20	2330	330	0.0011	32.1
10	2535	205	0.00068	32.7
0	3100	565	0.00188	34.4
-10	3240	140	0.00047	35.8
-20	3900	660	0.0022	36.8
-30	4400	500	0.00166	36.8

Specifications: Frequency change not to exceed 0.003% per degree Centigrade for each fifteen degrees change in ambient.

Note: At the time these tests were made the specifications allowed 0.001% frequency change per degree Centigrade for each ten degrees change in ambient.

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TABLE NO. 32

Model CXAR - 4
Frequency Stability vs. Humidity
Channel A Position A 600 Kc.

Antenna: Resistance 6 Ohms, Capacity 300 μμf
Temperature Constant at 50° C.

Time Minutes	Percent Relative Humidity	Beat Frequency Cycles	Maximum Frequency Change Cycles	Percent Frequency Change	R F Output Watts
0	30	500			17.7
5	30	800			17.7
10	30	920			17.7
20	30	920*			17.7
40	95	937			17.7
70	95	948	28	0.0047	14.0
85	56	942			15.0
110	30	918			15.0
140	30	898	22	0.0037	15.0

*End of first test.
Maximum change in power output 20.9%

Specifications: The frequency as observed any time after the end of the first test shall not vary by more than 0.12%, and the power output more than 20%.

TABLE NO. 33

Model CXAR - 4
Frequency Stability vs. Humidity
Channel A Position A 1500 Kc.

Antenna: Resistance 6 Ohms, Capacity 300 μμf
Temperature Constant at 45° C.

Time Minutes	Percent Relative Humidity	Beat Frequency Cycles	Maximum Frequency Change Cycles	Percent Frequency Change	R F Output Watts
0	--	1100			13.5
30	26	2550			--
50	30	2500*			--
60	87	2580	80	0.00533	--
65	93	2550			--
70	95	2550			--
100	95	2490			--
115	35	2600			--
120	30	2615			--
150	30	2615	115	0.00767	--

*End of first test.

Specifications: The frequency as observed at the end of the first test shall not vary by more than 0.12%.

TABLE NO. 34

Model CXAR - 4
Frequency Stability vs. Humidity
Channel B Position B 1400 Kc.

Antenna: Resistance 6 Ohms 300 μμf
Temperature Constant at 50° C.

Time Minutes	Percent Relative Humidity	Beat Frequency Cycles	Maximum Frequency Change Cycles	Percent Frequency Change	R F Output Watts
0	30	735			15.0
15	30	737*			14.6
35	93	745	8	0.00057	13.5
40	95	742			13.5
55	95	740			13.5
70	95	742			13.5
85	65	733			14.5
105	36	740			14.6
110	30	742			14.6
140	30	743	6	0.00043	14.2

*End of first test.

Maximum change in power output 7.5%.

Specifications: The frequency as observed any time after the end of the first test shall not vary by more than 0.12%, and the power output by more than 20%.

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TABLE NO. 35

Model CXAR - 4
Frequency Stability vs. Humidity
Channel C Position C 3000 Kc.

Antenna: Resistance 8.36 Ohms, Capacity 300 μμf
Temperature Constant at 50° C.

Time Minutes	Percent Relative Humidity	Beat Frequency Cycles	Maximum Frequency Change Cycles	Percent Frequency Change	R F Output Watts
0	18	2400			15.4
15	18	2250			--
30	18	2200*			--
45	95	1700			--
60	95	1450			--
75	95	1300	950	0.0316	--
125	26	2150			--
140	15	2200			--
155	15	2200			--

*End of first test.

Specifications: The frequency as observed any time after the end of the first test shall not vary by more than 0.06%.

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TABLE NO. 36

Model CXAR - 4
Frequency Stability vs Humidity
Channel C Position C 9000 Kc.

Temperature Constant at 50° C.

Time Minutes	Percent Relative Humidity	Beat Frequency Cycles	Maximum Frequency Change Cycles	Percent Frequency Change	R F Output Watts
0	9	4500			13.5
30	9	3950			--
48	9	4100			--
60	9	4150*			--
80	98	1450			--
95	98	1000			--
110	98	600	-3550	0.0394	--
200	27	2000			--
215	22	3000			--
230	20	2650			--

*End of first test.

Specifications: The frequency as observed any time after the end of the first test shall not vary by more than 0.06%.

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TABLE NO. 37

Model CXAR - 3
Frequency Stability vs. Channel Reset

The transmitter was completely tuned for maximum output. Frequency was recorded and another channel switched to operating position. The subject channel was again placed in operation and the frequency change determined. The results are an average of five trials for each channel.

Channel	Frequency Range Kc.	Frequency Kc.	Frequency Change Cycles	%
A	540-1500	600	12	.002
G	1500-3000	1500	8	.00053
G	1500-3000	3000	14	.00047
C	3000-9050	3000	10	.00033
C	3000-9050	9000	32	.00036
J	9050-15800	9000	24	.00027

Specifications: Changing channels shall not result in shifting the output frequency more than 600 cycles when operating on frequencies below 3000 Kc., and 300 cycles when operating on frequencies above 3000 Kc.

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TABLE NO. 38

Model CXAR - 3
Frequency Stability vs. Tune-Operate Switch

(1) Frequency change represents the difference between the M.O. output frequency in tune position and the M.O. output frequency in operate position. In both cases all stages are in a resonant condition.

Channel	Frequency Range	Frequency Kc.	Frequency Change Cycles	%
A	540/1500 Kc.	600	50	.0083
A	540/1500 Kc.	1500	120	.008
G	1500/3000 Kc.	1500	120	.008
G	1500/3000 Kc.	3000	116	.0038
C	3000/9050 Kc.	3000	440	.0146
C	3000/9050 Kc.	9000	1350	.015
J	9050/15800 Kc.	9000	1250	.0138

(2) Frequency change represents the difference between the M.O. output frequency in tune position with all other stages detuned, and the M.O. output frequency in operate position with all other stages resonated.

Channel	Frequency Range	Frequency Kc.	Frequency Change Cycles	%
A	540/1500 Kc.	1500	350	.0233
G	1500/3000 Kc.	1500	118	.0078
G	1500/3000 Kc.	3000	350	.0116
C	3000/9050 Kc.	3000	370	.0123
C	3000/9050 Kc.	9000	1250	.0138
J	9050/15800 Kc.	9000	1220	.0135

Specifications: The frequency deviation shall not exceed 3000 cycles when operating at frequencies less than 3000 Kc. and shall not exceed 1500 cycles when operating at frequencies above 3000 Kc.

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TABLE NO. 39

Model CXAR - 4
Frequency Stability vs. Vibration

Time Minutes	Beat Frequency Cycles	Frequency Change Cycles	Frequency Change %	Remarks
	Channel B	Position B	600 Kc.	
0	--			Power On
30	540			Record Frequency
30	•--			Power Off - Vibration On
90	--			Vibration Off - Power On
120	500	40	.00666	Record Frequency
	Channel C	Position C	3000 Kc.	
0	--			Power On
30	350			Record Frequency
30	--			Power Off - Vibration On
90	390			Vibration Off - Power On
120	350	0	0	Record Frequency
	Channel D	Position D	9000 Kc.	
0	--			Power On
30	1300			Record Frequency
30	--			Power Off - Vibration On
90	--			Vibration Off - Power On
120*	2000	700	.0078	Record Frequency

*Abrupt frequency changes of 600 to 700 cycles throughout test.

Specifications: The frequency variation due to vibration shall not exceed 0.04% for operating frequencies up to 3000 Kc., and shall not exceed 0.02% for operating frequencies above 3000 Kc.

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TABLE NO. 40

Model CXAR - 4

Frequency Stability vs. Voltage Input

Channel C Position D 9000 Kc.

Bus Volts	Beat Frequency Cycles	Frequency Change 28-24V	Frequency Change 28-21V	Antenna Watts
28	1300			26.5
27	2200			24.4
26	2650			22.7
25	3000	1300	2500	21.1
24	3100	.0144%	.0277%	19.3
23	2700			14.1
22	3250			10.85
21	4300			5.35
20	--			--
21	4250			4.7
22	3850			9.2
23	3250	-1400	-2600	14.1
24	3050	.0155%	.0289%	19.3
25	2750			20.8
26	2500			22.4
27	1950			24.4
28	1650			26.5

TABLE NO. 41

Model CXAR - 3

Frequency Stability vs. Voltage Input

(Test Data Submitted by Manufacturer)

Bus Voltage Changed from 28 to 23 Volts

Channel	Frequency Kc.	Percent Frequency Change
540-1500	600	.0055
540-1500	1500	.0265
3000-9050	3000	.0067
3000-9050	9000	.0125

Specifications: A change in bus voltage from 28 to 24 volts shall not change the emitted frequency by more than the following amount:

540-3000 Kc.	0.04%
3000-9050 Kc.	0.02%

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TABLE NO. 42

Model CXAR - 4
Frequency Stability vs. Locked Key Operation

Channel	Frequency Kc.	Time Minutes	Beat Frequency Cycles	Maximum Frequency Change		
				Cycles	Percent	% Allowed
A	600	0	805			
		5	880			
		10	855			
		15	900			
		20	950			
		25	965	85	0.0142	0.04
		30	950			
A	1500	0	300			
		5	390			
		10	430			
		15	434			
		20	431			
		25	433			
		30	450	60	0.004	0.04
B	600	0	--			
		5	680			
		10	655			
		15	643			
		20	630			
		25	614			
		30	603	-77	0.013	0.04
B	1500	0	350			
		5	305			
		10	295			
		15	305			
		20	305			
		25	305			
		30	305	-10	0.00067	0.04
C	3000	0	1100			
		5	1125			
		10	1170			
		15	1195			
		20	1190			
		25	1185			
		30	1250	125	0.0042	0.02

(Continued on next page)

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TABLE NO. 42 (Continued)

Channel	Frequency Kc.	Time Minutes	Beat Frequency Cycles	Maximum Frequency Change Cycles	Percent	% Allowed
C	9000	0	1500			
		5	2750			
		10	3000			
		15	2940			
		20	2750			
		25	2550			
		30	2275	475	0.0053	0.02
D	3000	0	965			
		5	1000			
		10	1000			
		15	975			
		20	975			
		25	960			
		30	950	-50	0.00167	0.02
D	3000	0	440			
		5	382			
		10	372			
		15	388			
		20	380			
		25	383			
		30	372	-10	0.00033	0.02
D	9000	0	1100			
		5	2155			
		10	2450			
		15	2550	395	0.0044	0.02
		20	2425			
		25	2050			
		30	2200			
D	9000	0	4200			
		5	4500			
		10	4340			
		15	4150			
		20	3200			
		25	3025			
		30	2850	1650	0.0183	0.02

(Continued on next page)

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TABLE NO. 42 (Continued)

Channel	Frequency Kc.	Time Minutes	Beat Frequency Cycles	Maximum Frequency Change		
				Cycles	Percent	% Allowed
E	3000	0	1350			
		5	1895			
		10	1900			
		15	1885			
		20	1885			
		25	1870			
		30	1865	30	0.001	0.02
E	9000	0	4200			
		5	4500			
		10	4340			
		15	4150			
		20	3200			
		25	3025			
		30	2850	1650	0.0183	0.02

Specifications: The maximum frequency change shall not exceed .04% for frequencies less than 3000 Kc. and shall not change more than .02% for frequencies greater than 3000 Kc.

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TABLE NO. 43

Model CXAR - 4
Frequency Stability vs. Roll and Pitch
Channel B Position B 800 Kc.

Time Minutes	Beat Frequency in Cycles Per Second: Horizontal Position	45° Right	Frequency Change From Horizontal	45° Left	Frequency Change From Horizontal
		Roll			
0	460	460	0	430	-30.0
5	450	455	+5	450	0.0
10	440	440	0	440	0.0
15	440	445	+5	440	0.0
20	440	445	+5	435	- 5.0
25	440	445	+5	435	- 5.0
30	435	455	+20	430	- 5.0
Average frequency change			7 cycles .000875%		8.6 cycles 0.00107%
		Pitch			
0	485	475	-10	480	-5.0
5	435	430	- 5	435	0.0
10	425	420	- 5	425	0.0
15	425	420	- 5	425	0.0
20	420	420	0	420	0.0
25	425	420	- 5	420	-5.0
30	425	420	- 5	420	-5.0
Average frequency change			-5 cycles .0006%		2.0 cycles 0.00025%

Specifications: Frequency change shall not exceed 0.01%.

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TABLE NO. 44

Model CXAR - 4
Frequency Stability vs. Roll and Pitch
Channel C Position C 3000 Kc.

Time Minutes	Horizontal Position	45° Right	Frequency Change From Horizontal	45° Left	Frequency Change From Horizontal
		Beat Frequency in Cycles Per Second			
		Roll			
0	500	490	10	470	-30
5	450	470	20	430	-20
10	400	420	20	380	-20
15	390	400	10	365	- 5
20	390	400	10	365	-35
25	380	390	10	350	-30
30	385	390	5	350	-35
Average frequency change			12.1 cycles 0.000403 %		-25 cycles 0.00083 %
		Pitch			
0	565	565	0	565	0
5	585	585	0	560	-25
10	495	495	0	495	0
15	410	410	0	400	-10
20	380	380	0	370	-10
25	340	340	0	335	- 5
30	295	280	15	280	-15
Average frequency change			2 cycles 0.00007 %		- 9.2 cycles 0.000306 %

Specifications: Frequency change shall not exceed 0.005%

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TABLE NO. 45

Model CXAR - 4
Frequency Stability vs. Roll and Pitch
Channel D Position D 6000 Kc.

Time Minutes	Horizontal Position	45° Right	Frequency Change From Horizontal	45° Left	Frequency Change From Horizontal
		Beat Frequency in Cycles Per Second			
		Roll			
0	430	620	190	300	-130
5	440	640	200	320	-120
10	545	710	165	400	-145
15	570	740	170	425	-145
20	590	760	170	450	-140
25	600	770	170	460	-140
30	615	780	165	480	-135
Average frequency change			176 cycles 0.00293%		-136 cycles -0.00227%
		Pitch			
0	470	510	40	400	-70
5	530	560	30	430	-100
10	520	570	50	470	-50
15	610	650	40	530	-80
20	690	710	20	610	-80
25	670	700	30	620	-50
30	690	740	50	650	-40
Average frequency change			37 cycles 0.00062%		-56 cycles 0.00093%

Specifications: Frequency change shall not exceed 0.005%

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TABLE NO. 46

Model CXAR -.4
Frequency Stability vs. Power Amplifier Reaction
(Detune P.A. ± 25%)

Channel	Position	Frequency Kc.	Ant. Resistance Ω	Ant. Cap. μμf	Power Watts	Plate Current MA.	Beat Freq. C.P.S.	Δ f	%Δ f
A	A	600	8.36	430	23.6	95	515		
					12.4	119	630	115	.019
					12.4	-119	610	95	.016
B	B	1500	8.36	150	16.4	100	480		
					12.4	125	395	-85	.00566
					10.1	-125	590	110	.00733
C	D	9000	8.36	300	26.5	113	2750		
					11.0	141	1050	-1700	.0188
					5.35	-141	1500	-1250	.0138
D	C	4500	8.36	500	16.4	112	2150		
					8.36	140	2300	150	.00333
					8.36	-140	2800	650	.0144

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TABLE NO. 47

Model CXAR - 3
Frequency Stability vs. Power
Amplifier and Antenna Reaction

Test Data Submitted by Manufacturer

Frequency Kc.	Change In P.A. Plate Current	% Frequency Change			Remarks
		Clockwise	C.Clockwise	Detach Antenna	
3000	30 ma.	.004	.01	--	Detune P.A.
9000	30 ma.	.0044	.0017	--	Detune P.A.
9000	--	--	--	.017	Antenna detached
9000	30 ma.	.0055	.0055	--	Detune Antenna
3000	30 ma.	.0033	.0011	--	Detune P.A.
3000	--	--	--	.0083	Antenna detached
600	45 ma.	0	.0083	--	Detune P.A.
600	45 ma.	.005	0	--	Detune Antenna
600	--	--	--	.0083	Antenna detached
1500	30 ma.	.003	.0066	--	Detune P.A.
1500	30 ma.	0	0	--	Detune Antenna
1500		--	--	.01	Antenna detached

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TABLE NO. 48

Model CXAR - 4
Frequency Stability vs. Altitude

Channel E Position D 3000 Kc.

Time Minutes	Temp-ature ° C.	Beat Frequency Cycles	Inches Hg.	Antenna Watts
0	-23.0	--	30.0	43.7
5	-23.0	2475	30.0	43.7
25	-23.0	2375	30.0	43.7
26	-23.0	2375	30.0	43.7
35	-24.0	2375	22.75	43.7
45	-25.0	2375	17.4	45.7
55	-25.5	2365	14.0	45.7
60	-26.5	2365	14.0	45.7
70	-27.0	2160	30.0	41.7
85	- 9.0	1690	30.0	41.7

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TABLE NO. 49

Model CXAR - 3
Dynamotor Characteristics
Voltage Regulatation and Ripple
(Test Data Submitted by Manufacturer)

All measurements made with constant primary bus voltage of 28 volts.

380 Volt Supply

	CW	MCW	Phone
Key Closed	400	380	375 (modulated)
Key Open	440	425	405 (carrier)
Regulation	10%	11.8%	8.0%

Maximum regulation encountered while operating between no load and MCW key closed condition was 17%.

Dynamotor Ripple measured with CW key closed operation was .4%.

1000 Volt Supply

Maximum regulation encountered while operating between no load and MCW key closed condition was 10%.

Dynamotor Ripple measured with CW key closed operation was 0.3%.

Specifications: The dynamotor ripple shall not exceed 3% as measured between average and extreme voltages.

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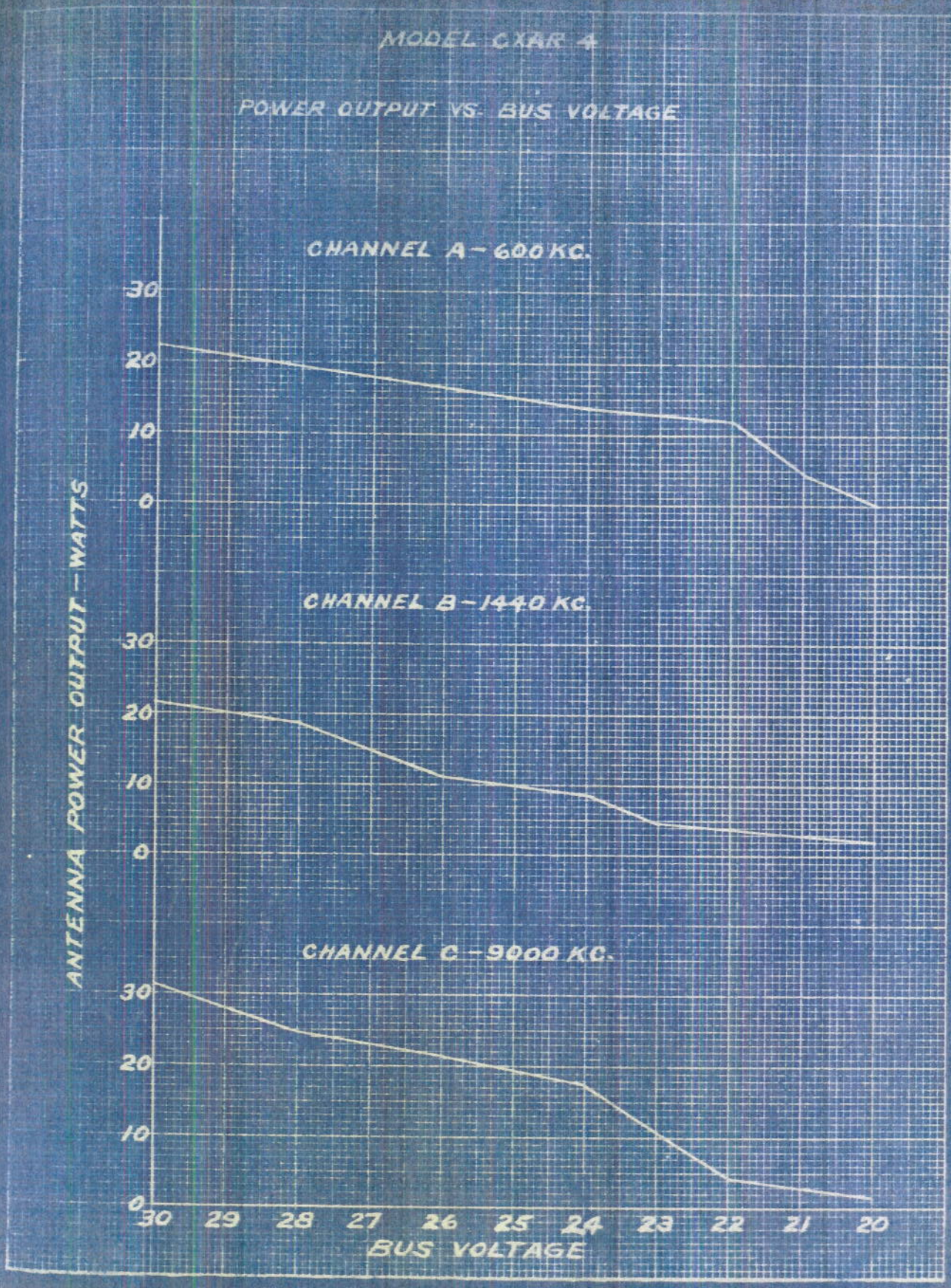
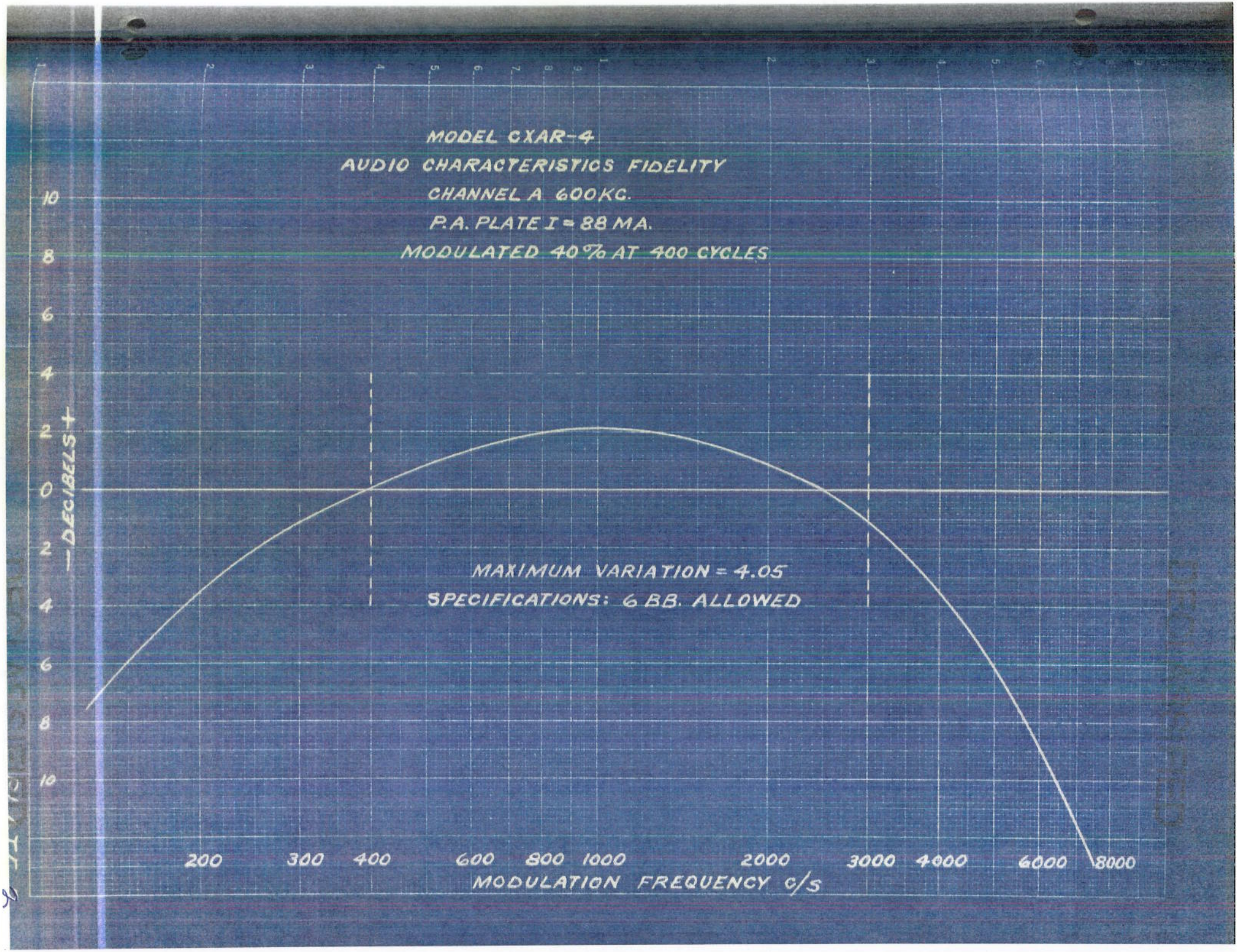
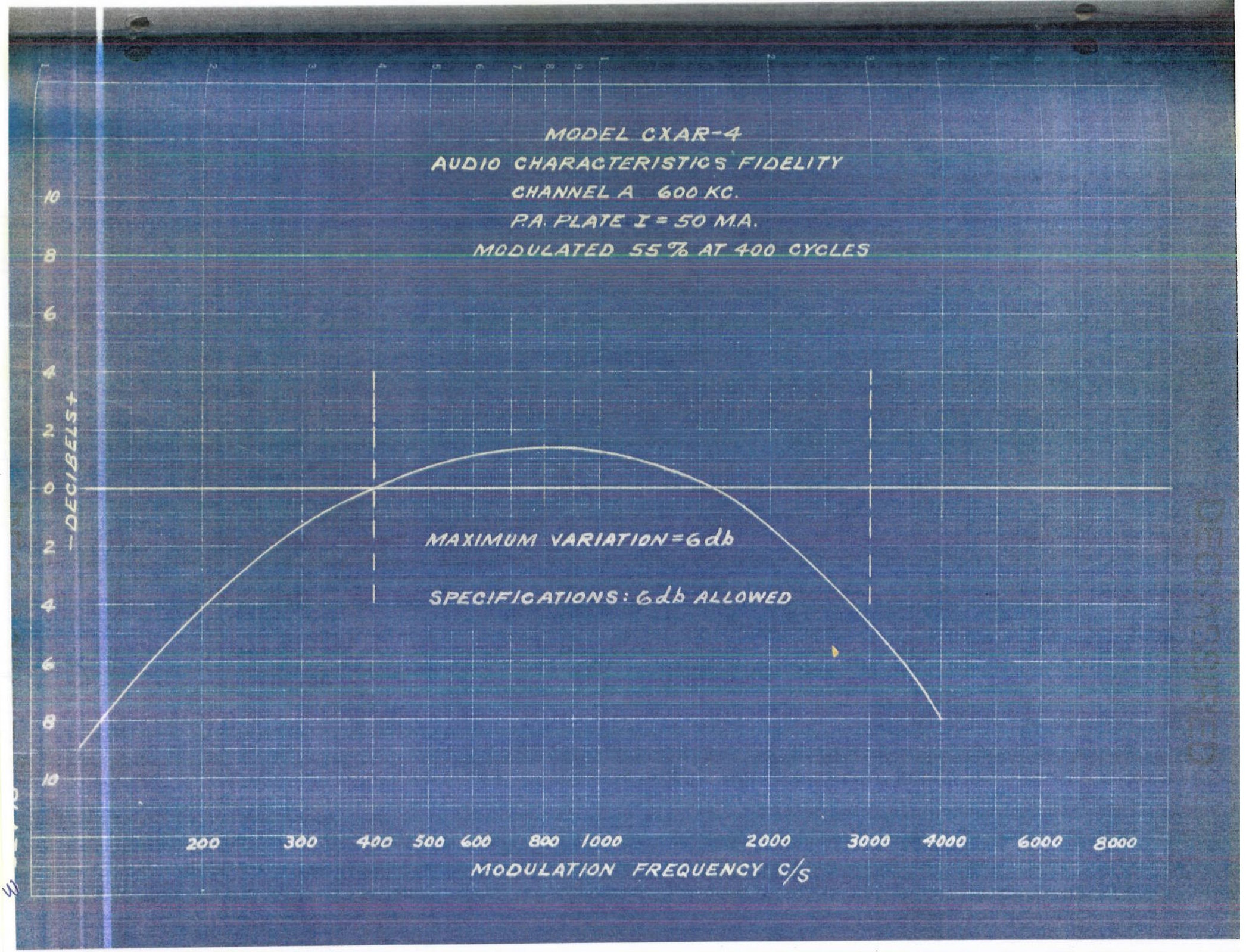


PLATE I

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MODEL CXAR-4
AUDIO CHARACTERISTICS FIDELITY
CHANNEL A 600KC.
P.A. PLATE I = 88 MA.
MODULATED 40% AT 400 CYCLES
10
8
6
4
2
0
2
4
6
8
10
— DECIBELS +
MAXIMUM VARIATION = 4.05
SPECIFICATIONS: 6 BB. ALLOWED
200
300
400
600
800
1000
2000
3000
4000
6000
8000
MODULATION FREQUENCY C/S


MODEL CXAR-4
AUDIO CHARACTERISTICS FIDELITY
CHANNEL A 600 KC.
P.A. PLATE I = 50 M.A.
MODULATED 55% AT 400 CYCLES
10
8
6
4
2
0
2
4
6
8
10
-DECIBELS+
MAXIMUM VARIATION = 6db
SPECIFICATIONS: 6db ALLOWED
200
300
400
500
600
800
1000
2000
3000
4000
6000
8000
MODULATION FREQUENCY C/S

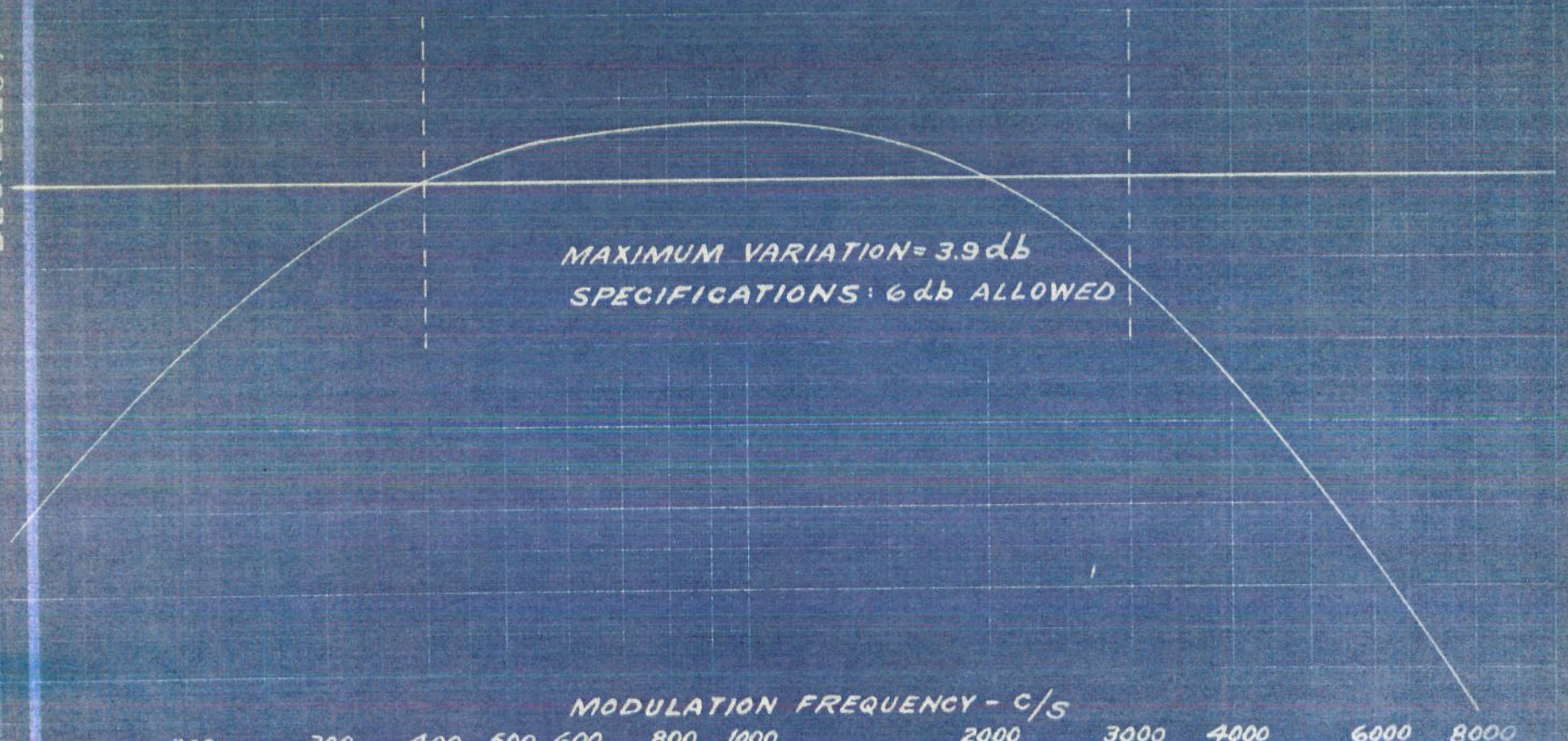
MODEL GXAR-4

AUDIO CHARACTERISTICS FIDELITY

CHANNEL A 1440 KC.

P.A. PLATE I = 100 M.A.

MODULATED 40% AT 400 CYCLES



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DECLASSIFIED PLATE 4

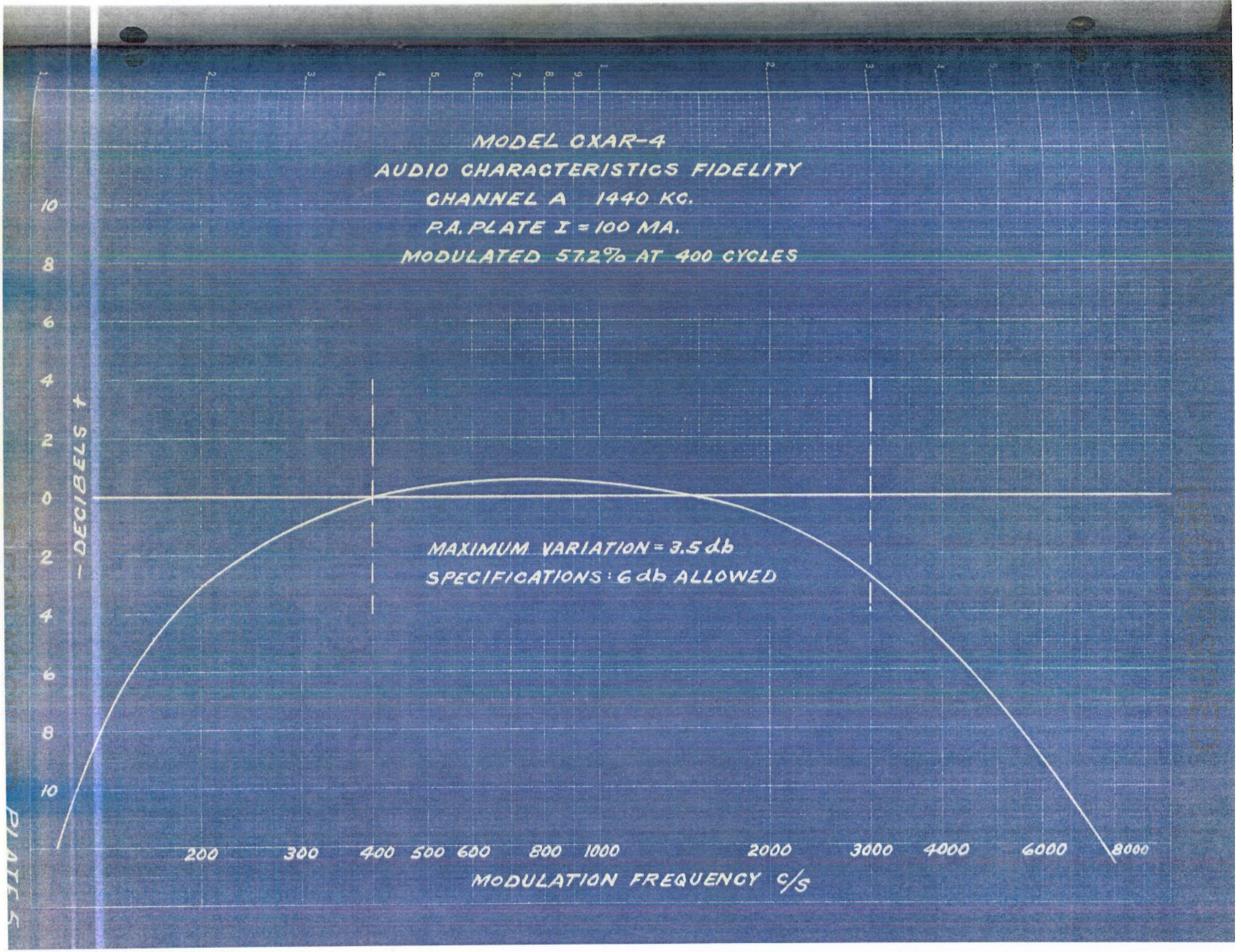
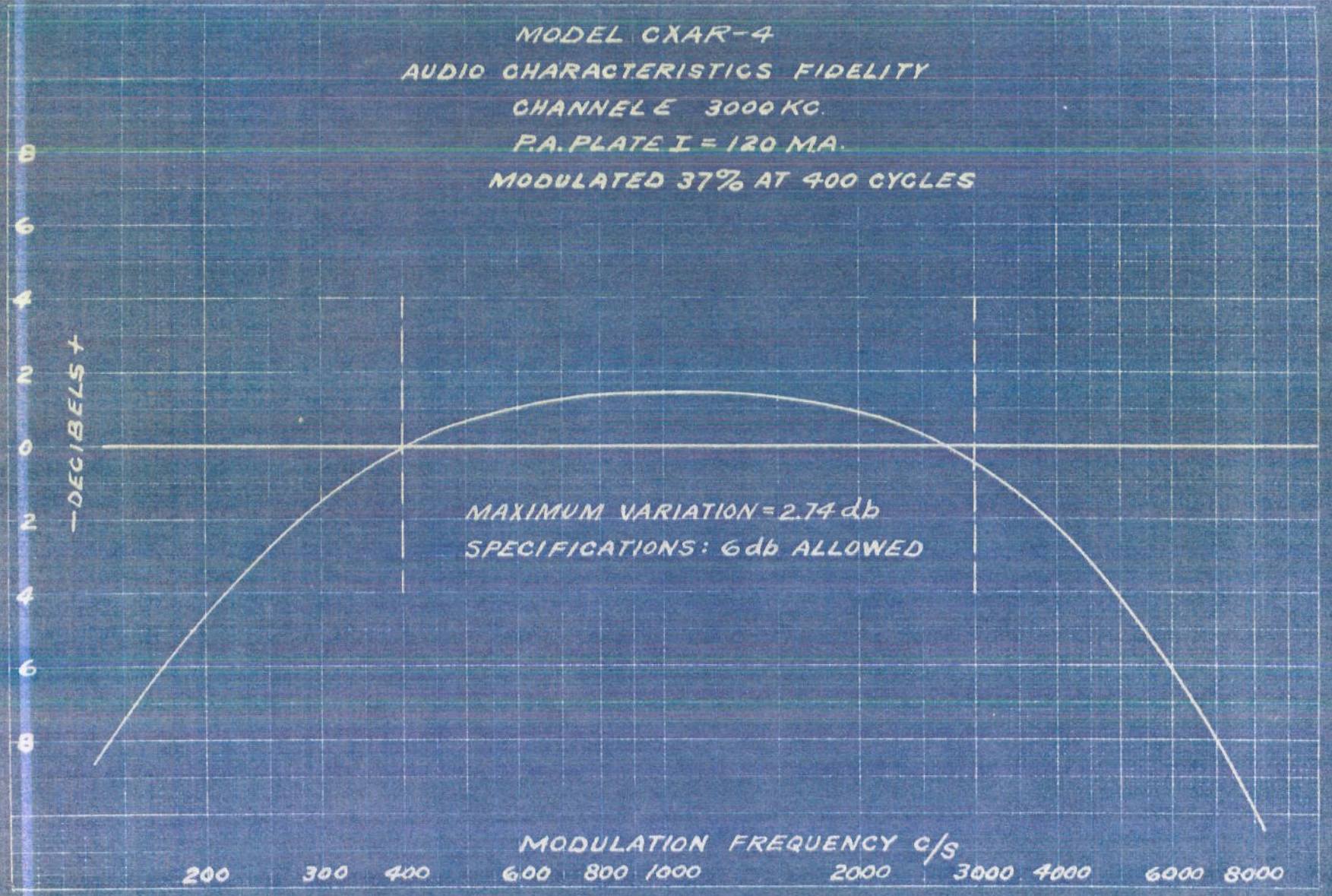

MODEL CXAR-4
AUDIO CHARACTERISTICS FIDELITY
CHANNEL A 1440 KC.
P.A. PLATE I = 100 MA.
MODULATED 57.2% AT 400 CYCLES
- DECIBELS +
10
8
6
4
2
0
2
4
6
8
10
MAXIMUM VARIATION = 3.5 db
SPECIFICATIONS: 6 db ALLOWED
200
300
400
500
600
800
1000
2000
3000
4000
6000
8000
MODULATION FREQUENCY C/S

PLATE 5



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PLATE 6

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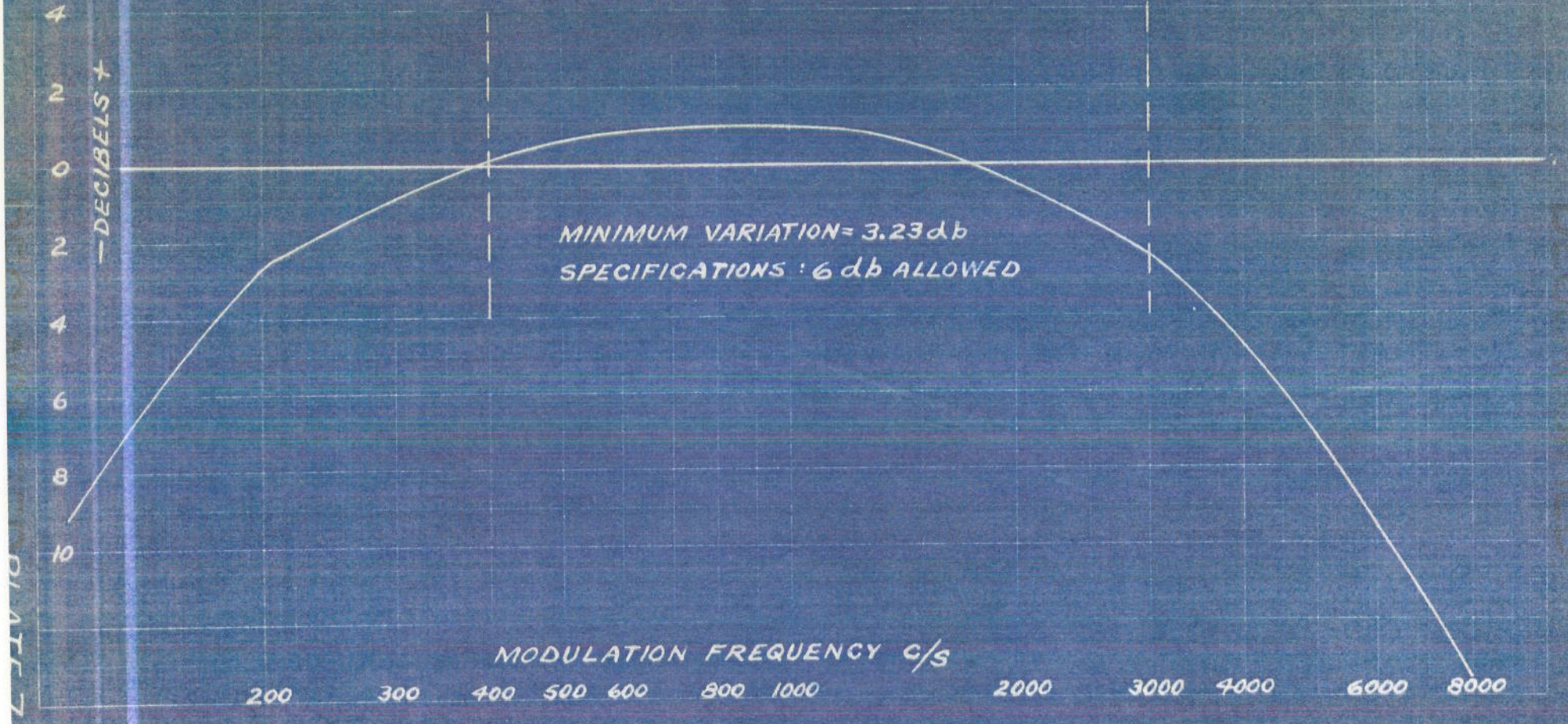
MODEL CXAR-4

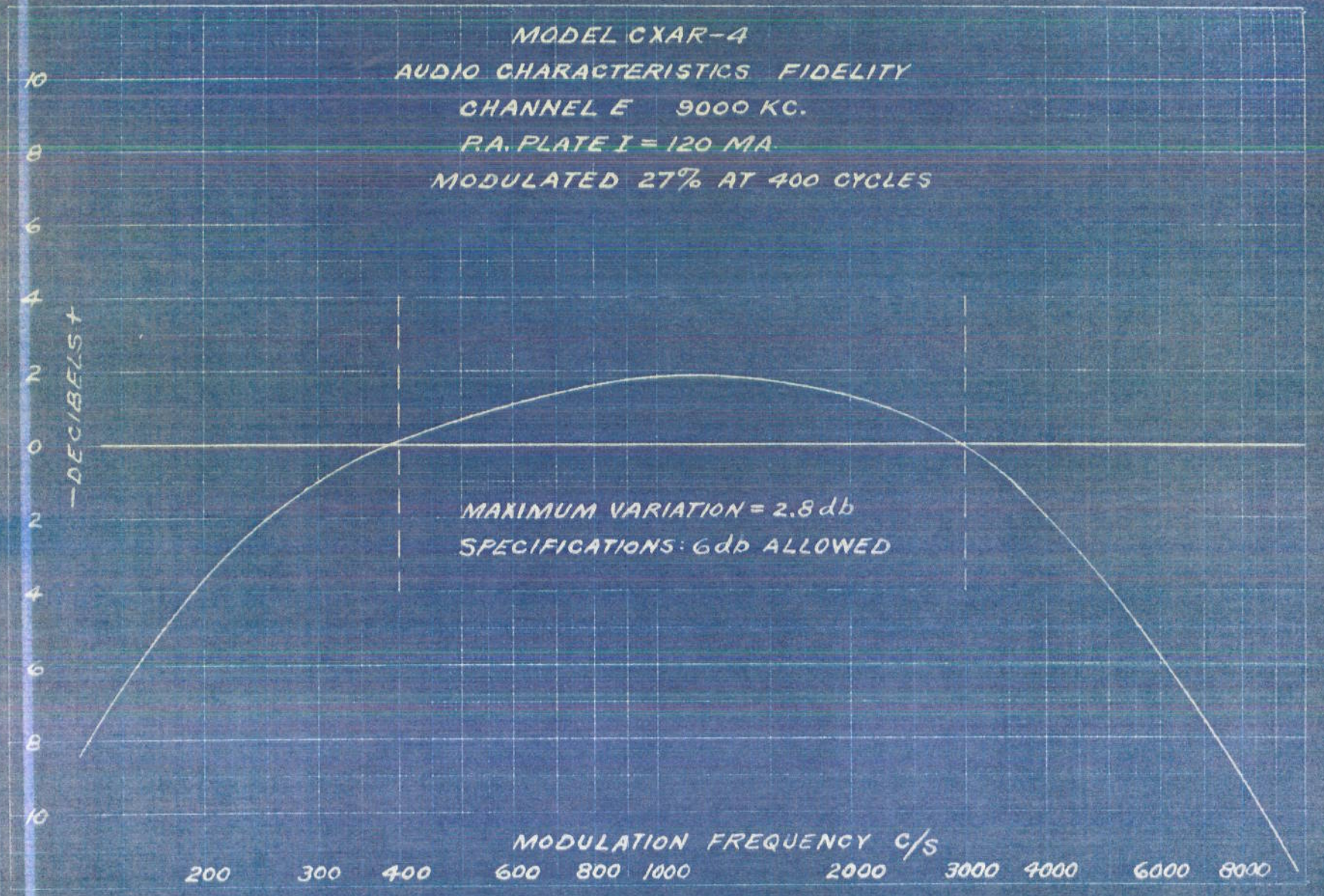
AUDIO CHARACTERISTICS FIDELITY

CHANNEL E 3000 KC.

P.A. PLATE I = 50 MA.

MODULATED 47% AT 400 CYCLES





DO NOT MODIFY
PLATE 8
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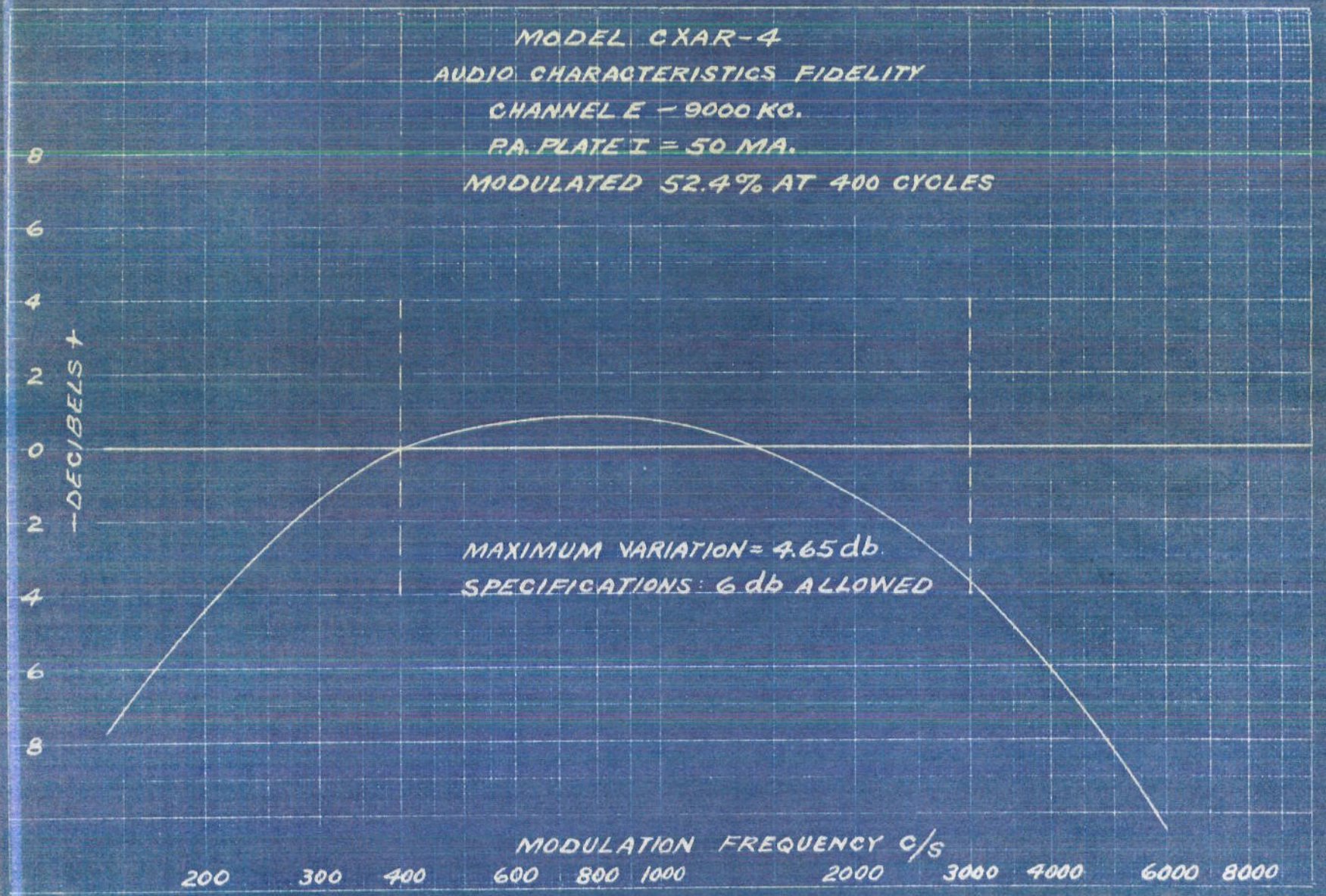
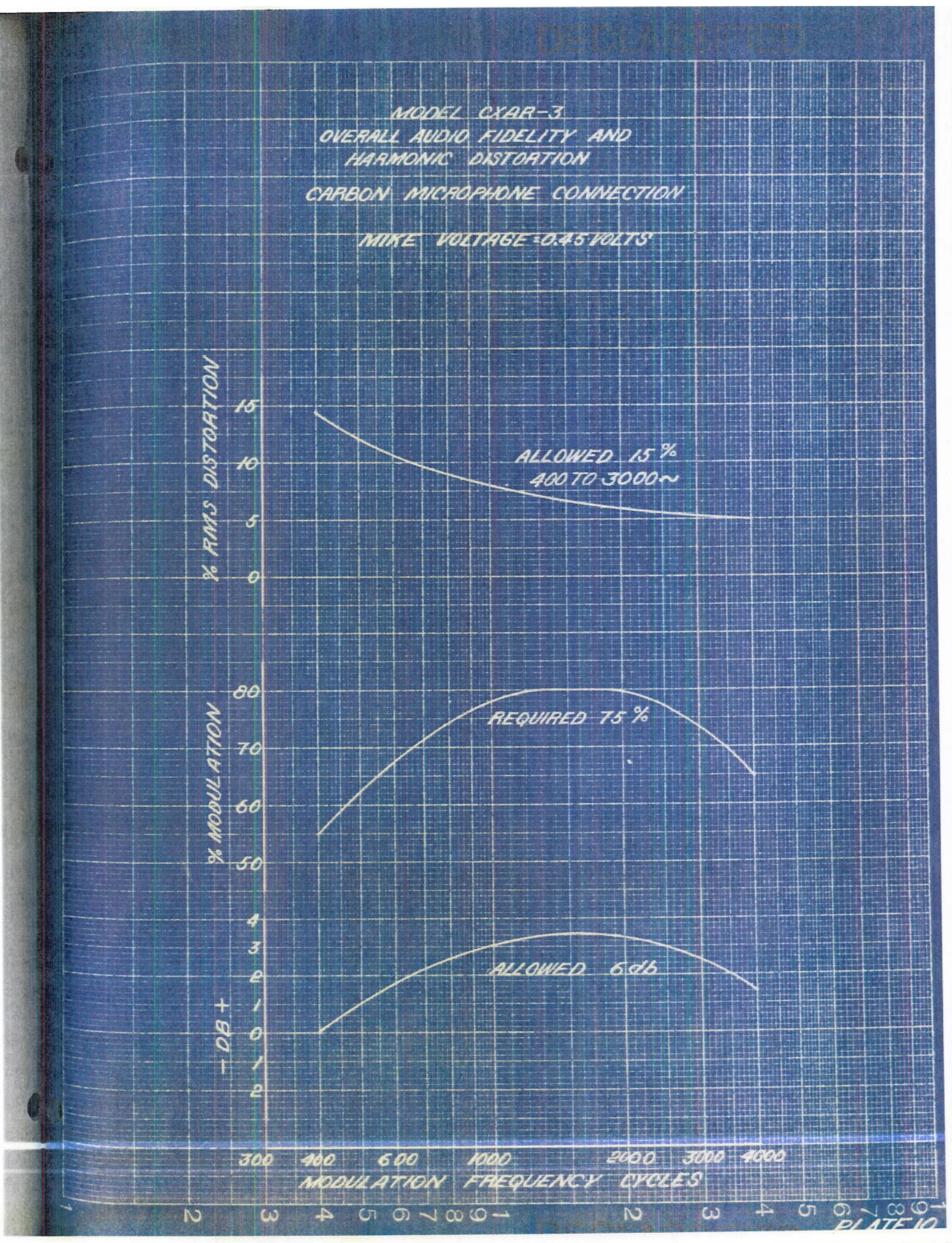
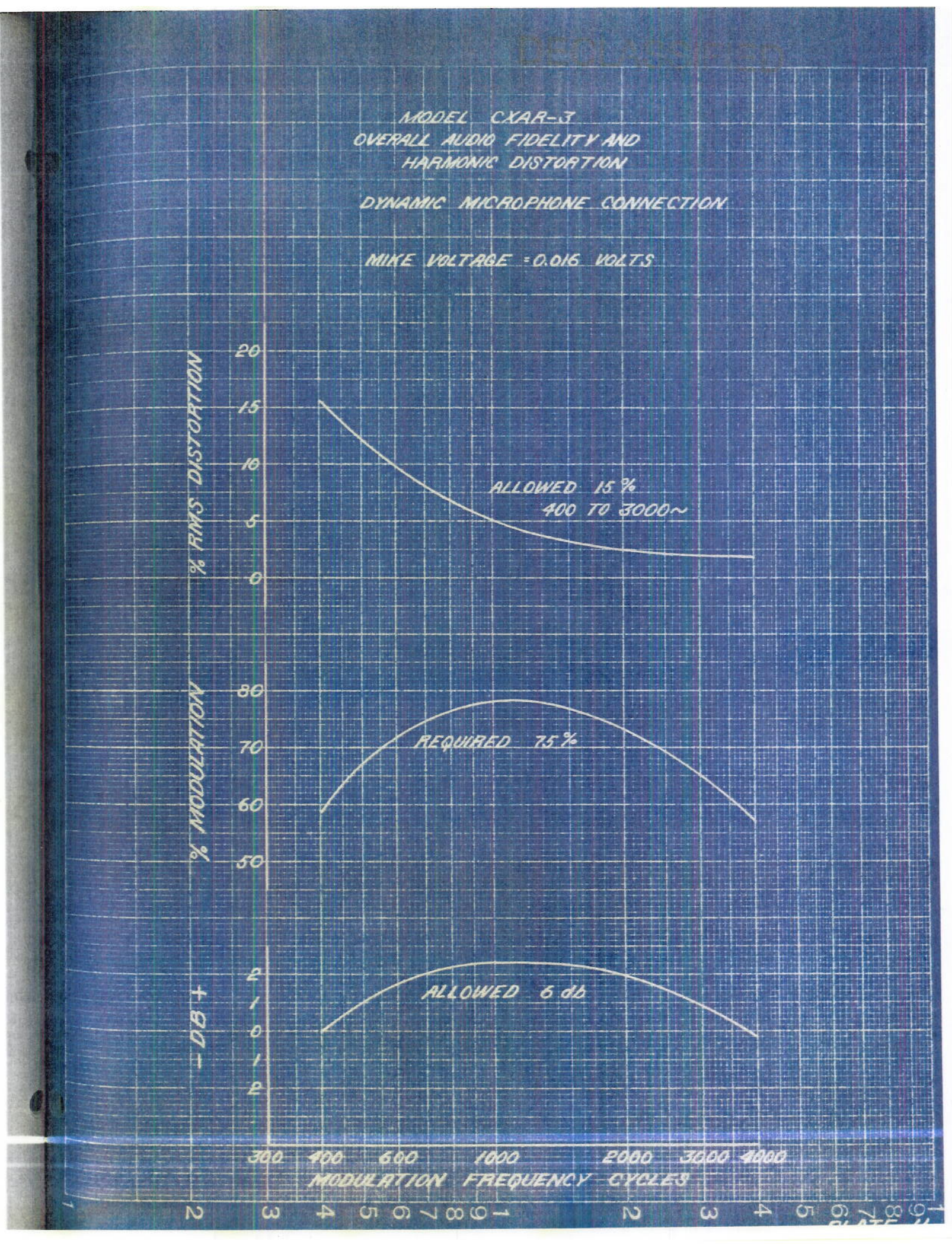

MODEL CXAR-4
AUDIO CHARACTERISTICS FIDELITY
CHANNEL E - 9000 KC.
P.A. PLATE I = 50 MA.
MODULATED 52.4% AT 400 CYCLES
8
6
4
2
0
2
4
6
8
-DECIBELS+
MAXIMUM VARIATION = 4.65 db
SPECIFICATIONS: 6 db ALLOWED
MODULATION FREQUENCY C/S
200
300
400
600
800
1000
2000
3000
4000
6000
8000

PLATE 9

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MODEL CXAR-3
SIDETONE AUDIO FIDELITY AND HARMONIC DISTORTION
CARBON MICROPHONE CONNECTION

MIKE VOLTAGE 0.45 VOLTS

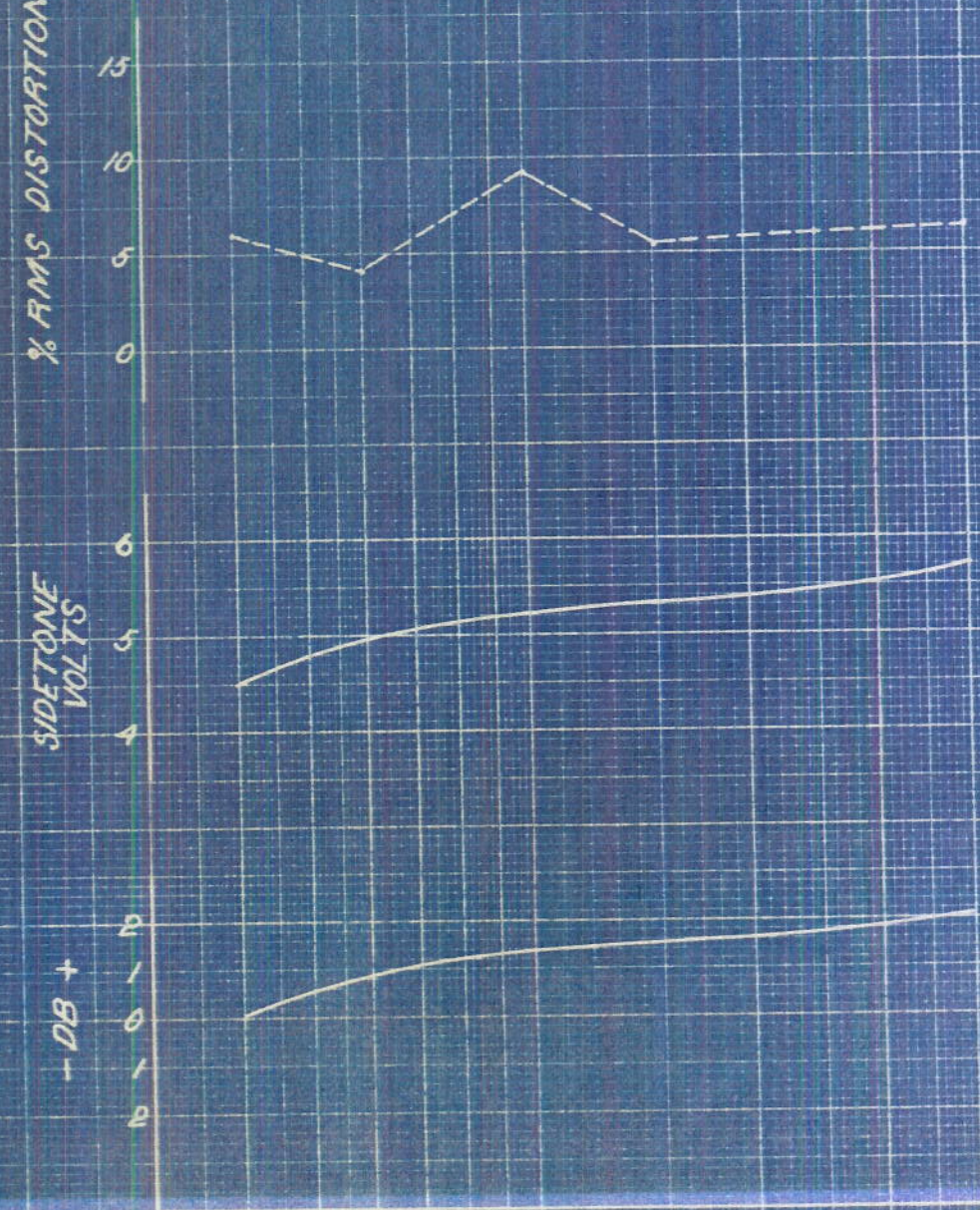


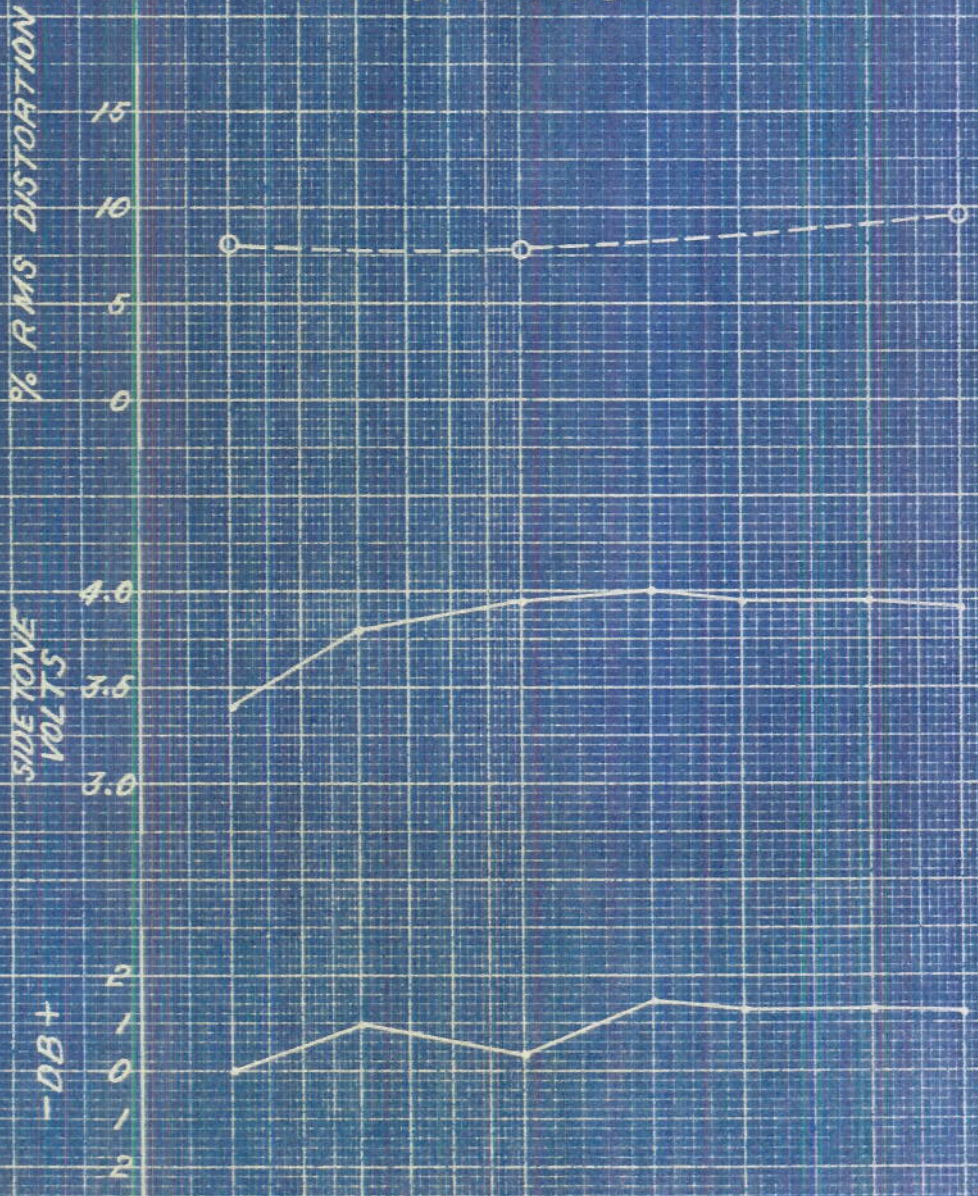
PLATE 12

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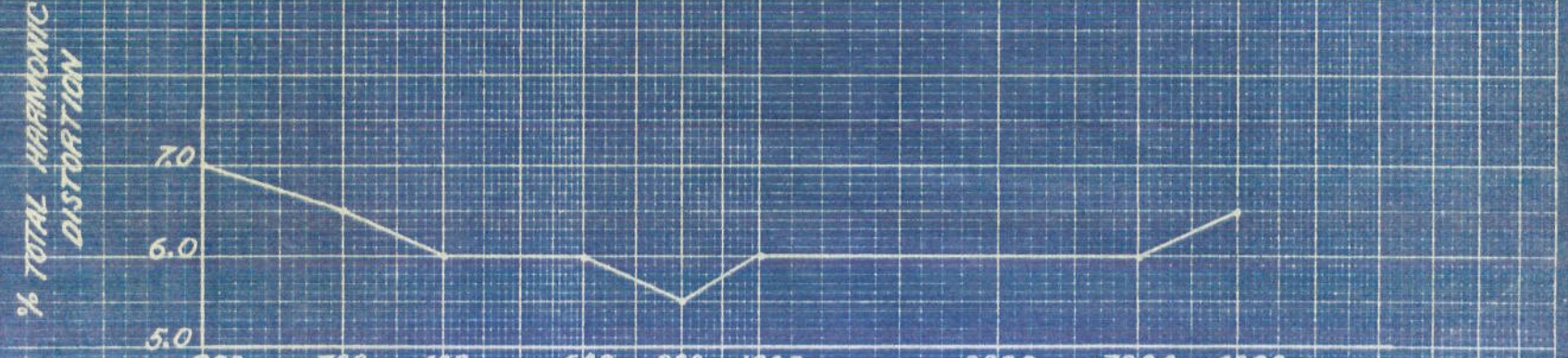
MODEL CXAR-3
SIDETONE AUDIO FIDELITY AND HARMONIC DISTORTION

DYNAMIC MICROPHONE CONNECTION

MIKE VOLTS 0.016 VOLTS



MODEL CXAR-4
AUDIO CHARACTERISTICS
TOTAL HARMONIC DISTORTION
CHANNEL A 600KC
P.A. PLATE I = 90 MA.
MODULATED 32.1% AT 400 CYCLES.



SPECIFICATIONS: T.H.D. NOT TO EXCEED 15 %
BETWEEN 400 AND 3000 CYCLES.

PLATE 14

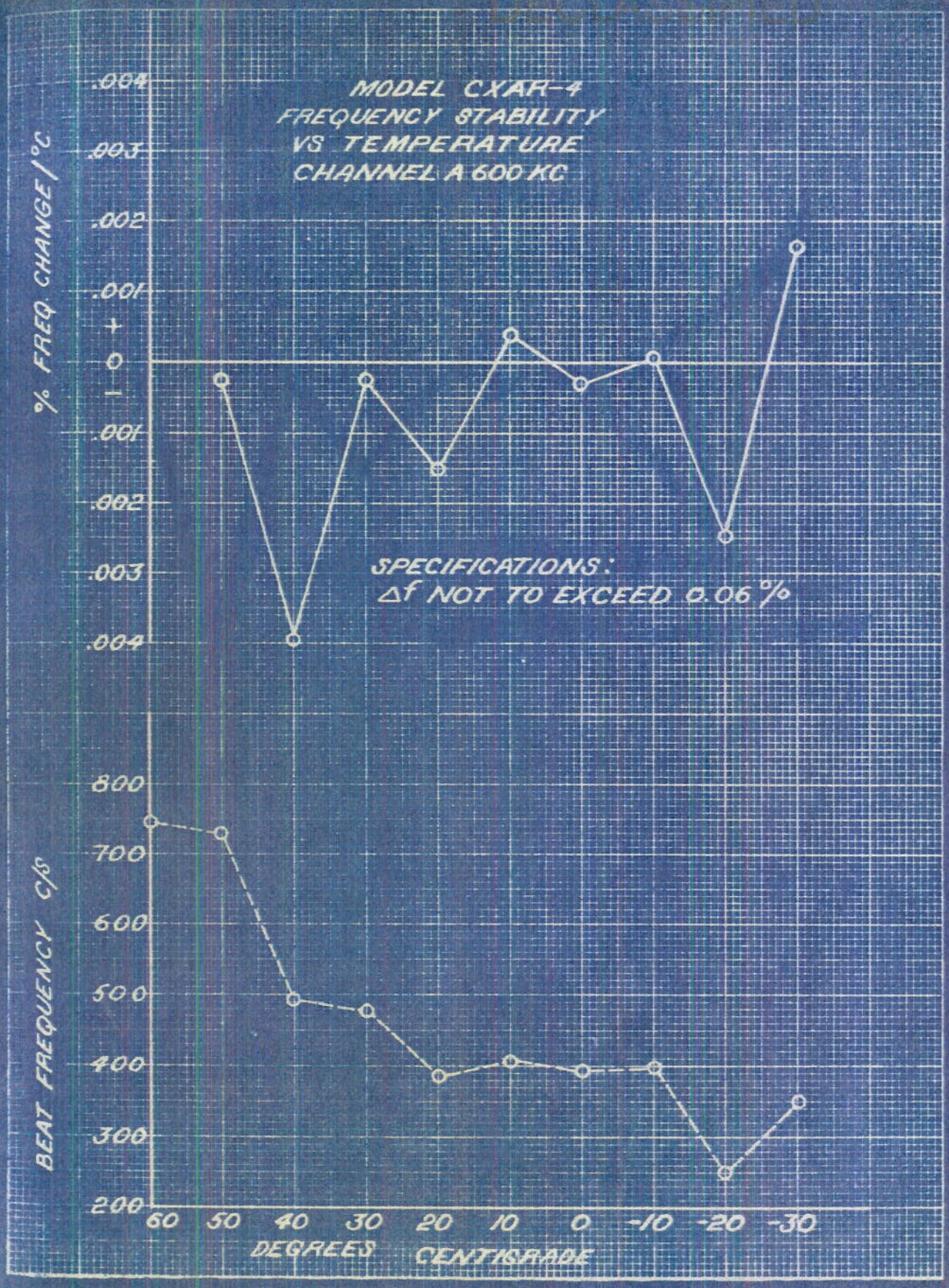

MODEL CXAR-4
FREQUENCY STABILITY
VS TEMPERATURE
CHANNEL A 600 KC
% FREQ CHANGE / °C
.004
.003
.002
.001
+
0
-
.001
.002
.003
.004
SPECIFICATIONS:
Δf NOT TO EXCEED 0.06 %
BEAT FREQUENCY C/S
800
700
600
500
400
300
200
60 50 40 30 20 10 0 -10 -20 -30
DEGREES CENTIGRADE

PLATE 15

RESEARCH LABORATORY
DATE

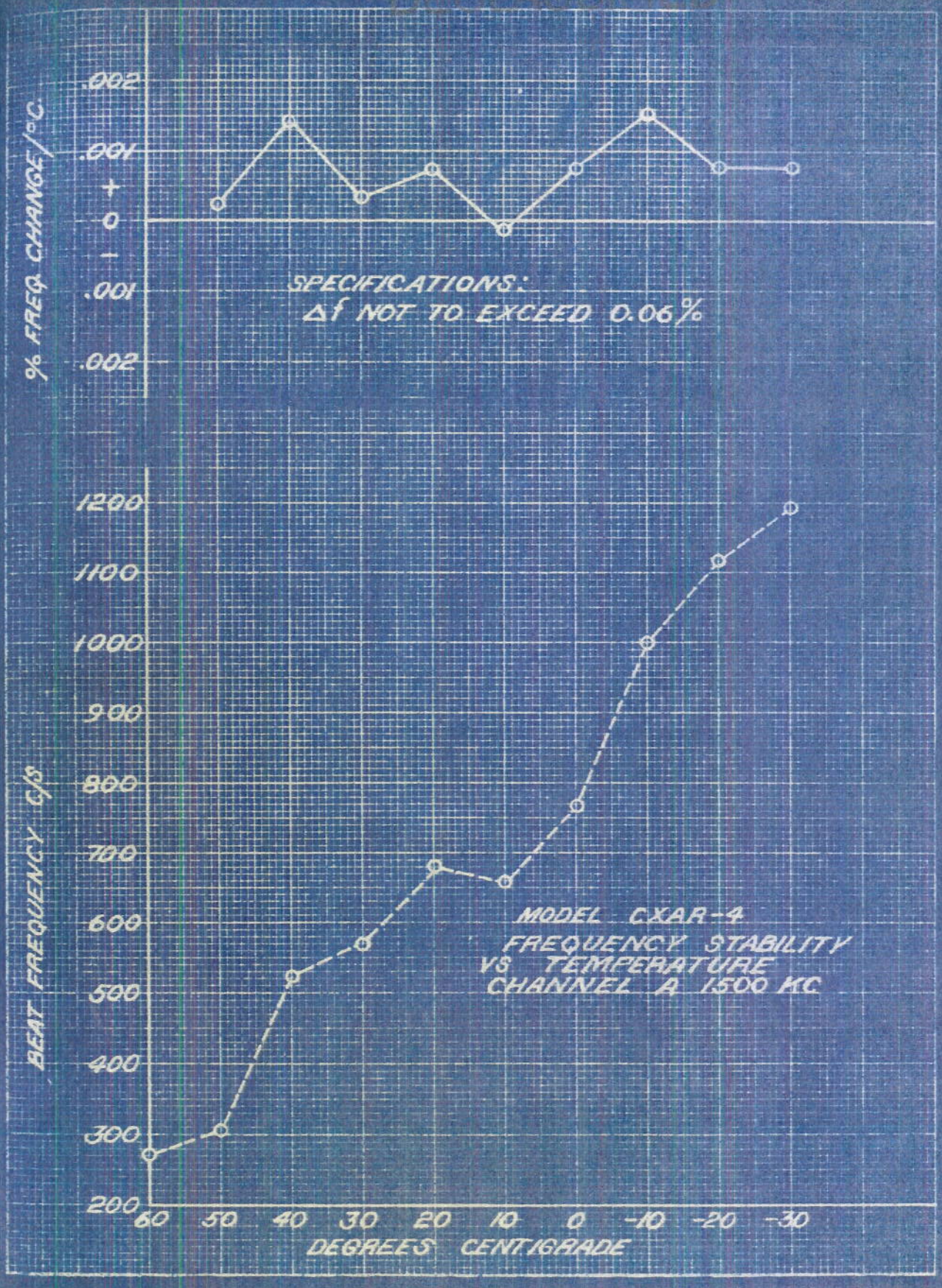


PLATE 16

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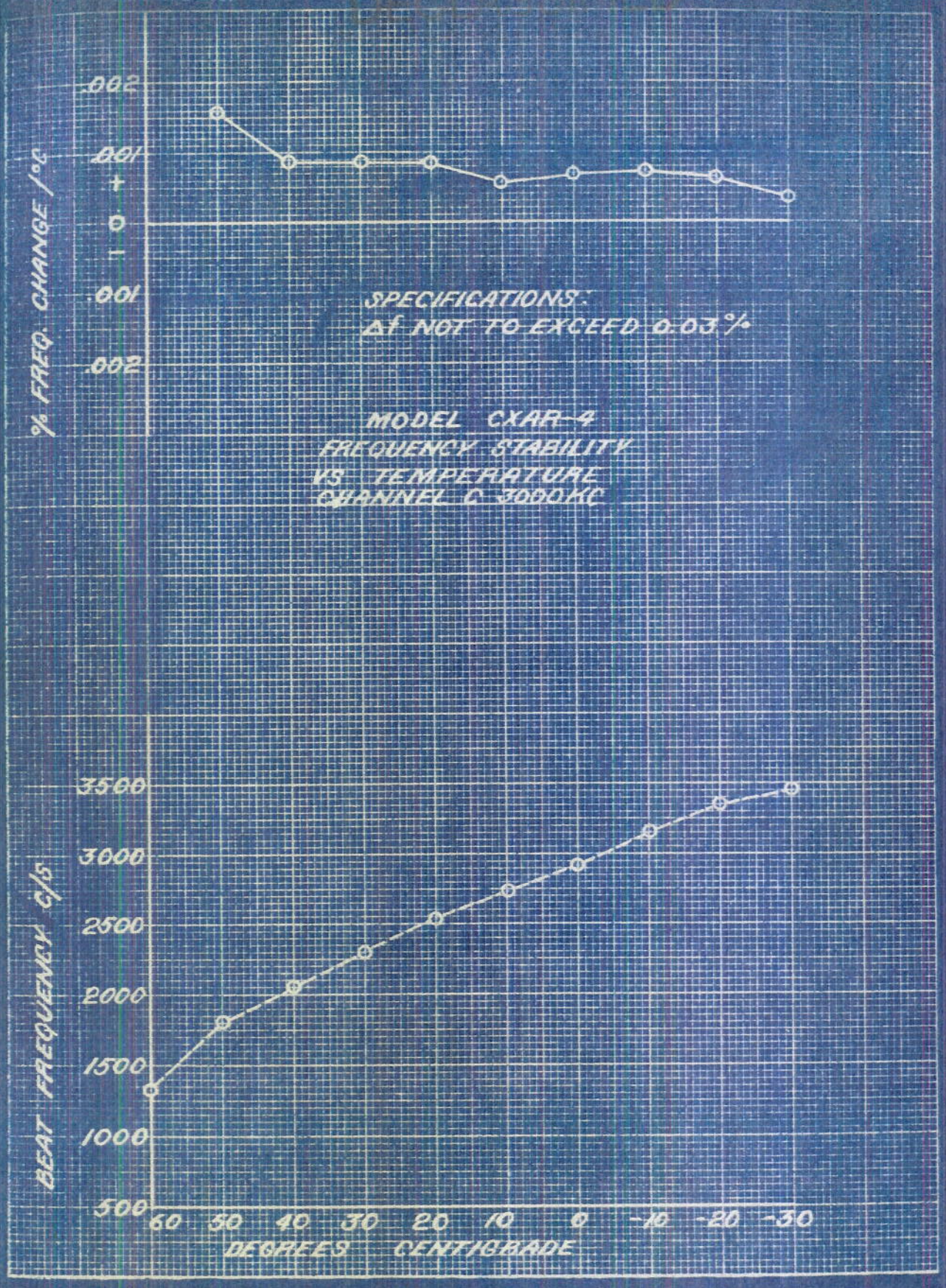


PLATE 17

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DECLASSIFIED DATE

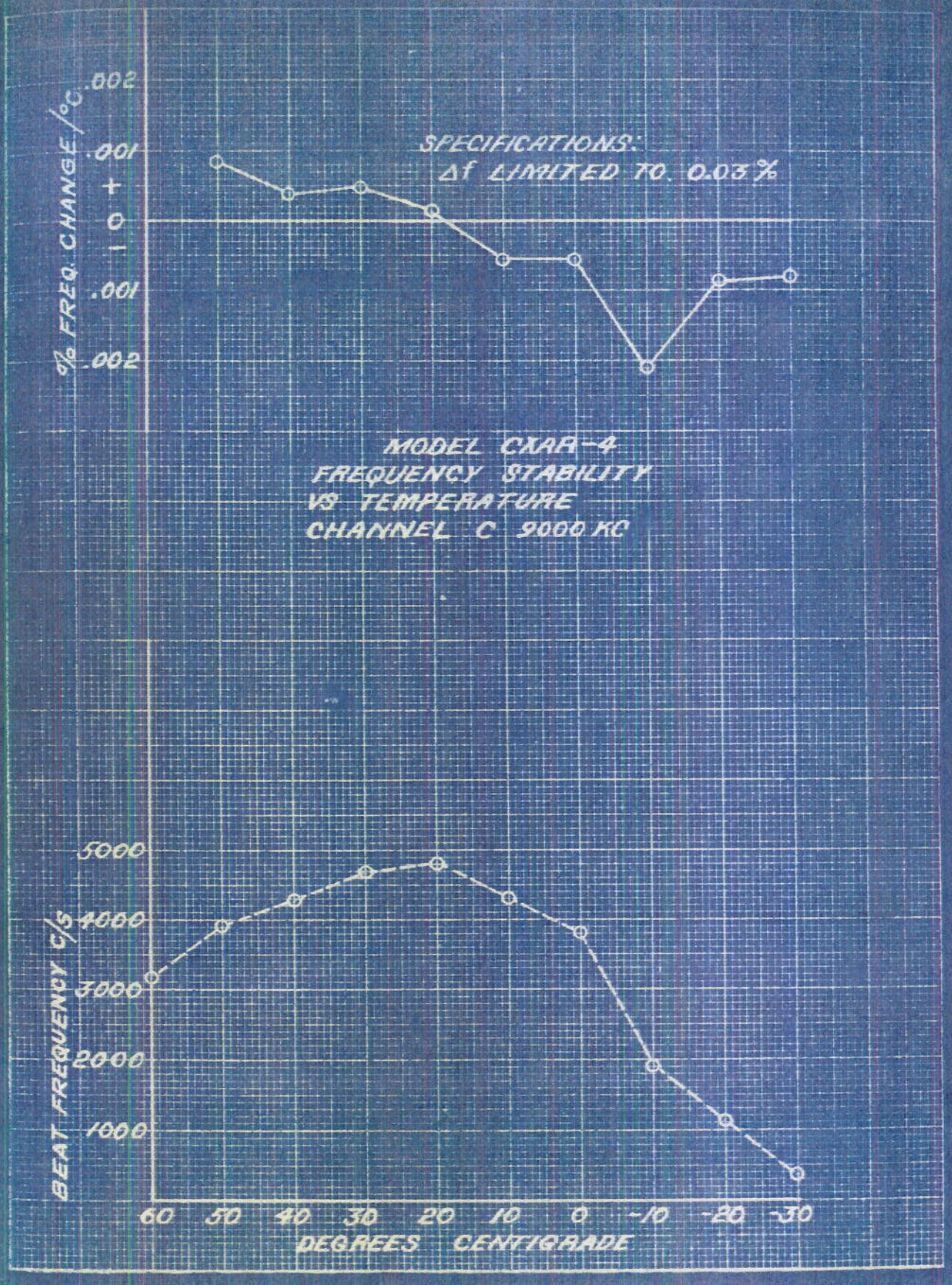
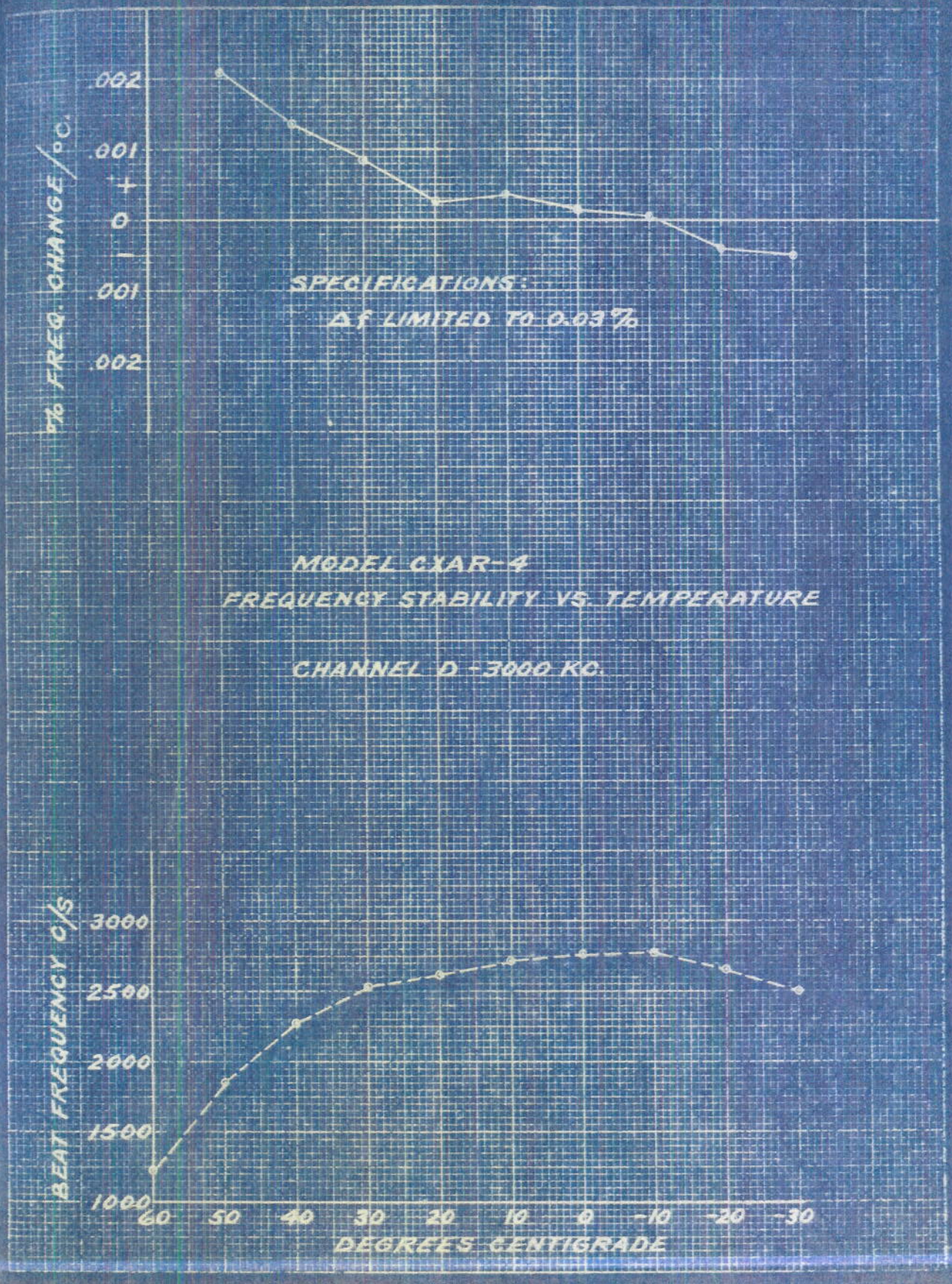


PLATE 18

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

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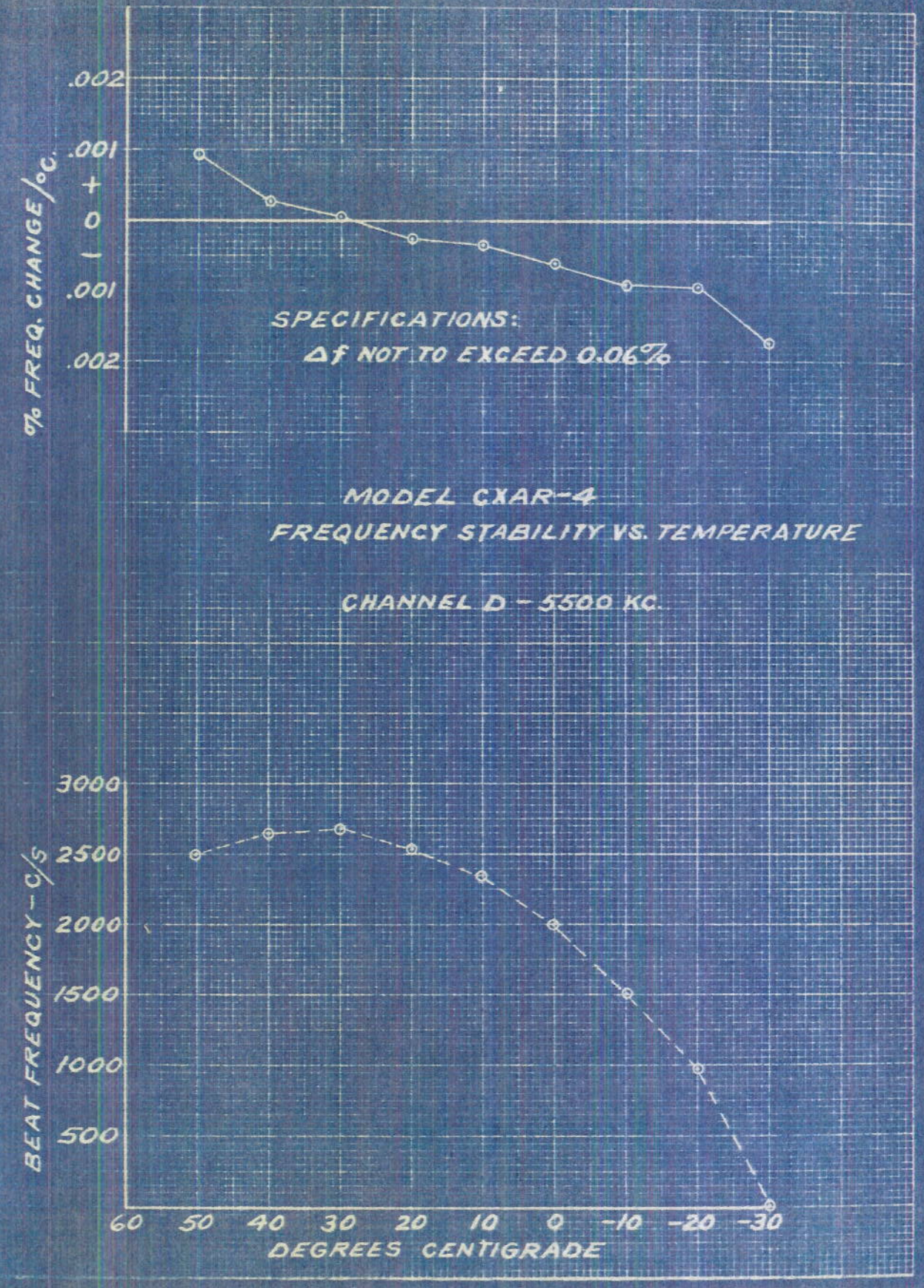


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PLATE 19

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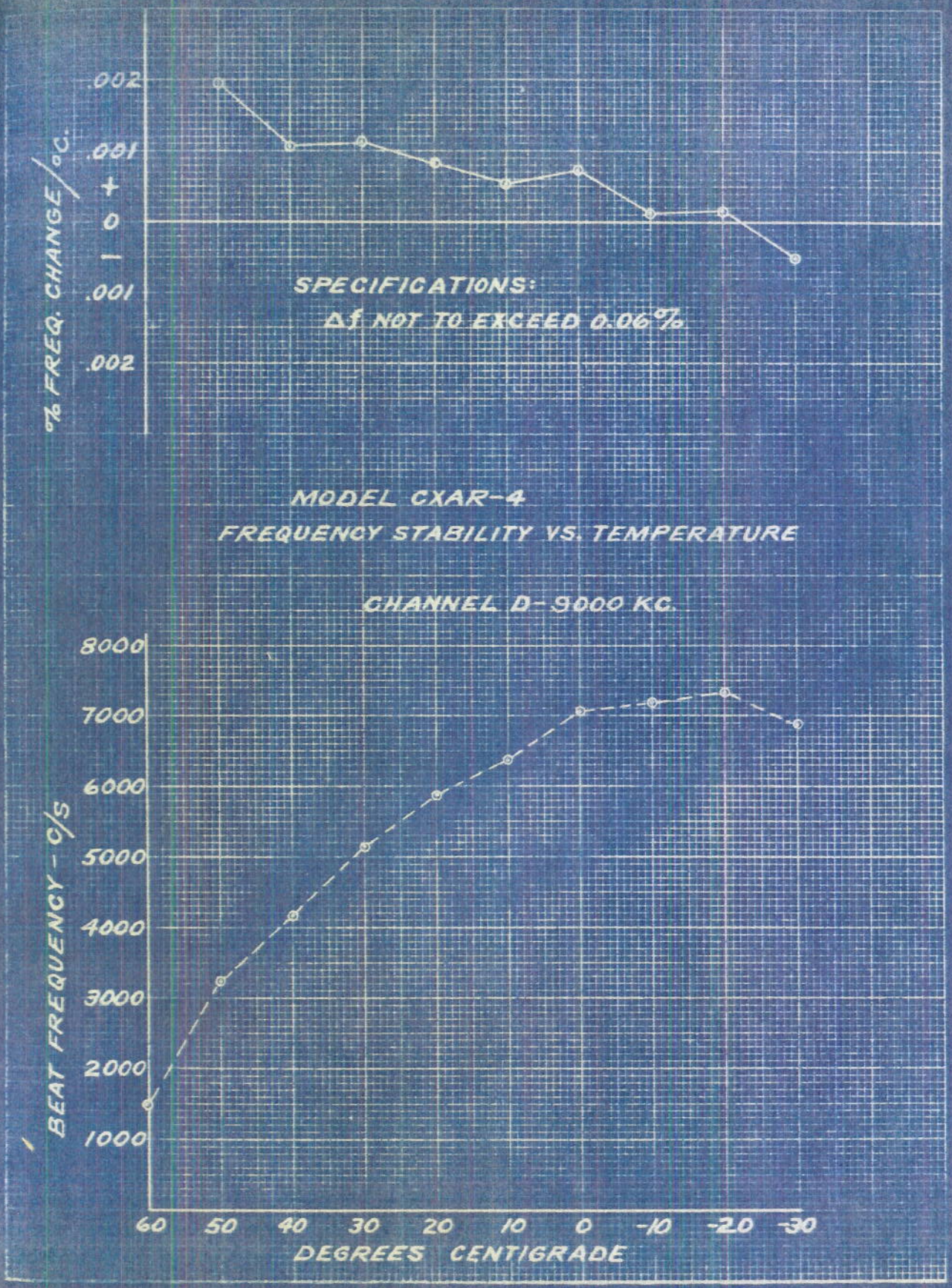
PLATE



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PLATE 2

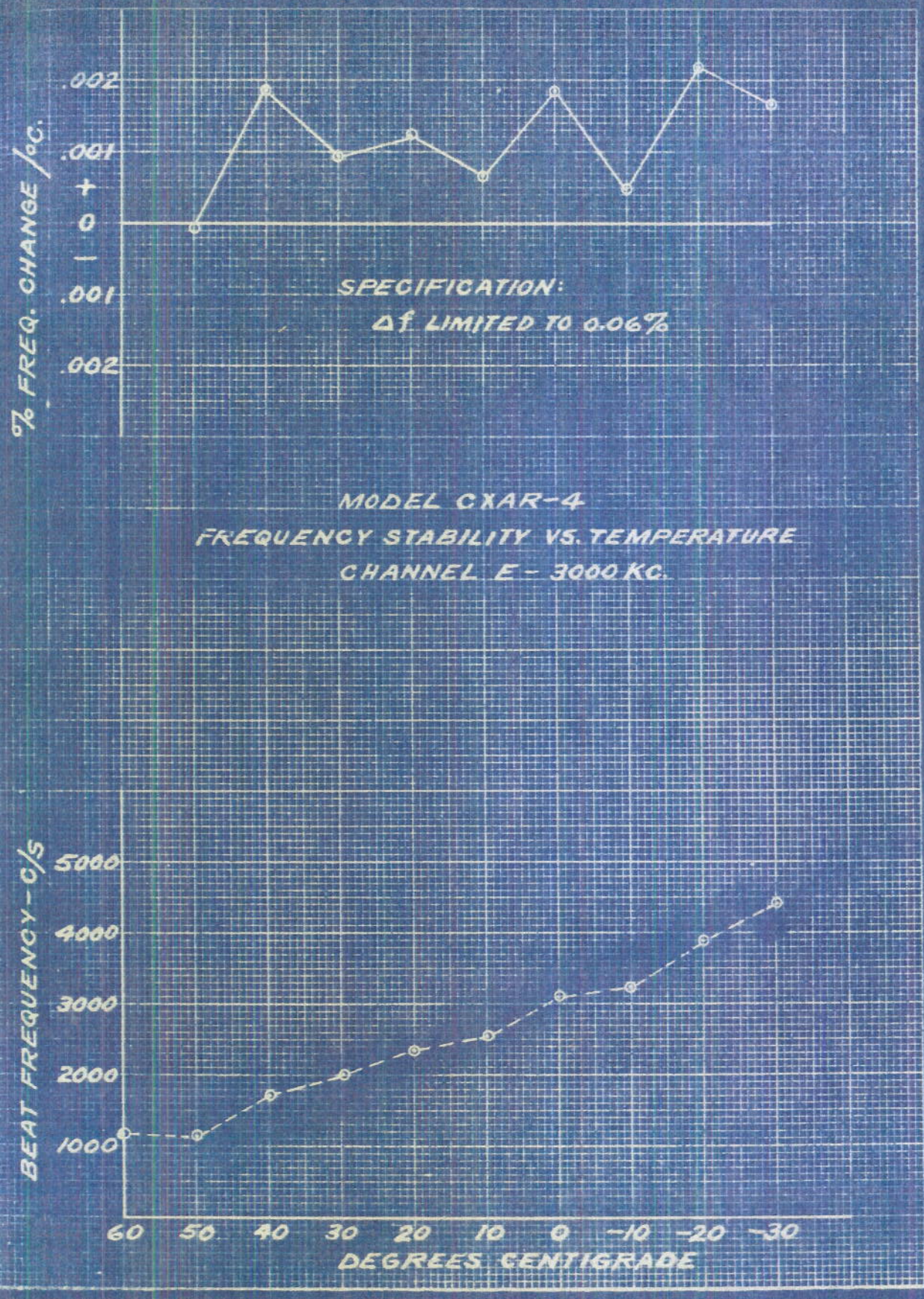
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PLATE 21

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PLATE 22

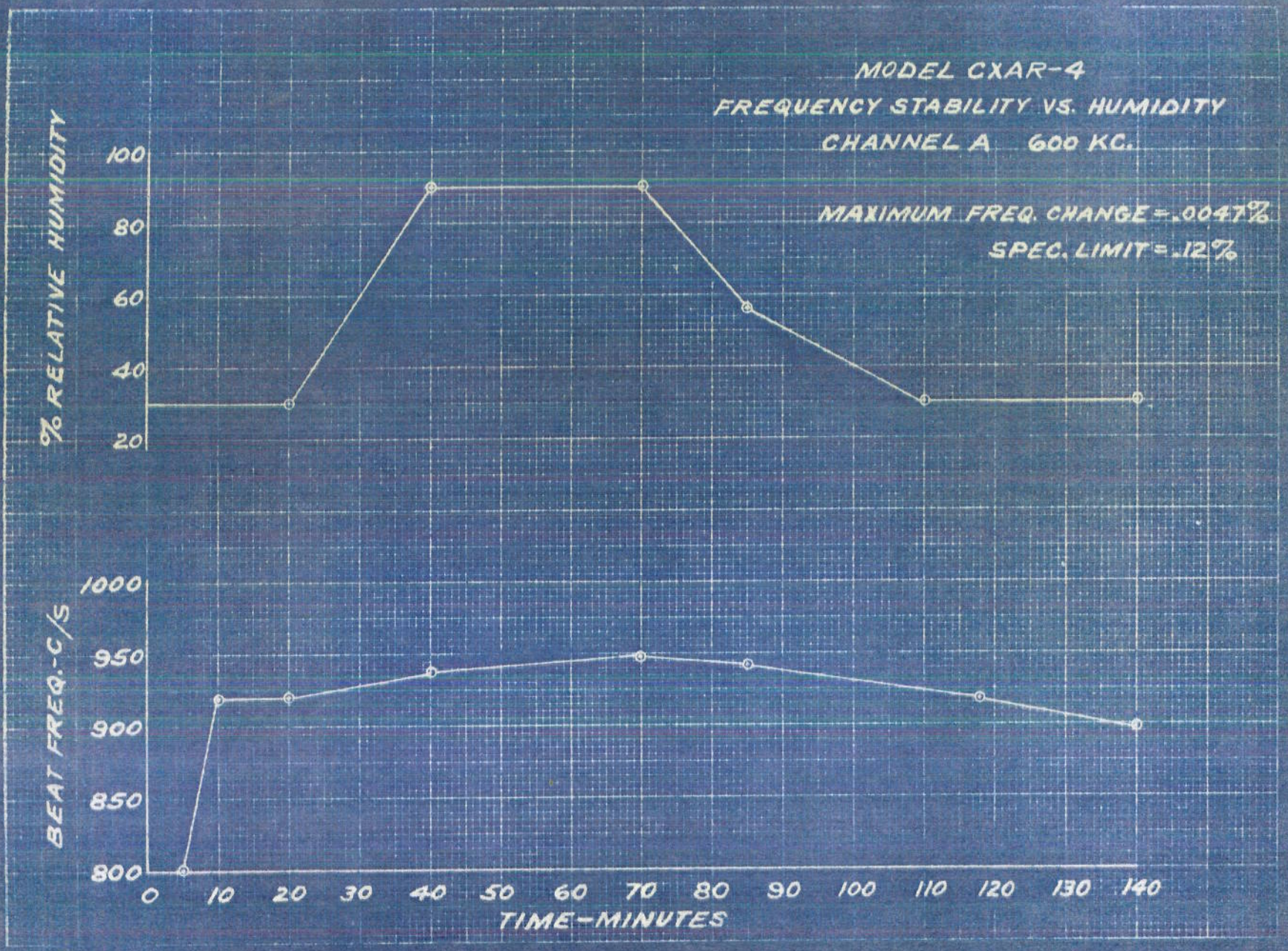

MODEL CXAR-4
FREQUENCY STABILITY VS. HUMIDITY
CHANNEL A 600 KC.
MAXIMUM FREQ. CHANGE = .0047%
SPEC. LIMIT = .12%
% RELATIVE HUMIDITY
100
80
60
40
20
BEAT FREQ.-C/S
1000
950
900
850
800
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140
TIME-MINUTES

PLATE 23

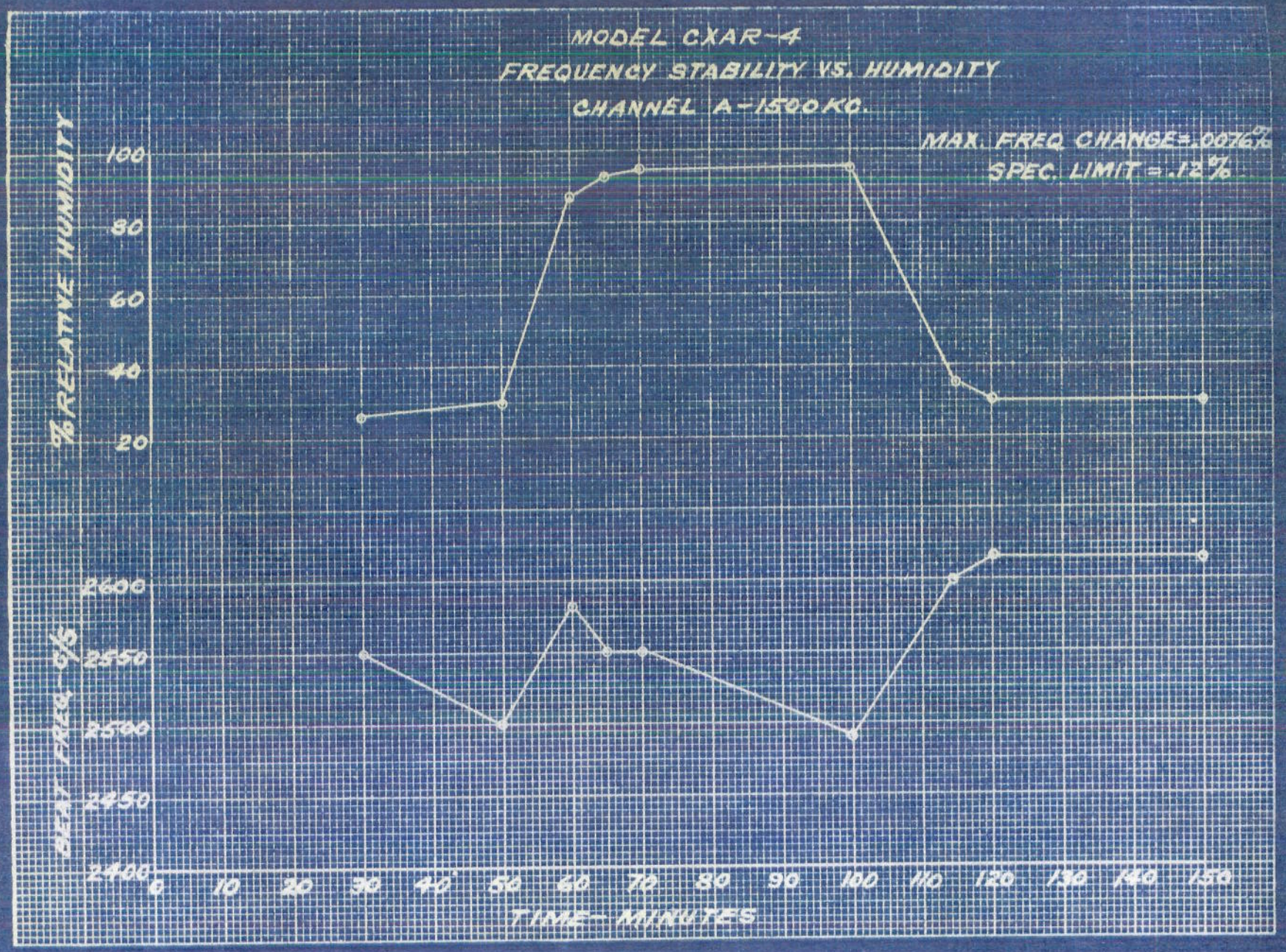

MODEL CXAR-4
FREQUENCY STABILITY VS. HUMIDITY
CHANNEL A-1500 KC.
MAX. FREQ. CHANGE=.0076%
SPEC. LIMIT = .12%
% RELATIVE HUMIDITY
100
80
60
40
20
2600
2550
2500
2450
2400
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
TIME - MINUTES

PLATE 24

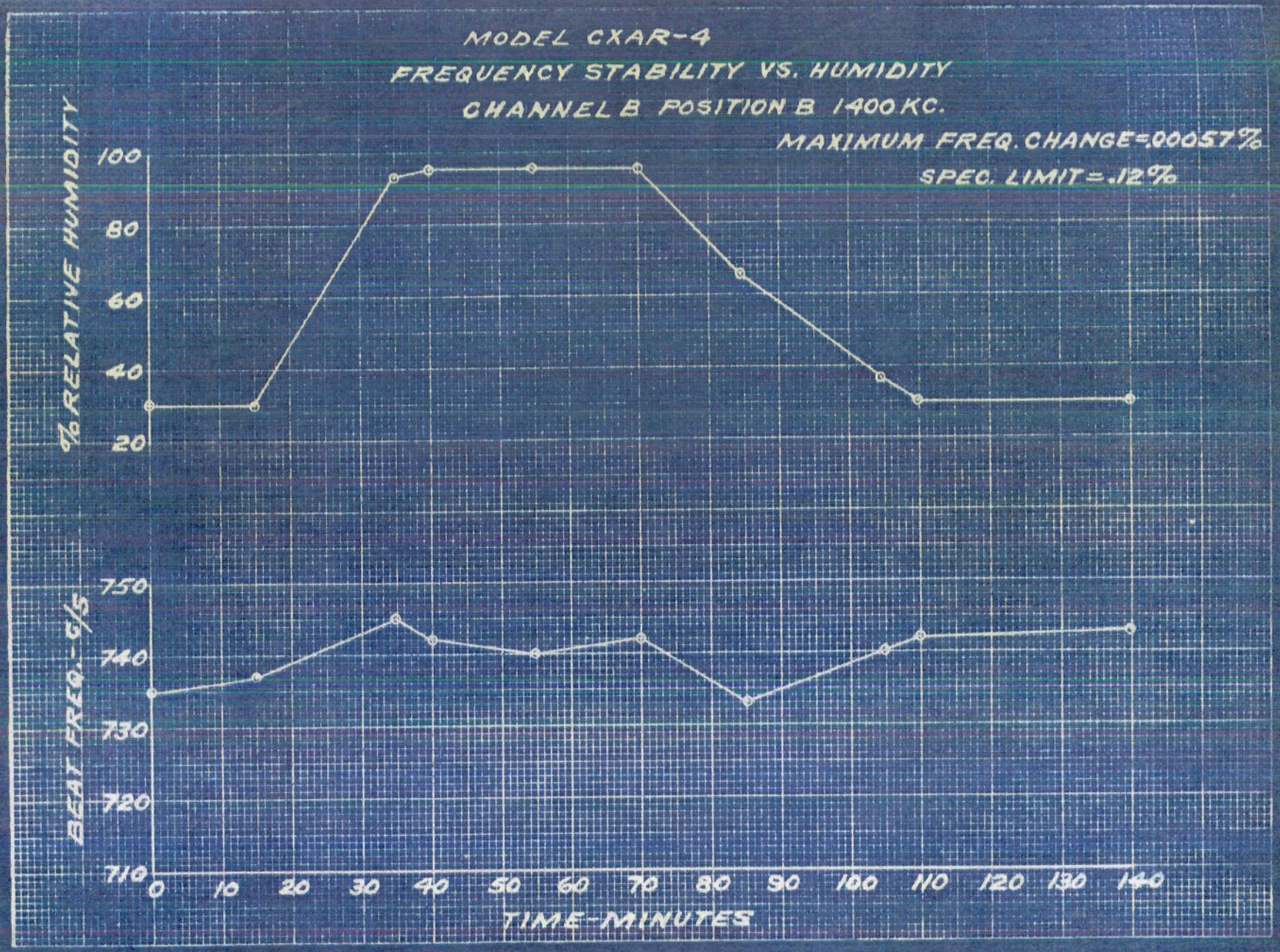

MODEL CXAR-4
FREQUENCY STABILITY VS. HUMIDITY
CHANNEL B POSITION B 1400 KC.
MAXIMUM FREQ. CHANGE=.00057%
SPEC. LIMIT=.12%
% RELATIVE HUMIDITY
100
80
60
40
20
BEAT FREQ.-C/S
750
740
730
720
710
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
TIME-MINUTES

PLATE 25

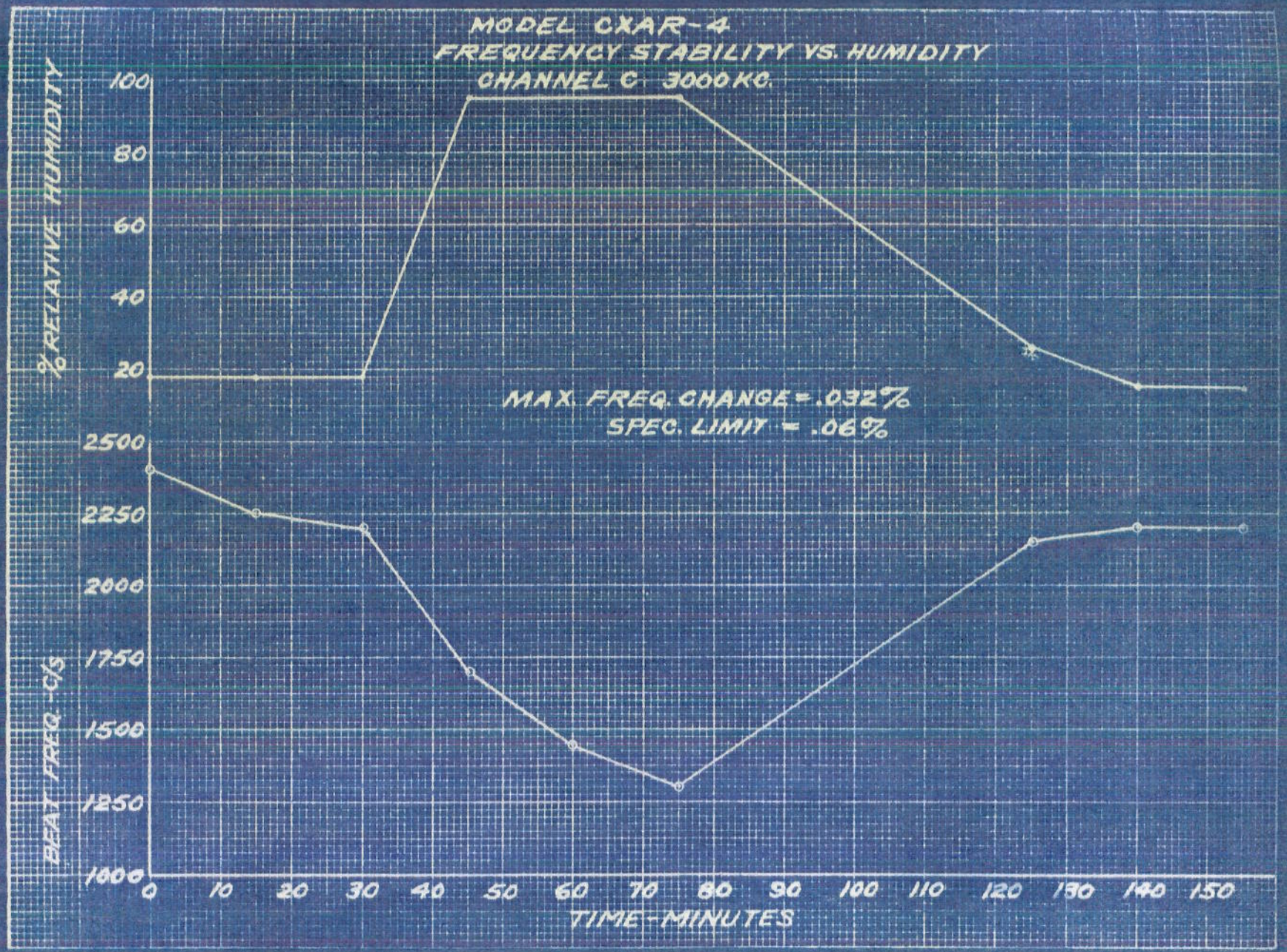

MODEL CXAR-4
FREQUENCY STABILITY VS. HUMIDITY
CHANNEL C 3000 KC.
% RELATIVE HUMIDITY
100
80
60
40
20
MAX. FREQ. CHANGE = .032%
SPEC. LIMIT = .06%
BEAT FREQ. - C/S
2500
2250
2000
1750
1500
1250
1000
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
TIME - MINUTES

PLATE 26

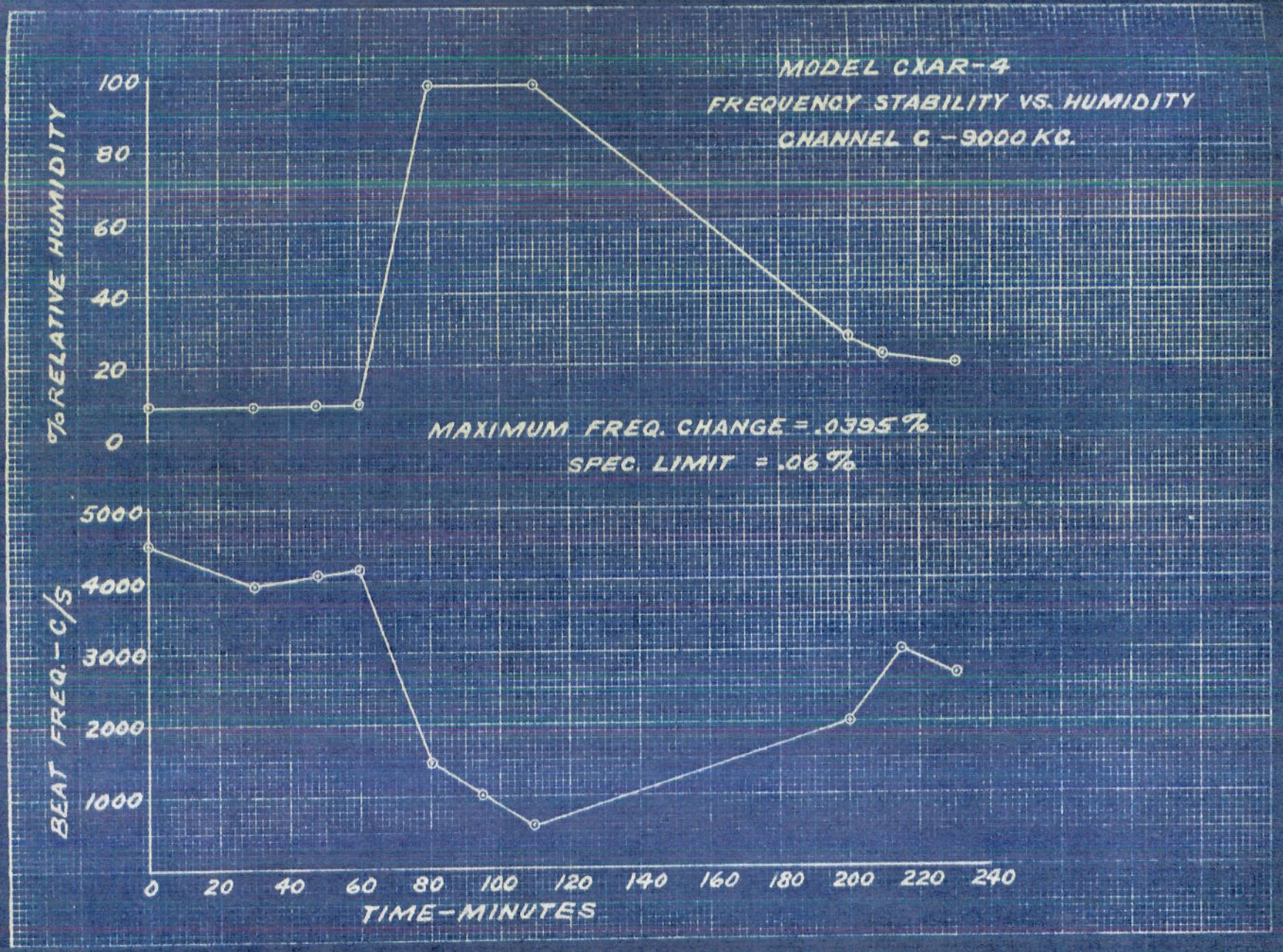

MODEL CXAR-4
FREQUENCY STABILITY VS. HUMIDITY
CHANNEL C - 9000 KC.
% RELATIVE HUMIDITY
100
80
60
40
20
0
MAXIMUM FREQ. CHANGE = .0395 %
SPEC. LIMIT = .06 %
BEAT FREQ. - C/S
5000
4000
3000
2000
1000
0
20
40
60
80
100
120
140
160
180
200
220
240
TIME - MINUTES

PLATE 27

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BELLEVUE, D. C.

DATE

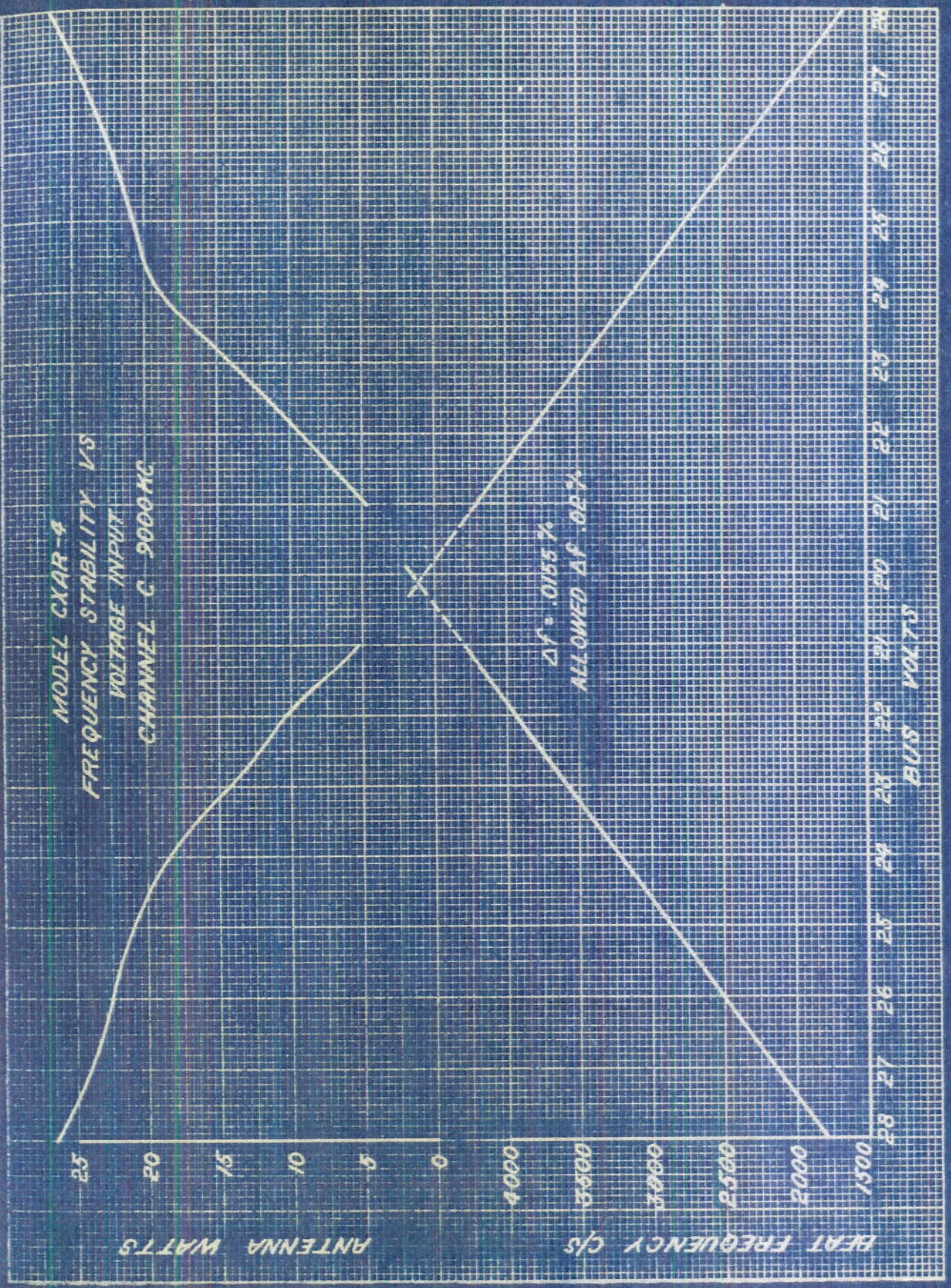


PLATE 28

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DATE

MODEL CXAR-4
FREQUENCY STABILITY VS
LOCKED KEY OPERATION
CHANNEL A

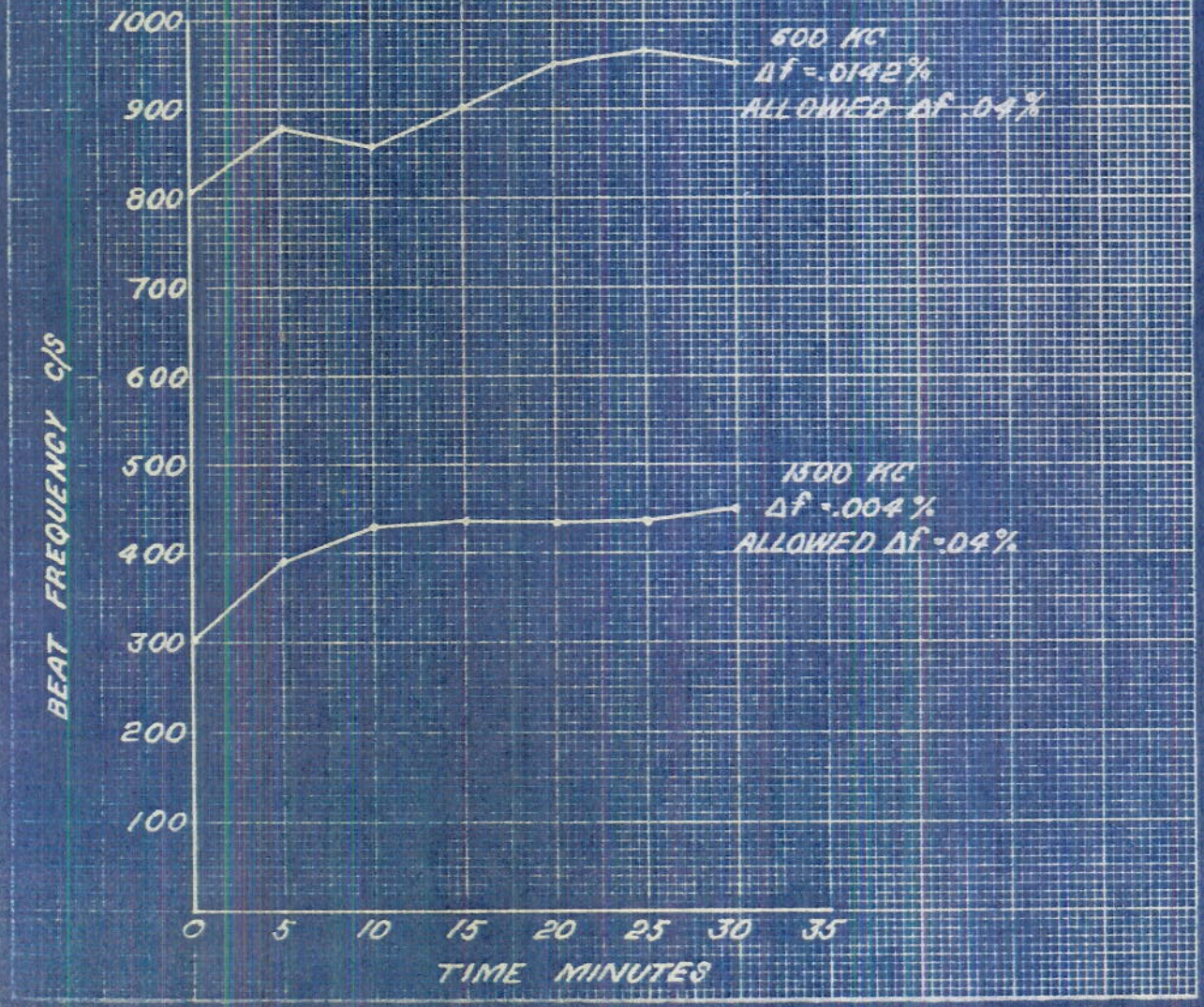


PLATE 29

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DATE

MODEL CXAR-4
FREQUENCY STABILITY VS LOCKED KEY OPERATION
CHANNEL B

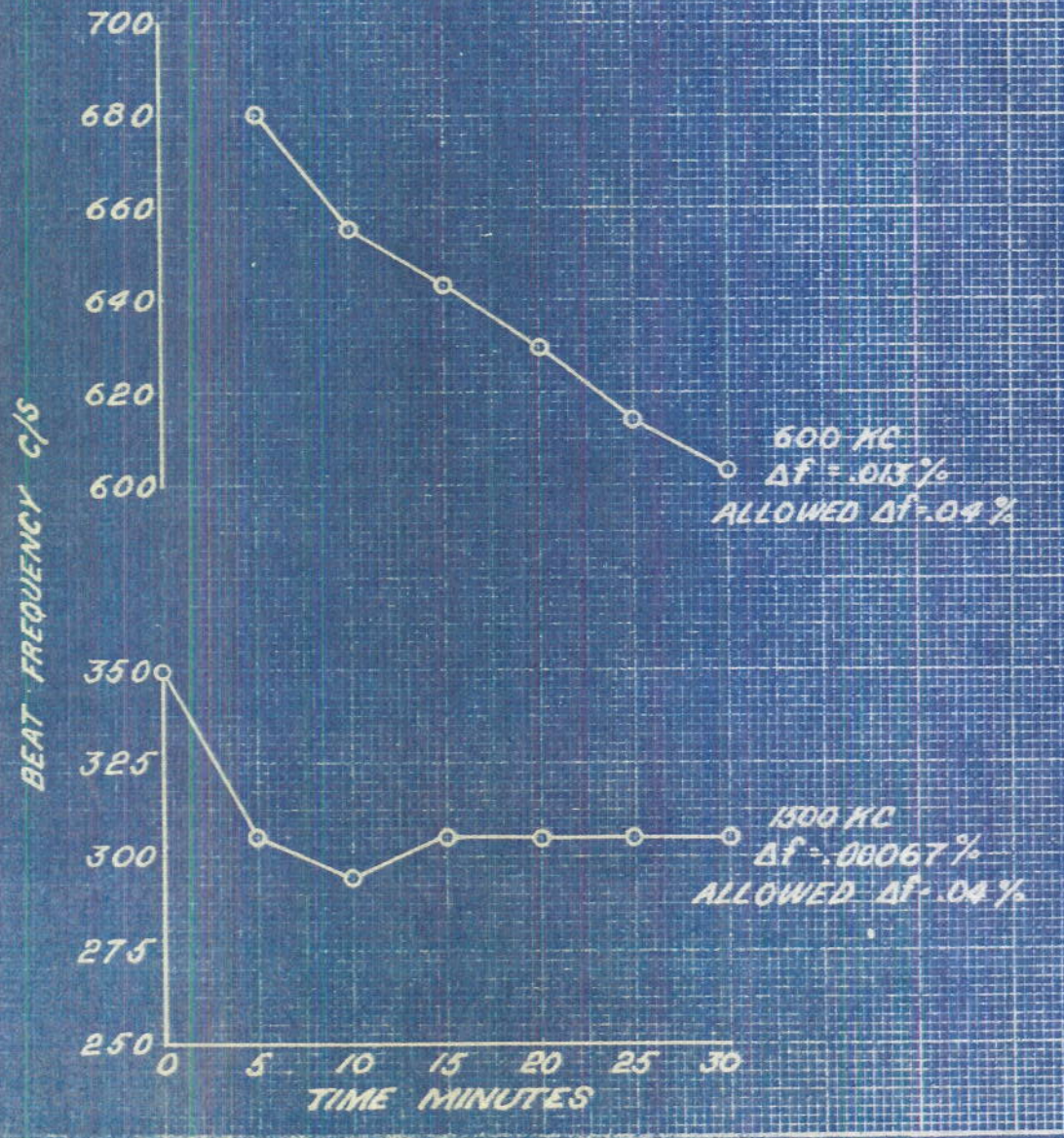


PLATE 30

DECLASSIFIED

MODEL CXAR-4
FREQUENCY STABILITY VS
LOCKED KEY OPERATION
CHANNEL C

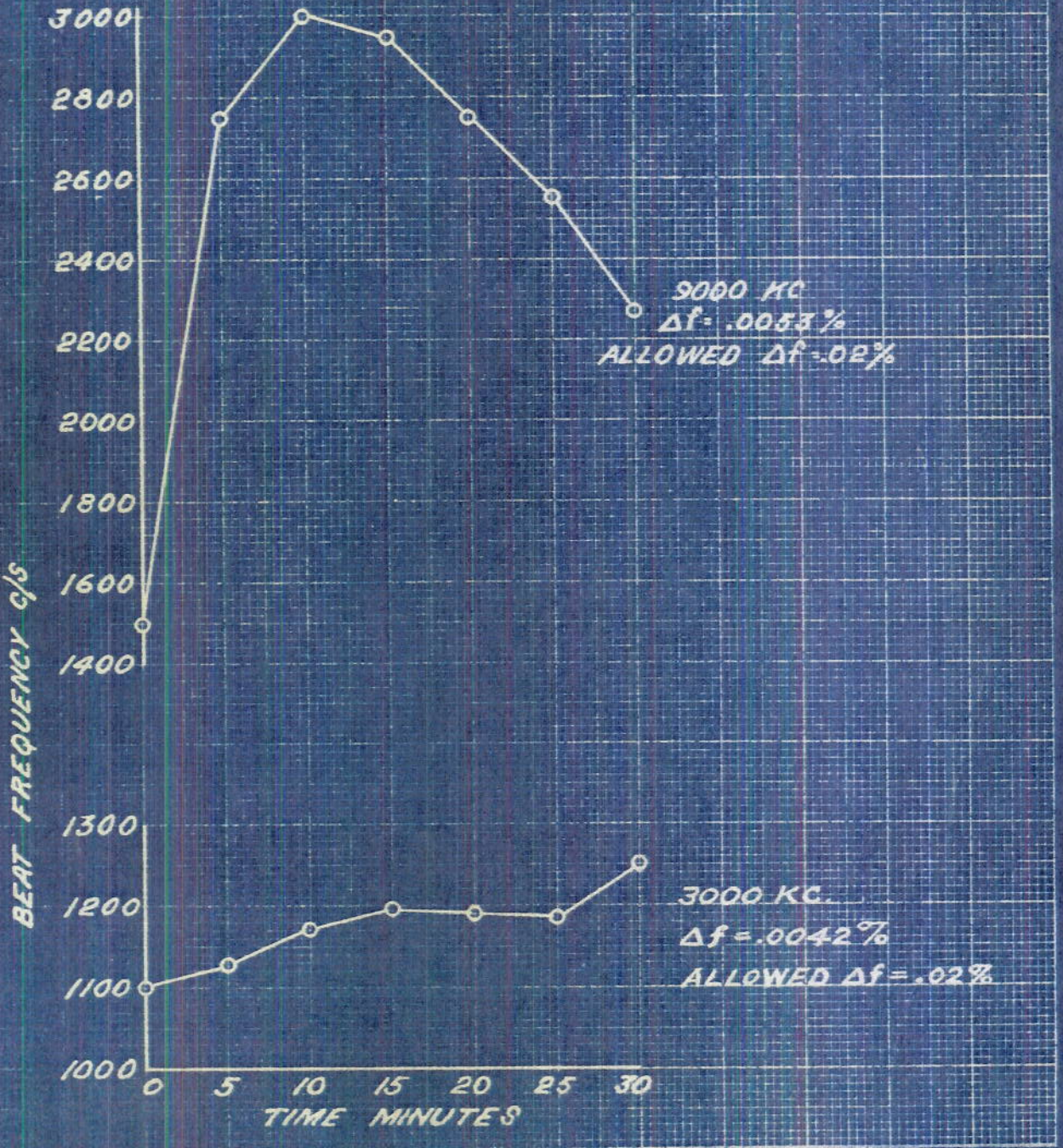


PLATE 31

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DATE

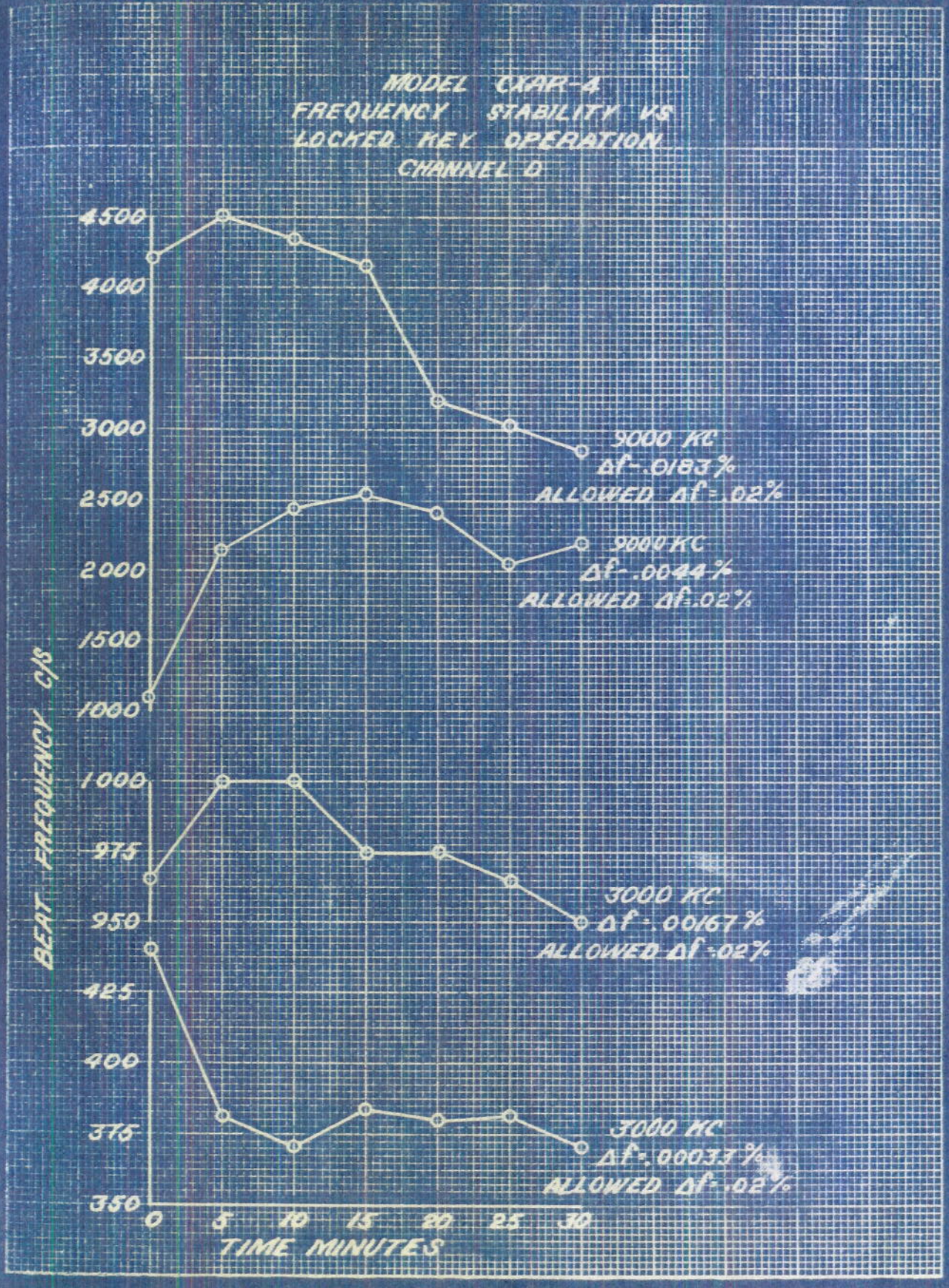
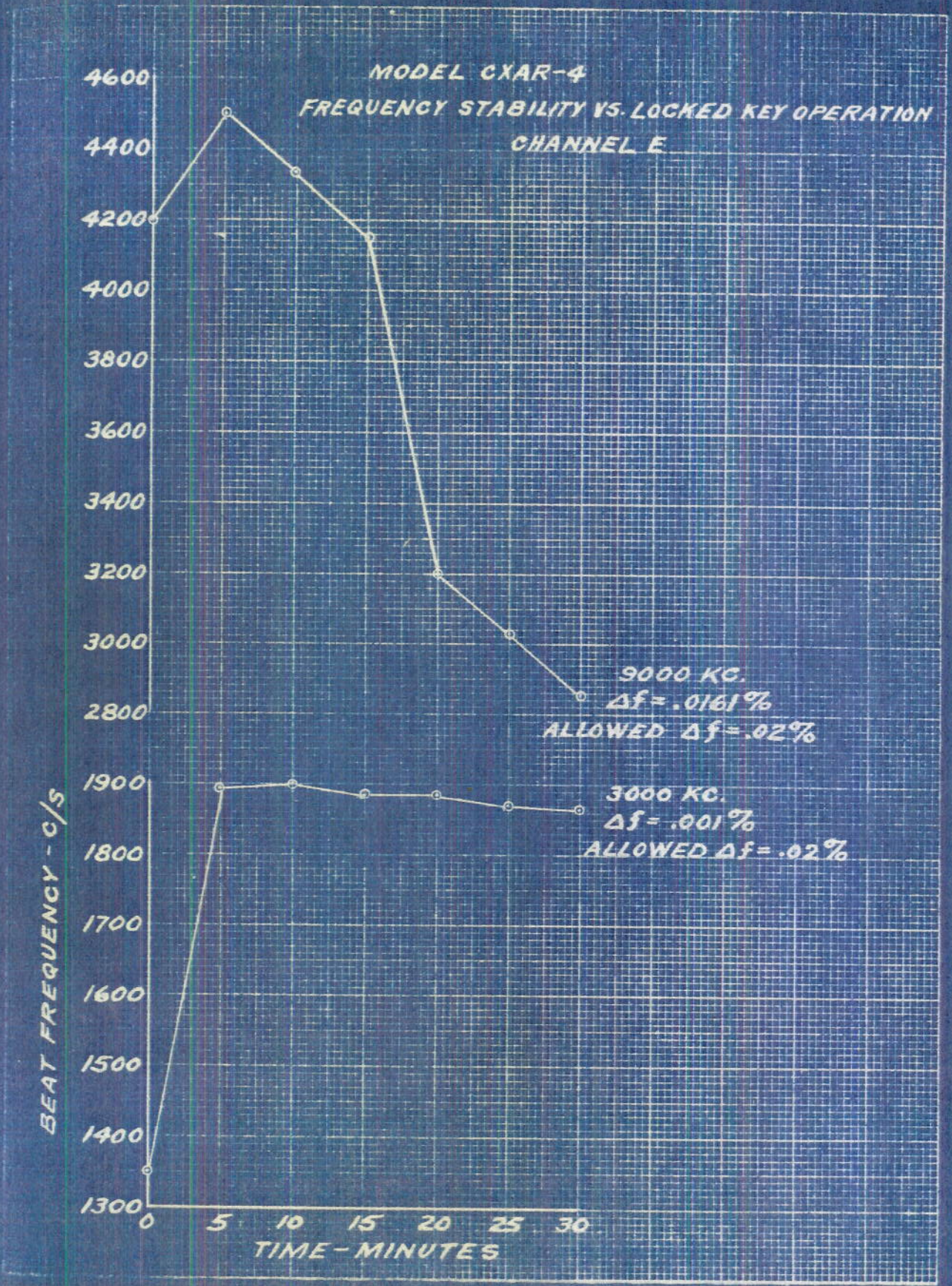


PLATE 32

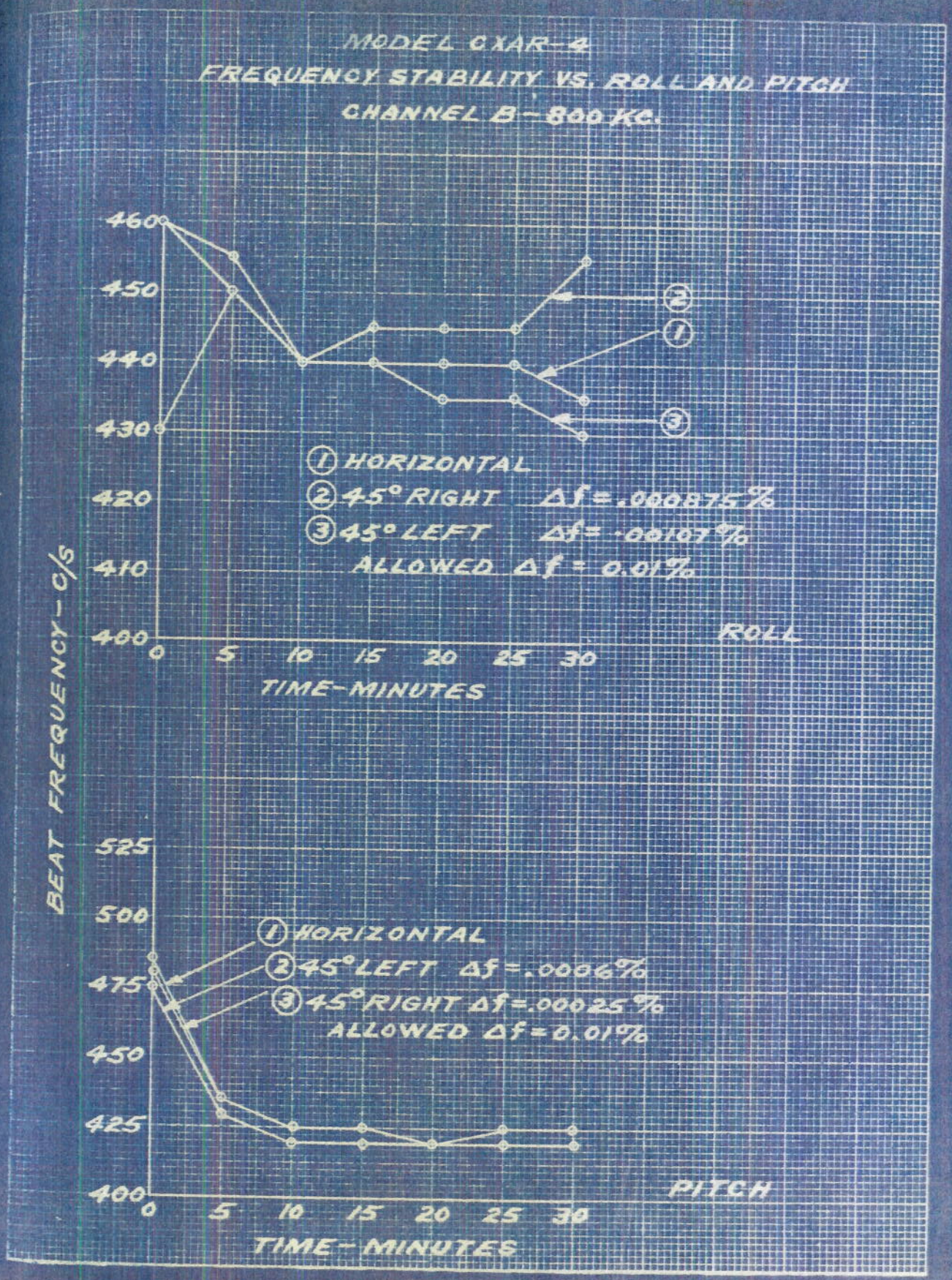
U. S. NAVAL RESEARCH LABORATORY
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DECLASSIFIED
DATE



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PLATE 33

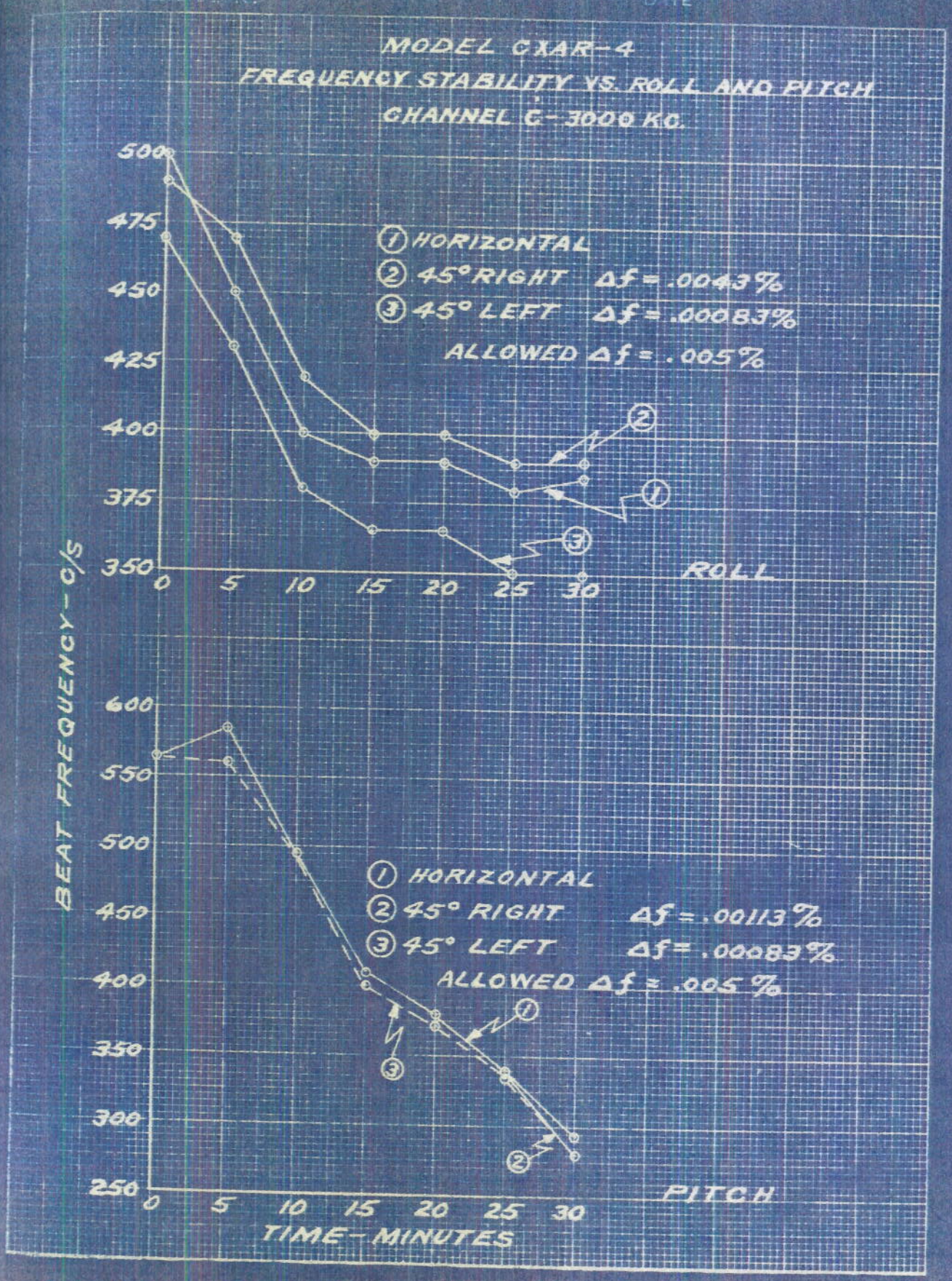
DECLASSIFIED



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PLATE 34

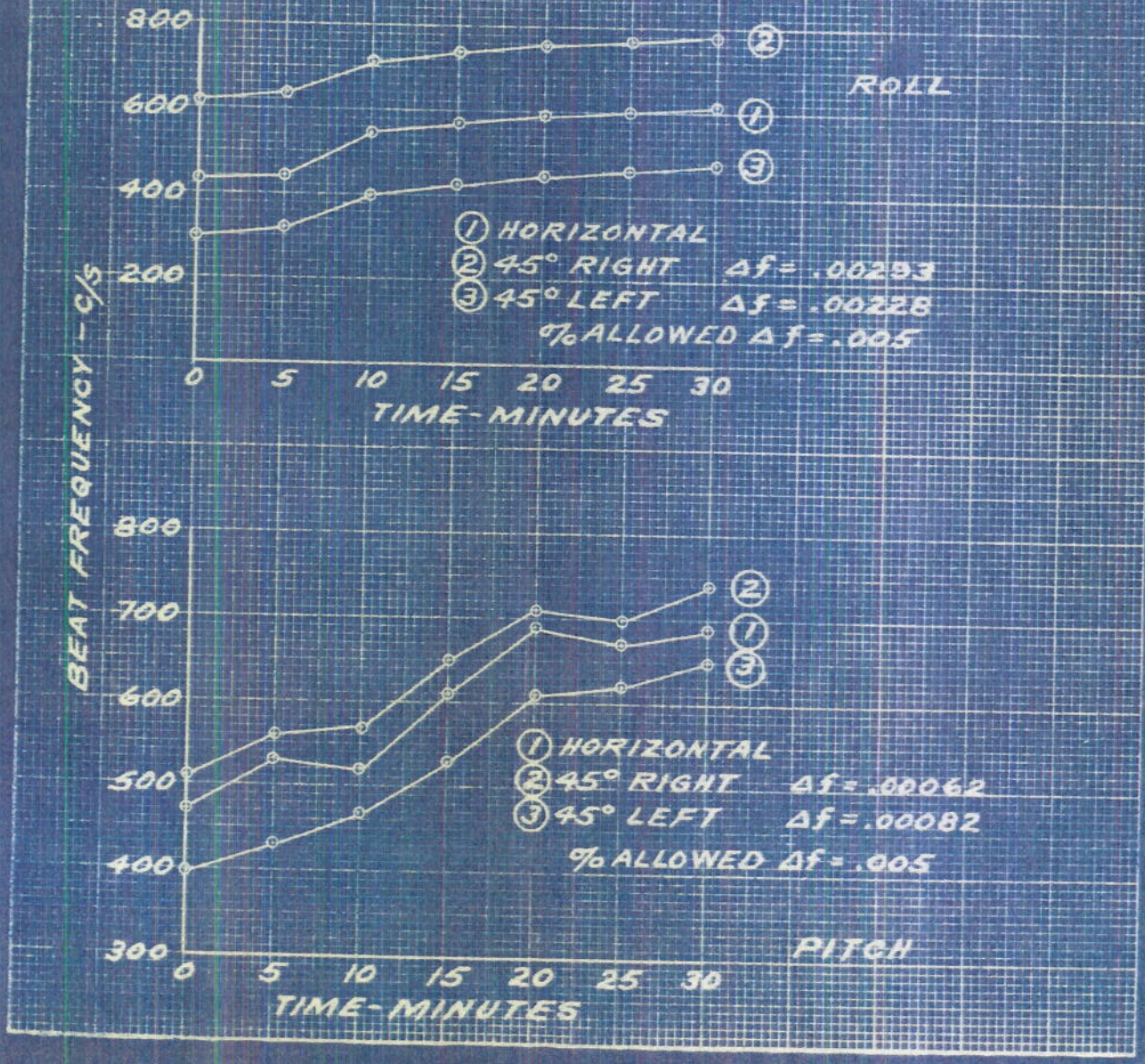
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MODEL CXAR-4
FREQUENCY STABILITY VS. ROLL AND PITCH
CHANNEL D-6000 KC.



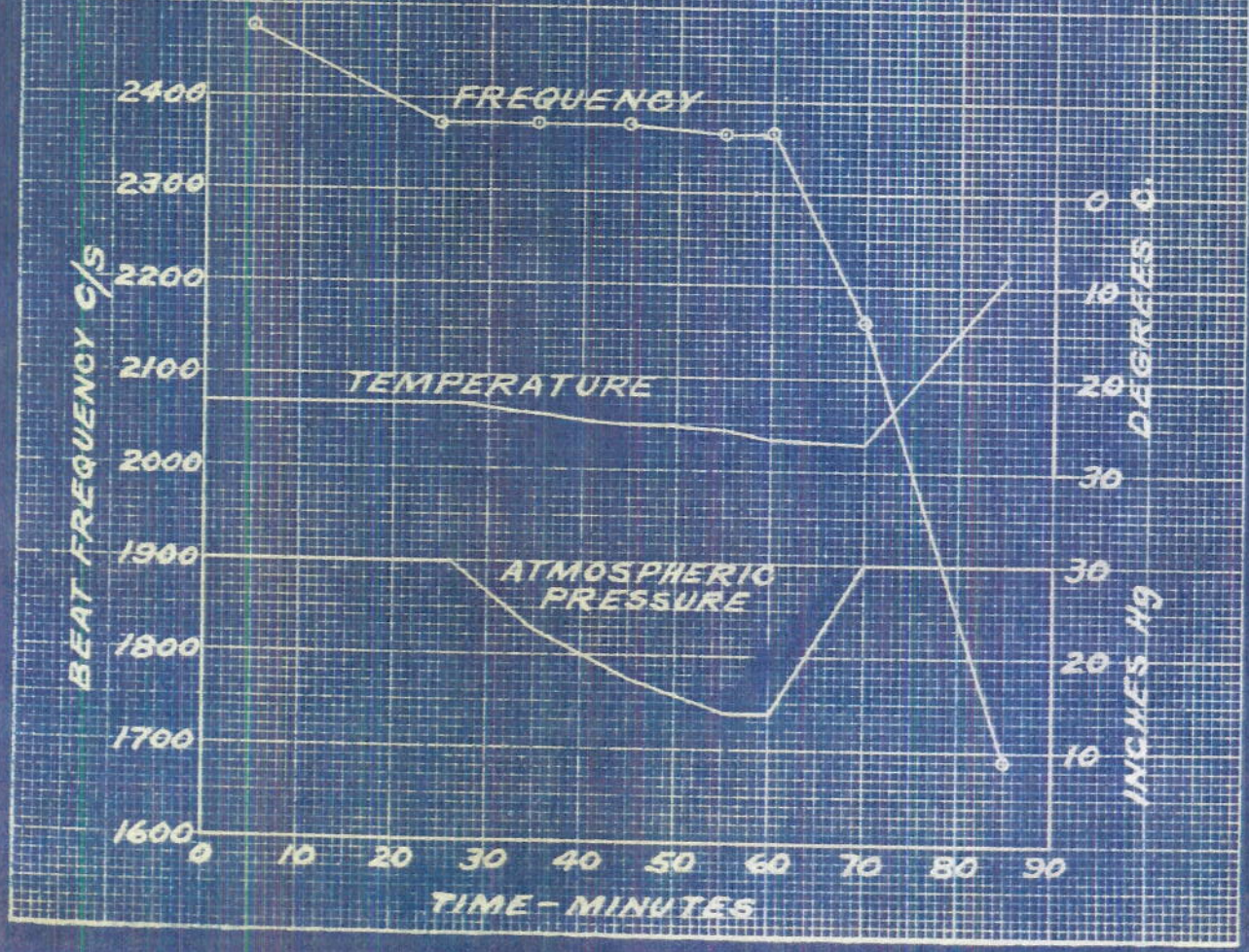
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MODEL CXAR-4
FREQUENCY STABILITY VS. ALTITUDE
CHANNEL E - 3000 KC.



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PLATE 27

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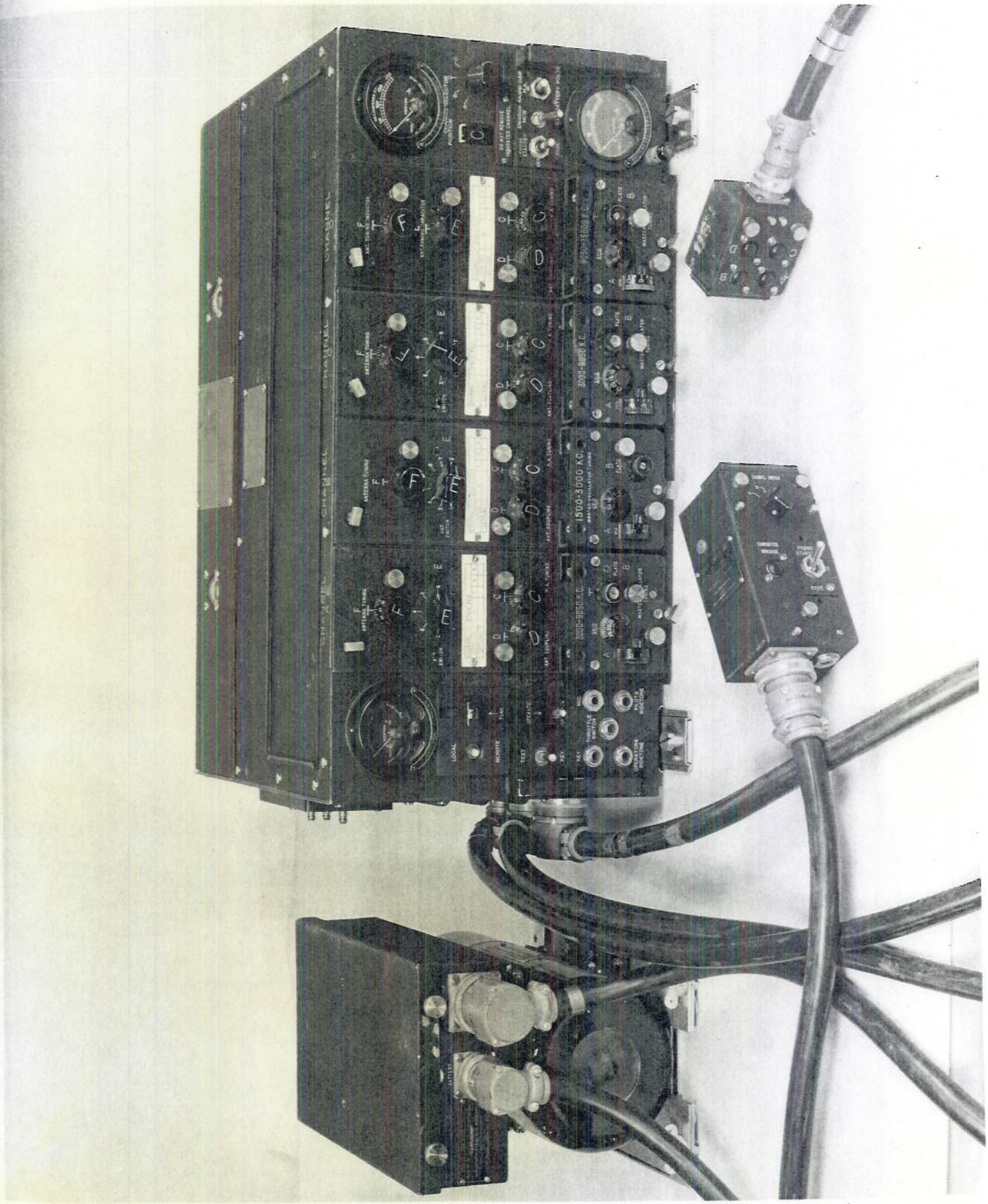


PLATE 38

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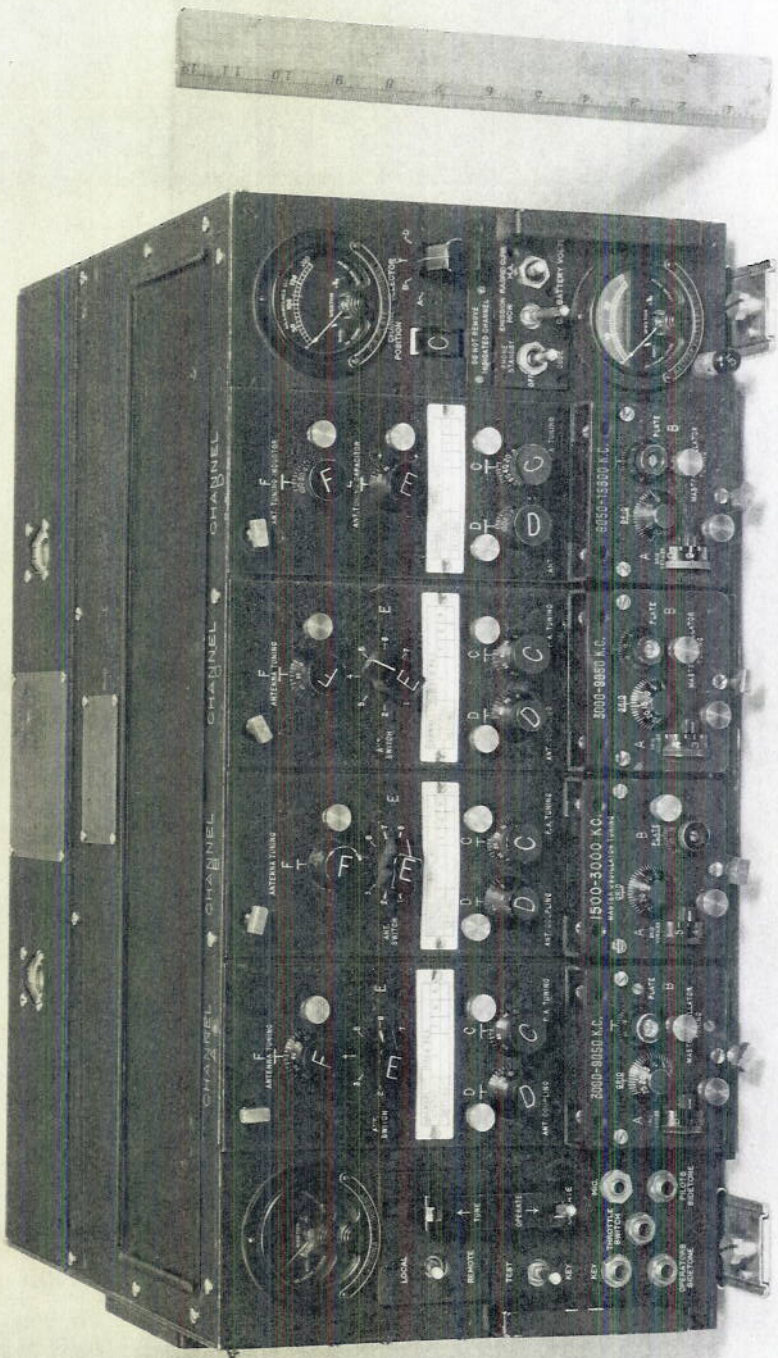


PLATE 39

DECLASSIFIED

DECLASSIFIED

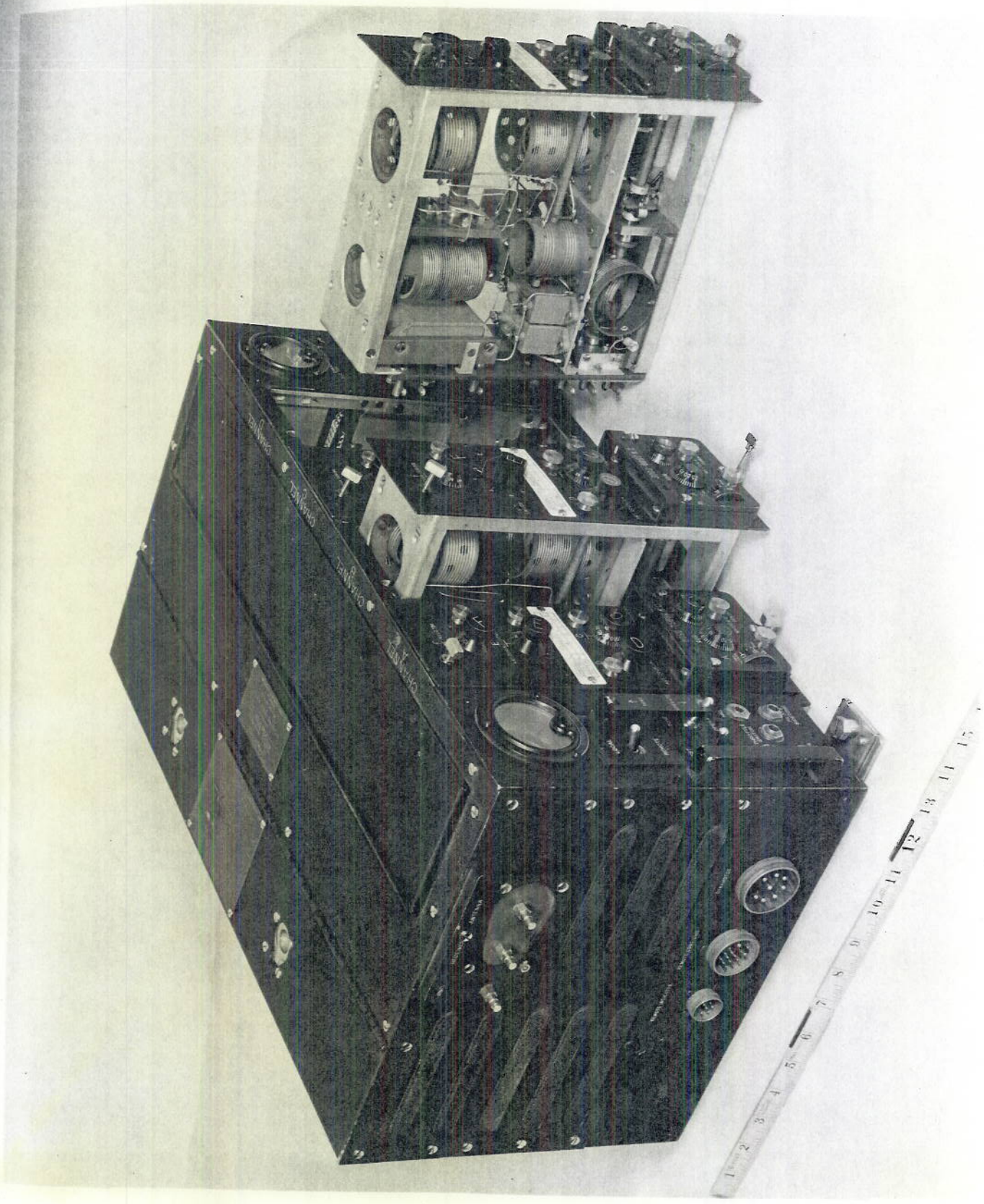


PLATE 40

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DECLASSIFIED

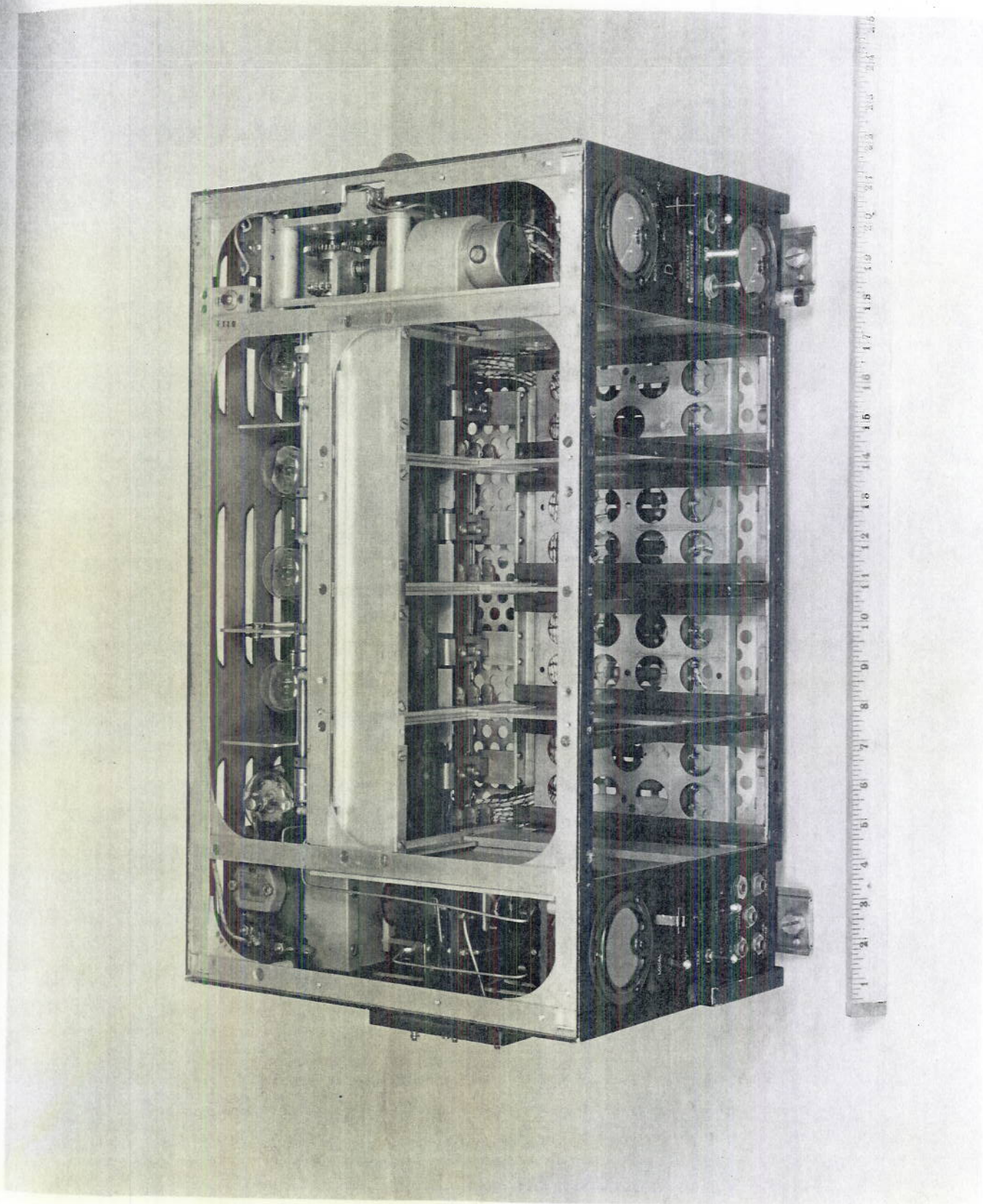


PLATE 41

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DECLASSIFIED

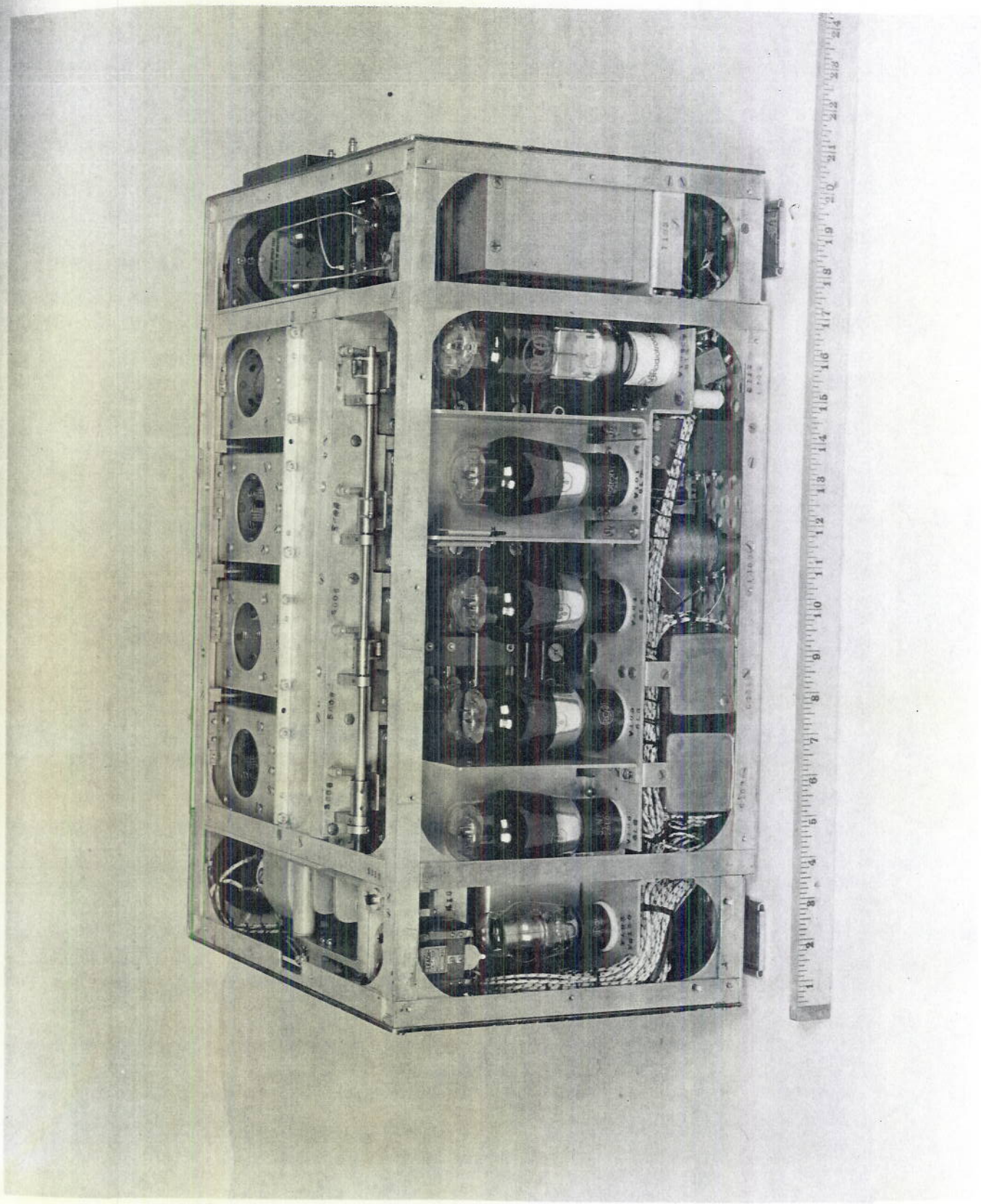


PLATE 42

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DECLASSIFIED

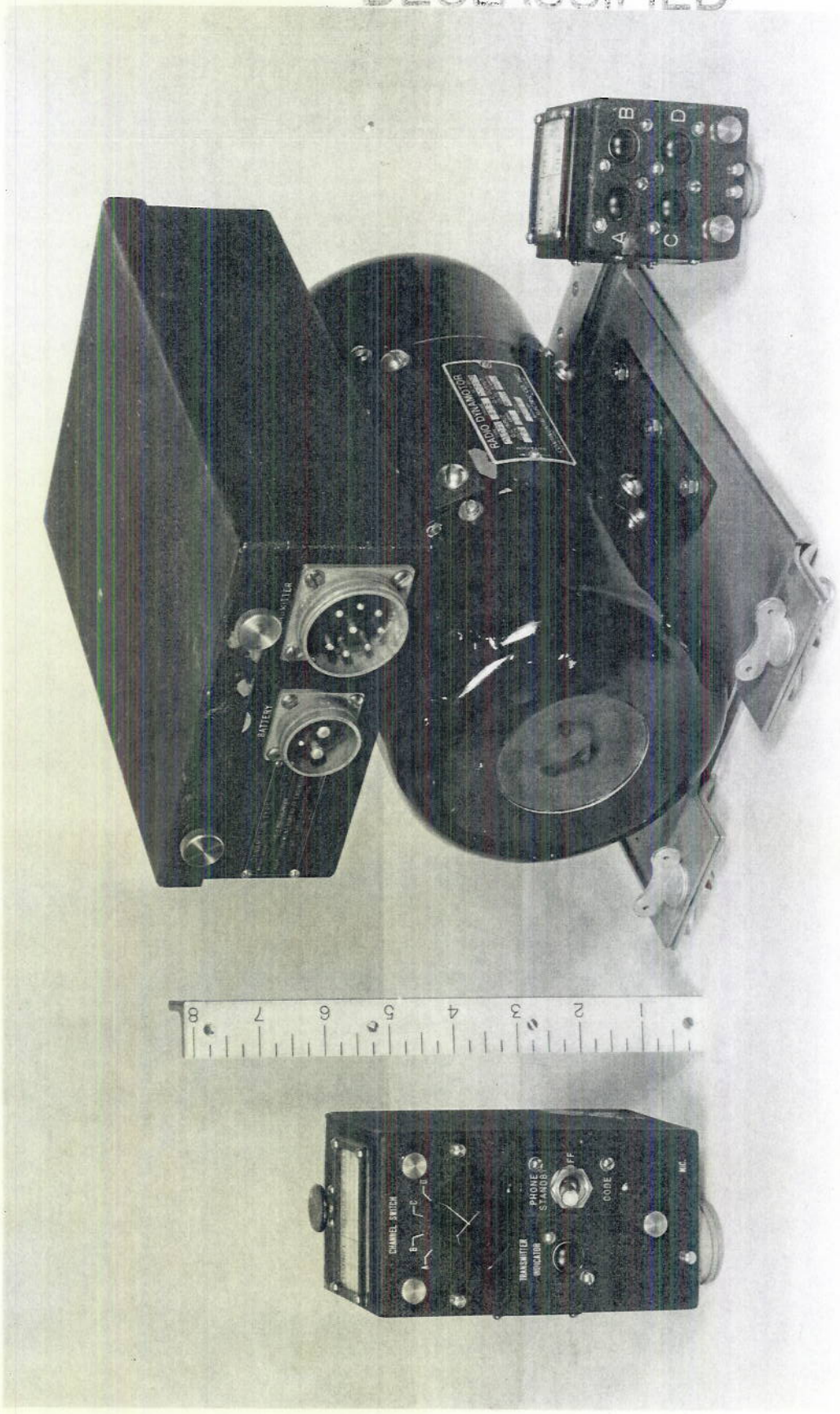


PLATE 43

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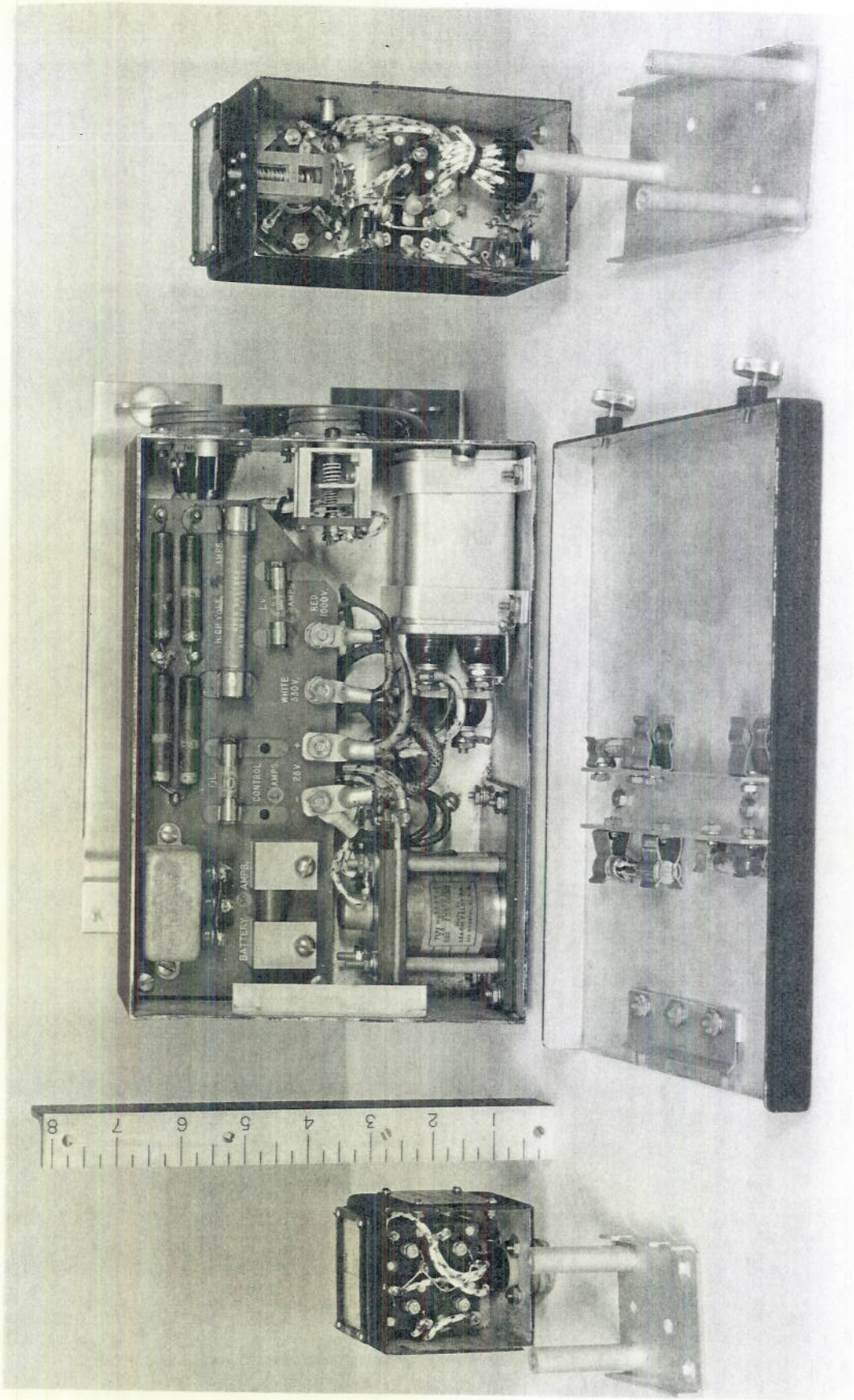


PLATE 11

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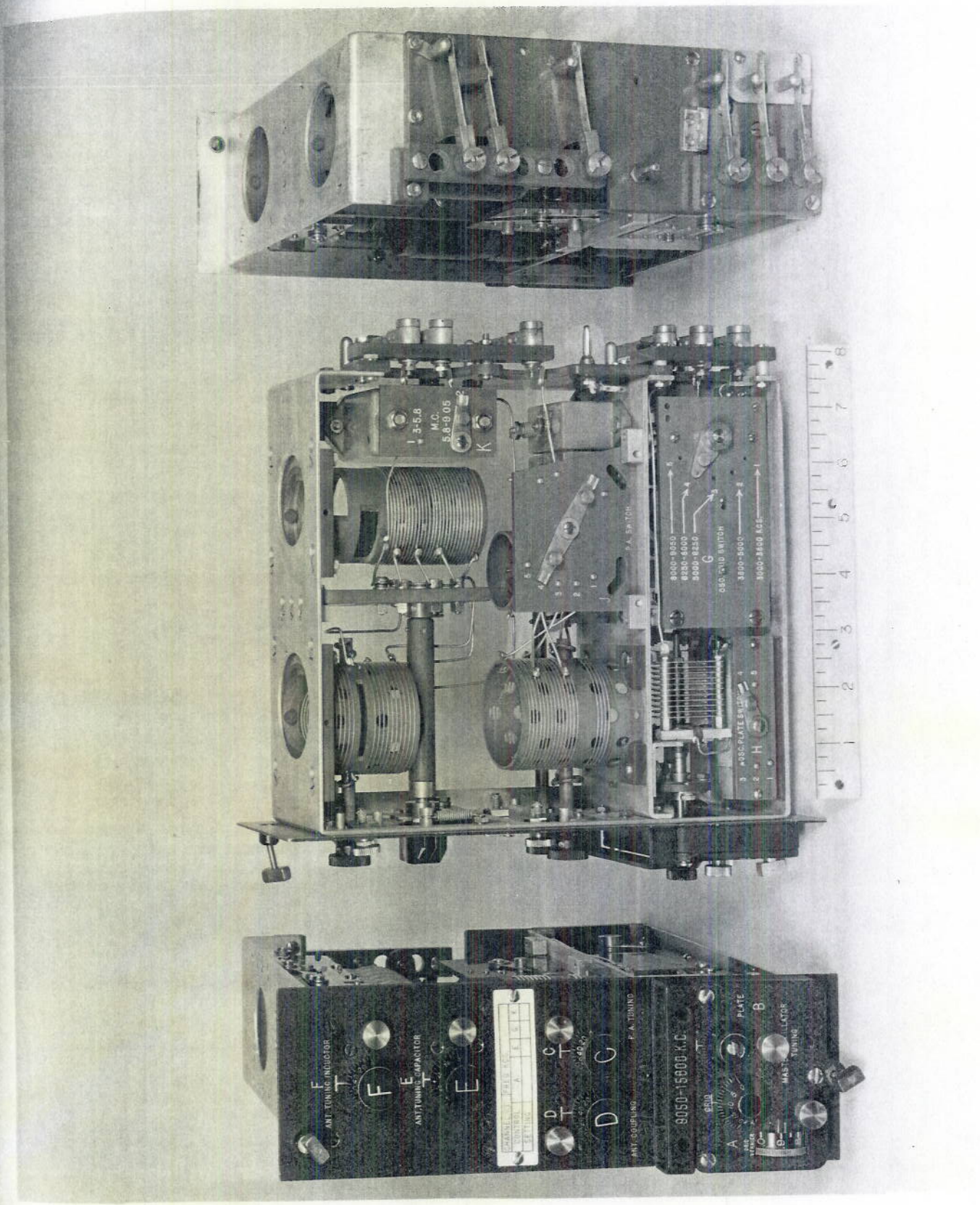


PLATE 45

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