

FR-1087

Report No. R-1087

Test of Model TBK Transmitting Equipment
(Preliminary Model)

REPORT NO. R-1087

DATE 24 October 1934

SUBJECT

Test of Model TBK Transmitting Equipment
(Preliminary Model)



BY

NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

U. S. GOVERNMENT PRINTING OFFICE: 1933

4-107-100

DISTRIBUTION STATEMENT A APPLIES

Further distribution authorized by _____

UNLIMITED only.

24 October 1934

NRL Report No. R-1087
BuEng. Prob. T5-15

NAVY DEPARTMENT
BUREAU OF ENGINEERING

Report on

Test of Model TBK Transmitting Equipment
(Preliminary Model)

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D.C.

Number of Pages: Text - 30 Tables - 37 Plates - 10

Authorization: BuEng ltr. NOs-36091(6-26-W8) of 27 June 1934.

Date of Test: September 1, 1934 to October 20, 1934

Prepared by:

R. B. Meyer, Assoc. Rad. Engr.
(Chief of Section)

O. C. Dresser, Asst. Rad. Engr.

Reviewed by:

A. Hoyt Taylor, Physicist, Supt. Radio Division.

Approved by:

H. R. Greenlee, Captain, U.S.N.,
Director.

Distribution:

Bu. Eng. (5)

LP
MBE

TABLE OF CONTENTS

<u>SUBJECT</u>	<u>PAGE</u>
1. AUTHORIZATION OF TEST.....	1
2. OBJECT OF TEST.....	1
3. ABSTRACT OF TESTS.....	1
(a) Conclusions.....	2a
(b) Recommendations.....	2b
4. MATERIAL UNDER TEST.....	3
5. METHOD OF TEST.....	3
6. DATA RECORDED.....	4
7. PROBABLE ERRORS IN RESULTS.....	4
8. RESULTS OF TESTS.....	5
9. CONCLUSIONS.....	30

Appendices

Check of Current in Rectifier Supply Lines.....	Table 1
Antenna Short Circuited and Open Circuited.....	" 2
Dimensions and Weights.....	" 3
Determination of Power Output.....	" 4
Determination of Power Output.....	" 5
Emergency Operation.....	" 6
Variation of Line Voltage.....	" 7
Frequency Change Caused by Detuning Resonant Circuits....	" 8
Frequency Change Between "Adjust", "Tune" & "Operate"....	" 9
Key Locked Test.....	" 10
40 W/P/M Keying Test.....	" 11
Change of Tubes in Master Oscillator and Buffer Ampere Circuit.....	" 12
Change of Tubes in Master Oscillator and Buffer Ampere Circuit.....	" 13
Two hour locked Key Test - 2000 Kc.....	" 14
Two hour Locked Key Test - 3000 Kc.....	" 15
Two hour Locked Key Test - 3000 Kc.....	" 16
Two hour Locked Key Test - 4500 Kc.....	" 17
Shock Test to Simulate Gun Fire.....	" 18
Variation of Resoant Frequency.....	" 19
Lost Motion and Back Lash in Master Oscillator.....	" 20
Effect of Locking Devices on Frequency.....	" 21
Accuracy of Reset.....	" 22
Range of Master Oscillator Adjusting Condenser.....	" 23
Control of Power Output.....	" 24

Appendices - cont'd

Power Required from Supply Lines.....	Table 25
Efficiency of Conversion of Main Plate Rectifier.....	Table 26
Voltage Regulation of Rectifier.....	Table 27
Voltage Regulation.....	" 28
Variation of Rectifier Output Voltage.....	" 29
Voltage Ripple Determinations.....	" 30
Change in Ambient Temperature - 2000 Kcs.....	" 31
Change in Ambient Temperature - 2000 Kcs.....	" 32
Change in Ambient Temperature - 3000 Kcs.....	" 33
Change in Ambient Temperature - 3000 Kcs.....	" 34
Change in Ambient Temperature - 4500 Kcs.....	" 35
Change in Ambient Temperature - 4500 Kcs.....	" 36
Change in Ambient Temperature - Summary.....	" 37
Keying Record.....	Plate 1
Ripple Voltages.....	Plate 2
" "	" 3
" "	" 4
Change in Ambient Temperature, 2000 Kc.....	" 5
" " " " 2000 Kc.....	" 6
" " " " 3000 Kc.....	" 7
" " " " 3000 Kc.....	" 8
" " " " 4500 Kc.....	" 9
" " " " 4500 Kc.....	" 10

AUTHORIZATION OF TEST

1. The tests herein reported were authorized by ref.(a). Other pertinent data are listed as refs.(b) to (g) inclusive.

- Reference: (a) BuEng let.NOs-36091(6-26-W8) of 27 June 1934.
 (b) Specifications RE 13A 442D
 (c) Westinghouse Company Descriptive Specifications R-770
 (d) Contract NOs-36091
 (e) Westinghouse Company Type Test Data for Preliminary Model TBK Transmitter.
 (f) BuEng let.NOs-31197(6-13-W8) of 11 July 1934.
 (g) BuEng let.NOs-36091(9-20-W8) of 28 Sept.1934.

OBJECT OF TEST

2. The object of the tests was to determine compliance of the preliminary Model TBK transmitter with the requirements of the applying contract specifications and the presence of desirable features over and above the specific requirements, and also to determine the presence of any undesirable features and to formulate recommendations for improvement of future equipment of this nature.

ABSTRACT OF TESTS

3. The tests herein reported were conducted to determine the degree of compliance of the Model TBK transmitting equipment (preliminary model) with the mechanical and electrical requirements set forth in refs.(b) and (d). Tests to determine frequency stability and accuracy under the following conditions were undertaken:

- (a) Variations in supply line voltage.
- (b) Variations in ambient temperatures between the limits of zero and 50° Centigrade.
- (c) Detuning of resonant circuits.
- (d) Changes between "adjust", "tune", and "operate" condition.
- (e) Key locked condition.
- (f) Intermittently keyed condition.
- (g) Effect of changing tubes.
- (h) Effect of temperature regulating devices.
- (i) Shock tests simulating gun fire.
- (j) Application of horizontal forces.

(k) Effect of locking devices.

4. Additional tests to determine the action of tubes under operating conditions imposed by the design of the circuits were also conducted.

5. Power output determinations were made at various frequencies within the range of the equipment, both at high and low power.

6. The power required from the supply lines was determined for various conditions of operation and the efficiency and character of the output of the rectifier equipment was checked.

7. The quality of the emission was observed locally and particular attention was given to the various types of emergency operation of which the equipment is capable.

8. The effect of the transmitting equipment upon receivers operated in the vicinity of the transmitter was studied and the effect of grounding one phase of the supply lines was determined.

Conclusions

(a) The appearance of the equipment is excellent and high grade materials have been used in its construction. The entire assembly impresses the observer and investigator as being the product of painstaking thought and experimentation.

(b) The original design employed in the construction of the master oscillator temperature controlled compartment has resulted in the production of a self-oscillating circuit of extreme frequency stability. The tests indicate that the TBK equipment is superior in many respects to equipment constructed under prior contracts and similar specifications.

(c) The TBK equipment draws less power amplifier grid current than the original TBK equipments manufactured by the same contractor, with a consequent reduction in the danger of injuring the life expectation of the 38161 tube.

(d) The data supplied by the contractor in the form of type test results agrees very closely with the results obtained during the tests conducted at the Naval Research Laboratory, indicating that the equipment is consistent in its operation and performance.

(e) No operational failures occurred during the tests conducted at the Naval Research Laboratory and no breakdown of any part was noted, with the exception of the failure of the 500 volt grid bias voltmeter.

(f) Certain corrections, modifications, and changes in the existing equipment are indicated to provide for greater safety factors under ship board conditions of operation, greater ease in handling the equipment and to correct minor mechanical defects. The major defects which require consideration and correction are:

The tendency of the emitted frequency to "hunt" during the heat cycle of the master oscillator compartment.

The critical adjustment of the "Doubler Grid Tuning" control.

The small size and constricted condition of the junction box.

Recommendations

It is recommended:

(a) That door latches and studs used for securing undervoltage relay cover be constructed from non-ferrous metal, nickel plated.

(b) That a suitable "De-Ion" circuit breaker, capable of properly protecting the equipment, be supplied in place of the circuit breaker now employed, that cotter pins be employed in securing overload relay parts, and that the construction of the overload relay reset device be improved.

(c) That improved insulation, capable of withstanding shipboard conditions of operation, be provided for insulating door switch interlocks.

(d) That means be provided for locking the adjustable turnbuckles by means of which the master oscillator compartment is suspended.

(e) That nameplates be provided for identifying the master oscillator compartment thermometer and the key relay.

(f) That the present hand wheel which controls the rectifier tap switch be provided with a suitable insulating cover or that a suitable insulated handle of adequate design be substituted therefore.

(g) That taper pins used for securing control knobs be countersunk in such a manner that they do not protrude above the knobs.

(h) That the main name plate designation be changed to read "Bu. Reqn. 817-34 NIRA".

(i) That all parts be marked with Navy Type Number in accordance with par. 2-27 of governing specifications.

(j) That controls "D" and "J" be provided with stops to limit the useful motion of these devices and that the backlash be removed from control "D".

(k) That marker tags, corresponding to wiring diagram designations, be secured near the item to be marked rather than on the item, wherever possible.

(l) That appropriate name plates be secured to the external shielding to indicate the location of the concealed lifting eyes and that the lifting eyes be increased in dimensions and strength to permit the passage of an object two inches in diameter.

(m) That the heater control relay used in connection with the master oscillator temperature control have its contacts insulated with a more suitable material which will withstand shipboard operating conditions.

(n) That the manufacturer be requested to make every effort to reduce the magnitude of the frequency "hunt" which exists in the present equipment and which is associated with the heat cycle of the master oscillator circuit.

(o) That the contractor provide thermometers for indicating the temperature of the master oscillator compartment which are not subject to column separation during shipment or handling.

(p) That a red mark be placed at the 10 volt reading of the filament voltmeter on the transmitter panel in order to indicate the proper filament potential.

(q) That the manufacturer be required to devise means for insuring a less critical adjustment of the "Doubler Grid Tuning" control.

(r) That the manufacturer be required to reduce the backlash now present in the master oscillator tuning control "B".

(s) That means be provided to prevent the loss of the knob of the locking device which operates on control "B" and that the locking device which operates on the "Doubler Grid Tuning" control "C" be corrected in order to prevent frequency shifts occurring during its operation.

(t) That means be provided so that the plate voltmeter will indicate the actual potential applied to the power amplifier tube in the various positions of the "Adjust-Tune-Operate" switch.

(u) That reliable voltmeters be supplied for indicating Grid Bias voltage.

(v) That the threaded portion of the thumb screws used for securing the shielding be increased in length sufficiently to permit the removal of the lower sections of shielding without the necessity of removing the upper portions of shielding.

(w) That the cable clamp in the vicinity of contactor K-104 in the rectifier unit be moved in order to increase the clearance between the stud of contactor K-104 and ground.

(x) That the ends of the bands of the high voltage connectors or lugs be bonded together to prevent corona or arcing.

(y) That all copper tubing leads in the transmitter and rectifier units be nickel plated and that the point of connection be tinned in order to produce a low resistance contact.

(z) That future specifications be revised to indicate definitely the action of the remote control circuits.

(aa) That the remote indicator lamp in the present TBK equipment be so connected that false indications cannot be obtained.

(bb) That all snap switches used in the TBK equipment be provided with hard composition handles.

(cc) That the manufacturer be required to eliminate noise from all a.c. contactors and that the Resident Naval Inspector be authorized to judge the degree of noise which will be acceptable.

(dd) That the contractor be required to improve the operation of the undervoltage relay in the rectifier unit.

(ee) That a normal 7.5 volt meter be substituted for the 300 volt meter now used for indicating rectifier filament potential and that a red mark be placed at the 5 volt reading on the scale of this meter.

(ff) That the output voltage of the control rectifier be increased sufficiently to produce a potential of 115 volts under full load.

(gg) That the interconnection diagrams supplied with instruction books be improved to show all actual connections between the various units of the equipment.

(hh) That the dimensions of the junction box be increased to facilitate connections; that the markings in the junction box use the actual designations of the transmitters involved; that steps be taken to prevent arcs from occurring when links in the junction box are shifted; that the fastening of the junction box door be improved and that proper stowage facilities be provided to prevent loss of links not in use.

(ii) That the "Emergency" switches on the transmitter and rectifier panels be modified to produce more positive operation.

(jj) That the contact fastenings of the a.c. overload relay, and that all similar contacts be improved to prevent misalignment of the contacts.

(kk) That the action of the Spencer Disk method of control in the rectifier tube compartment be approved.

(ll) That future specifications require that provision be made for maintaining a spare rectifier tube, properly conditioned, within the rectifier unit.

(mm) That the Bureau consider the advisability of providing a spare socket for maintaining a properly conditioned 38172 rectifier tube for replacement purposes in the Model TBK equipment.

(nn) That the changes suggested in Westinghouse Electric and Manufacturing Company's letter of September 10, 1934, be approved by the Bureau with the exception of the change relating to the method of perforating and securing the shielding and that in the case of this latter change the manufacturer be requested to submit a sample to illustrate the method he proposes to use.

(oo) That the preliminary model of the TBK transmitting equipment be considered satisfactory for Naval use after the pertinent recommendations listed above have been complied with in a manner meeting the approval of the Bureau of Engineering.

MATERIAL UNDER TEST

9. The material under test consisted of one complete Model TBK transmitting equipment (preliminary model), embracing the transmitter, rectifier and junction box. The equipment is so designed that through the medium of the junction box it is possible to operate the Model TBK transmitter in conjunction with a Model TAJ-5 transmitter. Normally, the TBK transmitter is operated from its own rectifier unit and the TAJ-5 is operated from its own rectifier unit. For emergency operation, however, it is possible to select one of the following modes of operation:

- (a) TBK and TAJ-5 transmitters both operated from the TBK rectifier.
- (b) TBK and TAJ-5 transmitters both operated from the TAJ-5 rectifier.
- (c) TAJ-5 transmitter operated from the TBK rectifier.
- (d) TBK transmitter operated from the TAJ-5 rectifier.

10. The Model TBK equipment was manufactured by the Westinghouse Electric and Manufacturing Company under Contract NOS-36091 and covers the frequency range of 2,000 kilocycles to 18,100 kilocycles. The transmitter is rated at 500 watts output when operating in the "high" power condition and 75 watts output when operating in the "low" power condition. In the "low" power condition the frequency range is restricted to the range 2,000 kilocycles to 9,050 kilocycles. The equipment operates from a 440 volt, 60 cycles, 3 phase power supply. The equipment was received at the Naval Research Laboratory on August 31, 1934, via motor truck transportation from the Chicopee Falls plant of the manufacturer.

METHOD OF TEST

11. The equipment, when received, was carefully examined to determine whether any breakage had occurred during transportation and whether adequate precautions had been observed in preparing the apparatus for shipment.

12. The equipment was then wired up and placed into commission, particular attention being paid to the preliminary instructions governing the installation to determine whether they were complete and adequate.

13. Power output determinations were accomplished through the medium of a 500 watt "C" lamp and a calibrated photronic cell, the output of which was measured by a microammeter. The base of the "C" lamp was removed in order to minimize capacity losses. In addition, output measurements were made using dummy antennas and the I^2R method of determining power.

14. Frequency changes and drifts were checked by means of the Model LH visual frequency indicating equipment, the transmitter being operated at full power output whenever the governing specifications required this method of operation.

15. Frequency range, overlap, and kilocycles per division of marking were determined through the use of a crystal controlled calibrator.

16. Determinations of the temperature coefficient of the transmitter were made at full power output over the temperature range of zero to 50° Centigrade. The temperature control facilities of the U.S. Bureau of Standards were utilized for these tests, frequency observations being taken on the Model LH visual frequency indicating equipment. The key of the transmitter was opened during the period while the temperature was being changed, the key being locked for one hour and ten minutes at each test temperature in order to permit the apparatus to reach temperature equilibrium.

17. Input power checks were made by the two wattmeter method. The efficiency of conversion was determined from input measurements made by the two wattmeter method and output measurements calculated from d.c. voltmeter and ammeter readings.

18. Keying records and ripple determinations were made through the use of a recording oscillograph.

19. Model RAB receivers were used in the tests for determining the quality of emission, while both Model RAA-1 and RAB-1 receivers were utilized to determine the effect of the rectifier tubes and a.c. contactors upon adjacent receivers.

20. Tests were conducted wherein one phase of the power supply was grounded in order to determine whether this had any effect upon the quality and stability of the emitted note of the transmitter. All three phases of the power supply were grounded in rotation.

DATA RECORDED

21. Complete data was recorded on all tests conducted and this information is contained in Tables 1 to 37 and Plates 1 to 10 inclusive.

PROBABLE ERRORS IN RESULTS

22. Every effort was made to eliminate errors in the results obtained during the tests recorded herein. The visual frequency measuring equipment used to determine shifts or changes in frequency has been repeatedly checked and has been shown to be accurate to within 1 or 2 cycles in 1,000,000.

23. The kilocycles per division of marking of the master oscillator circuit were determined through the use of a crystal calibrator whose accuracy is greater than 0.001%.

24. In conducting the tests outlined in pars. 3-7-1 and 3-7-7 of ref. (b), previous experience has shown that it is a difficult matter to isolate the effects for which these tests were specifically designed. However, the results obtained with the Model TBK equipment on these tests fell so far within the specification requirements that the influence of errors could be ignored.

25. The r.f., a.c., and d.c. meters used in making measurements for the determination of power, voltage, and current were all instruments of the precision type whose calibrations had been verified to insure their accuracy.

26. Before making tests to determine the ripple voltage in the output of the rectifier, the recording oscillograph was calibrated by means of an accurate audio oscillator and output voltmeter. A check of this nature was made previous to each test.

RESULTS OF TESTS

27. Upon receipt of the Model TBK equipment it was noted that satisfactory precautions had been taken to safeguard the material during shipment, and that no breakage had occurred during transportation.

28. In the following paragraphs of this report, reference is made to the governing specifications, RE 13A 442D, under which this equipment was constructed. Where no specific reference is made to any particular paragraph it is to be understood that the equipment under test complies with this paragraph and that no further explanatory remarks are considered necessary.

29. Section I. The Model TBK transmitter meets the general scope of this introductory section of the specifications.

30. Par. 2-3 and 2-4. The entire equipment is ruggedly constructed and excellent materials have been used throughout. The frame of the transmitter and rectifier units is fabricated from 1-1/2" x 1-1/2" x 1/8" hard aluminum angle and the assemblies are supported on 4" steel channels. Adequate support is furnished to all parts and spot welding is used at all main support members. Such items of construction where improvement is desirable or necessary will be discussed separately under appropriate headings in the following paragraphs of this report.

31. Par. 2-5. The equipment operates at any ambient temperature between the limits of minus 1 degree and plus 51.5 degrees Centigrade without breakdown. For a full discussion of the frequency stability of the equipment when subjected to varying temperatures, see par. 66 of this report. Page 4 of ref. (d) requires that suitable means shall be provided to automatically maintain an ambient temperature for the rectifier tubes between 15 and 50 degrees Centigrade regardless of variations of room temperature within the limitations given in par. 2-5 of the specifications. In the Model TBK rectifier equipment a thermostatically operated device known as a "Spencer Disk" is located in the tube compartment by means of which a heater circuit may be closed

to prevent the temperature around the tubes from falling too low. During the tests conducted at the Bureau of Standards it was found that this Spencer disk operated to close the heater circuit when the temperature of the air surrounding the rectifier tubes reached 19 degrees Centigrade and opened the heater circuit when the tube compartment temperature reached 29 degrees Centigrade. Thus the temperature surrounding the rectifier tubes rarely fell below 15 degrees Centigrade, although on one or two occasions the temperature dropped to 12 degrees when the ambient temperature was zero degrees. However, this drop below 15 degrees was only temporary and the temperature rose to approximately 20 to 25 degrees around the tubes while the ambient was still at zero. It was further noted that the temperature of the tube compartment was approximately 15 to 20 degrees higher than the ambient temperature, thus at 25 degrees ambient the tube compartment was at 45 to 45 degrees and at an ambient of 50 degrees the tube compartment reached a temperature of 69 to 73 degrees Centigrade. Thus it will be seen that the requirements of this portion of the contract are not complied with at all temperatures. However, it should be pointed out that it would require refrigeration to maintain the tubes at 50 degrees when the ambient is 50 degrees. This would add very undesirable complications and since no signs of failure or breakdown occurred when the tube compartment rose to 73 degrees, under full power key locked operation, it is believed that no trouble will be experienced from this source.

32. Par.2-6. Precautions have been taken to prevent corrosion as far as is practicable. All exposed metal parts have been painted black or have been provided with a metallic plating of corrosion resisting qualities.

33. Par.2-7. The use of iron or steel, except where specifically required for electromagnetic purposes has, in general, been reduced to a minimum. The following exceptions are noted:

(a) All door latches in transmitter and rectifier (with the exception of the master oscillator compartment) are constructed of steel or iron. The metal is thoroughly coated with a metallic plating of corrosion resisting qualities. However, these parts could be constructed from non-ferrous material without interfering with their usefulness.

(b) The rods used for supporting the glass case of the undervoltage relay in the rectifier are made of steel. They should be made of brass, nickel plated.

34. Par.2-8. Liberal use has been made of Isolantite and Mica-lex insulation, while phenolic insulation has been used only in such applications where its use does not constitute a hazard.

35. Par.2-9. No wood has been used in the construction of this equipment. The construction of the master oscillator compartment is such that wood has been dispensed with in the construction of the temperature control cabinet.

36. Par.2-10. The design of the electrical circuits and controls is liberal. All parts which are likely to carry an overload are protected by circuit breakers, relays or fuses. In connection with the circuit breakers and relays certain exceptions are noted which require correction.

(a) The 440 volt, 3 phase, 60 cycle line is brought into the rectifier through a 20 ampere "De-Ion" circuit breaker. This device contains thermal elements which trip the breaker in the presence of overloads. However, the "De-Ion" breaker supplied with the TBK equipment is not properly proportioned to give adequate protection. An additional load was drawn through this breaker in addition to the regular load of the rectifier and transmitter and it was found that when 29 amperes were flowing in the supply line it required 2 minutes and 4 seconds for the breaker to open. An instantaneous load of over 50 amperes was drawn but the breaker failed to open. Referring to Table 1 it will be seen that when both the TBK and the TAJ-5 transmitters are operating from a common rectifier under full load condition, the maximum current in the supply lines is approximately 8 amperes. Therefore, in order to provide adequate protection, the De-Ion breaker should be so proportioned that it will operate on line currents of from 10 to 12 amperes.

(b) The 3,000 volt plate overload relay in the transmitter did not operate when received. Inspection revealed that the clevis pin had come out of place due to the omission of a cotter key during assembly. After this defect had been corrected the relay operated satisfactorily.

(c) Reset of the overload relays in the transmitter is accomplished through the medium of a bakelite rod extending through the door which gives access to the relay compartment. This rod is encircled by a spiral spring which returns the rod to its normal position when pressure is released. This spring fits so loosely around the rod that it is enabled to slide over the pin with which it is supposed to engage. If the front end of the spring fails to contact this pin it is impossible to reset the relays by pressing on the bakelite rod. This difficulty can be overcome by making the spiral spring fit snugly over the bakelite rod and by increasing slightly the length of the metal pin which engages the front end of the spring.

37. Par.2-11. With the corrections noted in par.36(b) and 36(c) above, the vacuum tube relays provided will be satisfactory. These relays are so proportioned that they can be adjusted to operate at slightly more than normal plate current.

38. Par.2-12. Provision has been made to prevent personnel from accidentally coming in contact with dangerous potentials other than the 440 volt line potential. The method of insulating the door interlocks, however, is not considered satisfactory. Although no

trouble was experienced from this source during the tests of the TBK equipment at the Naval Research Laboratory, experience has shown that this type of switch fails in service afloat when subjected to moisture and vibration. At present, that portion of the interlock switch which is secured to the access door has its metallic parts insulated from the door by means of a very thin piece of fiber. This fiber frequently breaks down in service. This difficulty can be overcome by substituting a piece of bakelite 1/32" or 1/16" thick in place of the fiber now used.

39. Par.2-13. It is believed that ample provision has been made for all necessary ventilation and cooling. Perforated shielding is employed which permits the circulation of air and no signs of overheating were noted in either the transmitter or rectifier units during long periods of key locked operation at full power.

40. Par.2-15. During the course of these tests the equipment was subjected to numerous key locked runs of two hours or more duration at full power output without damage or signs of overheating. The equipment was also keyed at the rate of 100 words per minute without showing signs of brush discharge, corona, or sparking.

41. Par.2-16. Table 2 appended hereto shows the results of tests conducted to determine the action of the transmitter when the antenna was short circuited and open circuited. Tests were conducted at 2,000 kilocycles, 4,500 kilocycles, and 18,100 kilocycles. In all cases, with one exception, the plate current decreased when the antenna was shorted or opened. At 4,500 kilocycles when the antenna was shorted the plate current rose to 500 milliamperes. However, this overload would be taken care of by the plate overload relay when the latter is properly adjusted.

42. Par.2-17. The vacuum tubes incorporated in this equipment operate within the limits laid down in Navy Tube Specifications. The Rectigon tubes used in the control rectifier are not listed in the Navy Standard Tube List but reference (d) granted approval for their use.

43. Par.2-19. No facilities were available to conduct this test, but it is believed that the equipment is capable of satisfactory operation when installed in a vessel subject to the roll and pitch referred to in this paragraph of the specifications.

44. Par.2-20. Tests indicate that the equipment is so constructed that it will comply with the requirements of this paragraph. Both the transmitter and rectifier were subjected to the shock test outlined under paragraph 3-7-8 of the governing specifications without damage. The transmitter was also subjected to vibration of rather severe proportions. A one-half horse power motor was bolted to the frame of the transmitter. An eccentric weight was secured to the motor shaft and the speed of the motor was varied through wide limits. It was possible to make solid copy of the emitted signal through the vibration which ensued. Suitable lock washers have been provided where necessary and no indications of loose connections were noted. No relays or circuit breakers opened due to the shock test.

45. Par.2-21. All vacuum tubes have been cushioned against vibration through the use of "Lord" flexible mountings. The master oscillator compartment is suspended by means of coil springs of suitable dimensions. These springs are adjusted to the proper tension by means of turnbuckles. In this connection it is recommended that these turnbuckles be provided with a means to prevent accidental change in adjustment. This could be accomplished by drilling a hole through the turnbuckle at the proper point and inserting a cotter pin. The master oscillator and doubler grid tuning controls are cushioned by means of black sponge rubber. In the original TBF transmitter the entire panel in front of the master oscillator was cut away and the controls were mounted on a sub-panel assembly. In the TBK transmitter the panel of the transmitter is cut away only around the controls and this change results in a more pleasing appearance.

46. Par.2-23. All necessary indicating devices and controls are located on the front panels and are suitably marked for identification, with two exceptions.

- (a) The thermometer which registers the temperature of the master oscillator compartment is not provided with a name plate. A nameplate should be provided.
- (b) The key relay is not provided with a nameplate. A nameplate should be provided.

47. Par.2-24. All control shafts and bushings are grounded or insulated in accordance with the requirements of this paragraph. All control knobs and handles are insulated with the following exceptions:

- (a) The control of the main rectifier tap switch is in the form of a metal hand wheel. Although no trouble has been experienced with this control during the tests it is believed that it would be desirable to insulate this hand wheel in some approved manner or substitute a suitable insulated handle in its place.
- (b) The taper pins which are used to fasten control knobs to the shafts protrude from the knobs. If the operator over-reaches the knob he is likely to be subjected to an unpleasant burn. It is recommended that the taper pins be countersunk so that they do not protrude above the knobs and thus make it impossible for an operator to come in contact with these metallic parts.

48. Par.2-25. All electrical indicating instruments used in the construction of this equipment are of the 3.5 inch diameter flush type with bakelite case. All voltmeters employing external multipliers have a sensitivity of one thousand ohms per volt.

49. Par.2-26. Nameplates have been affixed to all major units in conformity with this paragraph. It is noted, however, that the nameplates bear the designation "Bu.Reqn. 817-34 Eng." while according to ref.(d) the designation should be "Bu.Reqn.817-34 NIRA".

50. Par.2-27. Transformers, reactors, etc., are properly marked with respect to voltage, frequency, etc., but are not marked with Navy type number.

51. Par.2-28. Since no spare parts have been supplied with the preliminary model compliance with this paragraph of the specifications could not be determined.

52. Par.2-30. The operation of all controls comply with the requirements of this paragraph. The following controls require counter-clockwise rotation of the control knob for an increase of the final controlled effect:

"C" Doubler Grid Tuning
 "D" Doubler Plate Tuning
 "E" I.A. Tuning
 "F" P.A. Tuning
 "H" Antenna Coupling
 "J" Antenna Tuning Capacitor
 "K" Antenna Tuning Inductance

The design of all controls is exceedingly rugged and they present a very pleasing appearance. The calibration markings are of adequate size and are easily readable and operate in such a manner that the operator is not likely to be confused. Controls "D" and "J" are not provided with stops to limit the useful motion of these controls and control "D" shows considerable backlash due to looseness of fit between shaft and gear.

53. Par.2-32. Table 3 contains the weights of the various units comprising the Model TBK equipment. It will be noted that the combined weight of the transmitter, rectifier, and junction box is 1754 pounds, whereas the specifications state that the weight shall not exceed 1750 pounds. In the opinion of the Laboratory this slight excess of weight should be waived in the interests of strength and ruggedness.

54. Par.2-33. The equipment complies with the requirements of this paragraph.

55. Par.2-35. All items entering into the construction of the transmitter have been legibly marked in accordance with the provisions of this paragraph. Round, aluminum colored tags (apparently of paper) have been affixed to or near the various units. These tags have been covered with lacquer for protection and bear the same designating symbols by which the unit is identified in the wiring diagrams and instruction book. It is desired to point out, however, that in some cases the tag has been affixed to the unit itself and thus if the unit is replaced the marking is lost. In all cases where it is possible to do so the tag should be affixed near the unit rather than on the unit.

56. Par.2-36. The rubber devices employed for shock proof tube mountings can easily be renewed with a minimum of labor. It would be a more difficult procedure to renew the sponge rubber which is used to cushion the master oscillator controls and it is estimated that renewal of this material would put the transmitter out of commission for probably one day.

57. Par.2-38. The Model TBK equipment has been provided with lifting eyes in each of the four top corners of the transmitter and rectifier. These eyes or "U" bolts are housed within the unit when not in use and are not visible to a man standing on the deck. For this reason it is believed that the presence of these lifting devices may be overlooked when the transmitter is being lowered into place and it is suggested that appropriate name plates be secured to the shielding near the lifting eyes to inform the personnel handling the transmitter and rectifier units that the lifting devices are available. The lifting devices supplied with the TBK equipment were adequate in strength, but the size of the "U" bolt created difficulties. In order to lift a weight of this magnitude at least a three inch line (1" dia.) should be employed. Generally the ends of such lines are seized or woven in such a manner that the end thickness is nearly twice the regular thickness. In the case of the TBK it was impossible to insert the end of such a line through the lifting eyes. It is recommended that the opening in the lifting eyes be enlarged so that they will permit the passage of an object 2" in diameter. This increase in the size of the opening will tend to decrease the strength of the "U" bolt and proper precautions should be taken to insure that the material used is of adequate strength to provide a sufficient safety factor.

58. Par.2-39. The front panels of the TEK equipment are finished with black wrinkle finish of uniform characteristics. The side, back and top shielding are painted flat black. The interior shielding retains the original aluminum color but has been treated by some method to prevent corrosion. This treatment does not affect the conductivity of the shielding since it possesses no insulating properties.

59. Par.3-1, 12-1, and 12-2. The requirements of these paragraphs have been complied with. A new method of construction and operation has been employed in the master oscillator compartment. This compartment consists of an aluminum casting properly machined and covered with heavy black felt of about 1/2" thickness to provide the necessary thermal insulation. The various parts of the frequency establishing circuit, with the exception of the oscillator tube, are mounted within this compartment and maintained at a constant temperature of approximately 60°. The entire compartment is spring suspended. The method of introducing the necessary leads and wiring to this compartment is a decided improvement over the methods employed in the original TBF design. Forced circulation is employed within this compartment, this being accomplished through the medium of a small motor driven blower which forms the upper part of the compartment. The circulated air is guided through a series of ducts and baffles and passes over the regulating thermostat which is positioned

in the outlet duct. This thermostat is inserted into position through the top of the compartment and it is not necessary to open the compartment to service this thermostat. The contacting portion of the thermostat is protected by a small metal cover which is easily removable. The entire assembly indicates that a large amount of thought and thorough investigation was resorted to to produce this design. The relay used to control the temperature of the master compartment is of the same type used in the Model TBF equipments. Although this relay has functioned satisfactorily during the tests conducted at the Naval Research Laboratory, experience with these relays afloat indicates that they are not suitable for use in a moist sea atmosphere. The fiber insulation between the contacts breaks down under these conditions. It is recommended that the manufacturer be required to supply a relay where the insulation is of such a nature as to preclude the possibility of failure at this point.

60. The contract "notes" contained in ref. (d) stated that the elimination of the bimetal compensating capacitor is not approved. A compensating capacitor has been provided but it operates on a different principle than the compensating condenser provided with the original TBF equipment. The action of the compensating condenser as provided with the TBK is undoubtedly superior to the TBF as is witnessed by the results obtained in the tests outlined under par. 3-7 of the governing specifications. This compensating capacitor is housed in an aluminum casting which is located within the temperature controlled compartment. One plate of this capacitor is a specially constructed bi-metallic element. This element is connected across the secondary of a low voltage, high current transformer, the primary of which is controlled by relay contacts operated in synchronism with the key relay. When the key is closed, the bimetallic capacitor plate carries current, the heating of which regulates the capacity in such a manner that it offsets the frequency changes resulting from changes in the heating of the master oscillator tube.

61. The action of this type of master oscillator control produces one undesirable phenomenon. The use of forced circulation and sensitive thermal control produces a rather rapid heat cycle within the master cabinet. The frequency of the emitted signal follows this heat cycle causing the frequency to "hunt". At 2000 kilocycles, this hunt is approximately 8 cycles, at 3000 kilocycles, 10 to 12 cycles and about 20 cycles at 4500 kilocycles. Since the principle of frequency multiplication is employed in the TBK transmitter, at 18,000 kilocycles the hunt has a magnitude of approximately 80 to 100 cycles. Thus, while at 2,000 kilocycles the hunt is not noticeable in a receiver it is very noticeable at 18,000 kilocycles, causing the beat note to rise and fall through a regular cycle. The frequency of this cycle is dependent upon the ambient temperature and, unfortunately, the heat cycle is more rapid at normal temperatures than it is at the extreme temperatures in the neighborhood of zero degrees or 50 degrees Centigrade. It is recommended that the manufacturer make every effort to reduce the magnitude of this "hunt". It should be stated, however, that this method of controlling the master oscillator circuit possesses so many manifest advantages that they should not be overlooked when considering the matter of this one undesirable characteristic. Over the greater portion of the frequency range and under ordinary conditions of keying, it is believed that this hunting will in no way interfere with communications.

62. Par.3-2, 3-3, and 12-3. The requirements of these paragraphs are complied with. Reference to Table 4 shows that the required power output into a "0" lamp is obtained over the entire frequency range, both on "high" and "low" power operation. The two 26161 tubes supplied with the equipment produced equal outputs. Table 5 reveals that when operating into dummy antennas of the required characteristics more than the required output is easily obtainable, both at "high" and "low" power operation. In this connection it may be pointed out that the antenna ammeter is connected into the high potential side of the antenna circuit and none of the difficulties which were encountered in connection with the Model TBF-a transmitter are present in the TEK equipment. The terms "Ant. Cur. Int." and "Ant. Cur. Ext." used in Table 5 refer to current values as read on the internal ammeter supplied with the transmitter and to the values obtained with a precision type external ammeter. The requirement which calls for both "High" and "Low" power operation introduces an undesirable condition which should be corrected. The filaments of the power amplifier tube are disconnected when operating in the low power position and the "High-Low" power switch introduces sufficient resistance in the primary of the filament transformer to compensate for this reduced load. The filament voltmeter is connected across the secondary of the transformer which supplies the Int. Amp. filaments. Thus the voltmeter reads 10 volts when the proper voltage is applied. In the TAJ-5 transmitter, which is a companion transmitter to the TEK, the proper voltage is applied to the filaments when the voltmeter reads 11 volts. This difference is confusing and undesirable, and steps should be taken to correct this condition. Two methods of correction may be applied. The TEK filament voltmeter may be connected to the 11 volt winding of the filament transformer and when the set is transferred to "Low" power, a dummy load could be inserted in place of the filament load of the power amplifier tube. This, however, is wasteful and the Laboratory recommends that the following method be adopted. A red warning mark should be placed on the TEK filament voltmeter at the 10 volt reading and a red mark at 11 volts on the TAJ-5 voltmeter.

63. Par.3-4. Adequate provision has been made for current feeding and voltage feeding the antenna.

64. Par.3-5. Local transmitting and receiving tests were conducted for the purpose of determining the quality of emission and to note the effects of emergency transmission; i.e., the simultaneous operation of the Model TEK and Model TAJ-5 transmitters from the same rectifier unit. The results of these tests are shown in Table 6. No signs of interaction between the two transmitters could be noted. The quality of the signal and freedom from reaction was equally good when the two transmitters were operating simultaneously from a common rectifier as when each transmitter was operated from its individual rectifier. Key clicks were negligible under the particular test conditions employed and it is believed that key clicks are present to no greater extent than in other well designed transmitters of a similar nature. The time required to shift the links in the junction box by means of which emergency operation is obtained was found to be between five and ten minutes.

65. Par.3-7-1. Table 7 lists the results of tests conducted in conformity with this paragraph. It will be noted that in all cases the results fall well within the specification requirements.

66. Par.3-7-2. The tests to determine the temperature coefficient of the Model TBK transmitter, in accordance with the terms of this paragraph, were conducted at the Bureau of Standards. The specifications require that the variation in frequency per degree Centigrade shall not exceed 0.0012% for any step between zero and 10 degrees Centigrade; 0.001% for any step in the range from 10 degrees to 25 degrees and 0.0005% for any step within the range from 25 degrees to 50 degrees Centigrade. Tables 31 to 36 inclusive, give the detailed results of tests wherein the ambient temperature was varied between the limits of zero and 50 degrees Centigrade. Tests were conducted at three frequencies; i.e., 2,000 kilocycles, 3,000 kilocycles, and 4,500 kilocycles. Plates 5 to 10 inclusive present this data in graphical form. Table 37 is a summary of all the tests conducted in accordance with par.3-7-2. It will be noted that the largest temperature coefficient arrived at from these tests is 0.00026%, while the total average coefficient of all tests is 0.000096%. As previously stated, the accuracy of the Model LH frequency measuring equipment has been determined to be in the neighborhood of 1 or 2 cycles in 1,000,000. Hence, many of the measurements herein set forth are actually beyond the limits of accuracy of the measuring equipment. However, these measurements are, in a large degree, averages based on measurements of greater magnitude, and as such may be considered accurate. The performance of the Model TBK transmitter under conditions of varying ambient temperatures is excellent and complies with the requirements of the specifications.

67. Par.3-7-3. Reference to Table 8 reveals the fact that the requirements of this paragraph are complied with. The frequency change caused by detuning any resonant circuit, other than the frequency establishing circuit, causes frequency shifts of considerably less magnitude than the change permitted by the specifications.

68. Par.3-7-4. Only negligible frequency changes are noted when the transmitter is subjected to the action of the "Adjust-Tune-Operate" control. See Table 9. The requirement of this paragraph of the specifications is complied with.

69. Par.3-7-5. Table 10 shows the results of tests conducted in conformity with this paragraph. Two conditions of test were employed, one where the master oscillator tube filament was not lighted during the shut down interval and the second where the oscillator filament was lighted during the shut down period. It will be noted that the specification requirements are complied with in all respects. In fact the frequency shifts recorded are of almost negligible proportions and are far less than those encountered with any previous transmitter of similar characteristics. Apparently this commendable performance may be attributed to the action of the compensating capacitor employed in connection with the master oscillator.

70. Par.3-7-6. Table 11 shows the results of tests conducted in conformity with this paragraph of the specifications. It will be noted that the specification requirements are complied with. The remarks made in par.69 above also apply to this test.

71. Par.3-7-7 (a) and (b). Tables 12 and 13 show that the requirements of this test are complied with. All the tubes used during these tests were of Westinghouse Electric and Manufacturing Company manufacture, although they were not all of the same manufactured lot. In this connection attention is invited to ref.(f).

72. Par.3-7-8. Table 14 shows the results of a test conducted in conformity with this paragraph at 2,000 kilocycles; Tables 15 and 16 were run at a frequency of 3,000 kilocycles, while Table 17 records a test conducted at 4,500 kilocycles. In all instances the specification requirements have been complied with.

73. Par.3-7-9. The shock test conducted in accordance with this paragraph produced frequency shifts of negligible proportions, as is illustrated in Table 18. The transmitter continued to operate normally during this test without any relay or contactor failures.

74. Par.3-7-10. The application of a horizontal force of 200 pounds at the top frame members produced no frequency change.

75. Par.3-7-11. All tests conducted in conformity with par.3-7 were made at full power. The design of the transmitter is such that no adjustment of the master oscillator voltages is necessary.

76. Par.3-8. The construction of the temperature controlled compartment meets the requirements of this paragraph. Attention is invited to the fact, however, that the thermometers supplied to read the cabinet temperature suffered from separated columns when received. These thermometers are of the spirit type and it was impossible to reunite the column completely. The manufacturer should be required to supply thermometers where separation of the column is less likely to occur. This trouble was not experienced with any of the Model TBF or TBF-a transmitters.

77. Par.3-9. The constant temperature compartment is protected by means of a bimetallic fuse which opens when the box temperature reaches 68 degrees Centigrade. This device does not require replacement since it automatically resets itself when the temperature within the compartment falls to the normal value.

78. Par.3-10. The equipment meets the requirements of this paragraph.

79. Par.3-12. The equipment meets the requirements of this paragraph. Plate 1 appended hereto shows keying records taken at speeds of approximately 20, 40, and 100 words per minute. It will be noted that the keying is clean cut as to dots and dashes but that the characters do not make intelligible words. This is due to the fact that the relay

used in connection with the automatic keying device by means of which the transmitter was keyed was operating on the back contacts and this fact was not discovered until the films were developed.

80. Par. 3-13. Where necessary, all band change switches are provided with interlocks and it is possible to make adjustment of frequency with power on the transmitter.

81. Par. 3-15. All controls are suitably marked to comply with the requirements of this paragraph.

82. Par. 3-16. Provision has been made for mounting, on the front panel of the transmitter, under a transparent non-breakable shield, a calibration card suitable for recording reset data for ten frequencies.

83. Par. 3-17. All verniers on the tuning controls are provided with positive gearing. In the master oscillator the vernier is of such a ratio as to provide for a variation of the resonant frequency between the limits of 0.0061% and 0.0013% of the frequency to which the circuit is tuned. Specification requirements state that this percentage shall be not more than 0.01%. The width of the smallest scale division is approximately 0.06" while the specifications state that the width shall be not less than 0.035". Table 19 shows the variation of resonant frequency obtained over the entire frequency range of the master circuit. The control marked "Doubler grid tuning" in the Model TBK transmitter is a variable capacitor which is easy to adjust to the proper setting to obtain full power output, but still requires a very critical setting. A change of one half division from the proper setting might prevent the set from radiating any power at all. Instances have been noted afloat in connection with the Model TBF transmitters which would indicate that some trouble has been experienced from this same source in connection with those transmitters. It is recommended that the manufacturer be required to devise some means which would tend to make the operation of this circuit more satisfactory and less critical. Attention is invited to the fact that in similar equipment use has been made of a tapped inductor in place of the tuned circuit employed in the TBK, and that the tapped inductor was not critical in adjustment. It is recognized, however, that due to the fact that the TBK covers a more extended frequency range, the use of the tapped inductor may not be practicable. However, some means should be devised to correct the condition here discussed. The remaining circuits are provided with controls which permit non-critical adjustment of the circuits. Attention is invited to Table 20 which contains data collected during tests to determine the amount of lost motion and back lash present in the master oscillator control. It was found that the degree of back lash varied in accordance with the number of revolutions through which the control was varied. Practically no back lash was apparent if the control was turned through one revolution or a fraction of one revolution, but considerable back lash was apparent after the control had been rotated through a number of full revolutions. It is believed that this is due to some mechanical defect. Attempts were made to isolate the reason for this action but apparently this can only be accomplished by removing the assembly from the transmitter. The manufacturer should be required to overcome this condition, since this action to a large extent tends to vitiate the excellent performance the equipment shows in the frequency stability tests referred to in par. 3-7.

84. Par. 3-18. The friction type locking devices with which the variable tuning controls are provided are satisfactory with the exception of the following:

- (a) The lock on tuning control "B" is provided with a knob which can be removed. This condition should be remedied to prevent accidental loss.
- (b) The lock on the doubler grid tuning control affects the frequency more than is considered desirable. (See Table No.21). It is believed that this condition results from some mechanical error which can be corrected by the manufacturer.

85. Par. 3-19. Table No. 22 reveals the fact that it is possible for an operator to adjust the transmitter to a previously calibrated frequency to a much greater accuracy than plus or minus 0.03% without the use of an external frequency standard. The time required for such an adjustment is approximately 45 seconds for one operator. Using a suitable crystal frequency indicator it is possible to adjust the transmitter to an accuracy greater than 0.001%. An adjusting condenser is provided by means of which it is possible to maintain the calibration of the transmitter. This condenser is operated from the front panel by means of a screw driver inserted through a metal guide sleeve. The range of this condenser at 2000 KC, 3000 KC and 4500 KC is illustrated in Table No. 23.

86. Par. 3-20. The requirements of this paragraph are complied with.

87. Par. 3-21. A three point switch is provided in accordance with this paragraph in order to facilitate the adjustment and tuning of the transmitter. It is considered desirable however, that the plate voltmeter on the transmitter panel indicate the actual voltage which is applied to the power amplifier tube. As present connected, the "Tune-Operate" switch does not indicate this change but permits the voltmeter to read full voltage at all times.

88. Par. 3-22. The test key provided with the TBK transmitter complies with the requirements of this paragraph.

89. Par. 3-23. The requirements of this paragraph are complied with.

90. Par. 3-24. Tests with a receiver installed adjacent to the transmitter showed that no interference is produced by the rotating unit used for circulating the air in the temperature controlled compartment. No interference could be detected when the antenna lead was actually inserted into this compartment through the holes in the perforated shielding.

91. Par. 3-25. Table No. 24 shows that it is possible to vary the power output of the transmitter between the limits of 11% and 124% by means of a seven point switch on the front panel of the rectifier.

It is possible to adjust this switch while the set is transmitting.

92. Par. 3-26. Suitable indicator lamps have been provided on the panel of the transmitter to indicate the functions required by this paragraph of the specifications.

93. Par. 3-27. Indicating instruments have been supplied to meet with the requirements of this paragraph. However, the voltmeter which indicates the bias voltage on the panel of the transmitter fails to indicate correctly at all times. An intermittent condition exists during which the meter will at times read as much as 90 volts below normal. Due to the fact that similar trouble was experienced with a voltmeter of the same type supplied with the TAJ-5 rectifier, it is recommended that the manufacturer be required to correct this condition and be required to provide adequate assurance that the type of meter being supplied is suitable and dependable. These meters are of Westinghouse manufacture, type NX, 500 volts full scale, and are provided with an external multiplier.

94. Par. 3-28. A suitable tube life meter has been provided. This meter conforms in size with the standard 3.5" meters. It has the additional advantage that it is provided with a tell-tale pointer similar to the second hand of a clock which indicates at all times, when voltage is applied, whether the meter is functioning. This meter was checked against time and was found to be very accurate.

95. Par. 3-29. The Transmitter consists of a single unit and complies with the dimensional requirements of this paragraph. (See Table No. 3).

96. Par. 3-32. The transmitter is completely shielded both externally and internally. The side shields are $5/64$ " thick while the front panels are $3/16$ " thick. The shielding is secured at frequent intervals to prevent variable effects and the thumb screws by means of which the shields are secured are staked into place to prevent loss. It would be desirable to have the threaded portion of these screws about $1/4$ " longer. The shields are split up into convenient sizes to provide ease in handling, but when it is desired to remove a bottom shield without disturbing the shield above it it is difficult to accomplish this since the length of the screws prevents the bottom shield from coming out far enough to slip over the top shield. The wiring is done in an exceptionally neat and workmanlike manner. It is well bonded and at all points where mechanical injury is likely it is protected by felt buffers. All bends are of sufficient radius to preclude the possibility of fracturing the insulation or lead sheath. Wherever possible, the lead cables are run in special ducts. There is one point in the wiring of the rectifier unit which should be corrected. The clearness between one of the studs on the main contactor K-104 and the clip holding the lead cables in place in this vicinity is only $1/8$ ". This clearance can be increased by changing the position of the clip.

97. The lugs used for terminating the high voltage leads are of the type provided with a band which is clamped around the insulation of the lead. There is a small gap between the ends of this band and under certain conditions of operation corona has been detected between these

ends. This arcing was at times severe enough to burn the insulation. Apparently this phenomena exists only when the humidity is high. This condition should be corrected by seeing that the two ends of this band are securely bonded together.

98. The copper tubing which is used for radio frequency and high voltage connections is covered with a protective coating of clear lacquer. It is recommended that these leads be given a metallic coating in order to improve the appearance of the wiring. Leads of this nature which were given a dull nickel finish with a tinned finish at the point of contact have been proven successful in other equipment and present a more pleasing appearance. It is possible that the application of clear lacquer over the nickel plating would be desirable.

99. Par. 3-33. Electrical indicating instruments are provided with suitable by-pass units to protect them against stray radio frequency potentials. This by-pass unit consists of a capacitor of 0.006 mfd rated at 1000 volts.

100. Par. 3-34. The transformers supplied with this equipment meet the requirements of this paragraph.

101. Par. 3-37-1. The transmitter and rectifier units are so constructed that they may be mounted flush against a bulkhead.

102. Par. 3-37-2. The foundation pedestal of the transmitter and rectifier units consists of two four inch steel channels, drilled in such a manner that they may be securely bolted to the deck.

103. Par. 3-37-3. All cable connections to the transmitter and rectifier can be effected at a terminal board suitably located for access at the bottom and near the front of the units. These terminal boards clear the deck by a distance of four inches. Access to these compartments is provided by means of a hinged door fitted with interlocks. This door is a decided improvement over the method used in the original TBF equipment, where access to this compartment was obtained by removing an aluminum plate secured by means of thumb nuts.

104. Par. 3-37-4. The renewal of vacuum tubes and the adjustment of circuits, relays, etc., is accomplished through hinged doors of adequate size, fitted with interlocks. The size of the door which gives access to the master oscillator tube compartment has been increased over the size of the door provided on the original TBK equipments enabling tubes to be changed with ease. A new method of door construction has been employed in the TBK equipment. The doors are about one inch larger on all sides than the openings over which they fit and are hung by means of piano type hinges. The corners have been rounded off on a considerable radius thus reducing the possibility of injury from sharp corners. The edges of the doors have been bevelled and this type of construction precludes the possibility of leaving gaps between the door and the panels of the transmitter as is often the case where the doors fit flush into the openings in the panel. The door latches are large and rugged and are provided with stops which prevent the possibility of turning the latch through a complete revolution. The knob of the latch has engraved upon it an indicating arrow to aid in properly securing the

door.

105. Par. 3-37-5. The keying relay has been mounted in an aperture in the front panel of the transmitter near the top. This aperture is covered over with a removable aluminum casing fitted with a window so that the action of the relay can be observed. This method of mounting the keying relay constitutes a decided improvement over the method used in the original TBF equipments.

106. Par. 3-37-6. Provision has been made for connecting the antenna lead at the top of the transmitter through the top shielding.

107. Par. 3-38 and 3-39. The access doors provided are suitable; see paragraph 104 above. No sliding doors in the side shielding are employed in the construction of this transmitter.

108. Par. 3-40. As stated in paragraph 104 above, all access doors are of adequate size to permit replacement of tubes without undue difficulty.

109. Par. 3-41. Rugged, insulated hand rails have been provided on the transmitter for the convenience of operating personnel when making adjustments during heavy weather.

110. Par. 3-42. Suitable time delay relays have been provided in the equipment to comply with the requirements of this paragraph of the specifications.

111. Par. 3-43. An adequate blocking condenser has been provided to eliminate the possibility of high potential D.C. reaching the antenna in case of failure of the antenna tuning units.

112. Pars. 5-1 to 5-7 inclusive. The equipment has been so constructed that it complies with these requirements of the specifications.

113. Par. 5-8. The keying relay operated satisfactorily at speeds up to 100 words per minute and the coil circuit of the relay draws about 180 M.A.

114. Par. 5-9. An indicator lamp has been provided on the transmitter panel and provision has been made for the connection of an external monitor light.

115. Par. 5-10. The local start-stop control of this transmitter complies with the requirements of this paragraph. An emergency stop switch, prominently marked, has been provided on the transmitter panel. This switch, however, contains a defect which should be remedied. It is possible to depress the stop button of this switch very slightly and cause the equipment to be shut down, yet the stop button appears to be in the normal position for operation. Thus the equipment could be placed in a non-operative condition and the operator might not be aware through what agency the set had been shut down and considerable delay might be caused before the reason for the shut down was discovered. This switch should be so constructed that it will not remain in any intermediate position. It should be necessary for an operator to depress the stop button entirely in order to cause the set to shut down. This criticism applies also to the emergency switch located on the panel of the rectifier unit.

A combination of circumstances is possible, however, which will cause the remote indicator lamp to give false indication. With the "local-remote" switch in "local" position and with the remote key locked, the remote indicator lamp will light when the local key on the transmitter panel is closed. Thus, under these circumstances the remote operator would be led to believe that he had control of the transmitter when such is actually not the case.

116. Par. 5-11. The current required in the transmitter start-stop remote control circuits is 480 M.A. at approximately 107 volts.

117. In connection with the switches provided on the panel of the transmitter and rectifier units for the operation of the start-stop and local-remote control circuits it is noted that two types of handles are provided. These switches are of the toggle type with the handles protruding through the panel. Some of these handles are a hard composition, apparently bakelite, while some handles are constructed from flexible rubber. It is believed that the hard handles are to be preferred since no experience is at hand to indicate whether the soft rubber handles would be satisfactory under ship board conditions of operation.

118. Par. 5-24. The equipment as supplied complies with the requirements of this paragraph, however, it is desired to point out that certain A.C. contactors in the Rectifier unit are intermittently noisy. It is believed that this noise is caused by improper machining or fitting of moving parts in the assembly of the contactors. The manufacturer should be required to give assurance that all contactors will be properly assembled to prevent noisy contactors from being incorporated into the equipment.

119. Par. 5-25. The emergency shut down feature is so designed that after an emergency shut down the equipment cannot be started from any other point than the one from which it was shut down.

120. Par. 6-3. The equipment operates satisfactorily when the supply line voltage is varied between the limits of minus 5% and plus 5% of normal.

121. Par. 6-4. The power equipment operates satisfactorily under full key locked transmitter load. It is also possible to operate both the Model TBK and TAJ-5 equipments from one rectifier simultaneously, key locked, without any signs of injury or overheating.

122. Par. 6-5. The total power required for the operation of the TBK equipment at full power output is 3100 watts. Specifications require that the power not exceed 3700 watts. See table No. 25.

123. Par. 6-38. The equipment is so designed that if proper motor generator equipment were substituted for the rectifier power unit operation could be secured. Some modification of the control system would be necessary.

124. Par. 6-40. All rectifier tubes used in the equipment are of

the hot cathode mercury vapor type with the exception of the tubes used in the control rectifier. These tubes are of the Westinghouse "Rectigon" type, approval for their use having been granted in reference (d).

125. Par. 6-41. The rectifier unit complies with the dimensional requirements of this paragraph. See Table No. 3.

126. Pars. 6-42, 6-43 and 6-44. The rectifier equipment complies with the requirements of these paragraphs.

127. Pars. 6-45. The efficiency of conversion from the supply lines to direct current output, including filament energy, is 84% for the main plate rectifier. See Table No. 26. Specifications require that the efficiency shall be not less than 80%.

128. Par. 6-46. The voltage regulation of the rectifier complies with the requirements of the specifications as is illustrated by Table No. 27. Table No. 28 illustrates the voltage regulation when both the TBK and TAJ-5 transmitters are operating at full load from the TBK rectifier. Under these conditions the regulation is such that it still complies with the requirements of the specifications for a single transmitter load.

129. Par. 6-47. This paragraph of the specifications requires that the voltage ripple of the main plate rectifier shall not exceed 0.5%. The voltage ripple of the auxiliary plate rectifier shall not exceed 0.5% and the voltage ripple of the bias rectifier shall not exceed one percent. No voltage ripple requirement is specified for the control rectifier. Table No. 30, and plates 2, 3 and 4 show the results of tests conducted to determine the percent of ripple voltage present in the various rectifier outputs. It will be noted that the specifications are complied with in all respects.

130. Par. 6-48. Suitable time delay relays have been incorporated into the Rectifier which permit the filaments of the rectifier tubes to attain proper operating temperature prior to application of plate power.

131. Par. 6-49. An undervoltage relay has been provided to open the plate contactor and ring an alarm if the filament voltage of the rectifier tubes becomes too low for safe tube operation. However, this relay does not function in a satisfactory manner. The line voltage was reduced to the point where the undervoltage relay operated, with the following results:

<u>Line Voltage</u>	<u>Filament Voltage</u>
440 V	5.0 V
410 V	4.7 V

When the line voltage was 410 volts the under voltage relay operated. However, this point of drop out is not definite and appears to change from time to time. Attempts to regulate the adjustment of this relay were not successful, although it should be stated that these adjustments may not have been made in an approved manner since no instructions were available. It has also been noted that the drop out will sometimes

operate when line voltage and filament voltage are normal, i.e., 440 volts and 5 volts respectively. The manufacturer should be required to give assurance that this type of relay can be adjusted satisfactorily to obtain proper operation at all times. The relay appears to be an excellently constructed piece of equipment and it may be that the trouble herein outlined was caused by the lack of proper instructions as to how to make the necessary adjustments.

132. Par. 6-50. Satisfactory provision has been made for control of the rectifier output voltage from 50% to 110% of normal voltage in six equal steps. This is accomplished through the medium of a ruggedly constructed seven point switch fitted with interlocks. Table No. 29 lists the data collected while conducting this test.

133. Par. 6-52. All tubes in the rectifier are readily accessible through a door in the front panel.

134. Par. 6-53. This paragraph states that "Suitable indicating instruments shall be provided on the rectifier unit in addition to those required on the transmitter as per Section III to indicate plate voltage from each source, main rectifier output current, rectifier filament voltage and bias rectifier output voltage". The following meters have been supplied:

Output Current
Plate Voltage
Bias Voltage
Filament Voltage

In addition a ruggedly constructed and well insulated voltmeter switch has been provided through the medium of which it is possible to read the output voltage of the Main plate rectifier, the mid-tap of the main plate rectifier and the auxiliary rectifier. This provision does not definitely comply with the requirements of the specifications quoted above, but the arrangement is very satisfactory and is believed to fulfill the spirit of the specifications. The use of the tap switch eliminates the necessity of carrying two additional spare meters and permits the meter arrangement on the rectifier to be made in a pleasing and symmetrical manner.

135. The meter which is used to indicate rectifier filament voltage does so in an indirect manner. The meter is connected across the primary of the filament transformer and is calibrated in terms of secondary voltage, thus a 300 volt full scale meter is marked 7.5 volts at full scale. It is recommended that a regular 7.5 volt meter be supplied connected directly to the filaments of the rectifier tubes and that a red mark be placed at the 5 volt point on the scale. It is true that this will subject the meter to full plate potential, but this is not deemed prohibitive since other meters in the same equipment are subjected to the same potential, i.e., the plate ammeter in the power amplifier circuit, and the governing specifications require the meter cases to withstand potential differences of 5000 volts. It is also believed that the filament voltage can be adjusted more accurately with the 7.5 volt instrument since a test showed that when the voltmeter in the rectifier was reading 5.0 volts the actual voltage on the filament was 5.35 volts

as determined with a precision type voltmeter whose calibration had been verified by comparison with a standard voltmeter.

136. Par. 6-54. A control rectifier utilizing two Westinghouse Type S289416D "Rectigon" tubes has been supplied to furnish a D.C. source for control circuit purposes. Under normal operating conditions when the Model TBK transmitter is operating from its own rectifier the output required from this rectifier is 480 M.A. The no load voltage of this rectifier is 112 volts, while full load voltage is 107 volts. This voltage is somewhat less than that required by the governing specifications and it is recommended that steps be taken to increase the potential from this source to produce 115 volts at full load. When emergency operation is employed, using the TBK rectifier for supplying power to the TBK and TAJ-5 transmitters simultaneously, the load requirements of the control rectifier are increased, as follows:

TBK Transmitter, alone, key up	-	260 MA
TBK Transmitter, alone, Key closed	-	450 MA
TAJ-5 Transmitter, alone, key up	-	260 MA
TAJ-5 Transmitter, alone, key closed	-	390 MA
TBK & TAJ-5 together, key up	-	480 MA
TBK & TAJ-5 together, key closed	-	810 MA

The lighted filaments of the Rectigon tubes are quite brilliant and produce considerable illumination. This point is mentioned since illumination of this magnitude may be undesirable under "darken ship" conditions.

137. Par. 6-56. Power is removed from the rectifier equipment by means of a "De-Ion" switch. (See comments under paragraph 36 above). An emergency push button switch has been provided for removing power from the rectifier.

138. Par. 6-58. Protective relays have been incorporated in the rectifier unit in accordance with this paragraph. While these relays are suitable from the overload standpoint difficulty was experienced with the A.C. overload relay K-108. During one of the tests at the Bureau of Standards it was found that the contacts of this relay had moved out of line breaking the circuit, causing the entire main plate rectifier to become inoperative. The fastenings of these contacts should be improved to prevent misalignment of the contacts.

139. Par. 6-59. A suitable "Filament Stand-By" switch has been provided by means of which the rectifier filaments may be energized continuously if the operator so desires. This switch is located on the panel of the rectifier unit. This location is satisfactory as long as the rectifier equipment is installed in the same compartment with the transmitter. If it were ever necessary to install the transmitter and rectifier in separate compartments, it would be more desirable to have the "Filament Stand-By" switch located on the panel of the transmitter unit.

140. Par. 6-60. The rectifier unit is so designed that it may be installed adjacent to the transmitter unit or as a separate unit, as required for any particular installation.

141. Pars. 6-61 to 6-65 incl. The construction of the rectifier is such that it complies with the requirements of these paragraphs of the specifications.

142. Section VII. Since no spare parts were supplied with the preliminary model this section of the specifications cannot be checked at this time.

143. Section VIII. Westinghouse Electric and Manufacturing Company Descriptive Specifications R-770 comply with the requirements of this section of the governing specifications.

144. Section IX. The instruction book furnished with the preliminary Model TBK equipment was, for the most part, adequate for placing the equipment into operation. Some difficulty was experienced in obtaining the proper connections to the Junction Box. These discrepancies, however, were corrected by a representative of the manufacturer. It is desired to point out that the form of interconnection diagram furnished with the preliminary model is not considered suitable for the final forms of the instruction books. In its present form this diagram shows the various connections of the units entering a single cable, the numerous inlets and outlets being designated by numerals. This method is likely to lead to confusion and it is recommended that the final form of interconnection diagrams actually show all interconnecting leads which are necessary between the various units of the equipment.

145. Section X. The material covered by this section of the specifications has been discussed in detail under the general body of the specifications.

146. Par. 11-2. The equipment has been designed and constructed for two conditions of operation, namely, emergency and normal.

147. Par. 11-3 & 11-4. The equipment has been so constructed that it meets the requirements of these paragraphs of the specifications.

148. Par. 11-5. The power required from the line when operating two transmitters simultaneously from one rectifier unit is less than 7.00 K.W. This figure could not be ascertained definitely since no suitable wattmeters were available. However, the TBK transmitter draws 3100 watts at full power and TAJ-5 draws 2660, hence when both transmitters are operating the power required is in the neighborhood of 5.5 K.W.

149. Par. 11-6. In order to facilitate the change from normal to emergency operation or vice versa, an enclosed junction box designed for bulkhead mounting has been supplied. Although the junction box supplied accomplishes the purpose for which it is designed, it is not considered entirely satisfactory. Reference to Table No. 3 reveals the fact that the size of the junction box is considerably smaller than the size permitted by specifications. This reduction in size has resulted in a junction box so restricted in various ways that it is exceedingly difficult to accomplish the proper cable connections and the possibility of making erroneous connections is greatly increased. Should shipboard conditions require the use of cables larger in diameter than those used during the tests it is doubtful whether the necessary connections could be accomplished.

150. The markings within the junction box refer to "Transmitter A" and "Transmitter B" and "Rectifiers Y & Z". Since this piece of equipment is to be actually used with the Model TEK and TAJ-5 transmitters it is believed that it would be more satisfactory to refer to these equipments by their regular type numbers.

151. Terminals No. 22 and 23 in the junction box are across the output of the control rectifier. This rectifier is not equipped with a bleeder resistance and hence the capacitors in the control rectifier filter retain their charge. When changing links in the junction box an objectionable arc occurs when these two links are short circuited. Although the potentials involved here are not high (115 volts) it is recommended that steps be taken to prevent this arc from occurring.

152. The door of the junction box is secured by means of a single hasp and staple. This method of securing is not considered satisfactory and at least two latches of an approved design should be substituted. The door of the junction box is flexible enough to interfere with the positive operation of the interlock switches. Some means should be provided for stiffening the door so that the interlocks will have no tendency to operate under the influence of shock or vibration.

153. The dimensions of the junction box should be increased and the terminals and connecting straps so arranged that no difficulty will be experienced in making the proper connections.

154. In the present arrangement of the junction box two connection links must be removed when resorting to emergency operation. Some suitable means should be provided for safeguarding these links from accidental loss when they are not actually employed in the circuit. If additional space were available these links would have to be removed entirely but could be secured to blank terminal posts.

155. Par. 11-7. The design of the equipment and the circuit arrangement is such that the equipment may be conveniently operated without resorting to the use of the junction box when the combined operation of two transmitters is not required.

156. Pars. 11-8 to 11-16 incl. The equipment has been so constructed that it complies with the requirements of these paragraphs of the specifications.

157. Par. 11-17. The overall dimensions and weight of the junction box comply with the requirements of this paragraph. See Table No. 3.

158. Par. 11-18. The equipment as supplied operates in compliance with the requirements of this paragraph of the specifications.

159. Section XII. The requirements of this section of the specifications were discussed simultaneously with the requirements listed under Section III. The equipment as supplied complies with the requirements herein outlined.

160. In conformity with the authority contained in paragraph 10-8 of the governing specifications, certain additional tests were conducted.

Each individual line of the 440 volt supply was grounded one after the other to determine whether such grounds influenced the emitted signal of the transmitter. No effects, whatever, could be noted when such direct grounds were applied to the power supply lines. Model RAA-1 and RAB-1 receivers were set up adjacent to the Model TBK equipment in an effort to determine whether the operation of the A.C. contactors or the action of the rectifier tubes created interference in the receivers. A slight increase in the noise level of the receiver was noted in the region of 10 KC when the rectifier was in operation but in order to produce this interference it was necessary to bring the receiving antenna lead very close to the rectifier and increase the gain of the receiver to the point where it would be objectionably high for ordinary reception. In general, it may be stated that the only interference which is created are sharp clicks in the receivers which are noted when the various switches in the transmitting equipment are operated. These "clicks" are caused by the arcs created when the switches and contactors actually make and break a circuit.

161. In connection with the operation of rectifier equipment employing 38172 tubes it is necessary to burn the filaments of such tubes after the initial installation for ten or fifteen minutes before applying the plate voltage. This conditioning process is necessary in order to prevent short circuits which might occur if the plate voltage was applied before the free mercury within the tube had been dispersed from the tube elements and tube walls. It is believed, therefore, that a spare socket should be provided within the rectifier unit where a spare tube, properly conditioned could be maintained in an upright position ready for immediate use. Thus the ten or fifteen minutes delay incident to conditioning the tube would be avoided when a tube replacement had to be effected during service operation.

162. Reference (g) forwarded Westinghouse Electric & Mfg. Company letter of September 10, 1934 wherein the manufacturer requested authority to make certain changes in the Model TBK equipment. The Naval Research Laboratory concurs in the recommendation of the Inspector of Naval Material, Hartford, Conn., that this list of changes be approved, with one exception. Approval of the change wherein the manufacturer requests permission to change the perforated shields and the method of securing same, should be withheld until such time as the manufacturer submits a sample shield wherein the new type of construction is employed. After an examination of this sample has been made to determine whether the workmanship and appearance of the new method of construction will or will not detract from the appearance of the transmitting equipment, a decision can be made as to whether or not approval of this change should be granted. The Naval Research Laboratory believes that the other changes recommended by the manufacturer will result in improvements to the Model TBK equipment.

163. A summary of the defects noted and such items as do not comply with the requirements of reference (b), together with suggested changes which it is believed will improve the performance of the Model TBK equipment, are listed below:

- (a) Par. 2-7 of Specs. Steel is used in the construction of door latches and meter studs.

- (b) Par. 2-10 of Specs. The overload feature of the "De-ion" circuit breaker should be corrected, cotter pins should be employed in securing overload relay parts; construction of overload relay reset should be improved.
- (c) Par. 2-12 of Specs. Improved insulation should be provided for door interlock switches.
- (d) Par. 2-21 of Specs. Means should be provided for locking adjustment of turnbuckles used in suspension of M.O. compartment.
- (e) Par. 2-23 of Specs. Name plates should be provided to identify M.O. compartment thermometer and key relay.
- (f) Par. 2-24 of Specs. An insulated handle should be provided on rectifier tap switch; taper pins used for securing knobs should be countersunk.
- (g) Par. 2-26 of Specs. Name plate designation reads "Bu. Reqn. 817-34 Eng."; should read "Bu. Reqn. 817-34 NIRA".
- (h) Par. 2-27 of Specs. All parts are not marked with Navy Type number.
- (i) Par. 2-30 of Specs. Controls "D" and "J" are not provided with stops and control "D" shows excessive backlash.
- (j) Par. 2-35 of Specs. Marker tags should be secured near items to be marked rather than on these items.
- (k) Par. 2-38 of Specs. Name plates should be provided to indicate location of concealed lifting eyes; lifting eyes should be larger.
- (l) Par. 3-1 of Specs. The heater control relay should be provided with more suitable insulation.
- (m) Par. 3-1 of Specs. The hunting of the frequency due to the M.O. heat cycle should be reduced.
- (n) Par. 3-32 of Specs. Definite indication of proper filament voltage should be supplied.
- (o) Par. 3-8 of Specs. Means should be taken to prevent thermometer column separation.
- (p) Par. 3-17 of Specs. Means should be provided to make the adjustment of the "Doubler Grid Tuning" control less critical; back lash should be reduced in MO control.
- (q) Par. 3-18 of Specs. Means should be provided to prevent loss of knob on locking device of control "B"; lock on doubler grid tuning affects frequency unduly.

- (r) Par. 3-21 of Specs. Plate voltmeter should indicate actual voltage on P.A. tube when "Tune-Operate" switch is operated.
- (s) Par. 3-27 of Specs. Grid Bias voltmeter is defective.
- (t) Par. 3-32 of Specs. Threaded portion of thumb screw holding shielding should be lengthened in order to provide greater ease in removing shielding; cable clamp in vicinity of contactor K-104 should be moved to increase voltage clearance.
- (u) Par. 3-32 of Specs. Bands on high voltage lugs should be bonded together at ends.
- (v) Par. 3-32 of Specs. Copper tubing leads to be nickel plated and tinned at point of contact.
- (w) Par. 5-10 of Specs. Remote indicator lamp gives false indication under certain conditions of operation. Emergency stop switch should be modified to give more positive operation.
- (x) Par. 5-11 of Specs. All snap switches should be provided with hard composition handles.
- (y) Par. 5-24 of Specs. Noise should be reduced in certain A.C. contactors.
- (z) Par. 6-49 of Specs. Operation of undervoltage relay should be improved.
- (aa) Par. 6-53 of Specs. 7.5 voltmeter with red mark at 5 volt reading should be provided for reading rectifier filament voltage.
- (bb) Par. 6-54 of Specs. Voltage of control rectifier should be increased.
- (cc) Section IX of Specs. Interconnection diagram should be improved.
- (dd) Par. 11-6 of Specs. A more satisfactory junction box should be provided.
- (ee) Provision should be made for conditioned stand-by tube in rectifier unit.
- (ff) Reference page 4 of contract NOs-36091. The temperature of the rectifier tube compartment exceeds the limitations of 15 to 50 degrees Centigrade.
- (gg) Par. 6-58 of Specs. The method of fastening contacts of the A.C. overload relay permits the contacts to become misaligned; improved fastenings should be provided.

CONCLUSIONS

164. The appearance of the equipment is excellent and high grade materials have been used in its construction. The entire assembly impresses the observer and investigator as being the product and painstaking thought and experimentation.

165. The original design employed in the construction of the master oscillator temperature controlled compartment has resulted in the production of a self-oscillating circuit of extreme frequency stability. The tests indicate that the TBK equipment is superior in many respects to equipment constructed under prior contracts and similar specifications.

166. The TBK equipment draws less power amplifier grid current than the original TBF equipments manufactured by the same contractor, with a consequent reduction in the danger of injuring the life expectation of the 38161 tube.

167. The data supplied by the contractor in the form of type test results agrees very closely with the results obtained during the tests conducted at the Naval Research Laboratory, indicating that the equipment is consistent in its operation and performance.

168. No operational failures occurred during the tests conducted at the Naval Research Laboratory and no breakdown of any part was noted, with the exception of the failure of the 500 volt grid bias voltmeter.

169. Certain corrections, modifications and changes in the existing equipment are indicated to provide for greater safety factors under ship board conditions of operation, greater ease in handling the equipment and to correct minor mechanical defects. The major defects which require consideration and correction are:

The tendency of the emitted frequency to "hunt" during the heat cycle of the M.O. compartment.

The critical adjustment of the "Doubler Grid Tuning" control.

The small size and constricted condition of the junction box.

Table 1

Model TBK Transmitter (Preliminary Model)

Check of Current in Rectifier Supply Lines

<u>TBK Rectifier</u>	Amperes		
	<u>Line 1</u>	<u>Line 2</u>	<u>Line 3</u>
TBK, Low power, key open	1.0	3.9	1.0
TBK, Low power, key closed	2.0	4.0	1.0
TBK, High power, key open	2.0	4.2	1.0
TBK, High power, key closed	5.6	5.7	2.7
<u>TAJ-5 Rectifier</u>			
TAJ-5, key open	0	3.3	1.0
TAJ-5, key closed	4.0	4.6	2.7
<u>TBK and TAJ-5 Rectifiers</u>			
TBK and TAJ-5, keys open	6.6	7.1	1.8
TBK and TAJ-5, keys closed	10.0	10.3	5.5
<u>TBK Rectifier</u>			
TBK and TAJ-5, keys open	4.0	5.1	1.5
TBK and TAJ-5, keys closed	8.0	8.1	4.7

Table 2

Model TBK Transmitter (Preliminary Model)

Antenna Short Circuited and Open Circuited

Test as per paragraph 2-16 of Specifications RE 13A 442D

<u>Frequency</u>	<u>Antenna</u>	<u>Plate Volts</u>	<u>P.A. Ip</u>	<u>Antenna I</u>
2000 kcs	normal	3000	350	4.3
2000 "	shorted	3000	310	
2000 "	open	3000	140	
4500 kcs	normal	3000	350	4.8
4500 "	shorted	3000	500	
4500 "	open	3000	305	
18100 "	normal	3000	350	2.2
18100 "	shorted	3000	200	
18100 "	open	3000	140	

Table 3

Model TBK Transmitter (Preliminary Model)

Data per paragraphs 3-29, 6-41, and 11-17 of Specifications RE 13A 442D

<u>Transmitter</u>	<u>Specification Requirements</u>	<u>Actual Dimensions of Frame</u>	<u>Actual Overall Dimensions</u>
Height	72"	71-3/4"	71-7/8"
Width	32"	31"	32"
Depth	24"	20-7/8"	24-3/8"
Weight	See note		695 lbs.
<u>Rectifier Unit</u>			
Height	72"	71-3/4"	71-7/8"
Width	24"	23"	24"
Depth	24"	20"	23-1/2"
Weight	See note		975 lbs.
<u>Junction Box</u>			
Height	48"	33-1/16"	37"
Width	24"	16"	17-1/4"
Depth	12"	11-3/8"	12-9/16"
Weight	150 lbs		84 lbs.

Note: Specifications require that the transmitter and rectifier equipment shall not exceed 1750 pounds.

Table 4
Model TBK Transmitter (Preliminary Model)
Determination of Power Output

Test per paragraph 3-3 of Specifications RE 13A 442D.
Output measurements obtained by using a photronic cell to determine power dissipated in a 115 volt, 500 watt "C" lamp.

Frequency kcs	M.O. Isg	M.O. Ip	Doub. Ip	I.A. Ig	I.A. Ip	P.A. Ig	P.A. Ip	Ant. I	Plate volts	Watts Output
2000	11	60	45	24	66	66	350	4.3	2980	587
2500	10.5	60	43	24	54	53	350	4.3	2980	579
3000	10.5	63	47	30	50	44	350	4.3	2990	560
3500	11	64	32	19.5	50	38	350	4.5	3000	559
4000	11	62	45	20	60	65	350	4.7	3000	620
4500	10.5	63	40	14	55	59	350	4.6	3000	600
6000	11	64	60	20	50	45	350	4.7	2990	577
7500	11	62	55	19	50	45	350	4.6	2990	561
9050	10.5	61	50	18	55	46	350	4.5	3000	555
12000	11	59	50	16	83	40	350	4.2	2990	488
16000	11.5	66	57	21	108	44	350	3.0	3090	404
18100	11	64	40	11	100	25	350	1.5	3090	355

Above measurements obtained with 38161 tube no. 26498

The following measurements obtained with 38161 tube no. 26515

9050	11	64	43	18	53	44	350	4.5	3080	548
12000	11	62	42	14	73	38	350	4.1	3060	500
16000	11	64	52	19	103	39	350	3.0	3040	395
18100	11	64	50	19	110	34	350	1.5	3060	364

Low Power Operation

2000	11	60	58	30	130			0.5	1575	101
2500	11	61	50	26	130			0.5	1560	97
3000	11	66	56	30	130			0.5	1570	96
3500	11	69	59	31	130			0.5	1550	96
4000	11	69	59	25	130			0.5	1570	96
4500	11	64	69	25	130			0.5	1575	93
6000	11	64	80	23	130			0.5	1575	92
7500	11	66	78	24	130			0.5	1570	92
9050	11	64	70	22	115			0.3	1575	88

Specifications require 500 watts output between 2000 kcs and 3035 kcs; 475 watts at 4105 kcs; 450 watts at 4525 kcs and 400 to 300 watts between 4525 and 18100 kcs. 75 watts output is required on low power operation between 2000 kcs and 6000 kcs; 65 watts up to 7500 kcs and 60 watts up to 9050 kcs.

Table 5

Model TBK Transmitter (Preliminary Model)

Determination of Power Output
(High Power Operation)

Test per paragraph 3-3 of Specifications RE 13A 442D
Output measurements obtained when using dummy antennas.

	<u>2000 kcs</u>	<u>2500 kcs</u>	<u>3000 kcs</u>	<u>3500 kcs</u>
Ant. cap.	500	1000	Inf.	Inf.
Ant. res.	6.0	10.0	29.0	20.0
M.O. Isg	11	10.5	11	11
M.O. Ip	61	63	66	67
Doub. Ip	49	45	48	50
I.A. Ig	25	24	31	33
I.A. Ip	68	56	50	50
P.A. Ig	67	52	43	38
P.A. Ip	350	350	350	350
Ant. cur. int.	9.8	7.4	4.2	5.1
Ep	3050	3030	3030	3040
Ant. cur. ext.	9.7	7.8	4.4	5.3
Watts output	564	608	561	562
Watts req'd	500	500	500	475

(Low Power Operation)

Ant. cap.	500	1000	Inf.	Inf.
Ant. res.	6.0	10.0	29.0	20.0
M.O. Isg	11	11	11	11
M.O. Ip	61	62	66	68
Doub. Ip	56	53	54	48
I.A. Ig	31	28	30	31
I.A. Ip	130	130	130	130
Ant. cur. int.	3.8	2.5	1.5	1.5
Ep	1500	1570	1530	1570
Ant. cur. ext.	3.65	2.9	1.85	2.25
Watts output	80	84	99.3	101
Watts req'd	75	75	75	75

Note: Due to the fact that the antenna ammeter within the transmitter covers a range of 0 to 15 amperes, it was difficult to read values below 4 amperes; therefore, the values of internal antenna current during low power operation cannot be considered as correct.

Table 6

Model TBK Transmitter (Preliminary Model)

Transmission tests to determine reaction between Model TAJ-5 and Model TBK transmitters while operating independently on their respective power supplies or simultaneously from a common power supply.

Test as per paragraph 3-5 of Specifications RE 13A 442D.

Test No. 1. TBK on 3000 kcs; TAJ-5 on 400 kcs; operated at full power with both transmitters on TAJ-5 rectifier. Key locked on TAJ-5 transmitter while TBK transmitter was keyed.

The emitted note of both transmitters was of excellent quality and no reaction between the two transmitters could be detected.

Test No. 2. TBK on 3000 kcs; TAJ-5 on 400 kcs; both transmitters operating simultaneously from TAJ-5 rectifier. Key locked on TBK while TAJ-5 was keyed.

The emitted note of both transmitters was of excellent quality and no reaction could be detected.

Test No. 3. TBK on 3000 kcs; TAJ-5 on 400 kcs; both transmitters operating simultaneously from TAJ-5 rectifier. Both transmitters being keyed simultaneously.

Quality of note good, no reaction between transmitters.

Test No. 4. TBK on 3000 kcs; TAJ-5 on 400 kcs; both transmitters operating simultaneously from TBK rectifier. TAJ-5 operated key locked while TBK was being keyed.

Good note on both transmissions; no reaction could be noted.

Test No. 5. TBK on 3000 kcs; TAJ-5 on 400 kcs; both transmitters operating simultaneously from TBK rectifier. TBK key locked while TAJ-5 was keyed.

Good note on both transmissions; no reaction could be noted.

Test No. 6. TBK on 3000 kcs; TAJ-5 on 400 kcs; both transmitters operating simultaneously from TBK rectifier. Both transmitters being keyed simultaneously.

Good note on both transmitters; no reaction.

Test No. 7. TBK on 4500 kcs; TAJ-5 on 400 kcs; both transmitters operating from TBK rectifier. Key locked on TAJ-5; TBK being keyed. TAJ-5 operating on CW and also MCW.

Good note on all transmissions; no reaction noted.

Table 6 (continued)

Test No. 8. TBK on 4500 kcs; TAJ-5 on 400 kcs; both transmitters operating simultaneously from TBK rectifier. TBK operating key locked; TAJ-5 keyed.

Good note; no reaction.

Test No. 9. TBK on 4500 kcs; TAJ-5 on 400 kcs; both transmitters operating simultaneously from TBK rectifier. Both transmitters being keyed simultaneously.

Good notes; no reaction.

Test No. 10. TBK on 2000 kcs; TAJ-5 on 600 kcs; both transmitters operating simultaneously from TBK rectifier. TAJ-5 key locked; TBK being keyed.

Good note on both transmitters; no reaction noticeable.

Test No. 11. TBK on 2000 kcs; TAJ-5 on 600 kcs; both transmitters operating simultaneously from TBK rectifier. Key locked on TBK; TAJ-5 being keyed.

Quality of both notes good; no interaction between transmitters.

Test No. 12. TBK on 2000 kcs; TAJ-5 on 600 kcs; both transmitters operating simultaneously from TBK rectifier. Both transmitters being keyed simultaneously.

Quality of both notes good; no interaction.

Test No. 13. TBK on 2000 kcs; TAJ-5 on 600 kcs. TBK transmitter on TBK rectifier; TAJ-5 transmitter on TAJ-5 rectifier. TAJ-5 key locked while TBK was keyed.

Good note on both transmitters; no reaction.

Test No. 14. TBK on 2000 kcs; TAJ-5 on 600 kcs. TBK transmitter on TBK rectifier; TAJ-5 transmitter on TAJ-5 rectifier. Key locked on TBK while TAJ-5 was being keyed.

Good note on both transmitters, no interaction.

- - -

All observations made on Model RAA and RAB receivers at distance of about 500 feet. Both transmitters were operating into regular antennas. During the entire series of tests it was impossible to detect any influence from the low frequency transmitter in the high frequency receiver and vice versa, no reaction from the high frequency transmissions could be noted in the low frequency receiver. Under the conditions of test key clicks were negligible in the receivers. Both transmitters followed keying speeds up to about 75 words per minute.

Table 7

Model TBK Transmitter (Preliminary Model)

Variation of Line Voltage
Voltage increased from 418 volts to 462 volts

Test as per paragraph 3-7-1 of Specifications RE 13A 442D

Line Volts	1% per minute variation			Rapid Variation		
	2000 kcs	3000 kcs	4500 kcs	2000 kcs	3000 kcs	4500 kcs
418.0	620	595	606	618	594	613
422.4	628	600	603			
426.8	624	598	608			
431.2	624	603	616			
435.6	628	600	622			
440.0	628	604	627			
444.4	626	606	635			
448.8	629	608	640			
453.2	631	611	646			
457.6	632	616	649			
462.0	632	616	659	628	616	649
Change	12 cy 0.0006%	21 cy 0.0007%	56 cy 0.0012%	10 cy 0.0005%	22 cy 0.0007%	36 cy 0.0008%

Change permitted by specifications - 0.0025%

Table 8

Model TBK Transmitter (Preliminary Model)

Frequency Change caused by Detuning Resonant Circuits

Test as per paragraph 3-7-3 of Specifications RE 13A 442D

Circuit Detuned	2000 kcs		3000 kcs		4500 kcs	
	cycles change	% change	cycles change	% change	cycles change	% change
"C" Dblr Grid Tun.	24	0.0012	24	0.0008	60	0.0013
"D" Dblr Plate Tun	3	0.00015	10	0.00033	33	0.00073
"E" I.A. Tuning	2	0.0001	4	0.00013	10	0.00022
"F" P.A. Tuning	3	0.00015	7	0.00023	8	0.00017
"H" Ant. Coupling	2	0.0001	2	0.00006	8	0.00017
"J" Ant. Tun Cond.	3	0.00015	2	0.00006	14	0.00031
"K" Ant. Tun Ind.	2	0.0001	4	0.00013	5	0.00011

Transmitter operated at full power, key locked

Change permitted by specifications - 0.005%

Table 9

Model TBK Transmitter (Preliminary Model)

Frequency Change between "Adjust", "Tune", and "Operate".

Test as per paragraph 3-7-4 of Specifications RE 13A 442D

	<u>2000 kc</u>	<u>3000 kc</u>	<u>4500 kc</u>
Step 1 (Adjust)	524	704	950
Step 2 (Tune)	522	706	980
Step 3 (Operate)	522	706	990
Max. Change	2 cycles	2 cycles	40 cycles
Per Cent Change	0.0001%	0.00006%	0.00089%

Permitted by Specifications - 0.001%

Table 10

Model TBK Transmitter (Preliminary Model)

Key Locked Test

Test as per paragraph 3-7-5 of Specifications RE 13A 442D

Test No. 1 - Oscillator filament not lighted during shut down.

	<u>2000 kc</u>	<u>3000 kc</u>	<u>4500 kc</u>
End of 10 min. key lock:	504	610	710
End of 10 sec. dash:	530	645	757
Change in cycles:	26	35	47
Per Cent Change:	0.0013	0.0011	0.0014

Permitted by specifications - 0.01%

Test No. 2 - Oscillator filament lighted during shut down.

	<u>2000 kc</u>	<u>3000 kc</u>	<u>4500 kc</u>
End of 10 min. key lock:	504	614	708
End of 10 sec. dash:	508	604	690
Change in cycles:	4	10	18
Per Cent Change:	0.0002	0.00033	0.0004

Permitted by specifications - 0.005%

Table 11

Model TBK Transmitter (Preliminary Model)

40 w.p.m. Keying Test

Test as per paragraph 3-7-6 of Specifications RE 13A 442D

	<u>2000 kc</u>	<u>3000 kc</u>	<u>4500 kc</u>
End of 30 min. keying	500	510	500
End of 10 sec. dash	506	511	478
Change in cycles	6	1	22
Per Cent Change	0.0003	0.00003	0.00049

Permitted by specifications - 0.0025%

Table 12

Model TBK Transmitter (Preliminary Model)

Change of Tubes in Master Oscillator Circuit

Test as per paragraph 3-7-7-a of Specifications RE 13A 442D

<u>Tube Serial No.</u>	<u>Frequency</u>	<u>Cycles Deviation from mean</u>
40939	2001.000	-2
30636	2000.850	-152
30715	2000.990	-12
30660	2000.900	-102
40233	2001.025	+23
40162	2001.255	+253
40363	2000.986	-16
40637	2000.940	-62
40375	2001.040	+38
30591	2001.040	+38

Mean frequency of 10 tubes - 2001.002 kcs

Average variation from mean - 69.8 cycles or 0.0034%

Max. plus variation from mean - 253 cycles

Max. minus variation from mean - 152 cycles

Maximum variation (average) allowed by specifications -
0.01% or 200 cycles.

Test as per paragraph 3-7-7-b of Specifications RE 13A 442D

Change of Tubes in Buffer Amplifier Circuit

40921	2000.710	0
40375	700	-10
40637	704	-6
40363	710	0
30591	706	-4
40162	710	0
40233	714	+4
30660	714	+4
30636	716	+6
30715	716	+6

Mean frequency of 10 tubes - 2000.710 kcs

Average variation from mean - 4 cycles or 0.0002%

Max. plus variation from mean - 6 cycles

Max. minus variation from mean - 10 cycles

Maximum variation (average) allowed by specifications -
0.001% or 20 cycles.

Table 13

Model TBK Transmitter (Preliminary Model)

Change of Tubes in Master Oscillator Circuit

Test as per paragraph 3-7-7-a of Specifications RE 13A 442D

<u>Tube Serial No.</u>	<u>Frequency</u>	<u>Cycles Deviation from mean</u>
40939	4500.730	396
40375	4500.310	-24
40637	4499.889	-445
30363	4500.124	-210
30591	4500.782	448
30660	4499.949	-385
40162	4500.993	659
40233	4499.949	-385
30636	4499.626	-708
30715	4500.993	659

Mean frequency of ten tubes - 4500.334

Average variation from mean - 431 cycles or 0.0096%

Max. plus variation from mean - 659 cycles

Max. minus variation from mean - 708 cycles

Maximum variation (average) allowed by specifications -
0.01% or 450 cycles

Test as per paragraph 3-7-7-b of Specifications RE 13A 442D

Change of Tubes in Buffer Amplifier Circuit

40921	4500.660	-82
30715	704	-38
30636	750	8
40233	726	-16
40162	740	-2
30660	750	8
30591	765	23
40363	775	33
40637	775	33
40375	775	33

Mean frequency of ten tubes - 4500.742

Average variation from mean - 27.6 cycles or 0.0006%

Max. plus variation from mean - 33 cycles

Max. minus variation from mean - 82 cycles

Maximum variation (average) allowed by specifications--
0.001% or 45 cycles

Table 14

Model TBK Transmitter (Preliminary Model)

Change in Frequency during Full Power Run of Two Hours beginning 3 hours after Voltage was applied to Temperature Regulating Devices and 20 minutes after start of Full Power Key Locked Condition. Frequency 2000 kcs.

Test as per paragraph 3-7-8 of Specifications RE 13A 442D

<u>Time</u>	<u>Ambient Temp.</u>	<u>Oven Temp.</u>	<u>Frequency kcs</u>	<u>Power Ig</u>	<u>Power Ip</u>	<u>Amplifier Ep</u>	<u>Line Volts</u>
0810	23.2	58.7	2000.440	68	350	3030	436
20	23.2	58.9	430	68	350	3030	436
30	23.2	59.1	440	67	350	3010	436
40	23.2	59.2	439	68	348	3010	436
50	23.8	59.3	440	68	345	3010	432
0900	23.8	59.3	440	66	340	2975	430
10	23.4	59.4	440	68	345	3000	440
20	23.2	59.4	442	68	346	3010	438
30	23.4	59.4	445	66	340	3000	436
40	23.7	59.5	444	66	340	3000	436
50	24.0	59.5	444	67	346	3010	440
1000	25.0	59.5	445	68	348	3010	440
10	24.8	59.5	446	67	348	3030	442

Greatest frequency change between 0830 and 1010 - 7 cycles
or 0.00035%

Permitted by specifications: 0.0025% or 50 cycles

Heat turned on - 0510

Table 15

Model TEK Transmitter (Preliminary Model)

Change in Frequency during Full Power Run of Two Hours beginning 3 Hours after Voltage was applied to Temperature Regulating Devices and 20 Minutes after start of Full Power Key Locked Condition.

Frequency 3000 kcs

Test per paragraph 3-7-8 of Specifications RE 13A 442D

<u>Time</u>	<u>Ambient Temp.</u>	<u>Oven Temp.</u>	<u>Frequency kcs</u>	<u>Power Amplifier</u>		
				<u>Ig</u>	<u>Ip</u>	<u>Ep</u>
0810	21.5	58.5	3000.660	42	350	3070
20	21.5	58.7	650	42	350	3050
30	21.0	58.8	650	42	350	3050
40	21.2	59.0	654	42	350	3030
50	21.5	59.1	664	41	345	3020
0900	21.5	59.2	670	41	345	3020
10	21.8	59.2	678	41	345	3020
20	22.2	59.3	688	40	342	3000
30	21.8	59.3	688	41	345	3020
40	21.0	59.3	690	41	345	3010
50	21.0	59.3	690	40	340	3000
1000	21.5	59.4	700	40	340	3000
10	21.5	59.4	698	40	340	3000

Greatest frequency change between 0830 and 1010 - 50 cycles
0.0016%

Permitted by specifications - 0.0025%

Heat applied to transmitter - 0510

Table 16

Model TBK Transmitter (Preliminary Model)

Change in Frequency during Full Power Run of Two hours beginning
3 Hours after Voltage was applied to Temperature Regulating Devices
and 20 Minutes after Start of Full Power Key Locked Condition.

Frequency 3000 kcs

Test as per paragraph 3-7-8 of Specifications RE 13A 442D

Time	Ambient Temp.	Oven Temp.	Frequency Kcs	Power Amplifier			Line Volts
				Ig	Ip	Ep	
1100	23.0	58.8	3000.724	42	349	3000	436
10	23.1	58.9	725	42	355	3000	440
20	23.4	59.0	728	42	350	3000	436
30	23.5	59.2	732	41	364	3000	440
40	23.4	59.2	733	39	355	3000	438
50	23.4	59.4	737	40	355	3020	446
1200	23.5	59.4	740	42	360	3060	450
10	23.5	59.3	746	41	360	3060	450
20	23.5	59.3	746	41	360	3060	448
30	23.3	59.5	746	42	360	3050	448
40	23.3	59.4	746	40	355	3010	444
50	23.4	59.4	748	40	350	3000	440
1300	23.4	59.4	747	40	350	3000	444

Greatest frequency change between 1120 and 1300 - 20 cycles
0.00065%

Permitted by specifications - 0.0025%

Heat applied to transmitter - 0800

Table 17

Model TBK Transmitter (Preliminary Model)

Change in Frequency during Full Power Run of Two Hours beginning 3 Hours after Voltage was applied to Temperature Regulating Devices and 20 Minutes after Start of Full Power Key Locked Condition.
Frequency 4500 kcs

Test as per paragraph 3-7-8 of Specifications RE 13A 442D

Time	Ambient	Oven	Frequency Kcs	Power Amplifier			Line Volts
	Temp.	Temp.		I _g	I _p	E _p	
1130	26.5	59.1	4500.619	59	350	3000	444
40	26.6	59.3	633	59	348	3000	444
50	26.8	59.4	674	58	345	3000	440
1200	26.7	59.5	686	59	345	3000	446
10	26.7	59.5	696	59	345	3000	446
20	26.5	59.5	711	59	345	3000	450
30	26.8	59.6	720	58	342	3000	444
40	27.2	59.6	727	58	342	3000	446
50	27.2	59.7	728	56	338	2960	436
1300	27.0	59.7	738	58	342	3000	448
10	27.0	59.7	744	58	342	3000	448
20	26.8	59.6	743	59	345	3000	446
30	26.7	59.6	740	58	342	3000	446

Greatest frequency change between 1150 and 1330 - 70 cycles, 0.0015%
 Permitted by specifications - 0.0025%
 Heat applied to transmitter - 0830

Table 18

Model TBK Transmitter (Preliminary Model)

Shock Test to Simulate Gun Fire

Test as per paragraph 3-7-9 of Specifications RE 13A 442D

Shock No.	Frequency before Shock	Frequency after Shock	Cycles Difference	Percentage Difference
		4500 kcs		
1	670	668	2	Negligible
2	688	690	2	"
3	690	690	0	"
		3000 kcs		
1	702	702	0	
2	694	702	8	0.00026
3	702	702	0	
		2000 kcs		
1	696	695	1	Negligible
2	695	696	1	"
3	696	696	0	

Permitted by specifications - 0.002%

Table 19
Model TBK Transmitter (Preliminary Model)

Variation of Resonant Frequency of Master Oscillator per Smallest
Division of Marking.

Test as per paragraph 3-17 of Specifications RE 13A 442D.

<u>Frequency</u>	<u>Control "A"</u>	<u>Control "B"</u>	<u>Divisions Change</u>	<u>Kc per Division</u>	<u>Percent Change</u>
900	1	487			
950	1	1265	1556	0.032	0.0033
1000	1	1974	1418	0.035	0.0035
1050	1	2467	986	0.050	0.0047
1100	1	2895	856	0.058	0.0053
1150	1	3297	804	0.062	0.0054
1200	1	3703	812	0.061	0.0051
1250	1	4180	954	0.052	0.0041
1100	2	1238			
1150	2	2175	1874	0.026	0.0022
1200	2	2662	974	0.051	0.0042
1250	2	3035	746	0.067	0.0054
1300	2	3368	666	0.075	0.0058
1350	2	3680	624	0.080	0.0059
1400	2	4000	640	0.078	0.0056
1450	2	4361	722	0.069	0.0047
1500	2	4990	1258	0.040	0.0026
1400	3	1879			
1450	3	2460	1162	0.043	0.0030
1500	3	2835	750	0.067	0.0044
1550	3	3133	596	0.084	0.0054
1600	3	3401	536	0.093	0.0058
1650	3	3647	492	0.101	0.0061
1700	3	3895	496	0.100	0.0059
1750	3	4149	508	0.099	0.0057
1800	3	4440	582	0.086	0.0047
1850	3	4842	804	0.062	0.0033
1700	4	760			
1750	4	1857	2194	0.023	0.0013
1800	4	2354	984	0.051	0.0028
1850	4	2691	674	0.074	0.0040
1900	4	2952	522	0.096	0.0050
1950	4	3183	462	0.108	0.0055
2000	4	3395	424	0.118	0.0059
2050	4	3600	410	0.122	0.0059
2100	4	3795	390	0.128	0.0061
2150	4	3997	404	0.124	0.0058
2200	4	4212	430	0.116	0.0053
2250	4	4445	466	0.107	0.0047
2300	4	4765	640	0.078	0.0034

Table 20

Model TBK Transmitter (Preliminary Model)

Test for Lost Motion and Back Lash in Master Oscillator

<u>Trial No.</u>	<u>Clockwise</u>	<u>Counter-clockwise</u>	<u>Cycles Difference</u>
		2000 kcs	
1	492	586	94
2	550	550	0
3	641	800	159
4	740	832	92
5	561	520	41
6	534	524	10
		4500 kcs	
1	468	438	30
2	468	466	2
3	552	612	60
4	478	460	18
5	462	460	2
6	460	461	1
7	650	440	210

Note: From the above results it will be noted that wide differences exist in the degree of the backlash present in this control. It was noted that if the dial were turned through a large number of revolutions wide differences in settings occurred while if the dial were turned through only a single revolution, accurate reset could be obtained either from a clockwise or counterclockwise direction.

Table 21

Model TBK Transmitter (Preliminary Model)

Effect of Locking Devices on Frequency
(4500 kcs)

Test as per paragraph 3-18 of Specifications RE 13A 442D

M.O. Dial Lock	10 cycles	0.0002%
Doub. Grid Tuning	35	0.00078%
Doub. Plate Tuning	0	-
Int. Amp. Tuning	0	-
P.A. Tuning	0	-
Antenna Coupling	0	-
Antenna Condenser	0	-
Antenna Inductor	0	-

Table 22

Model TBK Transmitter (Preliminary Model)

Accuracy of Reset and Time required to Shift Frequency.

Test as per paragraph 3-19 of Specifications RE 13A 442D

<u>Operator</u>	<u>Original Beat Note</u>	<u>Reset Beat Note</u>	<u>Cycles Difference</u>	<u>Percentage Difference</u>
		2000 kcs		
1	611	415	196	0.0095
2	550	522	28	0.0014
3	520	540	20	0.001
		3000 kcs		
1	583	631	48	0.0016
2	638	574	64	0.0021
3	582	640	58	0.0019
		4500 kcs		
1	724	810	86	0.0017
2	678	860	182	0.004
3	860	775	85	0.0017

Average time required to shift frequency - 45 seconds

Specifications require that it shall be possible for an operator to shift frequency within one minute to an accuracy of 0.03%.

Table 23

Model TBK Transmitter (Preliminary Model)

Range of Master Oscillator Adjusting Condenser

Test as per paragraph 3-19 of Specifications RE 13A 442D

2000 kcs - 343 cycles or 0.017%
 3000 kcs - 2200 cycles or 0.07%
 4500 kcs - 33 kilocycles or 0.73%

Specifications require range of plus or minus 0.003%

Table 24

Model TBK Transmitter (Preliminary Model)

Control of Power Output

Test as per paragraph 3-25 of Specifications RE 13A 442D

<u>Voltage Tap</u>	<u>Plate Volts</u>	<u>Plate Current</u>	<u>Power Watts</u>	<u>Percent Power</u>
1	1520	98	58	11%
2	1850	173	130	23
3	2150	228	230	41
4	2450	280	371	66
5	2730	320	475	84
6	2900	350	564	100
7	3240	395	700	124

Table 25

Model TBK Transmitter (Preliminary Model)

Power required from Supply Lines

Test as per paragraph 6-5 of Specifications RE 13A 442D
(Determined by two wattmeter method)

<u>Test No.</u>	<u>Wattmeter No. 1</u>	<u>Wattmeter No. 2</u>	<u>Total Watts</u>
1	Control circuits & Rectifier Fils. 500	0	500
2	Control, heater, M.O. Fil. & Rect. Fil. 780	0	780
3	All circuits energized, key open 1340	360	1700
4	Complete transmitter, key locked, full power 2020	1080	3100

Permitted by specifications - 3700 watts

Table 26

Model TBK Transmitter (Preliminary Model)

Efficiency of Conversion of Main Plate Rectifier

Test as per paragraph 6-45 of Specifications RE 13A 442D

Input Watts - 1882

Output Watts- 1588

Efficiency of Conversion - 84%

Efficiency of conversion required by specifications - not less than
80%

Table 27

Model TBK Transmitter (Preliminary Model)

Voltage Regulation of Rectifier

Test as per paragraph 6-46 of Specifications RE 13A 442D

<u>Rectifier</u>	<u>No Load</u>	<u>Full Load</u>	<u>Per Cent Regulation</u>
Main Plate	3100 V	3000 V	3.3%
Main Plate (Center Tap)	1560 V	1480 V	5.4%
Auxiliary	1020 V	980 V	4.1%
Bias	315 V	320 V	1.5%
Control	112 V	107 V	4.65%

Permitted by Specifications

Main plate - 5%

Bias & Aux. - 6%

Table 28

Model TBK Transmitter (Preliminary Model)

Voltage Regulation of TBK Rectifier when using both TBK and TAJ-5 Transmitters at full power as load.

Test as per paragraph 6-46 of Specifications RE 13A 442D

<u>Rectifier</u>	<u>No Load</u>	<u>Full Load</u>	<u>Per Cent Regulation</u>
Main Plate	3020	2950	2.3%
Mid-Tap	1520	1444	5.2%
Auxiliary	1020	980	4.1%

Line voltage - 448 volts

Table 29

Model TBK Transmitter (Preliminary Model)

Variation of Rectifier Output Voltage

Test as per paragraph 6-50 of Specifications RE 13A 442D

<u>Rectifier Tap Switch</u>	<u>Rectifier Output Voltage</u>	<u>Percentage of normal</u>
1	1520	50.7%
2	1800	60.0%
3	2100	70.0%
4	2400	80.0%
5	2700	90.0%
6	3000	100.0%
7	3300	110.0%

Note: Above potentials were taken with full transmitter load on rectifier. Line voltage - 444 volts.

Specifications require variation of output voltage from 50% to 110% of normal (3000 volts), in six approximately equal steps.

Table 30

Model TBK Transmitter (Preliminary Model)

Voltage Ripple Determinations

Test as per paragraph 6-47 of Specifications RE 13A 442D

<u>Rectifier</u>	<u>Ripple Voltage</u>			<u>Actual Percent</u>
	<u>Peak</u>	<u>RMS</u>	<u>Specs</u>	
Main Plate, 3075 volts	24.4	17.2	0.5%	0.5%
Main Plate, Mid Tap, 1500 V	9.9	7.0	0.5%	0.4%
Auxiliary Plate, 1005 volts	1.7	1.2	0.5%	0.1%
Grid Bias, 288 volts	1.3	0.9	1.0%	0.3%
Control, 109 volts	24.6	17.4	-	15.9%

Table 31
Model TBK Transmitter (Preliminary Model)

Effect of Change in Ambient Temperature (2000 kilocycles)

Time	Ambient °C	Cabinet °C	Actual Frequency	Power Amp. Grid Current	Power Amp. Plate Current	Line Volts
0810	24.6	58.8	2000.602	58	330	
20	24.8	59.0	.585	58	330	
30	25.2	59.0	.580	59	330	
40	25.0	59.2	.585	58	325	
50	25.0	59.3	.592	58	325	
0900	25.0	59.4	.595	58	325	
10	25.2	59.5	.606	57	325	
20	25.0	59.5	.634	55	310	
Key open 10 minutes while temperature was changed.						
0930	9.8	59.3	2000.657	55	310	
40	9.8	59.0	.630	56	310	
50	10.0	59.0	.630	58	310	
1000	10.0	59.0	.612	58	310	
10	10.2	59.0	.611	58	310	
20	9.8	59.0	.606	59	315	
30	10.0	59.0	.606	59	315	
40	10.0	59.0	.604	59	315	
Key open 10 minutes while temperature was changed.						
1050	5.0	58.8	2000.608	60	315	438
1100	4.8	58.6	.592	60	320	436
10	4.8	58.5	.594	60	320	438
20	5.0	58.5	.597	60	315	436
30	5.0	58.5	.595	60	315	438
40	5.0	58.5	.596	60	315	438
50	5.0	58.5	.595	60	315	438
1200	5.0	58.5	.594	62	315	436
Key open 10 minutes while temperature was changed.						
1210	0.5	58.3	2000.610	62	315	440
20	0.0	58.0	.592	62	320	438
30	0.0	58.0	.590	62	320	436
40	0.0	58.0	.590	62	320	436
50	0.0	58.0	.593	62	320	436
1300	0.5	58.0	.592	62	320	434
10	0.0	58.0	.596	62	320	436
20	0.0	58.0	.590	62	315	434
Key open 10 minutes while temperature was changed.						
1330	24.5	58.4	2000.610	62	320	434
40	25.0	58.5	.598	62	315	436
50	25.0	58.8	.601	60	315	434
1400	25.0	59.0	.602	60	310	434
10	25.0	59.0	.608	60	310	434
20	25.0	59.3	.610	59	310	434
30	25.0	59.5	.612	59	310	436
40	25.0	59.5	.614	58	310	437

Table 31
(continued)

Difference between readings taken at 0920 and 1040
Ambient temperature - 15.0°C
Difference in frequency - 30 cycles
Difference in frequency per degree Centigrade - 2 cycles, .0001%
Difference between readings taken at 1040 and 1200
Ambient temperature - 5.0°C
Difference in frequency - 10 cycles
Difference in frequency per degree Centigrade - 2 cycles, .0001%
Difference between readings taken at 1200 and 1320
Ambient temperature - 5.0°C
Difference in frequency - 4 cycles
Difference in frequency per degree Centigrade - 0.8 cycles, .00004%
Difference between readings taken at 1320 and 1440
Ambient temperature - 25.0°C
Difference in frequency - 24 cycles
Difference in frequency per degree Centigrade - 0.96 cycles, .00005%
Difference between readings taken at 0920 and 1440
Ambient temperature - none
Difference in frequency - 12 cycles, .0006%

Table 32

Model TBK Transmitter (Preliminary Model)

Effect of Change in Ambient Temperature (2000 kilocycles)

Time	Ambient °C	Cabinet °C	Actual Frequency	Power Amp. Grid Current	Power Amp. Plate Current	Line Volts
0830	25.4	59.0	2000.900	70	230	444
40	25.2	59.5	.865	69	230	444
50	24.8	59.5	.900	68	230	442
0900	25.2	59.5	.890	68	230	442
10	25.2	59.5	.890	68	230	440
20	25.0	59.5	.910	68	230	440
30	25.0	59.5	.925	65	225	438
40	25.0	59.5	.925	65	230	438
Key open 10 minutes while temperature was changed.						
0950	30.1	59.7	2000.960	65	230	436
1000	30.4	59.7	.940	66	230	436
10	30.0	59.8	.940	65	225	436
20	30.0	59.8	.940	65	230	436
30	30.0	59.9	.945	66	230	436
40	30.0	60.0	.942	65	230	436
50	30.1	60.0	.944	65	230	436
1100	30.0	60.0	.950	65	230	436
Key open 10 minutes while temperature was changed.						
1110	35.0	59.0	2000.970	65	225	436
20	35.2	60.0	.955	65	225	436
30	35.2	60.1	.955	64	225	436
40	35.0	60.2	.957	64	225	436
50	35.0	60.2	.960	64	225	437
1200	35.2	60.3	.962	64	225	438
10	35.0	60.2	.960	64	225	436
20	35.0	60.4	.960	64	230	436
Key open 10 minutes while temperature was changed.						
1230	50.5	60.4	2000.985	65	225	441
40	50.0	60.5	.968	64	225	440
50	50.0	60.6	.970	64	225	440
1300	50.0	60.8	.975	63	220	432
10	50.0	60.9	.973	62	220	434
20	50.0	61.0	.975	62	220	434
30	50.2	61.0	.980	62	220	436
40	50.0	61.0	.982	62	225	436
Key open 30 minutes while temperature was changed.						
1410	25.4	60.0	2000.980	65	220	439
20	24.8	60.0	.952	64	225	438
30	24.8	60.0	.952	64	225	438
40	24.8	59.9	.950	64	225	438
50	25.0	59.9	.950	64	225	438
1500	25.0	59.8	.950	64	230	436
10	24.8	59.8	.950	64	230	438
20	25.0	59.8	.945	64	235	436

Table 32
(continued)

Difference between readings taken at 0940 and 1100
Ambient temperature - 5.0°C
Difference in frequency - 25 cycles
Difference in frequency per degree Centigrade - 5 cycles, .00025%

Difference between readings taken at 1100 and 1220
Ambient temperature - 5.0°C
Difference in frequency - 10 cycles
Difference in frequency per degree Centigrade - 2 cycles, .0001%

Difference between readings taken at 1220 and 1340
Ambient temperature - 15.0°C
Difference in frequency - 22 cycles
Difference in frequency per degree Centigrade - 1.4 cycles, .00007%

Difference between readings taken at 1340 and 1520
Ambient temperature - 25.0°C
Difference in frequency - 37 cycles
Difference in frequency per degree Centigrade - 1.4 cycles, .00007%

Difference between readings taken at 0940 and 1520
Ambient temperature - none
Difference in frequency - 20 cycles, .001%

Table 33

Model TBK Transmitter (Preliminary Model)

Effect of Change in Ambient Temperature (3000 kilocycles)

Time	Ambient °C	Cabinet °C	Actual Frequency	Power Amp. Grid Current	Power Amp. Plate Current	Line Volts
0810	26.0	58.6	3000.598	43	350	444
20	24.8	58.8	.552	42	340	440
30	25.2	59.0	.550	40	345	440
40	25.2	59.0	.558	40	340	442
50	25.0	59.2	.570	40	340	440
0900	25.0	59.3	.574	40	340	440
10	25.0	59.5	.586	40	340	443
20	25.0	59.5	.590	40	340	444
Key open 10 minutes while temperature was changed.						
0930	10.3	59.2	3000.618	39	340	442
40	10.0	59.0	.582	40	340	440
50	9.8	58.9	.584	40	340	440
1000	10.0	58.9	.583	40	340	440
10	10.0	58.9	.582	40	340	440
20	10.0	58.8	.580	40	340	439
30	10.0	58.8	.580	40	340	438
40	10.0	58.8	.576	40	340	438
Key open 10 minutes while temperature was changed.						
1050	4.8	58.5	3000.602	38	340	439
1100	5.0	58.5	.575	40	340	440
10	4.8	58.3	.570	40	340	440
20	4.8	58.3	.563	39	340	439
30	5.0	58.3	.566	40	345	441
40	5.0	58.5	.562	40	345	440
50	5.0	58.4	.564	39	345	440
1200	5.0	58.4	.570	40	345	442
Key open 10 minutes while temperature was changed.						
1210	0.0	58.2	3000.594	39	345	442
20	0.5	58.1	.565	39	345	440
30	0.0	58.0	.560	40	345	440
40	0.0	58.0	.560	39	345	440
50	0.0	58.0	.560	40	345	440
1300	0.0	58.0	.564	39	345	440
10	0.0	58.0	.568	39	345	440
20	0.0	58.0	.564	40	345	439
Key open 10 minutes while temperature was changed.						
1330	24.8	58.2	3000.597	39	340	440
40	25.0	58.5	.574	39	345	440
50	25.0	58.7	.572	40	340	438
1400	25.0	59.0	.580	40	345	440
10	25.2	59.1	.587	40	345	440
20	25.0	59.2	.598	40	340	438
30	25.0	59.4	.606	40	345	441
40	25.0	59.5	.615	39	345	440

Table 33
(continued)

Difference between readings taken at 0920 and 1040
Ambient temperature - 15.0°C
Difference in frequency - 14 cycles
Difference in frequency per degree Centigrade - .93 cycles, .00003%

Difference between readings taken at 1040 and 1200
Ambient temperature - 5.0°C
Difference in frequency - 6 cycles
Difference in frequency per degree Centigrade - 1.2 cycles, .00004%

Difference between readings taken at 1200 and 1320
Ambient temperature - 5.0°C
Difference in frequency - 6 cycles
Difference in frequency per degree Centigrade - 1.2 cycles, .00004%

Difference between readings taken at 1320 and 1440
Ambient temperature - 25.0°C
Difference in frequency - 51 cycles
Difference in frequency per degree Centigrade - 2 cycles, .00006%

Difference between readings taken at 0920 and 1440
Ambient temperature - none
Difference in frequency - 25 cycles, .0008%

Table 34
(continued)

Difference between readings taken at 0930 and 1050
Ambient temperature - 5.0°C
Difference in frequency - 38 cycles
Difference in frequency per degree Centigrade - 7.6 cycles, .00025%
Difference between readings taken at 1050 and 1210
Ambient temperature - 5.0°C
Difference in frequency - 40 cycles
Difference in frequency per degree Centigrade - 8 cycles, .00026%
Difference between readings taken at 1210 and 1330
Ambient temperature - 15.0°C
Difference in frequency - 44 cycles
Difference in frequency per degree Centigrade - 2.9 cycles, .00009%
Difference between readings taken at 1330 and 1450
Ambient temperature - 25.0°C
Difference in frequency - 44 cycles
Difference in frequency per degree Centigrade - 1.7 cycles, .00005%
Difference between readings taken at 0930 and 1450
Ambient temperature - none
Difference in frequency - 78 cycles, .0026%

Table 34

Model TBK Transmitter (Preliminary Model)

Effect of Change in Ambient Temperature (3000 kilocycles)

Time	Ambient °C	Cabinet °C	Actual Frequency	Power Amp. Grid Current	Power Amp. Plate Current	Line Volts
0820	24.8	59.0	3000.602	42	350	442
30	25.2	59.0	.576	44	350	442
40	25.0	59.1	.578	44	350	442
50	25.0	59.3	.586	44	350	444
0900	25.0	59.4	.595	43	350	440
10	25.0	59.5	.606	43	350	439
20	25.2	59.5	.614	43	350	442
30	25.0	59.6	.612	43	350	440
Key open 10 minutes while temperature was changed.						
0940	29.8	59.6	3000.650	40	340	438
50	29.8	59.7	.626	42	345	438
1000	30.0	59.8	.609	42	340	439
10	30.2	59.9	.636	42	340	440
20	30.0	60.0	.637	43	340	438
30	30.0	60.0	.640	42	345	441
40	30.0	60.0	.648	42	345	440
50	30.0	60.0	.650	42	340	440
Key open 10 minutes while temperature was changed.						
1100	34.8	60.0	3000.680	40	340	438
10	35.0	60.0	.654	42	340	438
20	35.2	60.1	.658	40	340	438
30	35.0	60.2	.655	40	340	438
40	35.2	60.3	.676	42	340	439
50	35.0	60.3	.674	40	340	438
1200	35.0	60.4	.686	42	345	442
10	35.0	60.4	.690	42	340	440
Key open 10 minutes while temperature was changed.						
1220	50.2	60.5	3000.722	40	340	442
30	50.0	60.6	.698	40	340	440
40	50.0	60.7	.710	40	340	441
50	50.2	60.9	.718	40	340	440
1300	50.0	61.0	.725	40	340	440
10	50.2	61.0	.725	40	340	438
20	49.8	61.1	.735	40	340	438
30	50.0	61.2	.734	40	340	438
Key open 10 minutes while temperature was changed.						
1340	25.0	60.8	3000.765	38	340	436
50	24.8	60.6	.724	39	340	438
1400	25.0	60.4	.712	39	340	438
10	25.0	60.3	.710	39	340	438
20	25.0	60.1	.706	40	340	438
30	25.2	60.0	.700	39	340	438
40	25.0	60.0	.694	39	340	438
50	25.0	60.0	.690	39	340	438

Table 35

Model TBK Transmitter (Preliminary Model)

Effect of Change in Ambient Temperature (4500 kilocycles)

<u>Time</u>	<u>Ambient °C</u>	<u>Cabinet °C</u>	<u>Actual Frequency</u>	<u>Power Amp. Grid Current</u>	<u>Power Amp. Plate Current</u>	<u>Line Volts</u>
0810	25.0	58.8	4500.530	42	350	444
20	25.1	58.9	.430	42	350	446
30	25.0	59.0	.450	40	350	446
40	25.0	59.2	.464	40	350	443
50	25.0	59.2	.485	39	350	444
0900	25.0	59.4	.500	40	350	446
10	25.0	59.5	.520	39	350	444
20	25.0	59.5	.530	39	350	444
Key open 10 minutes while temperature was changed.						
0930	10.5	59.4	4500.590	40	350	442
40	9.8	59.0	.530	42	350	446
50	10.0	58.9	.535	42	350	445
1000	10.0	59.0	.520	42	350	444
10	9.8	59.0	.516	40	350	444
20	10.0	58.9	.510	42	350	445
30	10.0	58.9	.520	42	350	445
40	10.0	58.9	.510	42	350	446
Key open 10 minutes while temperature was changed.						
1050	5.0	58.6	4500.560	42	350	447
1100	4.8	58.4	.510	42	350	446
10	5.0	58.3	.510	42	350	444
20	5.0	58.3	.506	42	350	444
30	5.0	58.4	.508	42	350	446
40	5.0	58.4	.514	42	350	444
50	5.0	58.5	.514	42	350	444
1200	5.0	58.5	.512	42	350	445
Key open 10 minutes while temperature was changed.						
1210	0.5	58.3	4500.560	42	350	446
20	0.5	58.0	.524	42	350	446
30	0.0	58.0	.513	42	350	447
40	0.5	57.8	.511	42	350	445
50	0.0	57.7	.536	42	350	444
1300	0.0	57.6	.536	42	350	444
10	0.0	57.7	.540	42	350	444
20	0.0	57.9	.548	42	350	444
Key open 10 minutes while temperature was changed.						
1330	24.5	58.0	4500.624	42	350	446
40	25.0	58.3	.580	42	350	445
50	25.0	58.7	.584	42	350	445
1400	24.8	59.0	.604	40	350	446
10	25.0	59.0	.618	40	350	446
20	25.0	59.2	.632	40	350	446
30	25.0	59.4	.645	40	350	446
40	25.0	59.5	.655	39	350	446

Table 35
(continued)

Difference between readings taken at 0920 and 1040
Ambient temperature - 15.0°C
Difference in frequency - 20 cycles
Difference in frequency per degree Centigrade - 1.3 cycles, .00003%

Difference between readings taken at 1040 and 1200
Ambient temperature - 5.0°C
Difference in frequency - 2 cycles
Difference in frequency per degree Centigrade - 0.4 cycles, .00001%

Difference between readings taken at 1200 and 1320
Ambient temperature - 5.0°C
Difference in frequency - 36 cycles
Difference in frequency per degree Centigrade - 7.2 cycles, .00016%

Difference between readings taken at 1320 and 1440
Ambient temperature - 25.0°C
Difference in frequency - 107 cycles
Difference in frequency per degree Centigrade - 4.3 cycles, .00009%

Difference between readings taken at 0920 and 1440
Ambient temperature - none
Difference in frequency - 125 cycles, .0028%

Table 36

Model TEK Transmitter (Preliminary Model)

Effect of Change in Ambient Temperature (4500 kilocycles)

Time	Ambient °C	Cabinet °C	Actual Frequency	Power Amp. Grid Current	Power Amp. Plate Current	Line Volts
0810	24.5	58.5	4500.520	42	350	446
20	25.0	58.5	.440	42	350	444
30	25.0	58.7	.440	40	350	444
40	25.0	59.0	.450	40	350	440
50	25.0	59.0	.484	40	350	442
0900	25.0	59.1	.506	39	345	440
10	25.0	59.2	.524	39	345	444
20	25.0	59.4	.536	39	345	442
Key open 10 minutes while temperature was changed.						
0930	30.0	59.5	4500.605	39	340	442
40	30.2	59.5	.556	39	340	443
50	30.0	59.8	.560	39	340	442
1000	30.2	59.9	.560	38	340	444
10	29.8	59.9	.560	38	340	444
20	30.0	60.0	.568	37	340	442
30	30.0	60.0	.576	38	340	442
40	30.0	60.0	.582	37	340	440
Key open 10 minutes while temperature was changed.						
1050	35.0	60.0	4500.644	37	340	440
1100	35.2	60.0	.585	37	340	443
10	35.0	60.2	.586	37	340	444
20	35.0	60.2	.594	33	330	442
30	35.0	60.3	.594	35	335	442
40	35.0	60.4	.595	34	330	442
50	35.0	60.4	.597	34	330	442
1200	35.0	60.4	.600	34	330	444
Key open 10 minutes while temperature was changed.						
1210	50.0	60.5	4500.675	34	330	444
20	49.5	60.6	.608	32	330	444
30	50.5	60.7	.615	32	330	443
40	50.0	60.9	.620	32	330	442
50	50.0	61.0	.652	32	330	442
1300	50.0	61.0	.655	32	330	442
50	49.0	60.7	.670	34	330	444
1400	50.0	60.9	.662	32	330	444
10	50.0	61.0	.660	32	325	442
Key open 10 minutes while temperature was changed.						
1420	25.0	60.7	4500.650	35	325	443
30	25.0	60.4	.576	35	330	444
40	25.0	60.3	.560	35	330	440
50	25.0	60.2	.560	35	330	442
1500	25.0	60.1	.536	34	330	442
10	25.0	60.1	.522	34	330	444
20	25.0	60.1	.522	35	330	444
30	25.0	60.1	.520	35	330	444

Table 36
(continued)

Difference between readings taken at 0920 and 1040

Ambient temperature - 5.0°C

Difference in frequency - 46 cycles

Difference in frequency per degree Centigrade - 9.2 cycles, .0002%

Difference between readings taken at 1040 and 1200

Ambient temperature - 5.0°C

Difference in frequency - 18 cycles

Difference in frequency per degree Centigrade - 3.6 cycles, .00008%

Difference between readings taken at 1200 and 1410

Ambient temperature - 15.0°C

Difference in frequency - 15 cycles

Difference in frequency per degree Centigrade - 1 cycle, .00002%

Difference between readings taken at 1410 and 1530

Ambient temperature - 25.0°C

Difference in frequency - 140 cycles

Difference in frequency per degree Centigrade - 5.6 cycles, .00012%

Difference between readings taken at 0920 and 1530

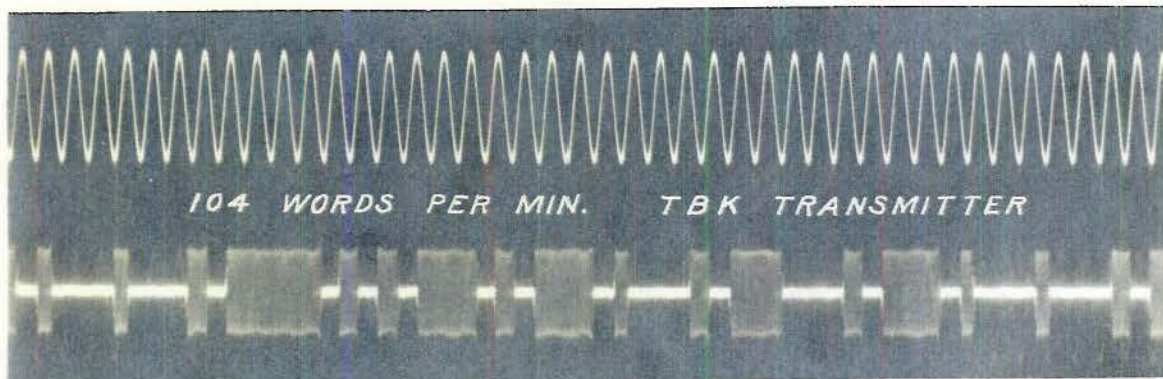
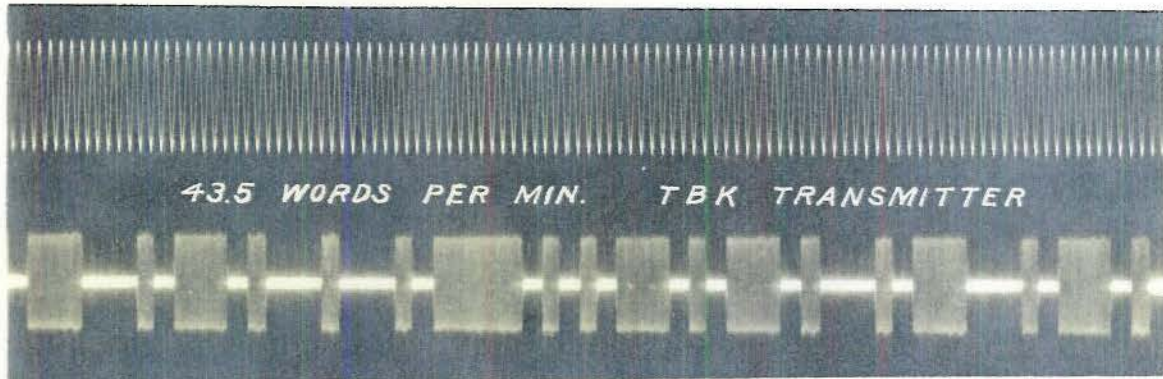
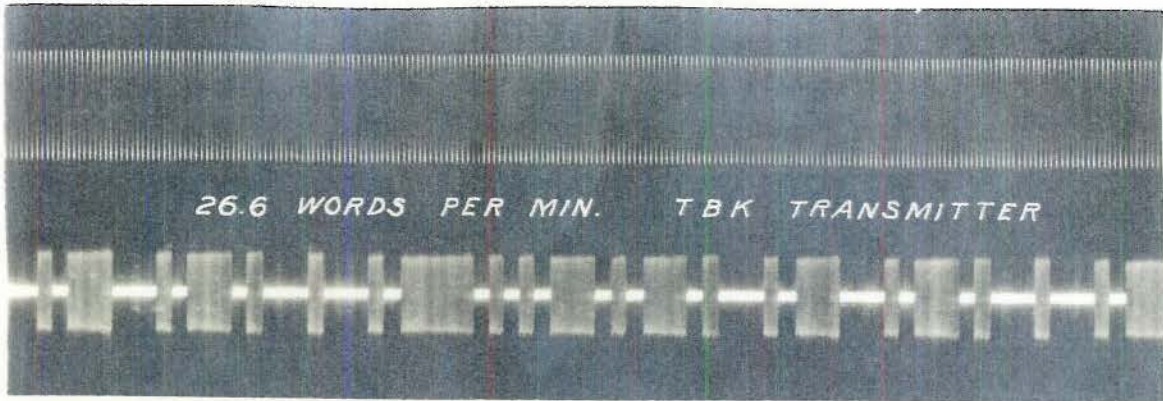
Ambient temperature - none

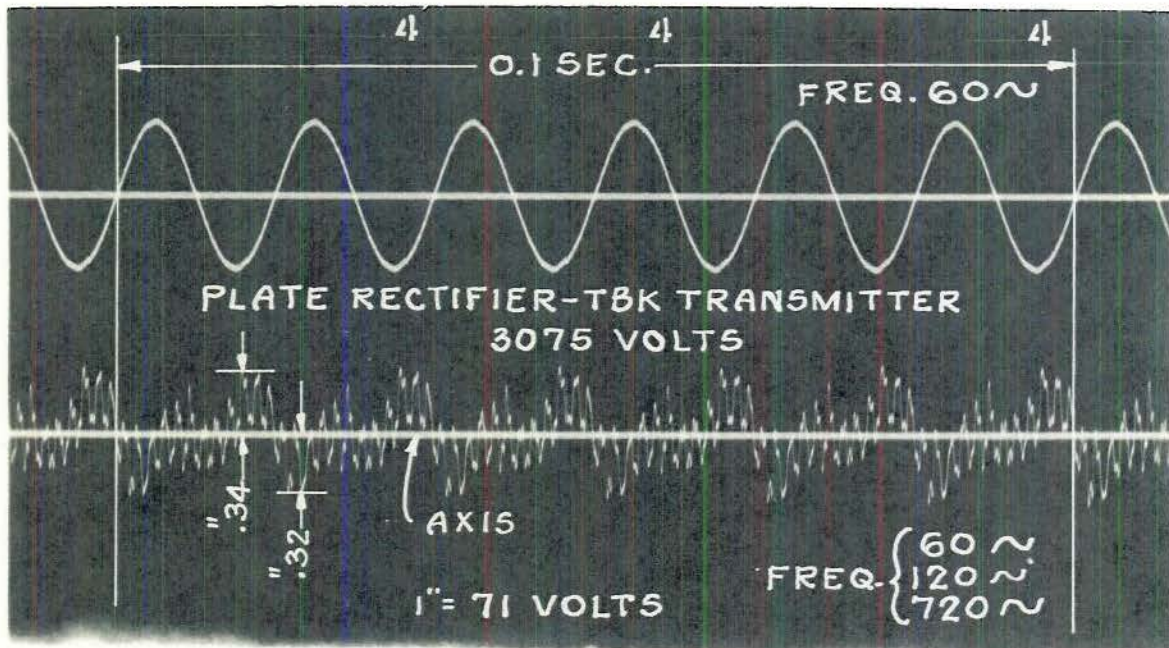
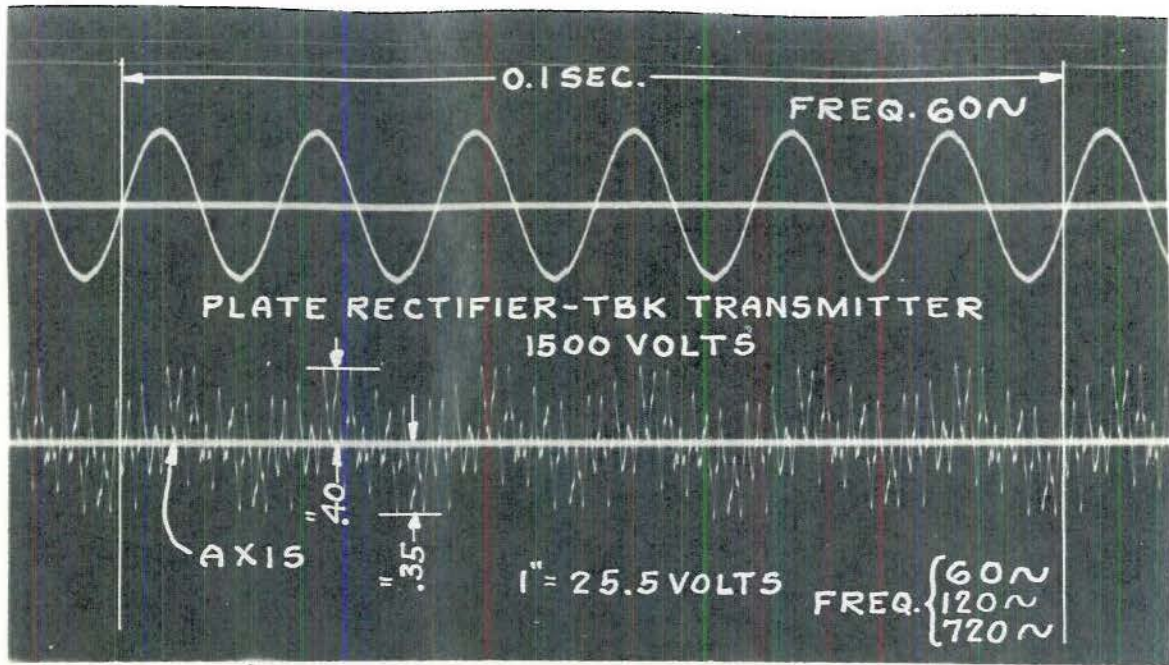
Difference in frequency - none

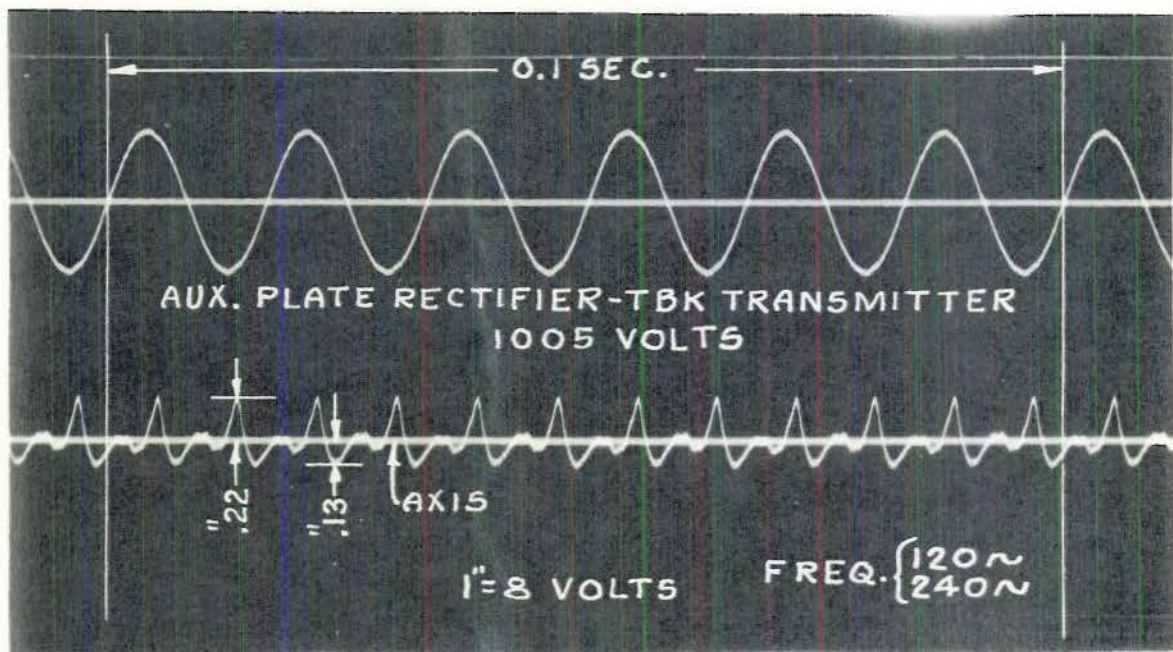
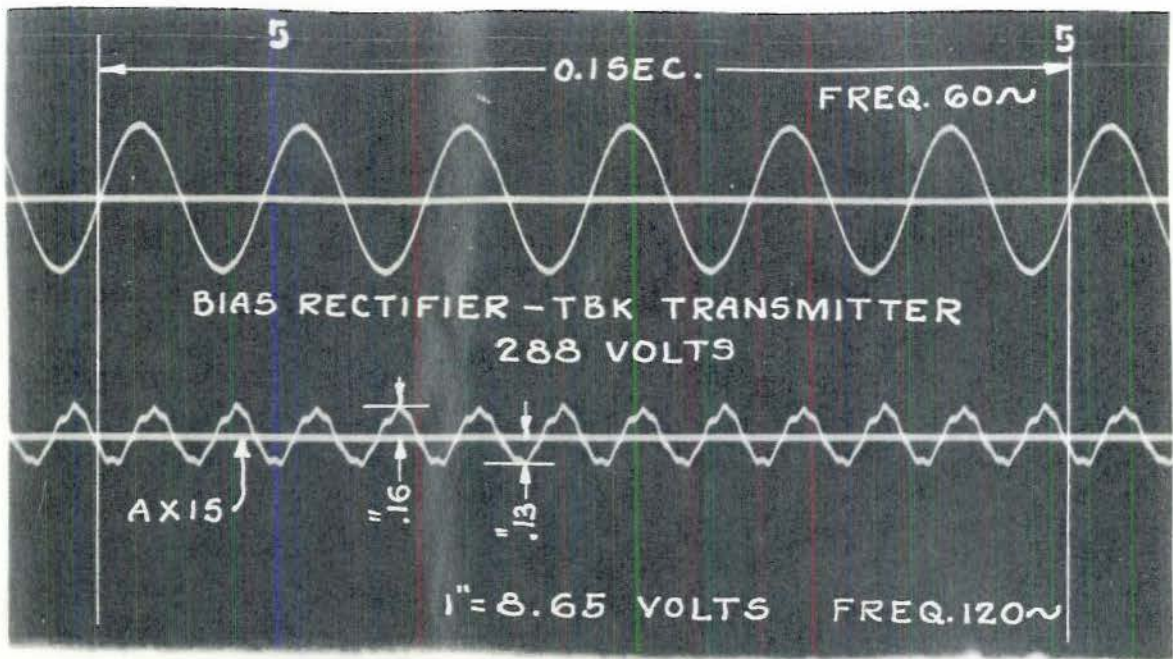
Table 37

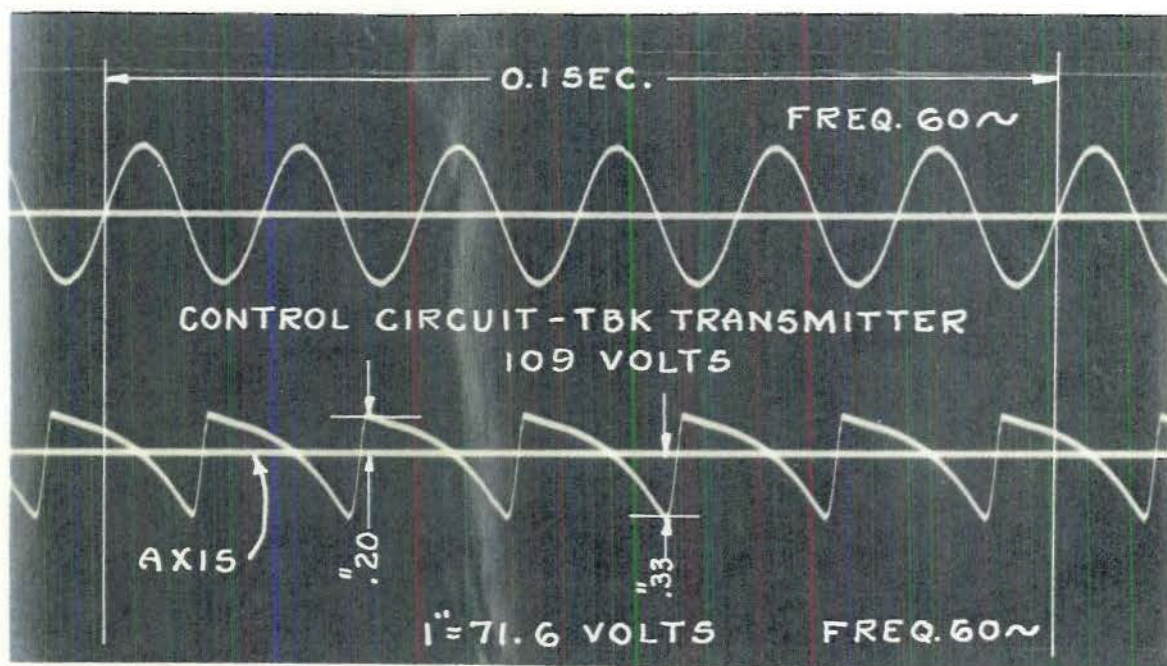
Summary of Tables 31 to 36 inclusive.

<u>Temperature range</u>	Percentage frequency change per °C		
	<u>2000 kcs</u>	<u>3000 kcs</u>	<u>4500 kcs</u>
0-25	.00005	.00006	.00009
25-30	.00025	.00025	.0002
30-35	.0001	.00026	.00008
35-50	.00007	.00009	.00002
50-25	.00007	.00005	.00012
25-10	.0001	.00003	.00003
10-5	.0001	.00004	.00001
5-0	.00004	.00004	.00016
Average	.000097	.0001	.00009
Total Average -	.000096% per °C		









FREQUENCY

CABINET

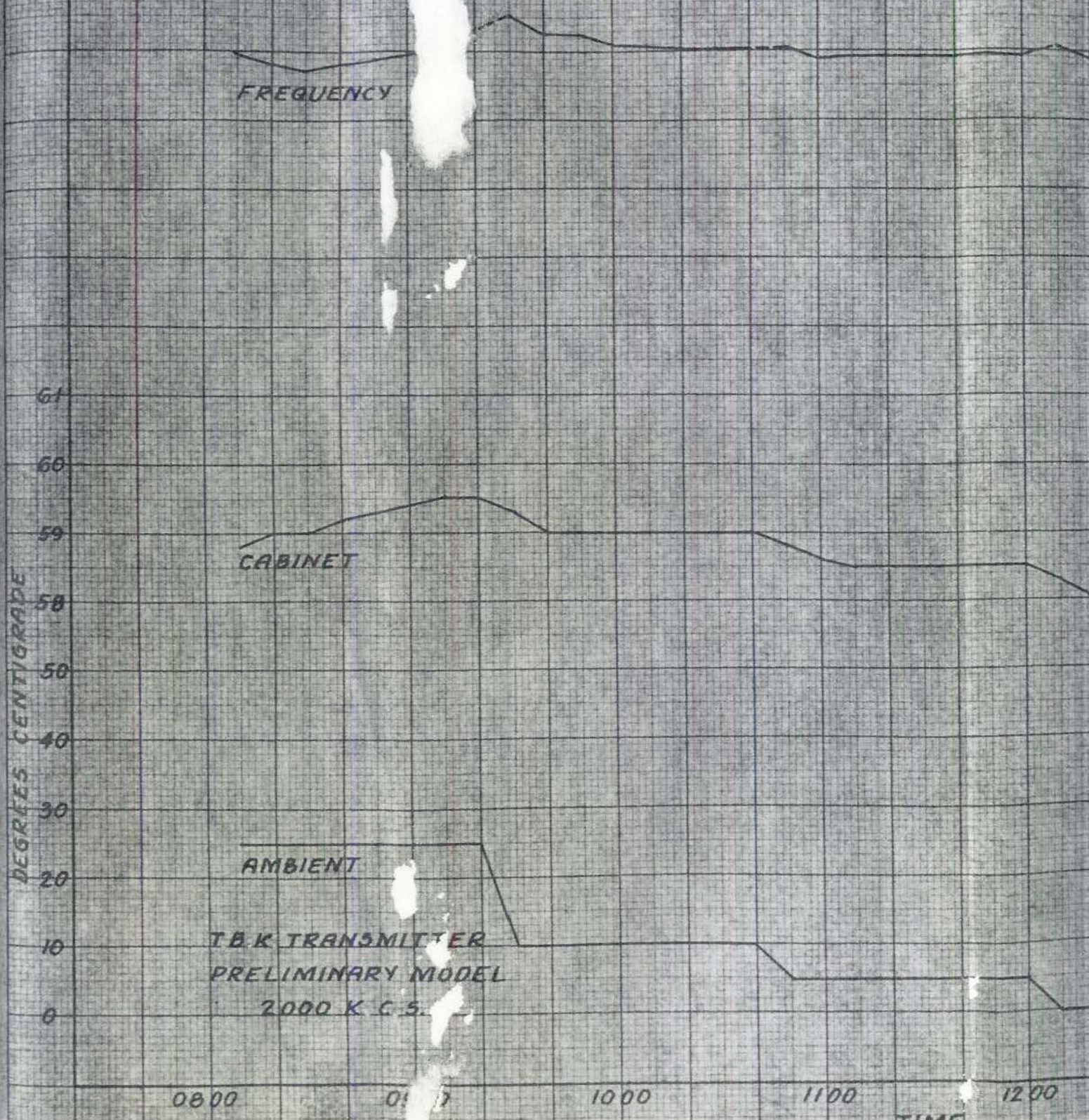
AMBIENT

T.B.K. TRANSMITTER
PRELIMINARY MODEL
2000 K.C.S.

DEGREES CENTIGRADE

0800 0900 1000 1100 1200

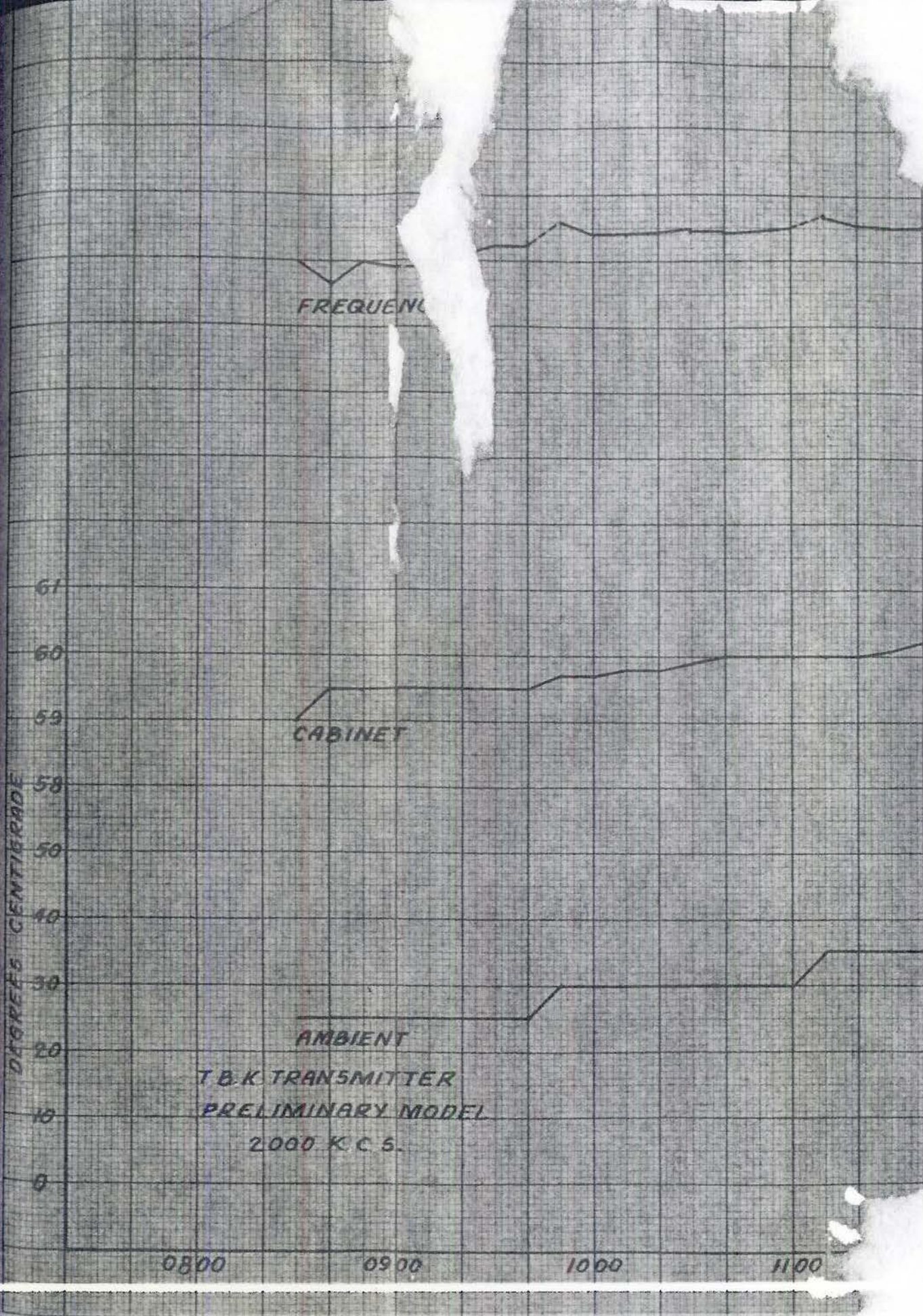
5-A



PERCENTAGE FREQUENCY DRIFT 10 CYCLES PER DIV.



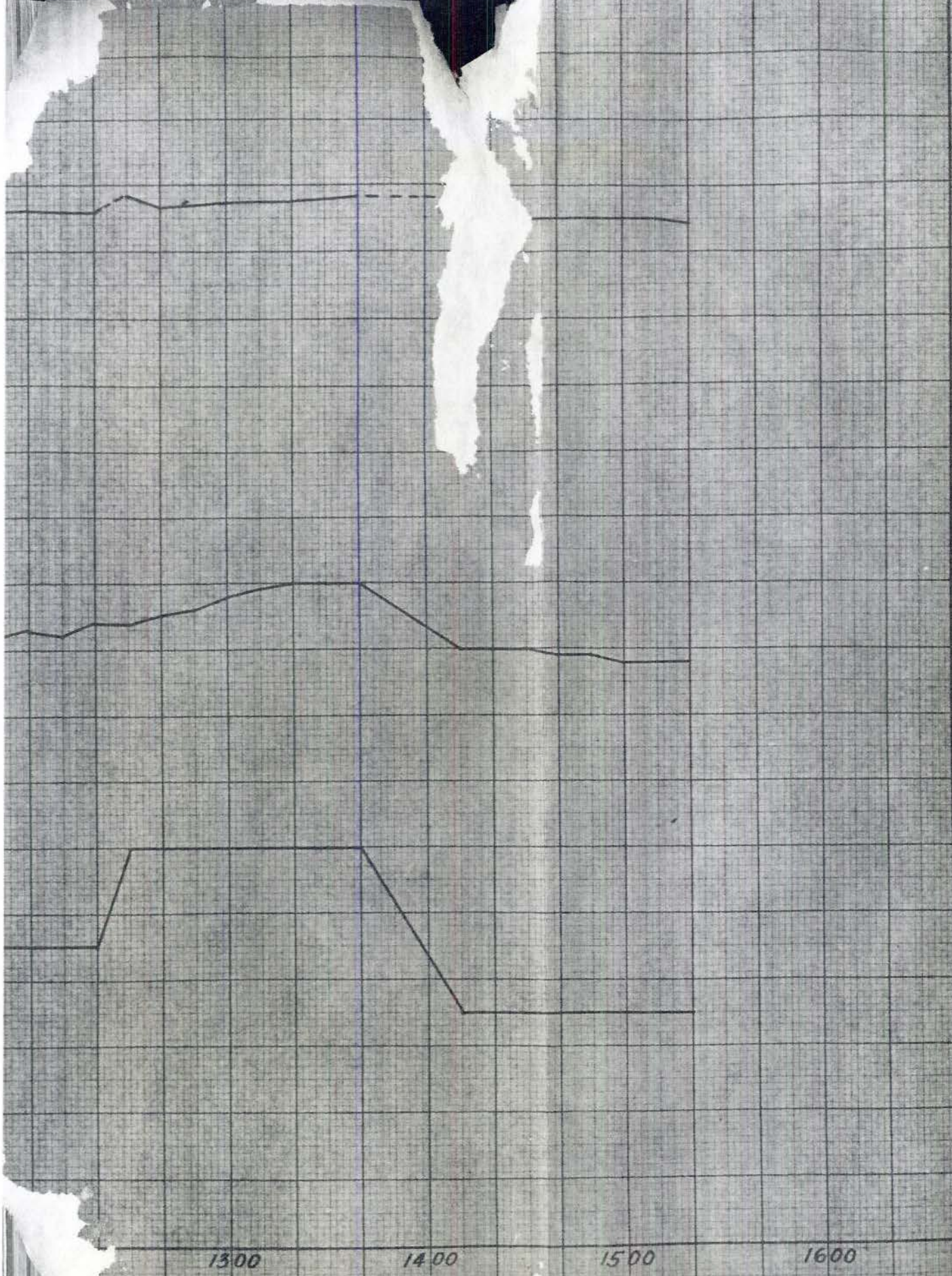
5-B



6-A

6

PERCENTAGE FREQUENCY DRIFT 10 CYCLES PER DIV.



TIME

1300

1400

1500

1600

6-B

KENEFEL & ESSER CO. N. Y.

PLATE 6

DEGREES CENTIGRADE

FREQUENCY

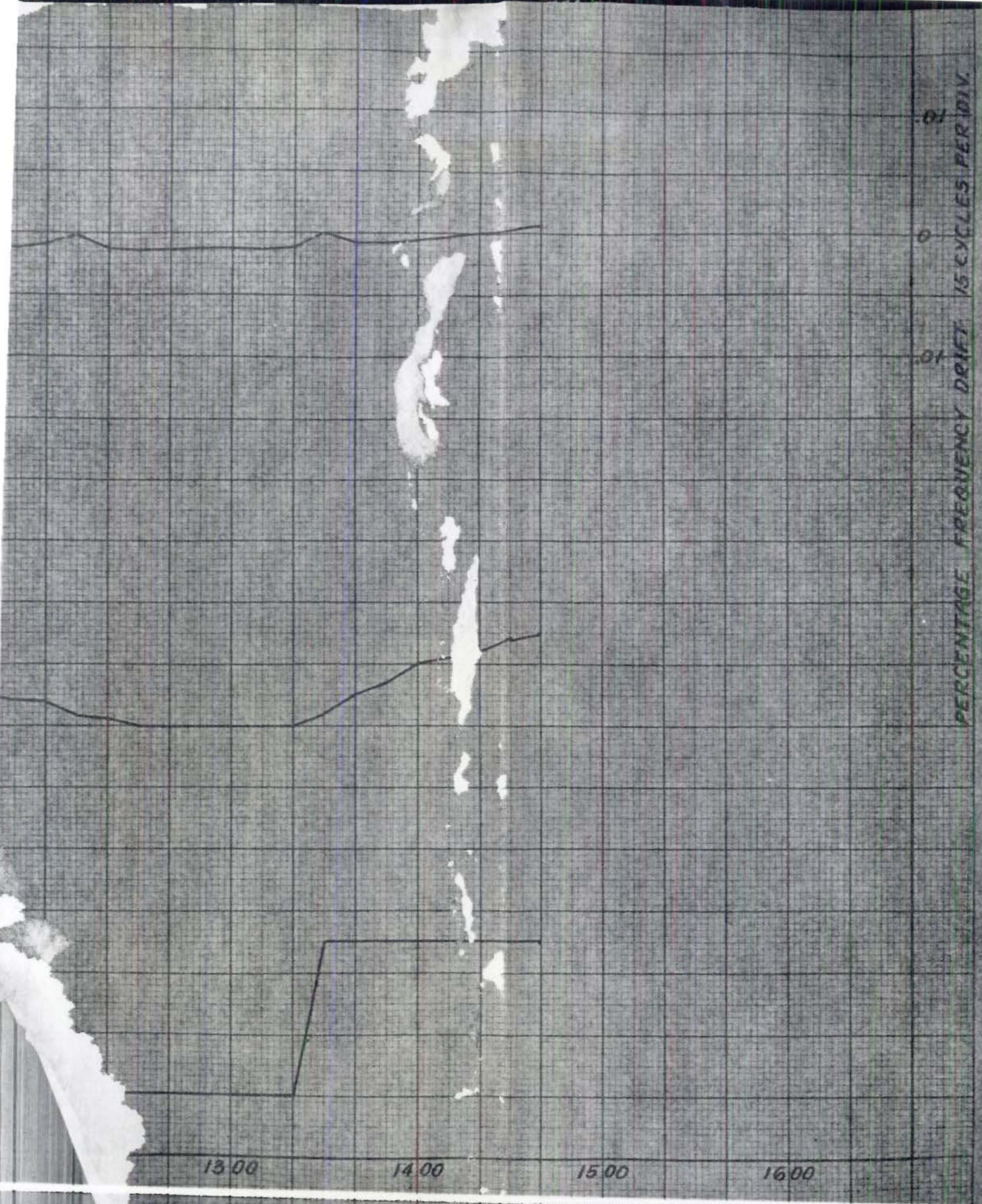
CABINET

AMBIENT

T.B.K. TRANSMITTER
PRELIMINARY MODEL
3000 W. C. P.

7-A

7A



13.00

14.00

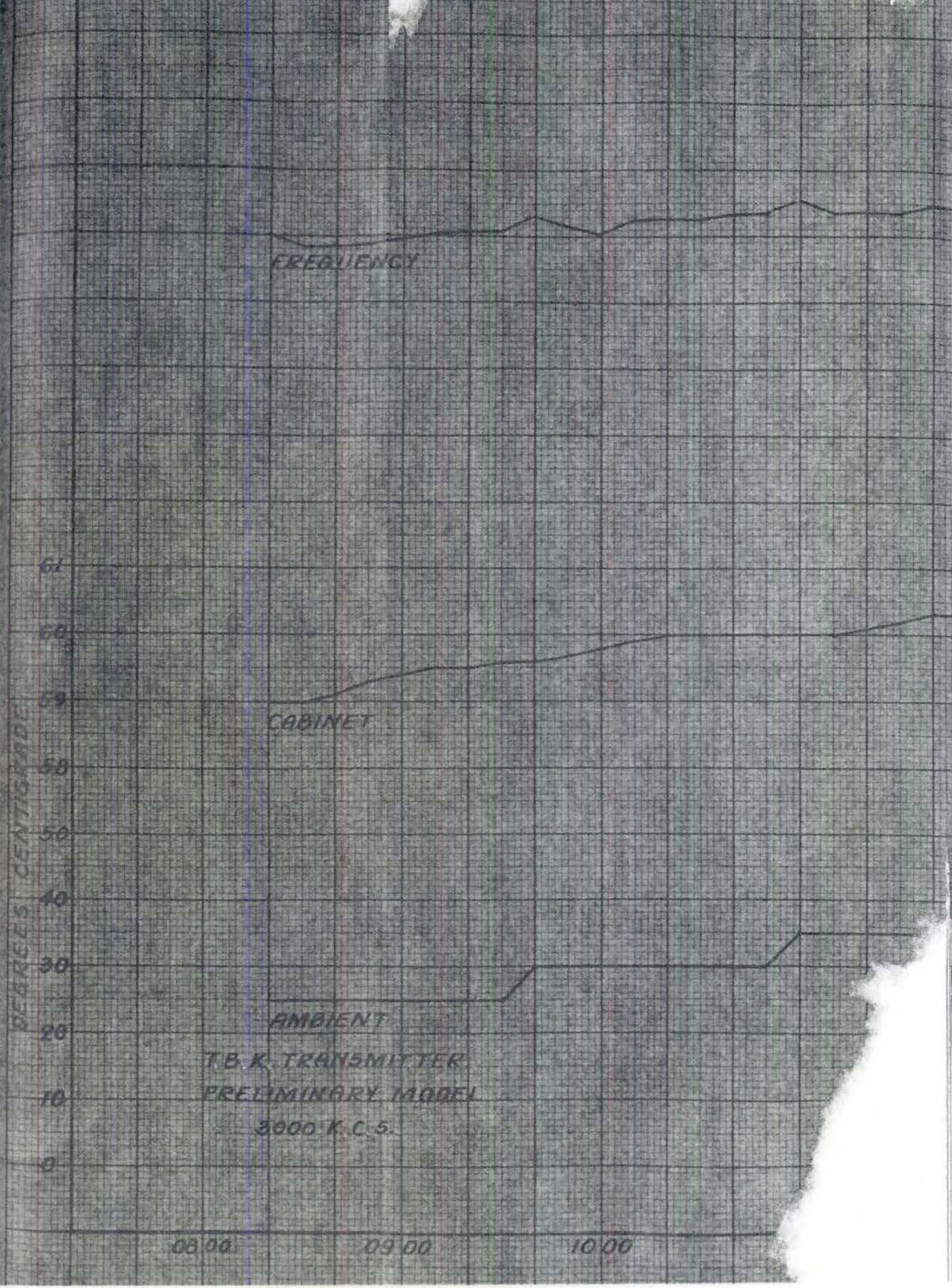
15.00

16.00

PERCENTAGE FREQUENCY DRIFT
15 CYCLES PER DIV

7-B

KEUFFEL & ESSER CO. N. Y.
PLATE 7



FREQUENCY

CABINET

AMBIENT

T.B.K. TRANSMITTER
PRELIMINARY MODEL
3000 K.C.S.

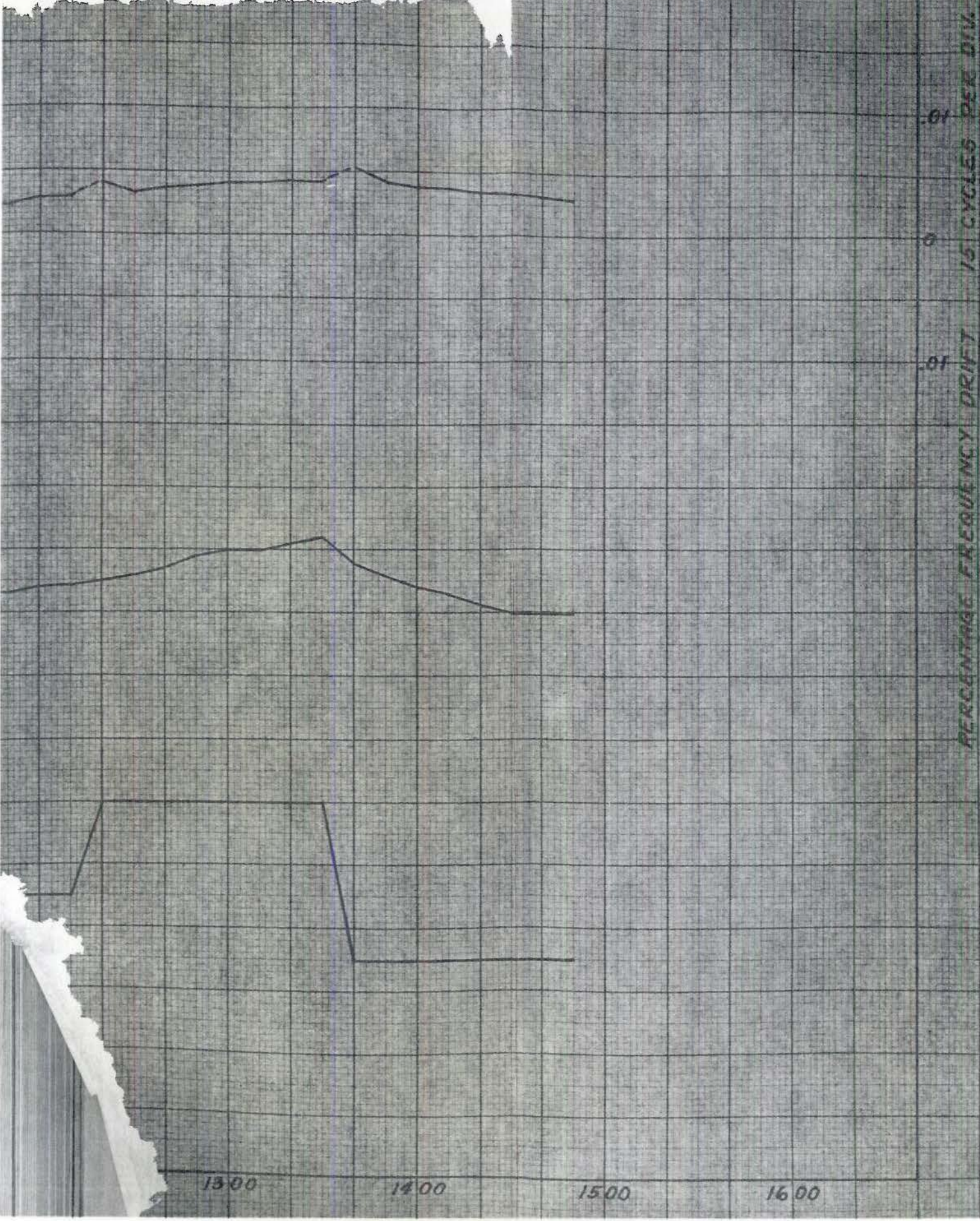
DEGREES CENTIGRADE

08 00

09 00

10 00

8-A



PERCENTAGE FREQUENCY DRIFT 15 CYCLES PER DIV.

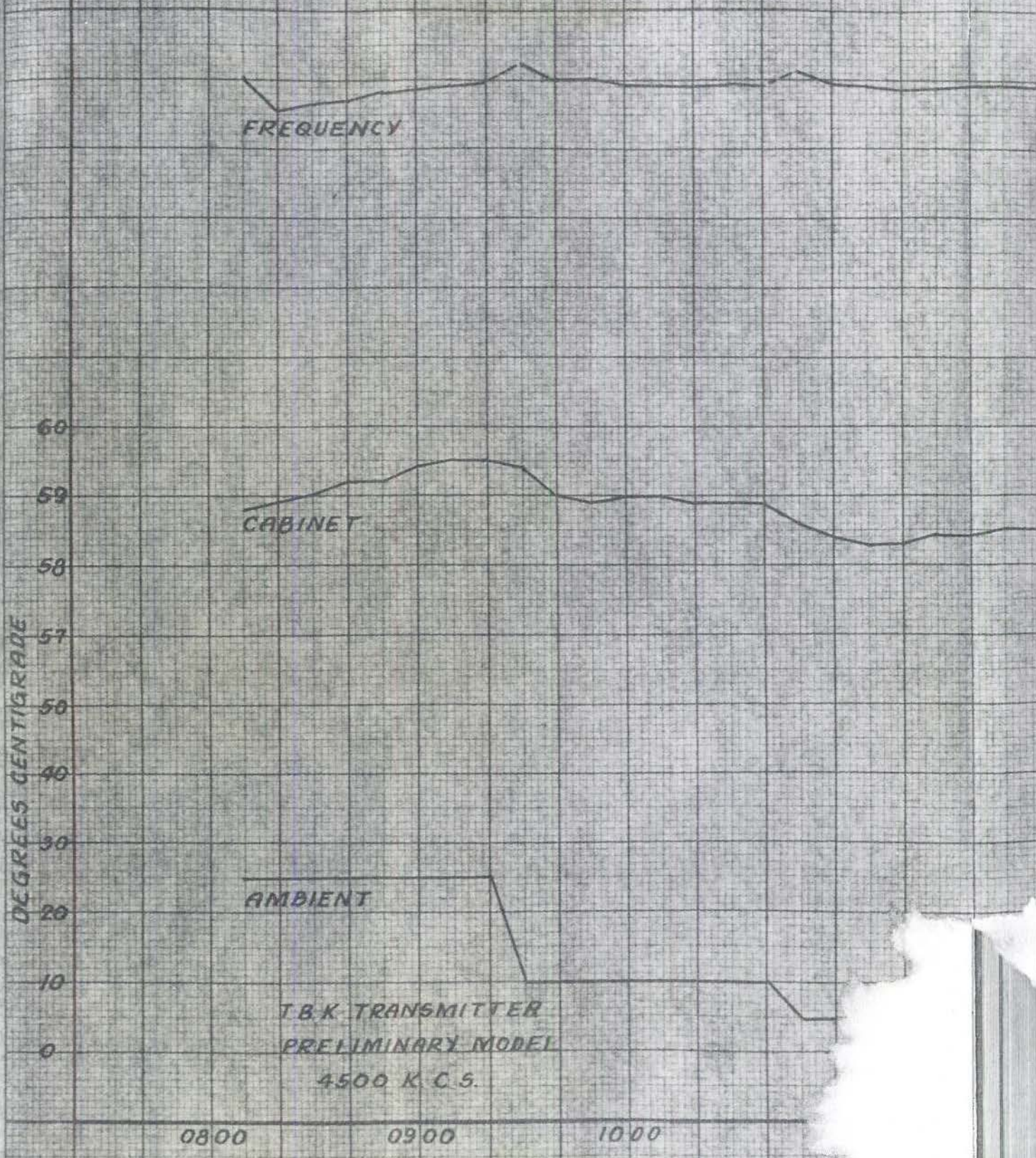
1300

1400

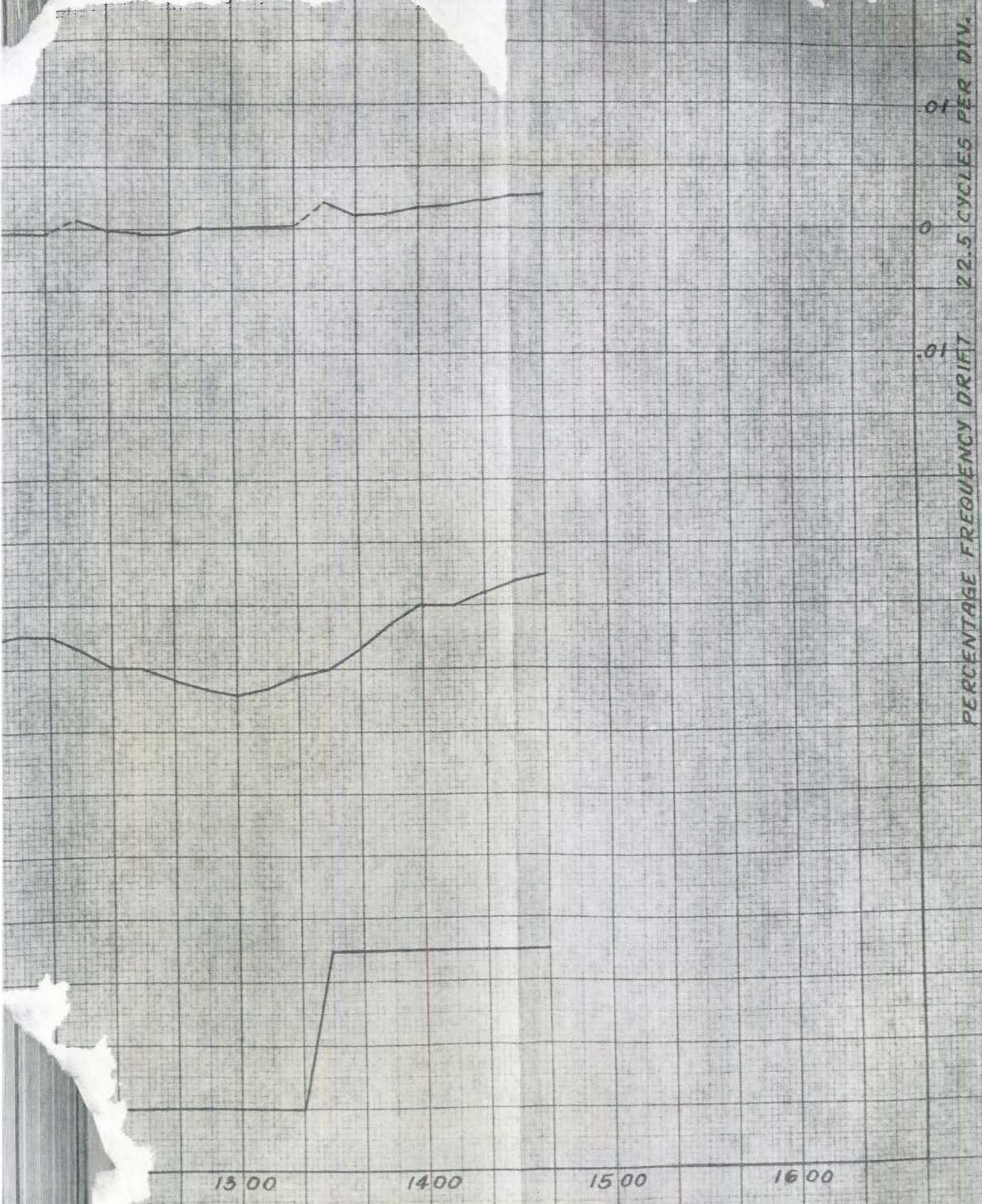
1500

1600

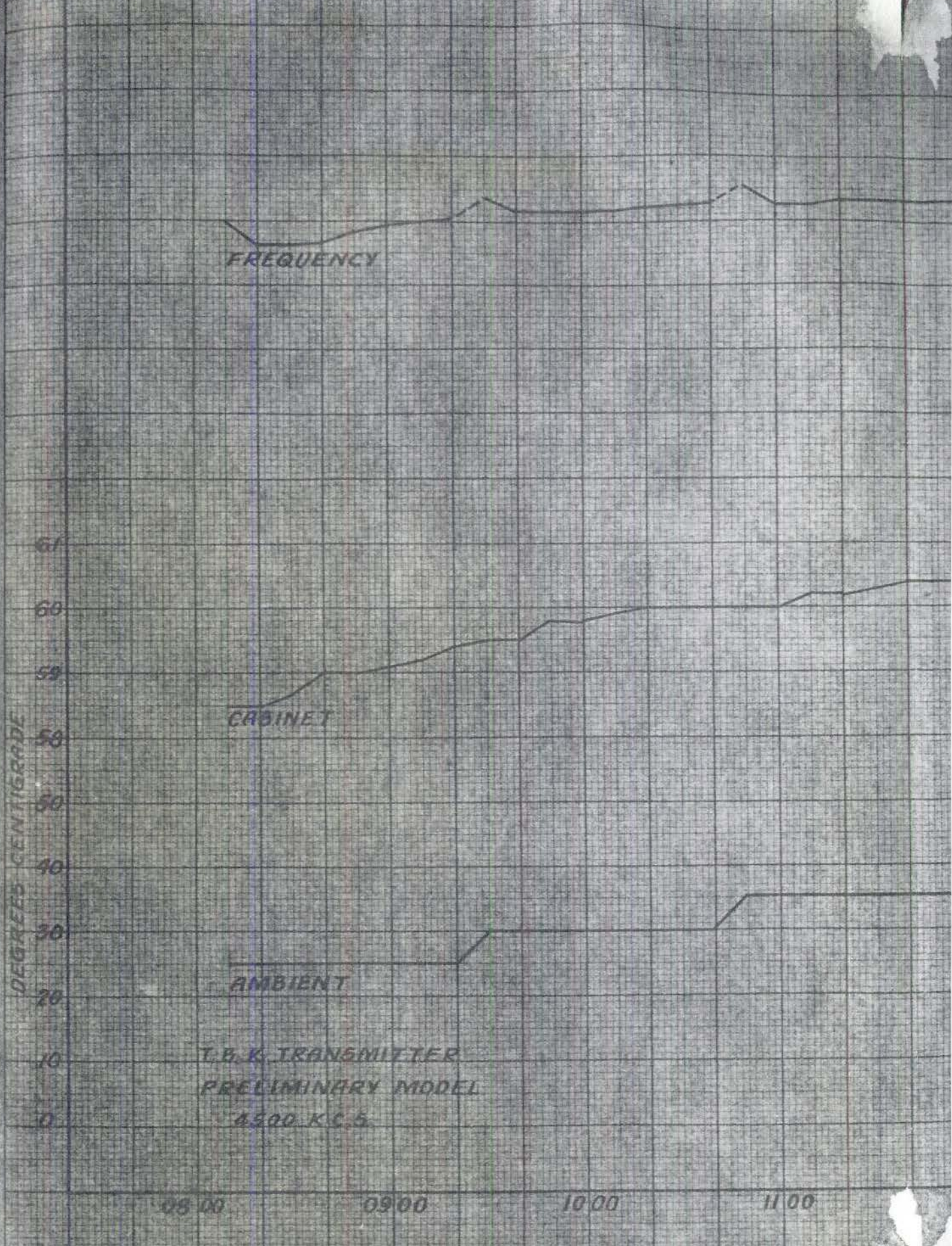
8-B



9-A



9-B



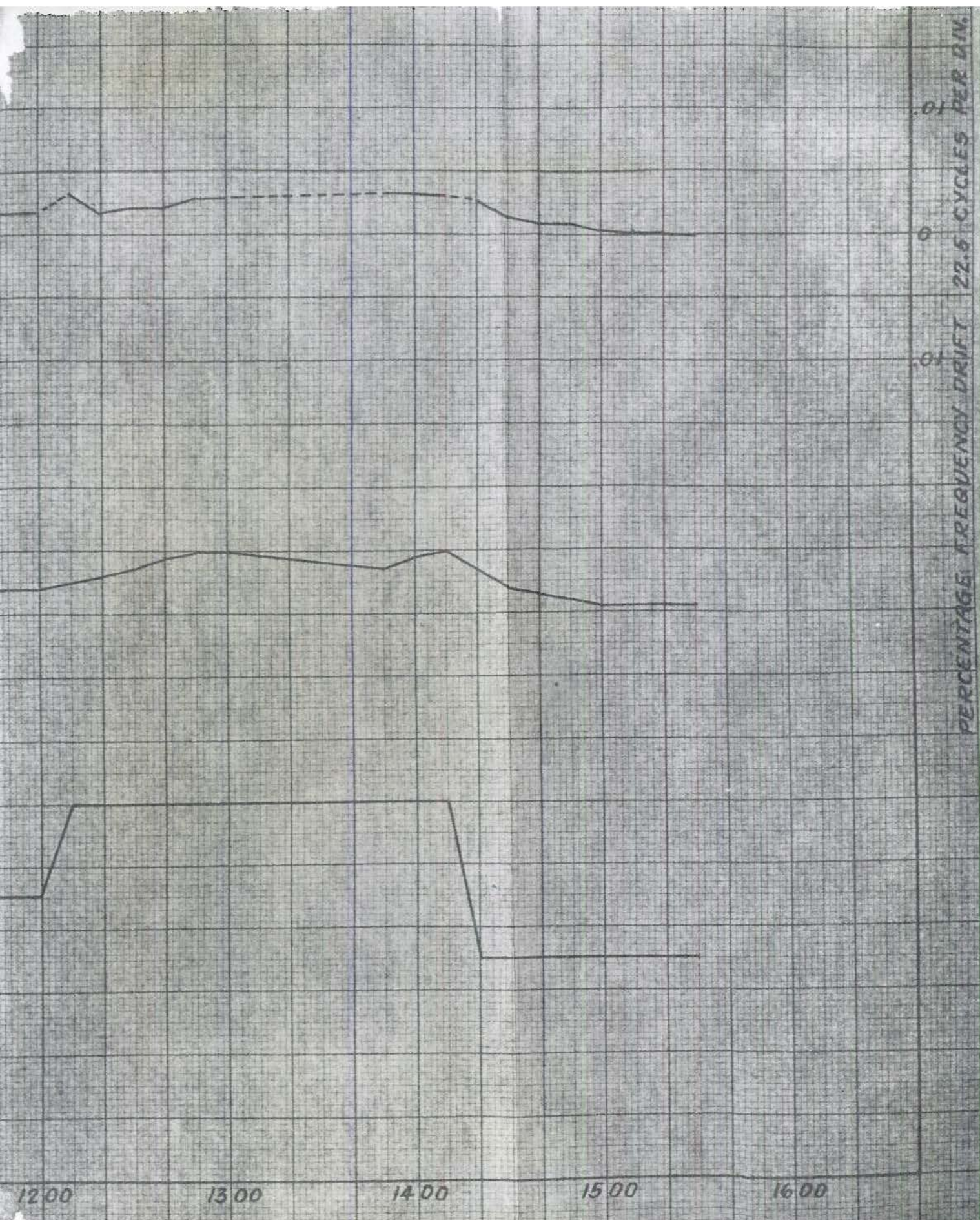
FREQUENCY

CABINET

AMBIENT

T. B. K. TRANSMITTER
PRELIMINARY MODEL
4500 KC. S.

10-A



10-B