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Report on  
Test of  
Model TAQ-4 Transmitting Equipment

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## AUTHORIZATION

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

- Reference: (a) BuEng let.NOs-37323(9-22-W8) of 25 September 1934.  
(b) Specifications RE 13A 351H  
(c) General Electric Company descriptive specifications RA-1437, May 1934.  
(d) Contract NOs-37323 of May 25, 1934.  
(e) General Electric Company type test data covering preliminary Model TAQ-4.  
(f) NRL let.S67/52 of 1 Feb.1935, with enclosures.

## OBJECT OF TESTS

2. The object of the tests was to determine compliance of the preliminary Model TAQ-4 transmitting equipment 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 TAQ-4 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) Effect of two hour key locked operation.
- (b) Re-set accuracy.
- (c) Degree of back lash present in tuning controls.
- (d) Variation of supply line voltage.
- (e) Effect of variations in ambient temperature.
- (f) Effect of variation of antenna constants.
- (g) Effect of detuning amplifier circuits.
- (h) Control of power output.
- (i) Effect of changing tubes.
- (j) Effect of "Adjust-Tune-Operate" Switch.
- (k) Effect of shocks simulating gun fire.

4. Power output determinations were made at various frequencies within the range of the equipment with various combinations of antenna constants.

5. 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.

6. Particular attention was given to the operation of the control circuits with a view to standardizing operation of such circuits.

7. The quality of emission was observed locally under normal conditions of operation and when the equipment was subjected to vibration and shock.

8. The effect of short circuiting and open circuiting the antenna was determined.

9. The operation of the transmitter when emitting MCW signals was studied.

10. The frequency range, overlap, and cycles per division of marking were determined.

## Conclusions

(a) The appearance of the Model TAQ-4 equipment is excellent and high grade materials have been used in its construction. The design of the equipment is such that accessibility is good and servicing operations can be performed readily and with ease.

(b) The transmitter produces excellent output and the overall efficiency is high. The tuning operations required to obtain full output are simple and direct.

(c) The manufacturer has supplied a new type of control circuit whereby the equipment may be started at any time by means of a.c. without the necessity of maintaining the control rectifier in an operative condition at all times. This method of operation is very desirable. Certain features of operation were not entirely satisfactory, but through the medium of comparatively minor modifications these undesirable conditions may be overcome.

(d) The equipment fails to operate in ambient temperatures between zero and 5°Centigrade due to the fact that the mercury vapor rectifier tubes cease operation. This condition can be corrected by supplying tube heaters of greater capacity than those now provided. The only other serious operational failure was caused by the failure of the auxiliary plate rectifier transformer.

(e) Certain corrections, modifications, and changes in the existing equipment are indicated to provide for greater safety factors under shipboard conditions of operation, greater ease in handling the equipment and to correct minor mechanical defects.

## Recommendations

It is recommended:

(a) That precautions be taken to insure that the equipment is securely and adequately packed to prevent damage during transportation and handling. (Par.34)

(b) That the Bureau of Engineering approve the use of 10 watt lamps as current limiting resistors in the screen grid circuits of the transmitter. (Par.37)

(c) That the footing members of the equipment be strengthened by the addition of heavy gusset plates or some other suitable method be provided to accomplish this end. (Par.38).

(d) That the manufacturer be required to incorporate the necessary means to insure the satisfactory operation of the rectifier equipment in ambient temperatures as low as 0° Centigrade. (Par.40, 82, and 151)

(e) That the use of steel hinges be **prohibited** and that suitable hinges of non-corrosive material be substituted. (Par.42)

(f) That the current carrying capacity of the contacts of the starting contactor be increased to a point where they will carry the required current without overheating and that the location of the fuse in the mid tap of the main plate transformer be changed to a point in the circuit where the rupture of this fuse will not endanger the equipment. (Par.45)

(g) That the positioning of all door interlocks be made with great care to insure positive action and to prevent injury of the interlocking mechanism. (Par.47)

(h) That the support provided for mounting the ventilating fan be improved to insure satisfactory operation when the transmitter is subjected to vibration. (Par.48 and 101)

(i) That the screws in all meters be provided with lock washers to prevent them from becoming loose under the influence of vibration and that adequate means be employed to prevent the failure of any of the control members. (Par. 54)

(j) That the hinged handles of all controls be so adjusted that they will not open under the influence of shock or vibration. (Par. 58)

(k) That an adequate method of permanently marking the various elements in the equipment in accordance with the symbol designations used in the wiring diagrams be provided. (Par. 68)

(l) That means be provided to prevent the lifting devices from rattling under the influence of vibration and that name plates be provided near these lifting devices to indicate their location. (Par. 71)

(m) That the Bureau of Engineering consider the advisability of approving the use of a six point tap switch in the primary of the main plate rectifier by means of which the output power is varied and that if powers of less than 15% to 16% are desired that they be obtained by uncoupling the antenna system. (Par. 85 and 102)

(n) That the wiring of the "Tune-Operate" switch be modified so as to permit tuning operations to be accomplished at a lower value of plate voltage in order to prevent tripping the d.c. circuit breaker. (Par.98)

(o) That the circuit arrangements be modified in order to permit key locked operation, by means of the local key on the transmitter panel, on MCW emission. (Par.99)

(p) That satisfactory means be provided to prevent damage to the lead sheathed cables in the rectifier unit when the main plate transformer is removed or replaced. (Par.107)

(q) That the meters in the rectifier unit be provided with adequate bypass units and that future specifications be so worded as to require the installation of such units. (Par.108)

(r) That all doors on the transmitter and rectifier units be supplied with two securing latches. (Par.113)

(s) That in order to prevent the doors on the transmitter and rectifier from sagging under their own weight that stronger hinges of the continuous or piano type be employed. (Par.115)

(t) That the four wire remote control circuit leads be numbered from 1 to 4 inclusive in order to correspond with equipments of other makes in the interests of standardization and that future specifications require that this method of designation be employed. (Par.123)

(u) That the control circuits be modified in accordance with the provisions outlined in ref.(f) and that the equipment be provided with a filament stand-by switch. (Par.121 and 122)

(v) That the emergency switches be marked more distinctively by means of red name plates. (Par.129 and 154)

(w) That a more satisfactory main plate transformer be provided in the rectifier unit. (Par. 136)

(x) That the manufacturer be required to give assurance that suitable and satisfactory auxiliary plate transformers will be provided in the rectifier unit. (Par. 137)

(y) That the connection studs on the a.c. overload relays be reduced to a length of 3/4". (Par.150)

(z) That the manufacturer be required to incorporate a grid protective relay in the rectifier so arranged that plate voltage cannot be obtained in the absence of grid voltage. (Par.151)

(aa) That a high voltage disconnect switch be provided in the equipment in accordance with the requirements of Par.6-61 of the governing specifications. (Par. 153)

(bb) That the manufacturer be requested to investigate the possibility of reducing the a.c. interference experienced in receivers when installed adjacent to the rectifier equipment. (Par. 163)

(cc) That the preliminary model of the TAQ-4 transmitting equipment be considered satisfactory for Naval use after the recommendations listed above have been complied with in a manner meeting the approval of the Bureau of Engineering.

## MATERIAL UNDER TEST

11. The material under test consisted of one complete Model TAQ-4 transmitting equipment (preliminary model) consisting of a transmitter unit and a rectifier unit. The TAQ-4 was manufactured by the General Electric Company under Contract NOs-37323 and covers the frequency range of 175 kilocycles to 600 kilocycles. The equipment operates from a 440 volt, 60 cycle, 3 phase power supply and is nominally rated at 2 kilowatts output. The equipment was received at the Naval Research Laboratory, on December 20, 1934.

## METHOD OF TEST

12. 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.

13. 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.

14. Power output determinations were accomplished at various frequencies through the use of dummy antennas.

15. Frequency changes and drifts were checked under various conditions of operation 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.

16. Determinations of the effect of change in ambient temperature were made at full power output over the temperature range of zero to 50° Centigrade in 5° steps. The temperature control facilities of the U.S. Bureau of Standards were utilized for these tests; frequency observations being taken on the Model LH equipment. The key of the transmitter was locked during the entire test period, one hour and ten minutes being allowed for the transmitter to stabilize at the various temperatures attained during the test.

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

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

19. Measurement of the ripple voltage present in the output of the various rectifiers was made by means of a Model 636 Wave Analyzer.

20. Model RAA receivers were used in the tests for determining the quality of emission under various conditions of operation.

30. The 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 accuracy.

31. The method of making ripple voltage measurements has been determined to be of the same order of accuracy as that obtained when using accurately calibrated oscillographs.

32. By comparing the key click interference produced by the regular keying system with the interference produced by the special keying circuit, it was possible to arrive at an accurate estimate of the advantages to be gained through the use of special keying circuits. A separate report on the above will be submitted.

33. The temperature control facilities used are such that it is possible to obtain any temperature within the specified range to an accuracy of  $\pm 0.2^{\circ}$  Centigrade.

#### RESULTS OF TESTS

34. Upon receipt of the Model TAQ-4 equipment it was noted that the floor of the packing case containing the transmitter unit had been broken during shipment. Fortunately, the transmitter suffered no damage, but this incident indicates that the flooring of such cases should be more securely fastened to the heavy transverse members forming the supports underneath the case.

35. In the following paragraphs of this report reference is made to the governing specifications RE 13A 351H 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.

36. Section I. The Model TAQ-4 transmitter meets the general scope of this introductory section of the specifications.

37. Par.2-2. The component parts used in the construction of the equipment comply, in general, with the requirements of the sub-specifications referenced under this paragraph. It may be pointed out, however, that the resistors employed in the screen grid circuits of the four element vacuum tubes for regulating the current and voltage do not comply with specifications RE 13A 372G covering fixed resistors. The Model TAQ-4 employs small compensating lamps (10 watt) for this purpose. The advantage in using these lamps lies in the fact that they form a self-regulating resistor, the action of which is superior to that obtained with a wire wound resistor of the vitrohm type. Experience indicates that these lamps are rugged and give long life. Hence, it is recommended that the use of these lamps be approved.

38. Par.2-3. The Model TAQ-4 equipment is ruggedly constructed. The frame is fabricated from 1-1/2" x 1-1/2" x 3/16" hard aluminum, while all cross members are secured by means of 5-5/8" x 5-5/8" x 3/16" gusset plates. The front panels are 3/16" thick; the side shields are 1/8" thick perforated

the hinges. Hinges should not be constructed of steel since even a small amount of corrosion or rust will prevent them from functioning properly. Therefore, it is recommended that brass hinges be employed.

43. Par.2-8. The insulation employed in the construction of the Model TAQ-4 transmitter is of excellent quality. Liberal use has been made of micalex and isolantite. Phenolic insulation has not been employed in such locations as constitute a violation of the specifications.

44. Par.2-9. No wood has been used as an electrical insulator in the construction of this equipment.

45. Par.2-10. The design of the electrical circuits and controls is liberal. However, it was noted that the starting contactor contacts overheated due to the current they are required to carry. The contactor is equipped with double poles but only one pole was employed. This condition should be improved by connecting the two poles of the contactor in parallel. This connection was actually made during the tests herein described with satisfactory results. All parts which are likely to carry an overload are protected by relays or fuses. However, the location of the fuse in the mid-tap of the main plate rectifier should be changed. With the present circuit arrangement a very unsatisfactory condition results if the mid tap fuse blows. The blowing of this fuse affects only the keying bias and the difficulty is not readily located because keying action of an uncertain character is still obtained due to leakage currents. Under this condition if the test key is opened and the antenna coupling control is opened, severe arcing takes place in the antenna and power amplifier circuits which is likely to damage the equipment. In order to remedy this undesirable condition the fuse, item 565, should be moved from its present position in the circuit to a point ahead of the screen grid potentiometer; that is, in the lead which now connects the common point of capacitors 520 and 521 to the common point of resistors 528 and 572. If the fuse blows in this location, the intermediate amplifier ceases to operate and no destructive arcing occurs.

46. Par.2-11. In case the remote key is kept closed for more than five seconds, the keying circuit is opened through the medium of a time relay. The local test key is not affected by the time relay. An overload relay is provided in the output of the plate rectifier to protect the equipment in case the plate current rises to an excessive value. When this relay opens, plate voltage is removed from the transmitter. The operation of the overload or tube protective relay is not entirely satisfactory but careful study of the conditions involved reveals the fact that no improvement can be wrought and that the manufacturer has provided the best possible protection. An explanation of this matter is deemed desirable in order to anticipate future criticism. At the present time whenever the plate overload relay opens due to an overload, it is necessary to wait for a period of 30 to 60 seconds before the plate voltage is again available. This is caused by the fact that the relay contacts open the starting contactor and it is necessary to permit the filaments to attain the proper operating temperature before plate voltage is applied to the rectifier tubes. If the plate overload relay were placed in the coil circuit of the plate contactor an overload would cause the plate contactor to chatter in and out since the plate overload relay is of the automatic reset type and this

chattering would continue until the equipment was shut down manually or until a protective fuse was caused to blow. In transmitters of lower power but which use the same line up of rectifier tubes, this unsatisfactory condition can be avoided by utilizing two overload relays, one in the transmitter and one in the rectifier. But since the TAQ-4 transmitter requires that the total safe current output of the main plate rectifier be utilized, no advantage would be gained by having two overload relays in series. In the case of lower powered transmitters the overload relay in the transmitter could be set to a value to protect the transmitter tubes while the overload relay in the rectifier could be set to a somewhat higher value and still give adequate protection to the rectifier tubes. In the case of the TAQ-4, however, the overload relay in the transmitter must carry the 2 amperes power amplifier plate current, grid current and intermediate amplifier plate current and screen current. This total is about 2.3 or 2.4 amperes which is the safe limit for the output current of the main plate rectifier. Hence, it is impossible to stagger the setting of the two relays should two be provided. Thus a single overload relay gives the same protection as would be afforded by two relays, and no suitable method to improve the overload relay action is available.

47. Par.2-12. Protective interlocks have been provided on all access doors to prevent personnel from accidentally coming in contact with dangerous potentials. These door interlock switches have been provided with sufficient insulation to prevent grounds and short circuits. Difficulty was experienced with two of the interlocks, however. The interlock on the lower right hand door of the transmitter which gives access to the terminal panel is likely to be damaged. The portion of the switch which is secured to the door strikes the frame of the transmitter when the door is opened and closed. This difficulty can be overcome by lowering the door switch assembly  $1/8$ ". During locked key tests of the transmitter it was found that the equipment would shut down even though no overloads were present. This trouble was finally traced to the interlock on the lower left hand door of the transmitter which gives access to the left hand terminal panel. This interlock was making such precarious contact that a very slight amount of vibration caused the circuit to be interrupted. This difficulty was corrected by placing a bakelite shim under the section of the switch which is secured to the door.

48. Par.2-13. Ample provision has been made for ventilation and cooling. Perforated shielding is employed which permits the circulation of air through the equipment. A ventilating fan has been provided for cooling the antenna variometer. This fan is placed into operation when the filaments of the transmitter tubes are lighted. The mounting of this fan is unsatisfactory. When the transmitter is subjected to vibration the blades of the fan strike the walls of the antenna coil. The means for securing this fan should be improved to prevent this unsatisfactory condition. No interference from this fan could be detected in a nearby receiver, nor did the fan cause any frequency variation or modulation.

49. Par.2-14. After numerous locked key tests of several hours duration, in ambient temperatures ranging up to  $50^{\circ}$  Centigrade, inspection revealed that no capacitors or other parts were damaged and there was no evidence that wax or other compounds used in capacitors had softened or flowed from the containers.

50. Par.2-15. During the course of these tests the equipment was subjected to numerous key locked tests for periods of two hours and more 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. Tables 1, 2, 3, and 4 are records of two hour key locked tests conducted at frequencies of 177, 355, and 500 kilocycles.

51. Par.2-16. Table 5 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 frequencies of 500, 355, and 175 kilocycles. It will be noted that when the antenna was shorted or open circuited the power amplifier plate current dropped to a value less than normal. The equipment complies with this paragraph of the specifications.

52. Par.2-17. The design of the equipment is such that all vacuum tubes employed operate within the power limitations of Navy tube specifications.

53. Par.2-19. No facilities were available to conduct a test wherein the equipment would be subjected to conditions approximating the roll and pitch of a vessel at sea. However, the construction of the equipment is such that it is believed that satisfactory operation will be secured under the conditions outlined in this paragraph of the specifications. A greater degree of strength and stability will be secured, however, if the corner angles by means of which the transmitter and rectifier are secured to the deck, are provided with heavy gusset plates, as recommended in par.38 of this report.

54. 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 par. 3-42 of the specifications without any damage or non-operation resulting. The transmitter was also subjected to vibration of a rather severe nature. A one-half horsepower motor was bolted to the frame of the equipment. 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 through the vibration which ensued. Observation of the emitted signal on a nearby RAA receiver failed to reveal any effects which could be attributed to the vibration. Suitable lock washers have been provided in most places and no indications of loose connections were noted. No relays, circuit breakers or door latches failed due to vibration or shock. The rectifier was also subjected to vibration. The following effects were noted. The overload relays were noisy although they continued to function satisfactorily. The main plate voltmeter gave false indications due to the fact that the dial card loosened up under the influence of vibration. This card is secured to the meter proper by means of two small screws and no lock washers were used to prevent these screws from becoming loose. The filament voltmeter also failed to function properly due to the same reason. It is recommended that all meters provided with this equipment be provided with the necessary lock washers. Another defect was noted after the transmitter had been transported to and from the U. S. Bureau of Standards where the temperature tests were conducted. Two screws became loose in the universal coupling of the power amplifier tuning control. The loss of these screws prevented

the control from functioning. Apparently these screws had not been provided with lock washers. Care should be taken to see that this defect is prevented in production models.

55. Par.2-21. All vacuum tubes have been cushioned against the effects of vibration. Lord flexible mountings have been used for this purpose. All of the tubes in the transmitter are mounted by means of a single framework suspended on four Lord mountings. In the rectifier all tubes are mounted on a single frame which is supported on four Lord mountings.

56. Par.2-22. The design of the circuits is such and the method of control provided is such that it is believed no further simplification could be obtained without sacrificing other necessary and desirable features.

57. Par.2-23. All necessary controls and indicating devices are located on the front panels and are suitably marked for identification.

58. 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. None of the controls possess sharp corners or edges which are likely to inflict injury. A number of the controls are varied through the medium of a hinged handle. When the desired setting is obtained the handle folds into a recess and locks itself into place. It is noted, however, that several of these handles do not lock tightly and it is feared that under the influence of vibration and shock of greater intensity than that applied during the tests these handles may release themselves and shut down the equipment. Some of these handles lock tightly enough so that this failure cannot take place, but the following controls should be made more secure:

- Control "A" - M.O. and I.P.A. Band Change Switch
- Control "D" - P.A. Band Change Switch
- Control "G" - Antenna Coupling Switch
- Control of Signal Switch when in CW position
- Control of Plate Transformer Tap Switch

59. Par.2-25. All indicating instruments used in the construction of this equipment are of the 3.5 inch diameter, flush type, with bakelite case. A felt washer has been placed between the rim of the meter and the panel to which it is mounted in order to prevent breakage. All voltmeters employing external multipliers have a sensitivity of 1,000 ohms per volt. The instruments furnished were checked against precision type instruments and were found to comply with the specification requirements of 2% accuracy. Table 6 lists the meters supplied with the Model TAQ-4 equipment.

60. Par.2-26. Appropriate nameplates which comply with the requirements of the governing specifications have been prominently and securely affixed to all major units of the equipment.

61. Par.2-27. All assembled separate units, such as transformers, reactors, and capacitors have been marked as to operating voltage, current, frequency etc.

62. Par.2-28. No spare parts are required with the preliminary model; hence compliance with this paragraph of the specifications cannot be determined.

63. Par.2-30. The controls are so designed that the final controlled effect is increased as the values of the settings increase numerically. Clockwise rotation of the control knob increases the final controlled effect in all cases except on the controls which govern the intermediate amplifier tuning, power amplifier tuning, and the antenna loading. These three controls must be turned in a counter-clockwise direction to produce an increase in the final controlled effect.

64. Par.2-31. The design of the equipment is such that ample space has been provided for the vacuum tubes employed and replacement can be readily accomplished. All relays are readily accessible.

65. Par.2-32. The combined weight of the equipment, exclusive of spares, is 1895 pounds. Specifications permit a weight of 2600 pounds. See Table 7.

66. Par.2-33. The size of the units which comprise the TAQ-4 equipment are such that they will pass through a door or hatch of the dimensions specified in this paragraph. For complete dimensional details see Table 7.

67. Par.2-34. The line voltage was varied over the limits of -5% to +5% and the equipment functioned satisfactorily when subjected to this variation.

68. Par.2-35. Resistor mountings are marked with the Navy type number and the value of resistance. Tube sockets are marked to indicate the type of tube to be used. Relays are marked to indicate their function in the circuit. Capacitors, reactors, transformers, etc., are not marked with other than nameplate data. No provision is made in the preliminary model to identify the parts in the equipment with a symbol corresponding to the symbols used in the wiring diagrams and in the instruction book.

69. Par.2-36. The construction of the shockproof mountings is such that replacement of the rubber parts employed can be accomplished readily and with ease if spare Lord mountings are available.

70. Par.2-37. The equipment is capable of satisfactory operation under varying line voltage conditions, as specified in this paragraph of the specifications.

71. Par.2-38. The Model TAQ-4 equipment has been provided with lifting devices in the four top corners of each unit. These eyebolts are of satisfactory size and strength, but some means should be provided for securing these devices when they are not in use to prevent them from rattling under the influence of vibration. In addition, it is recommended that appropriate nameplates be affixed to the shielding near the lifting devices to inform the personnel handling the equipment that such devices are available. Since the lifting eyes are not visible to a man standing on the deck, the presence of these lifting eyes may be overlooked. Nameplates secured to the side shields would prevent this oversight.

equipment complies with the requirements of pars. 3-2 and 3-3 of the specifications.

75. Par.3-4. This paragraph states in part that "Harmonics, key clicks, lilt or other objectionable features in the equipment shall be reduced to a minimum".

- (a) The intermediate power amplifier stage of the TAQ-4 transmitter is provided with a suitably tuned plate circuit and excitation from this stage is capacity coupled to the control grids of the power amplifier stage.
- (b) The power amplifier plate circuit is suitably tuned and capacity coupled to the antenna tuning system.
- (c) This portion of the specifications states that "The product of the ratio of antenna system KVA to antenna system KW times the ratio of power amplifier tank KVA to power amplifier tank KW shall not be less than 150 under any of the operating conditions listed under par.3-3. Power amplifier tank KW shall be taken as the sum of the power loss in the tank plus the power coupled out to the antenna system. No actual check to determine this factor was made, since study indicated that the errors involved in making these measurements would be of such a magnitude that the final result would be less accurate than the results obtained from making a practical determination of the overall efficiency of the equipment. Overall efficiencies are listed in Table 29. It will be noted that when operating at normal adjustments the efficiency is as great as 38.6%, which is an exceedingly favorable factor. Hence, in the opinion of the Laboratory, the Model TAQ-4 equipment complies with this requirement of the specifications.
- (d) The equipment is adequately shielded in order to minimize extraneous couplings between the various circuits.

Harmonics are present as was determined by listening on an RAB receiver in close proximity to the transmitter. With the transmitter operating into an actual antenna at 215 kilocycles, it was possible to detect harmonic emission as high as 16,000 kilocycles. However, these emissions were of no greater intensity than are usually found in the output of similar equipment of the same power. No lilt or undesirable modulation was noted and no continuously oscillating tubes produce interference. Key clicks are present to a considerable degree, but again it should be stated that the magnitude of this type of interference compares favorably with the interference produced by other transmitters of similar characteristics. The transmitter was keyed through the medium of a special anti-key click keying device and a great reduction in the intensity of key clicks was obtained. A report on this phase of the investigation will be submitted in separate corre-

spondence. In general, therefore, it may be stated that the Model TAQ-4 equipment complies with the requirements of par.3-4 of the governing specifications.

76. Par.3-5. The transmitter is capable of emitting a signal modulated not less than 70% at 800 cycles per second with a consequent reduction in power output of less than 50%. Details of this test are listed in Table 13. Selection of CW or MCW method of transmission is effected by means of a suitable control on the front panel of the transmitter.

77. Par.3-6. It is possible to adjust the transmitter for operation at any frequency within the specified range by means of controls located on the front panel of the equipment. In the opinion of the Laboratory the number of controls provided are a minimum compatible with efficient operation. Table 14 lists the actual controls provided.

78. Par.3-7. The equipment complies with this paragraph of the specifications.

79. Par.3-8 and 3-9. The specifications require that the momentary or periodic frequency variations due to the causes listed shall not exceed a maximum of 350 cycles. The results of the individual tests are discussed in the following paragraphs.

80. Par.3-9-1. Since highly accurate crystal controlled frequency measuring equipment was used to set the frequency, no errors resulted from the calibration.

81. Par.3-9-2. Errors in resetting to the desired frequency. Table 15 lists the results of tests conducted to determine the reset accuracy. Tests were conducted at 355 and 500 kilocycles. The maximum deviation noted was 127 cycles at 500 kilocycles. Table 16 lists the results of tests conducted to determine the degree of lost motion or back lash in the master oscillator control. It will be noted that the average deviation due to backlash resulting from five trials was 86 cycles at 500 kilocycles and 133 cycles at 355 kilocycles. This is considered satisfactory performance.

82. Par.3-9-3. Variations in ambient temperature. Tables 17, 18, 19, 20, and 21 list the results of tests conducted to determine the frequency changes resulting from changes in ambient temperature. Plates 3, 4, 5, and 6 show this data in graphic form. Table 21 presents a summary of the temperature tests and it will be noted that the largest frequency shift due to a change of 5° ambient temperature was 121 cycles at 500 kilocycles. During these tests it was discovered that the rectifier tubes ceased operation when the ambient temperature reached about 3.5°C and the tube compartment temperature was 17°. Hence, it was impossible to make any frequency determinations at zero degrees Centigrade. This deficiency is discussed in detail under par.151 of this report.

83. Par.3-9-4. Variation in supply line voltage. The supply line voltage was varied between the limits of 418 and 462 volts; i.e.  $\pm 5\%$  of 440 volts. Table 22 shows the results of tests conducted at 500 kilocycles and 355 kilocycles. The voltage was varied slowly in steps of 1% and also rapidly from -5% to +5%. The maximum change noted for the 1% step change was 39 cycles at 500 kilocycles, while the maximum change resulting from a rapid change in voltage was 8 cycles at 355 kilocycles.

84. Par. 3-9-5. Variation in antenna constants. Table 23 lists the results of tests conducted at 500 and 355 kilocycles to determine the frequency change resulting from a 25% change in antenna constants. It will be noted that the maximum change resulting from this cause was 13 cycles at 500 kilocycles. Table 23 also lists the variations in frequency caused by detuning the power amplifier circuit.

85. Par. 3-9-6. Control of power output. Table 24 shows the results of tests conducted at 355 and 500 kilocycles in order to determine the action of the transmitter when the power was varied between maximum and minimum limits by means of the rectifier tap switch. It will be noted that the frequency change resulting from this change in power was 76 cycles at 355 kilocycles and 52 cycles at 500 kilocycles. It will be further noted that the power could not be reduced to 10%, but that the lowest value was **16% if tap 5 is taken as 100%** and about 15% if tap 6 is designated as the full power tap. Under the conditions of the test, however, tap 6 was designated as 110% at 500 kilocycles.

86. Par. 3-9-7. Change of vacuum tubes. Table 25 lists the results of tests conducted to determine the change in frequency resulting from changing tubes in the transmitter. These tests were conducted at 500 kilocycles and it will be noted that the largest frequency change noted from this cause was 50 cycles.

87. A summary of the tests conducted in conformity with the provisions of par. 3-9 is contained in Table 26. Reference to this table reveals that the Model TAQ-4 transmitting equipment complies with the requirements of this paragraph of the specifications.

88. Par. 3-10. Neutralization has been employed to the extent necessary to assure satisfactory operation. This neutralization is fixed and requires no further adjustment.

89. Par. 3-11. The design of the keying circuit is such that all tubes cease to oscillate when the key is open, with the exception of the audio oscillator tube. This tube continues to oscillate for five seconds after the key is open. This provision is necessary in order to **obtain** a satisfactory degree of modulation when operating at high keying speeds. Tests were conducted to determine whether the audio oscillator created interference while it was oscillating in the key open condition. No signs of interference could be detected in a nearby Model RAA receiver.

90. Par. 3-12. The frequency range of the transmitter is divided into several bands controlled by range selector switches. These selector switches are as follows:

- M.O. and I.P.A. Band Change Switch, 6 positions
- P.A. Band Change Switch, 6 positions
- Antenna Band Change Switch, 15 positions

The circuits are so constructed that ample overlap is provided to assure continuity of the frequency range. The band change switches are provided with interlocks which open the keying circuit when these switches are operated. It is possible to make adjustments within any band with power on the transmitter.

91. Par.3-13. The transmitter is capable of adjustment to and operation at any frequency within the bands specified by means of front panel controls. In the opinion of the Laboratory these controls have been kept to a minimum consistent with efficient operation. See Table 14.

92. Par.3-14. Each control is legibly marked to indicate its function. In addition, the frequency controls have been given designating letters ranging from "A" to "H", inclusive. All markings are of a permanent character and are easily readable at a distance of 24 inches.

93. Par.3-15. A calibration card is mounted on the front panel suitable for logging twelve frequencies. The card is protected by a transparent, non-breakable waterproof shield. The card holder is so constructed that cards can readily be changed without resorting to the use of tools.

94. Par.3-16. Table 27 is a calibration of the master oscillator circuit which shows that the frequency per division of marking does not exceed 0.05% except for the slight deviation at 275 and 400 kilocycles. These deviations are of such a minute character that they in nowise interfere with operation. At no place in the range does the variation fall below 0.02%. The width of the smallest scale division is 0.05". In the remaining circuits the vernier ratio is such that the non-critical adjustment of the various circuits is provided.

95. Par.3-17. Suitable friction type locking devices have been provided on the variable controls to prevent accidental movement. However, as pointed out in par.58 of this report the locking feature of a number of the hinged handle switch controls requires correction.

96. Par.3-18. It is possible for an operator to adjust the transmitter to a previously calibrated frequency in less than one man minute. Controls "C", "E", and "F" are equipped with adjustable positioning devices; ten devices to each control. The reset accuracy obtainable when using these positioning devices was checked at 500 kilocycles. The average frequency deviation was about 10 cycles.

97. Par.3-19. The equipment is so designed that it is possible to shift from one frequency to another or from one type of emission to another, without readjustment of any of the potentials applied to the transmitter.

98. Par.3-20. A three position "Adjust-Tune-Operate" switch has been provided to facilitate tuning operations. In step one only the master oscillator circuit is energized. Step two applies reduced voltage to the amplifier circuits while in the operate position full potential is applied to all circuits. The Model TAQ-4 is equipped with two plate contactors. One of these contactors operates when the "Tune-Operate" switch is in the "operate" position, while the other contactor is energized when the "Tune-Operate" switch is in the "Tune" position. This latter contactor is so connected that it operates on the second tap of the plate transformer, giving a plate potential of 1575 volts. This voltage is high enough to cause the plate overload relay to trip during tuning operations. When using the plate potential supplied by tap 1 of the plate transformer all tuning operations can be performed without blowing the overload relays. Therefore, it is recommended that the connections be changed so that when operating in

the "Tune" position transformer tap no.1 will be utilized. Table 28 shows the frequency variations due to the operation of the "Adjust-Tune-Operate" switch. These measurements were made at 500 and 355 kilocycles. The largest frequency change noted was 140 cycles at 355 kilocycles.

99. Par.3-21. A suitable test key has been provided on the panel of the transmitter which permits three types of operation; namely, key open, momentary key closed and key locked. The keying circuit is so arranged that when the momentary key is locked the five second drop-out relay is inoperative, thus permitting the transmitter to radiate continuously on CW. When the transmitter is adjusted for MCW emission and the local test key is locked the set will radiate on MCW for five seconds after which the audio oscillator time relay operates and the MCW modulation is removed. The transmitter then continues to radiate on CW. It is believed that this type of operation is not satisfactory. Conditions may arise where it may be desirable or necessary to operate key locked on MCW. It is recommended, therefore, that the circuit be so arranged that the key on the transmitter panel can be locked when operating on MCW and that the transmitter continue to radiate on MCW as long as the key is closed.

100. Par.3-22. The transmitter is so designed that the requirement of "break-in" operation has been complied with. It should be pointed out that when operating at ordinary keying speeds the antenna post of the receiver remains grounded. This is due to the fact that the coil of the relay which short circuits the receiver input terminals is energized through a pair of contacts on a slow acting relay in the transmitter and not directly from the key relay. This slow acting relay fails to respond to every dot and dash and thus the receiver remains grounded until the key is left open for a considerable fraction of a second. It is believed that this type of operation is desirable since it affords maximum protection to the receiver.

101. Par.3-23. The TAQ-4 equipment employs a motor driven fan for the purpose of cooling the antenna variometer circuit. This fan does not cause any interference in a nearby receiver. However, the mounting of this fan is not satisfactory. When the transmitter is subjected to vibration, the fan moves sufficiently to permit its blades to strike against adjacent members. Steps should be taken to overcome this undesirable condition.

102. Par.3-24. This paragraph requires that it must be possible to vary the power output of the transmitter from the maximum value to a minimum value not in excess of 10%. Tables 24 and 29 show the results of tests conducted at 355 and 500 kilocycles. The power is varied by means of a six point switch on the rectifier. It will be noted that the minimum power output obtainable is 16%, whereas the specifications require a reduction to 10%. In order to make the TAQ-4 transmitter comply with this requirement it will be necessary to provide an additional tap on the plate transformer which will produce a voltage lower than is at present obtained with tap no.1. It may be pointed out, however, that a lower value of power output can readily be obtained by uncoupling the transmitter from the antenna. It is possible that this method of obtaining reduced output would be more stable and satisfactory than that obtained by still further reducing the plate potential applied to the power amplifier and intermediate amplifier tubes. It would also obviate the necessity of still further complicating the plate transformer by the addition of three more taps.

103. Par. 3-25. Suitable indicator lamps have been provided on the panel of the transmitter to indicate the following functions:

- (a) Amber light to indicate when bias voltage is applied.
- (b) Red light to indicate when power is applied to the equipment.
- (c) Red light to indicate when plate power is applied.

104. Par. 3-26. The necessary indicating instruments have been supplied with the equipment to meet the requirements of the specifications. Table 6 lists the type and range of meters supplied.

105. Par. 3-27. The Model TAQ-4 is equipped with a filament life meter which registers the number of hours of operation. This meter was checked against time and found to be accurate.

106. Par. 3-28. The Model TAQ-4 transmitter consists of two units bolted together. Each unit of the transmitter is 24-7/8" wide. The transmitter meets the requirements of this paragraph of the specifications as is illustrated in Table 7.

107. Par. 3-31. The transmitter is completely shielded, both externally and internally. Lead sheathed cable is used for connections except in radio frequency circuits and in such places where lead sheath is not suitable. There is one point in the wiring which needs modification. The lead sheathed cable running along the left hand side in the bottom of the rectifier had its sheath damaged. It is necessary to remove the main plate transformer during shipment and replace this transformer when the set is placed into commission. This transformer is very heavy and it must be inserted through the left side of the rectifier. While maneuvering the transformer into place it is very likely that this sheath was damaged and this same form of damage is likely to occur when the rectifier is being installed on board ship. Therefore, it is recommended that this cable be run in a different manner so that it will not be subjected to injury or that the cable be protected by means of a substantial metal cover.

108. Par. 3-32. All meters in the transmitter unit are by-passed by means of 0.01 mfd. capacitors, rated at 1200 volts and marked tested at 2500 volts. Meters in the rectifier unit are not by-passed. The specifications do not definitely require or exempt the meters in the rectifier unit from complying with this requirement. The rectifier meters in other equipment purchased by the Navy have been provided with by-pass units and in the interest of safety, it is recommended that all meters be so protected. In the case of ship installations antenna leads may run very near the rectifier units and under such conditions by-pass units on the rectifier meters may be a necessity.

109. Par. 3-33. The filament transformer in the transmitter unit complies with the requirements of this paragraph.

110. Par. 3-34. The transformers are compact, air-cooled and capable of continuous operation at full operating load without showing signs of excessive heating. The transformer in the transmitter unit is equipped with a suitable terminal panel, properly marked to indicate connections. Certain

of the transformers in the rectifier unit are subject to criticism and these points will be discussed under par.6-63 of the specifications.

111. Par.3-35. No undue filament voltage variations occur when the equipment is keyed and satisfactory operation was secured when the line voltage was varied between the limits of -5% to +5%.

112. Par.3-36. The transmitting equipment is so constructed that:

- (a) It can be installed with its back  $1/2$ " from a bulk-head. (The knurled head screws by means of which the shielding is secured to the frame extend  $1/2$ ".)
- (b) The foundation pedestal may be bolted to the deck for security. However, as pointed out in par.38 of this report it is believed that the foot members, by means of which the transmitter is secured to the deck, should be strengthened by the addition of heavy gusset plates.
- (c) All cable connections can be effected at a terminal board suitably located for access at the bottom and near the front of the equipment. The terminal boards are suitably enclosed to protect personnel and the doors giving access to these spaces are equipped with interlocks. The terminal boards clear the deck by 5 inches.
- (d) The renewal of vacuum tubes and the adjustment of circuits, relays, or auxiliaries can readily be accomplished through access doors in the front panel. Most of the relays in the transmitter are mounted directly on the front panel and hence can be adjusted without opening any of the access doors.
- (e) The keying relay is mounted on the front panel.
- (f) The antenna lead can be connected to the proper terminal through an opening in the top shield.

113. Par.3-37. The shielding is secured by means of knurled head screws which are suitably secured to prevent loss. The shielding is of excellent construction and well fitted so that any shield may be removed and replaced without difficulty. The access doors are secured by means of latches operated by bakelite knobs. The design of these latches is satisfactory, but it is recommended that the large tube access doors on both the transmitter unit and the rectifier unit be secured by means of two knobs each. At the present time these doors are fitted with only one knob, although the smaller doors which give access to the terminal panels are secured by means of two similar knobs and latches. The addition of the extra latch on these large doors will tend to make the fastenings more secure and eliminate any tendency of the doors to open under the influence of vibration or shock.

114. Par. 3-38. No access doors in the sides of the set are required.

115. Par. 3-39. All access doors in the front of the set are of the hinged type and are of ample size to permit convenient replacement of tubes. It is pointed out, however, that the weight of the doors is sufficient to cause them to sag, making closure difficult. This sag also causes a gap between the top of the door and the panel immediately above, thus detracting from the appearance of the equipment. It is recommended that the doors be hung on continuous piano type hinges instead of the two small butt hinges now employed. In addition, the hinges should be of brass instead of steel. The present hinges are steel. It may be pointed out that transmitting equipment being supplied to the Navy on recent contracts has been fitted with access doors of the overlapping type. These doors, instead of fitting flush into the panels overlap the panels by about one inch. This form of construction presents a pleasing appearance if properly executed and prevents gaps from appearing around the doors.

116. Par. 3-40. The transmitter and rectifier units are equipped with vertical, insulated hand rails, 14" long.

117. Par. 3-41. The equipment is provided with the necessary relays to prevent the application of plate voltage before the filaments have reached proper operating condition.

118. Par. 3-42. The transmitter was subjected to the shock test outlined in this paragraph of the specifications. Table 30 lists the results of tests conducted at 355 and 500 kilocycles. It will be noted that the maximum frequency deviation noted was 8 cycles at 500 kilocycles. The transmitter complies with the requirements of this test. The rectifier was also subjected to the shock test without any ill effects being apparent.

119. Par. 3-43. An antenna blocking condenser is provided to eliminate the possibility of high potential d.c. reaching the antenna circuit. This capacitor is rated at 5,000 volts and 0.01 mfd.

120. Section V. Transmitter Control. The transmitter control circuit provided in the Model TAQ-4 transmitter operates in a manner different from previous circuits of this nature. With the advent of rectifier power supply operated transmitters the control circuits were necessarily modified. In equipment supplied to date it has been the practice to permit the control rectifier which furnished the 110 volts d.c. for relay operation to operate continuously since no means were provided to start this rectifier from the remote control position. The Model TAQ-4 equipment is provided with a circuit which enables the entire equipment to be started and shut down, either locally or from the remote control station. This is accomplished by utilizing the standard four wire control circuit to carry both a.c. and d.c.

121. The original form of the control circuit incorporated in the preliminary Model TAQ-4 equipment possessed certain features which were not deemed desirable. These are listed below:

- (a) The equipment could be started when the local start stop switch is open; local remote switch in local position; remote start stop switch closed and both local and remote keys closed. With the above condition if the local key were opened the key relay was subjected to 60 cycles.
- (b) The remote indicator lamp lights whenever the local indicator lamp is lighted. Thus the remote indicator lights when only filament energy is applied to the equipment. The desirable condition is that the remote indicator burns only when the remote operator has full control of the equipment and will not burn under any other condition.
- (c) The action of the "start-operate" switch on the rectifier panel does not provide the type of operation desired. In the operate position it is possible to start the rectifier by means of the local or remote **start** switches in the normal manner. In the start position the filaments of the rectifier are lighted but no high voltage is available either in the rectifier or transmitter. The operation desired is that which is accomplished by a high voltage disconnect switch so that the rectifier may be operated in a normal manner but no high voltage is impressed upon the transmitter.
- (d) In the present condition the remote key operates the key relay regardless of the position of the "local-remote" switch, if the remote start switch is closed. The remote key should key the transmitter only when the remote-local switch is in the remote position.
- (e) At the present time it is possible to start the transmitter from the remote station regardless of the position of the local start stop switch. The circuit arrangement should be such that the local start stop switch must be closed in order to start the transmitter from either local or remote position.
- (f) No filament stand-by switch is provided, nor is such a switch **required** by the specifications. A stand-by switch should be provided.

122. These matters were discussed with a representative of the manufacturer and the type of operation desired was outlined. After consideration had been given to this matter the General Electric Company submitted sketches of a revised circuit. This circuit was carefully studied and certain undesirable features noted. Certain modifications **were** suggested by the Naval Research Laboratory and a revised **schematic** diagram embodying the various features considered necessary and desirable was submitted to the Bureau of Engineering in ref.(f), Naval Research Laboratory letter 367/52 of 1 February 1935. In order to obtain the necessary method of

operation, it is recommended that the operation outlined in ref. (f) be called for. It is pointed out that there are several ways of obtaining the same final results and it is not deemed desirable to limit a manufacturer to the exact method outlined in Drawing RA 43AA 214A, but the circuit adopted should be capable of giving the same performance.

123. Par. 5-6. The keying relay is mounted on the front panel of the transmitter and provision has been made on the transmitter terminal board for the connection of all monitor and remote control lines. In this connection it is pointed out that a large majority of the transmitters furnished to the Navy on other contracts have the four remote control lines numbered in accordance with the markings shown in Drawing RE 43AA 216E which forms a part of the governing specifications. Thus the control lines always bear the same numbers, 1 to 4 inclusive. In the interests of convenience and standardization it is believed that this same method of numbering the control lines should be employed in all transmitters. This plan is not followed in the Model TAQ-4 transmitter and it is recommended that the Bureau of Engineering request the General Electric Company to adopt this method in all transmitters where the provisions of the remote control system apply. The key relay in the Model TAQ-4 performs the following functions:

- (a) Controls the emission of the transmitter for telegraphic signalling.
- (b) Transfers the antenna circuit from the transmitter to a receiver when the key is open and restores it to normal for transmission when the key is closed.
- (c) Grounds the antenna terminal of the receiver (by means of an auxiliary relay) while the set is being keyed and ungrounds the receiver terminal when keying ceases. This function is accomplished through the medium of a slow acting relay associated with the key relay. (See par. 100 of this report.)

124. Par. 5-7. The keying control circuit is so arranged that the keying relay is not energized until the rectifier has been brought up to the operating condition.

125. Par. 5-8. The keying relay operates satisfactorily at speeds up to 100 words per minute. See Plates 1 and 2. The keying relay operates satisfactorily at 115 volts d.c. and draws a current of 220 milliamperes.

126. Par. 5-9 and 5-10. See pars. 120, 121, and 122 of this report.

127. Par. 5-11. The a.c. control circuits operate at 110 volts 325 milliamperes.

128. Par. 5-24. The requirements of this paragraph are complied with in the construction of the TAQ-4 equipment.

129. 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 is shut down. In this connection it is believed that the name plates which identify the emergency switches should be colored red. This method of coloring in order to provide more distinctive markings for the emergency switches is employed in other transmitting equipment and it is recommended that the TAQ-4 equipment be modified to conform with this requirement.

130. Par. 6-3. The equipment operates satisfactorily when the supply line voltage is varied between the limits of -5% and +5% of normal. No means were available for varying the frequency of the supply voltage, but it is believed that this equipment will operate satisfactorily on a supply where the frequency is subject to a  $\pm 2\%$  change.

131. Par. 6-4. The power equipment operated satisfactorily under full power, key locked transmitter load for periods ranging between one hour and seven hours continuous operation.

132. Par. 6-5. Reference to Table 29 shows that it is possible to operate the TAQ-4 equipment at full power and draw only 7100 watts from the supply lines. When operating on tap 6 where the power output was 113% of normal the equipment consumed 7800 watts. Specifications require that the equipment shall not draw more than 9250 watts from the supply line at full power output.

133. Par. 6-38. The equipment is so designed that if proper motor generator equipment were substituted for the rectifier supply, operation could be secured. Some modification of the control circuits would be necessary.

134. Par. 6-40. All rectifier tubes used in the equipment are of the hot cathode mercury vapor type.

135. Par. 6-41. The dimensions of the rectifier unit comply with the requirements of the specifications. See Table 7.

136. Par. 6-42. The rectifier for main plate supply is of the three phase full wave type designed for operation from 440 volts and employs six type 38172A tubes. This rectifier operated satisfactorily as far as power output is concerned but certain features of the design are not considered entirely satisfactory. At least 50% of the time that this rectifier has plate voltage applied to it, the a.c. overload relays in the primary circuit trip open. The overload relays are set for sufficiently high current values to remain closed under full load operation and hence it would be undesirable to increase the current setting of these relays. Apparently the surges occurring when the plate contactors close cause these relays to trip. The relays are of the self-resetting type and actual operation is not interfered with. However, the fact that these overload relays are caused to trip so frequently appears to indicate the existence of an unsatisfactory condition. No starting or surge resistors are employed in this rectifier. Other equipment supplied to the Navy has been equipped with starting resistors which apparently prevented these surges from rising to sufficient heights to cause the overload relays to trip.

In addition, the construction of the main plate transformer does not reflect the best workmanship. The transformer is not equipped with a terminal panel for securing all of the connections which are required. The leads from the transformer are left sufficiently long to reach the necessary points of connection and in some instances this results in semi-flexible leads between two and three feet in length. Due to the fact that this transformer must be removed during shipment, it is felt that some of these leads may be broken or injured and it is believed that a suitable terminal panel mounted directly on the transformer would obviate this difficulty. One high voltage lead to the transformer was found broken on receipt. The metal conductor was unbroken but the insulating covering had been cracked and had to be repaired. These high voltage connections are provided with terminals on the transformer but the leads are brought up alongside the transformer in such a manner that they are subject to breakage. It is recommended that the manufacturer be required to correct this condition in order to provide greater safety.

137. Par.6-43. The design of the main plate rectifier is such that approximately one-half of the output voltage is available for auxiliary use. Plate power for the intermediate amplifier is obtained from the main plate rectifier while plate voltage for the master oscillator circuit is obtained from an auxiliary transformer employing two type 38166A rectifier tubes. This rectifier operated satisfactorily during the majority of the tests conducted but during that period when the keying characteristics of the transmitter were being investigated, the plate transformer developed a short circuited secondary which placed it out of commission. The exact cause of this failure could not be determined without destroying the transformer. The manufacturer should be required to give assurance that the transformers he supplies are capable of continuous and satisfactory operation.

138. Par.6-44. The bias rectifier is of the single phase full wave type, suitable for the purpose intended and uses two Type 38166A tubes. In connection with the bias supply, attention is invited to par.151 of this report.

139. Par.6-45. Table 31 covers tests conducted to determine the efficiency of conversion of the main plate rectifier. It will be noted that the efficiency of conversion is high, being in excess of 91%, whereas the specifications require that the efficiency of conversion shall not be less than 80%.

140. Par.6-46. Table 32 illustrates the results of tests conducted to determine the voltage regulation of the various rectifiers included in the TAQ-4 rectifier unit. It will be noted that in all cases the percentage of regulation is within the requirements of the specifications.

141. Par.6-47. Table 33 shows the detailed results of tests conducted to determine the percentage of voltage ripple present in the output of the various rectifiers. The actual ripple voltage present is less than the value permitted by the governing specifications.

142. Par.6-48. A suitable time delay relay has been incorporated in the rectifier to permit the tubes to attain proper operating temperature before the application of plate potential.

143. Par.6-49. A relay has been provided which gives both under voltage and over voltage protection. When the line voltage exceeds the safe limits of operation the plate contactor opens and an alarm bell rings. It was found that this relay operated on an over voltage of 460 volts and on an under voltage of 392 volts.

144. Par.6-50. A six point tap switch has been provided on the panel of the rectifier to meet the requirements of this paragraph. By means of this tap switch it is possible to vary the plate voltage applied to the intermediate and power amplifier tubes between the limits of 50% to 104%. See Tables 24 and 29.

145. Par.6-52. All tubes used in the rectifier unit are accessible from the front of the equipment through an access door of adequate size.

146. Par.6-53. Indicating meters have been provided on the panel of the rectifier unit in accordance with the requirements of this paragraph. See Table 6. However, as pointed out in par.54 of this report, steps should be taken to prevent the dial cards of the meters from becoming loose under the influence of vibration.

147. Par.6-54. A source of 115 volts d.c. is required for the operation of the key relay and associated relays. This potential is developed by means of a single phase, full wave rectifier employing one 16X897 full wave tungar rectifier tube.

148. Par.6-55. The total power required from the supply main for operation of the transmitter and all auxiliaries is less than that permitted by the governing specifications.

149. Par.6-56. A suitable main switch, controlled from the front panel of the rectifier unit, is provided for removing power from the equipment. Provision has also been made to remove power from the rectifier unit by means of an emergency switch.

150. Par.6-58. Two instantaneous opening, self-reclosing, alternating current overload relays, with indicating targets have been provided in the primary of the main rectifier plate transformer. A time delay opening, instantaneous reclosing direct current overload relay has been provided in the direct current output circuit of the rectifier. The studs, by means of which the a.c. overload relay connections are made, have been left excessively long. The studs are three inches in length; a 3/4" length would be sufficient. In connection with the overload relay circuits, attention is invited to pars. 46 and 136 of this report.

151. Par.6-59. Two Calrod heater units have been provided in the rectifier unit. These heaters are so arranged that a coil surrounds the base of each tube, and their purpose is to hold the temperature around the base of the tubes above 15° Centigrade. As pointed out in par.82 of this report, the rectifier tubes ceased to operate when the ambient temperature surrounding the equipment reached 3.5° Centigrade. At this temperature the tube compartment temperature was 17° Centigrade. Due to this failure of the rectifier tubes it was impossible to conduct tests at an ambient

temperature of zero Centigrade. The manufacturer should be required to increase the heating capacity of the heaters provided or provision should be made to enclose the bases of the rectifier tubes in a compartment wherein the temperature will be maintained at a high enough level to permit satisfactory operation when the ambient temperature is zero. When the bias rectifier fails, due to low temperatures or for any other reason, the plate supply is still impressed upon the transmitter tubes. This causes the tubes to draw excessive current. An interlocking relay should be provided so that if the bias voltage fails the plate potential will automatically be removed and that in the absence of bias voltage it will be impossible to start the main plate rectifier.

152. Par.6-60. The rectifier unit is so designed that it may be installed adjacent to the transmitter or as a separate unit.

153. Par.6-61. The rectifier unit is provided with a switch which is designated as a "start-operate" switch. This switch must be in the "operate" position in order to start the equipment from the transmitter panel. When the switch is in the start position only the filament circuits are energized and no high voltages are developed. As pointed out in par.121 (c) of this report, the action desired is that provided by a high voltage disconnect switch. A complete discussion of the control circuits will be found in pars. 120, 121, and 122 of this report. An emergency switch has been provided by means of which the complete rectifier equipment may be shut down and after such an emergency shut down the equipment cannot be started from any point other than the one from which it was shut down.

154. Par.6-62. The various switches and controls are suitably marked to identify each control for convenient operation under normal operating conditions. It is recommended that the emergency switches be provided with a red nameplate as described in par.129 of this report.

155. Par.6-63. The transformers supplied with this equipment comply with the requirements set forth in this paragraph.

156. Par.6-64. The requirements of Section III regarding details of construction with reference to shielding, method of securing shielding and access doors have been carried out in the construction of the rectifier unit.

157. Par.6-65. Suitable vertical hand rails have been furnished on the rectifier unit, corresponding in construction with those furnished on the transmitter unit.

158. Section VII. The governing contract does not require spare parts to be submitted with the preliminary model of the TAQ-4 equipment.

159. Section VIII. The descriptive specifications submitted by the manufacturer are complete and the equipment supplied agrees with the descriptive specifications in major details. The guaranteed power outputs have been complied with and the tubes are operated within the limits specified.

160. Section IX. The preliminary instruction books submitted with the preliminary model were complete and adequate for placing the transmitter into operation.

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

162. In addition to the tests called for specifically in ref.(b) certain additional tests were conducted. Each phase of the supply was grounded in rotation. No effect could be noted from these grounds, the transmitter and rectifier equipment continued to operate normally and the quality of the emitted note was not impaired.

163. Tests were conducted to determine whether the operation of the rectifier caused interference in nearby receivers. A Model RAA receiver was used for this test. With the receiver in close proximity to the rectifier, very noticeable interference is caused up to about 70 kilocycles, at which point it fades out rapidly. Grounding of the phases caused no difference in the intensity of the interference caused by the rectifier. A coupling lead run close to the tubes caused a very decided increase in the noise level in the receiver but considerable interference could be noted when the RAA receiver was connected to an outdoor antenna. Application of filament potential to the tubes in the rectifier and transmitter caused a slight increase in the noise level. When the plate potentials were applied to the rectifier tubes a very decided increase in the noise level was noted.

164. A summary of the defects noted and such items as do not comply with the requirements of ref.(b), together with suggested changes or modifications, are listed below.

(Note: The numerals enclosed in parentheses refer to the paragraphs of this report under which these items are discussed in detail.)

(a) (34) The floor of the packing case containing the transmitter was broken during transit.

(b) (38) The strength of the footing members of the transmitter and rectifier should be increased.

(c) (40, 82, 151) Mercury vapor rectifier tubes fail to function in low ambient temperatures.

(d) (42) Steel parts are employed where other metals would be more suitable.

(e) (45) The current carrying capacity of the contacts of the starting contactor should be increased; the location of the fuse in the mid tap of the main plate transformer should be changed.

(f) (47) The installation of the door interlocks should be improved.

(g) (48, 101) The mounting of the ventilating fan is unsatisfactory under vibration.

(h) (54) Meters in rectifier failed due to vibration; power amplifier universal coupling joint became inoperative.

(i) (58) The hinged handles of certain controls do not lock securely.

(j) (68) The component parts of the transmitter and rectifier units are not identified by means of symbol markings.

(k) (71) Means should be provided to prevent lifting devices from rattling under influence of vibration; nameplates should be provided to indicate location of lifting devices.

(l) (85, 102) Output power reduction to 10% is not obtained.

(m) (98) The tune-operate switch should connect to plate transformer tap no. 1 in tune position.

(n) (99) Provision should be made to enable key locked operation on MCW to be obtained.

(o) (107) Lead sheath on cable in rectifier damages; means should be provided to prevent this.

(p) (108) Meters in rectifier unit are not provided with by-pass units.

(q) (113) Large doors on transmitter and rectifier should be equipped with two securing latches.

(r) (115) Large doors on transmitter sag; stronger hinges should be provided.

(s) (121,122) Control circuits contain undesirable features.

(t) (129,154) Emergency switches should be marked more distinctively.

(u) (136) A.C. overload relays trip when starting main plate rectifier; terminal panel on transformer does not accommodate all leads; high voltage lead on main plate transformer was damaged.

(v) (137) Auxiliary plate transformer failed due to short circuited secondary.

(w) (150) Connection studs on a.c. overload relays are too long.

(x) (151) A grid protective relay should be provided.

(y) (153) No means is provided for removing high voltage from transmitter and confining the high voltage to the rectifier unit.

(z) (163) Rectifier produces interference in nearby receivers.

Table 2

## MODEL TAQ-4 TRANSMITTER (PRELIMINARY MODEL)

2 hour key locked run at full power

Test per par. 2-15 and 10-3-8 of Specifications RE 13A 351H

Antenna: 1.65 ohms, 2000 uuf capacity

<u>Time</u>	<u>Frequency Kilocycles</u>	<u>Antenna Current</u>	<u>Ambient Temp.</u>	<u>Plate Volts</u>	<u>Plate Current</u>	<u>Line Volts</u>
1125	355.828	34.5	25.4	2350	2050	440
1135	811	34.7	25.8	2360	2100	442
1145	803	34.6	26.5	2360	2100	442
1155	797	34.7	27.0	2360	2100	442
1205	810	35.2	27.2	2375	2150	444
1215	790	35.2	27.5	2375	2150	444
1225	785	35.0	28.0	2375	2100	446
1235	783	34.6	28.0	2350	2100	442
1245	781	34.8	28.5	2350	2100	442
1255	778	34.8	28.6	2350	2100	442
1305	779	34.5	29.0	2350	2100	442
1315	776	34.8	29.0	2360	2100	444
1325	772	35.0	29.2	2360	2100	440

Maximum frequency change: 56 cycles

Table 4

MODEL TAQ-4 TRANSMITTER (PRELIMINARY MODEL)

2 hour key locked run at full power

Test as per par.2-15 and 10-3-8 of Specifications RE 13A 351H

Antenna: 1.65 ohms, 2000 uuf capacity

<u>Time</u>	<u>Frequency Kilocycles</u>	<u>Antenna Current</u>	<u>Ambient Temp.</u>	<u>Plate Volts</u>	<u>Plate Current</u>	<u>Line Volts</u>
1410	500.750	34.0	30.4	2350	2000	440
1420	696	33.8	30.8	2325	2000	440
1430	658	33.7	31.2	2325	2000	440
1440	625	34.0	31.6	2325	2000	438
1450	619	34.0	31.2	2350	2000	440
1500	611	33.8	31.6	2325	2000	438
1510	595	34.0	31.6	2325	2000	436
1520	590	33.7	31.6	2300	2000	432
1530	590	33.9	31.7	2325	2000	436
1540	585	33.8	31.9	2325	2000	434
1550	589	33.9	31.6	2325	2000	436
1600	585	34.5	31.9	2350	2050	442
1610	581	34.4	32.0	2350	2000	442

Maximum frequency change: 169 cycles

Table 5

## MODEL TAQ-4 TRANSMITTER (PRELIMINARY MODEL)

Antenna Short-Circuited and Open-Circuited

Test as per par.2-16 of Specifications RE 13A 351H

<u>Frequency</u>	<u>Antenna</u>	<u>Plate Volts</u>	<u>P.A. I<sub>p</sub></u>	<u>Ant. Cur.</u>
500 kcs	Normal	2340	2120	31.2
500	Shorted	2380	1500	14.0
500	Open	2360	1650	14.0
355 kcs	Normal	2350	2100	31.0
355	Shorted	2400	590	-
355	Open	2400	700	-
175 kcs	Normal	2360	2180	39.0
175	Shorted	2420	700	-
175	Open	2420	750	-

Table 6

MODEL TAQ-4 TRANSMITTER (PRELIMINARY MODEL)

Meters supplied with Equipment

Test as per pars.2-25 and 3-26 of Specifications RE 13A 351H

TRANSMITTER

- 1 - M.O. Plate Ammeter; 0-200 m.a., d.c., Type CG-22063
- 1 - I.P.A. Plate Ammeter; 0-500 m.a., d.c., Type CG-22067
- 1 - P.A. Plate Ammeter; 0-4 amperes, d.c., Type CG-22007
- 1 - Antenna Ammeter; 0-50 amperes, r.f., with external thermocouple, Type CG-22041
- 1 - Filament Voltmeter; 0-15 volts, a.c., Type CG-22080
- 1 - Bias Voltmeter; 0-500 volts, d.c., with external resistor, (1 unit) 500,000 ohms; 1,000 ohms per volt; Type CG-22100
- 1 - Audic Oscillator Plate Ammeter; 0-200 m.a., d.c., Type CG-22063
- 1 - Plate Voltmeter; 0-3 kv, d.c., with 3 unit external resistor, 3,000,000 ohms total, 1,000 ohms per volt, Type CG-22108.

RECTIFIER

- 1 - Main Plate Ammeter, 0-4 amperes, d.c., Type CG-22007
- 1 - Filament Voltmeter; 0-150 volts, a.c., Type CG-22084
- 1 - Main Plate Voltmeter; 0-3 kv, d.c., with 3-unit external resistor, 3,000,000 ohms total, 1,000 ohms per volt, Type CG-22108.
- 1 - Auxiliary Plate Voltmeter; 0-3 kv, d.c., with 3-unit external resistor, 3,000,000 ohms total, 1,000 ohms per volt, Type CG-22108.
- 1 - Bias Voltmeter; 0-500 volts, d.c., with external resistor, (1 unit) 500,000 ohms; 1,000 ohms per volt; Type CG-22100.

Table 7

## MODEL TAQ-4 TRANSMITTER (PRELIMINARY MODEL)

## List of Dimensions

Data as per par.2-32, 2-33, 3-28 and 6-41 of Specifications RE 13A 351H

<u>TRANSMITTER</u>	<u>Specification Requirements</u>	<u>Actual Dimensions of Frame</u>	<u>Actual Overall Dimensions</u>
Height	72"	72"	72"
Width	50"	49"	49-3/4"
Depth	36"	31-3/8"	36"
Weight:	See note below.		915 lbs.
<u>RECTIFIER</u>			
Height	72"	72"	72"
Width	24"	23"	23-3/4"
Depth	37"	31-3/8"	36"
Weight	See note below.		980 lbs.

The width of each unit of the transmitter, which consists of two units bolted together, is 24-7/8".

NOTE: The specifications require that the total weight of the equipment shall not exceed 2600 pounds; the combined weight of the Transmitter and Rectifier units is 1895 pounds.

Table 8

## MODEL TAQ-4 TRANSMITTER (PRELIMINARY MODEL)

## Determination of Power Output

Test per par.3-2 and 3-3 of Specifications RE 13A 351H

Column No.	1	2	3	4	5
Control or <u>Meter</u>	175 <u>kcs</u>	175 <u>kcs</u>	175 <u>kcs</u>	175 <u>kcs</u>	175 <u>kcs</u>
A	1	1	1	1	1
B	295	295	295	295	295
C	119	110	110	112	111
D	1	1	1	1	1
E	75	32	100	110	35
F	47	44	94	113	50
G	4	4	3	2	4
H	1	1	1	5	7
Sig Switch	CW	CW	CW	CW	CW
MO I	92	94	90	94	95
IPA P I <sub>p</sub>	190	185	190	188	192
PA I <sub>g</sub>	280	270	280	280	280
Act PA I <sub>p</sub>	2000	2000	2000	2000	2000
E line	440	439	440	440	442
E fil	11	11	11	11	11
E plate	2300	2290	2325	2300	2310
E bias	253	251	260	258	256
E aux	1490	1480	1500	1500	1490
Ant Cap	1000	1000	1000	1300	1600
Ant Res	7.15	4.95	3.03	1.04	6.6
Ant I int	23	26	30.8	41	24.9
Ant I ext	18.8	21.2	25.2	35.0	20.1
Ant Power	2522	2226	1924	1276	2668
Guar Power	2300	2170	1760	1000	2550

Table 10

## MODEL TAQ-4 TRANSMITTER (PRELIMINARY MODEL)

## Determination of Power Output

Test as per par.3-2 and 3-3 of Specifications RE 13A 351H

Column No.	1	2	3	4	5
Control or <u>Meter</u>	215 <u>kcs</u>	215 <u>kcs</u>	215 <u>kcs</u>	215 <u>kcs</u>	215 <u>kcs</u>
A	2	2	2	2	2
B	558	558	558	558	558
C	150	153	153	155	153
D	2	2	2	2	2
E	178	139	143	167	156
F	127	167	165	67	67
G	4	3	3	2	2
H	6	6	6	10	10
Sig Switch	CW	CW	CW	CW	CW
MO I <sub>p</sub>	95	92	95	95	95
IPA I <sub>p</sub>	190	200	195	197	195
PA I <sub>g</sub>	270	280	280	260	280
Act PA I <sub>p</sub>	2000	2000	2000	2000	2000
E line	438	444	444	436	440
E fil	11	11	11	11	11
E plate	2300	2350	2330	2270	2320
E bias	255	260	255	254	255
E aux	1480	1500	1490	1480	1490
Ant Cap	1000	1000	1000	1600	1600
Ant Res	8.7	3.03	2.04	1.03	0.65
Ant I int	22.9	32.2	36.0	44.2	49.0
Ant I ext	17.3	26.3	29.3	37.4	42.0
Ant Power	2600	2100	1753	1440	1147
Guar Power	2460	1920	1620	1380	1100

Table 11

## MODEL TAQ-4 TRANSMITTER (PRELIMINARY MODEL)

## Determination of Power Output

Test as per par.3-2 and 3-3 of Specifications RE 13A 351H

Column No.	1	2	3	4	5
Control or <u>Meter</u>	<u>355</u> <u>kcs</u>	<u>355</u> <u>kcs</u>	<u>355</u> <u>kcs</u>	<u>355</u> <u>kcs</u>	<u>355</u> <u>kcs</u>
A	4	4	4	4	4
B	552	552	552	552	552
C	149	147	143	143	143
D	5	4	5	5	5
E	114	210	95	72	75
F	147	150	158	159	100
G	3	3	2	2	2
H	12	12	12	12	13
Sig Switch	CW	CW	CW	CW	CW
MO I <sub>p</sub>	99	99	100	100	100
IPA I <sub>p</sub>	200	191	210	208	197
PA I <sub>g</sub>	240	250	210	218	260
Act PA I <sub>p</sub>	2000	2000	2000	2000	2000
E line	440	440	443	436	444
E fil	11	11	11	11	11
E plate	2300	2300	2300	2290	2330
E bias	250	260	253	255	260
E aux	1475	1490	1495	1500	1500
Ant Cap	1300	1300	1300	1300	1660
Ant Res	7.15	4.12	2.03	0.79	1.03
Ant I int	26.0	31.0	38.5	48.0	46.8
Ant I ext	19.2	24.3	30.8	39.8	39.6
Ant Power	2640	2432	1927	1253	1615
Guar Power	2500	2180	1650	1030	1570

Table 12

## MODEL TAQ-4 TRANSMITTER (PRELIMINARY MODEL)

## Determination of Power Output

Test as per par.3-2 and 3-3 of Specifications RE 13A 351H

Column No.	1	2	3	4	5
Control or Meter	355 kcs	565 kcs	565 kcs	565 kcs	565 kcs
A	4	6	6	6	6
B	552	505	505	505	505
C	146	144	145	144	145
D	5	6	6	6	6
E	73	111	120	107	109
F	125	99	110	93	111
G	2	4	2	4	2
H	13	14	14	15	15
Sig Switch	CW	CW	CW	CW	CW
MO $I_p$	100	120	120	110	110
IPA $I_p$	199	199	200	204	200
PA $I_g$	240	200	210	200	200
Act PA $I_p$	2000	2000	1740 *	2000	2000
E line	444	440	444	446	444
E fil	11	11	11	11	11
E plate	2320	2300	2330	2340	2325
E bias	259	250	255	258	252
E aux	1500	1490	1500	1500	1490
Ant cap	2000	1300	1300	2300	2500
Ant res	0.82	8.1	0.53	8.1	1.35
Ant I int	50	25	49.5	24	44.5
Ant I ext	43	18.2	40.0	18.0	36.2
Ant power	1518	2680	848	2624	1768
Guar power	1450	2410	800	2580	1650

\* denotes maximum plate current that could be drawn and yet keep antenna ammeter on scale. Set was capable of generating more power than 848 watts.

Table 13

## MODEL TAQ-4 TRANSMITTER (PRELIMINARY MODEL)

## MCW Operation

Tests as per par.3-5 of Specifications RE 13A 351H

	<u>175</u> <u>kcs</u>	<u>215</u> <u>kcs</u>	<u>355</u> <u>kcs</u>	<u>565</u> <u>kcs</u>
MCW Power	1505 W	1684 W	1653 W	1588 W
CW Power	2522 W	2600 W	2640 W	2680 W
% MCW to CW	59.6%	64.8%	62.6%	59.2%
% Mod.Pos. Peaks	-	15	42	42
% Mod. Neg. Peaks	100	100	100	100

Frequency of Modulation - 800 cycles

Specifications require that the **signal** be modulated not less than 70%; that the power output be reduced to not less than 50% and that the frequency of modulation be 800 cycles  $\pm$  5%.

Table 14

## MODEL TAQ-4 TRANSMITTER (PRELIMINARY MODEL)

## List of Controls for operation of TAQ-4 Equipment

Data as per pars. 3-6 and 3-13 of Specifications RE 13A 351H

<u>Control Designation</u>	<u>Purpose</u>
(TRANSMITTER)	
A	M.O. and I.P.A. Band Change Switch, 6 positions, provided with key circuit interlock.
B	M.O. Variometer
C	I.P.A. Variometer
D	P.A. Band Change Switch, 6 positions, provided with key circuit interlock.
E	P.A. Variometer
F	Antenna Variometer
G	Antenna Coupling Switch, 4 positions, provided with key circuit interlock.
H	Antenna Band Change Switch, 15 positions provided with key circuit interlock.
	Signal Switch, CW - Tone; 2 positions, provided with key circuit interlock.
	Adjust-Tune-Operate Switch; 3 positions, provided with key circuit and plate voltage interlocks.
	Filament Rheostat
	Remote-Local Switch
	Start-Stop Switch
	Emergency Switch
	Filament Hour Meter
	Tube Protective Relay
	Keying Relay
	Audio Oscillator Standby Relay
(RECTIFIER)	
	Line Switch
	Start-Operate Switch
	Emergency Switch
	Plate Transformer Tap Switch, 6 positions, interlocked for plate voltage.
	Filament Rheostat
	D.C. Plate Overload Relay
	A.C. Overload Relays (Two)
	Under-Over Voltage Relay

Table 15

## MODEL TAQ-4 TRANSMITTER (PRELIMINARY MODEL)

## Reset Accuracy

Test as per par. 3-9-2 of Specifications RE 13A 351H

<u>Trial No.</u>	<u>Frequency kilocycles</u>	<u>Time Seconds</u>	<u>Deviation in cycles</u>	<u>Frequency Percent</u>
Orig.	355.806			
1	355.899	50	+93	0.026
2	355.805	40	- 1	-
3	355.825	50	+19	0.005
4	355.845	45	+39	0.011
5	355.875	35	+69	0.019
		Average	44 cycles	0.0124%
Orig.	500.638			
1	500.726	45	+92	0.018
2	500.702	40	+64	0.013
3	500.765	40	+127	0.025
4	500.600	45	-38	0.008
5	500.640	35	+ 2	-
		Average	64 cycles	0.0128%

Table 16

MODEL TAQ-4 TRANSMITTER (PRELIMINARY MODEL)

Test for lost motion and back lash.

<u>Frequency when approaching setting from clockwise direction.</u>	<u>Frequency when approaching setting from counter clock- wise direction.</u>	<u>Cycles Back Lash</u>
500.658	500.797	139
500.803	500.852	49
500.735	500.822	87
500.763	500.810	47
500.740	500.849	109
	Average: 86 cycles	
355.636	355.870	234
355.626	355.768	142
355.642	355.699	57
355.676	355.783	107
355.684	355.807	123
	Average: 133 cycles	

Table 17

## MODEL TAQ-4 TRANSMITTER (PRELIMINARY MODEL)

## Effect of Change in Ambient Temperature

Test as per par.3-9-3 of Specifications RE 13A 351H

355 Kilocycles

<u>Time</u>	<u>Ambient °C</u>	<u>Rectifier tube comp °C</u>	<u>Actual Frequency</u>	<u>Power amplifier plate Voltage</u>	<u>Power amplifier plate current mils</u>	<u>Line Volts</u>
0820	25.0	42.5	355.952	2250	2000	418
30	24.5	39.0	925	2250	2000	418
40	25.5	37.5	905	2250	2000	422
50	25.0	36.0	885	2250	2000	422
0900	25.5	38.0	875	2250	2000	420
10	25.0	36.0	865	2250	2000	418
20	25.0	36.5	860	2250	2000	414
30	25.0	33.5	855	2250	2000	418
0940	30.0	40.0	355.845	2200	2000	416
50	30.0	41.0	835	2200	2000	416
1000	30.0	41.5	825	2200	2000	416
10	30.0	42.0	820	2200	2000	414
20	30.0	42.5	815	2200	2000	414
30	30.0	43.5	812	2225	2000	416
40	30.0	43.0	805	2225	2000	415
50	30.0	44.0	805	2200	2000	415
1100	35.0	47.5	355.795	2200	2000	414
10	35.5	47.0	785	2225	2000	415
20	35.0	49.0	780	2200	2000	415
30	35.0	50.0	780	2200	2000	414
40	35.0	49.5	775	2200	2000	414
50	35.0	49.0	770	2225	2000	415
1200	35.0	49.5	765	2200	2000	415
10	35.0	50.0	760	2250	2000	417
1220	40.0	53.0	355.755	2250	2000	418
30	40.0	53.5	750	2250	2000	418
40	40.0	54.0	750	2200	2000	416
50	40.0	54.5	748	2200	2000	416
1300	40.0	54.5	750	2200	2000	416
10	40.0	55.0	750	2200	2000	414
20	40.0	54.5	750	2200	2000	414
30	40.0	54.5	750	2200	2000	412

Table 17 (cont'd)

<u>Time</u>	<u>Ambient °C</u>	<u>Rectifier tube comp. °C</u>	<u>Actual Frequency</u>	<u>Power amplifier plate Voltage</u>	<u>Power amplifier plate current mils</u>	<u>Line Volts</u>
1340	44.5	56.0	355.748	2200	2000	414
50	45.0	56.5	748	2200	2000	415
1400	45.0	60.0	735	2200	2000	414
10	45.0	60.0	725	2200	2000	416
20	45.0	60.0	717	2200	2000	416
30	45.0	60.0	714	2200	2000	416
40	45.0	60.0	710	2225	2000	416
50	45.0	57.0	705	2200	2000	415
1500	50.0	65.0	500.795	2200	2000	415
10	50.0	65.0	690	2200	2000	415
20	50.0	61.5	682	2200	2000	413
30	50.0	61.5	672	2200	2000	416
40	50.0	62.5	670	2200	2000	416
50	50.0	60.5	670	2200	2000	416
1600	50.0	60.0	664	2200	2000	416
10	50.0	61.5	662	2250	2000	415

Difference between readings taken at 0930 and 1050

Ambient temperature - 5.0°C

Difference in frequency = -50 cycles

Difference in frequency per degree Centigrade = -10 cycles, .0028%

Difference between readings taken at 1050 and 1210

Ambient temperature - 5.0°C

Difference in frequency = -45 cycles

Difference in frequency per degree Centigrade = -9 cycles, .0025%

Difference between readings taken at 1210 and 1330

Ambient temperature - 5.0°C

Difference in frequency = -10 cycles

Difference in frequency per degree Centigrade = -2 cycles, .00056%

Difference between readings taken at 1330 and 1450

Ambient temperature - 5.0°C

Difference in frequency = -45 cycles

Difference in frequency per degree Centigrade = -9 cycles, .0025%

Difference between readings taken at 1450 and 1610

Ambient temperature - 5.0°C

Difference in frequency = -43 cycles

Difference in frequency per degree Centigrade = -8.6 cycles, .0024%

Table 18

## MODEL TAQ-4 TRANSMITTER (PRELIMINARY MODEL)

## Effect of Change in Ambient Temperature

Test as per par. 3-9-3 of Specifications RE 13A 351H

355 kilocycles

<u>Time</u>	<u>Ambient °C</u>	<u>Rectifier tube comp. °C</u>	<u>Actual Frequency</u>	<u>Power amplifier plate Voltage</u>	<u>Power amplifier plate current mils</u>	<u>Line Volts</u>
0830	20.0	36.5	355.432	2250	2000	416
40	20.0	41.0	420	2250	2000	414
50	19.5	41.5	410	2250	2000	420
0900	20.0	42.5	400	2250	2000	420
10	20.0	42.5	392	2250	2000	417
20	20.0	37.0	386	2250	2000	417
30	20.5	33.0	374	2250	2000	418
40	20.0	33.5	372	2250	2000	416
0950	15.0	37.0	355.374	2250	2000	417
1000	15.0	38.0	385	2250	2000	416
10	15.0	35.0	392	2225	2000	416
20	15.0	33.5	400	2250	2000	414
30	15.0	34.0	405	2200	2000	412
40	15.0	34.0	405	2225	2000	413
50	15.0	33.5	410	2225	2000	414
1100	15.0	34.0	407	2225	2000	414
1110	10.0	32.0	355.420	2250	2000	414
20	10.0	30.0	426	2225	2000	412
30	10.0	29.0	432	2225	2000	414
40	10.0	29.0	438	2225	2000	414
50	10.0	28.5	440	2225	2000	414
1200	10.0	28.0	444	2225	2000	414
10	10.0	28.0	450	2225	2000	416
20	10.0	28.0	450	2250	2000	416
1230	5.5	27.5	355.450	2250	2000	416
40	5.0	27.5	450	2200	2000	416
50	5.0	26.5	456	2250	2000	418
1300	4.5	26.5	455	2250	2000	418
10	5.0	26.5	455	2250	2000	418
20	5.0	25.5	458	2250	2000	418
30	5.0	25.0	460	2250	2000	418
40	5.0	25.0	460	2250	2000	416

NOTE: Due to failure of rectifier tubes, this test had to be discontinued before reaching zero degrees Centigrade.

Table 18 (cont'd)

Difference between readings taken at 0940 and 1100

Ambient temperature - 5.0°C

Difference in frequency = +35 cycles

Difference in frequency per degree Centigrade = +7 cycles, .0019%

Difference between readings taken at 1100 and 1220

Ambient temperature - 5.0°C

Difference in frequency = +43 cycles

Difference in frequency per degree Centigrade = +8.6 cycles, .0024%

Difference between readings taken at 1220 and 1340

Ambient temperature - 5.0°C

Difference in frequency = +10 cycles

Difference in frequency per degree Centigrade = +2 cycles, .00056%

NOTE: When ambient temperature reached 3.5°, rectifier compartment temperature was 17°, rectifier tubes ceased to operate.

Table 19

MODEL TAQ-4 TRANSMITTER (PRELIMINARY MODEL)  
 Effect of Change in Ambient Temperature  
 Test as per par. 3-9-3 of Specifications RE 13A 351H  
 500 kilocycles

Time	Ambient °C	Rectifier tube comp. °C	Actual Frequency	Power amplifier Plate Volts	Power amplifier plate curr. mils	Line Volts
0830	24.5	40.0	500.830	2325	2000	434
40	25.0	46.0	743	2325	2000	432
50	25.0	45.0	692	2325	2000	434
0900	25.0	40.0	657	2325	2000	432
10	25.0	38.0	630	2300	2000	432
20	25.0	37.0	618	2300	2000	430
30	25.0	37.5	592	2300	2000	428
40	25.0	34.0	573	2300	2000	428
0950	29.5	40.0	500.560	2300	2000	426
1000	30.0	43.5	538	2300	2000	426
10	30.0	43.0	520	2250	2000	426
20	30.0	38.0	520	2250	2000	426
30	30.0	36.0	530	2250	2000	426
40*	27.0	34.0	538	2250	2000	426
50	30.0	40.5	530	2275	2000	426
1100	30.0	42.5	534	2275	2000	425
1110	34.5	44.0	500.494	2275	2000	425
20	35.0	45.0	488	2250	2000	424
30	35.0	46.0	482	2250	2000	425
40	35.0	47.0	468	2250	2000	424
50	35.0	47.0	454	2250	2000	424
1200	35.0	46.0	435	2250	2000	426
10	35.0	48.0	424	2250	2000	426
20	35.0	47.5	413	2250	2000	426
1230	39.5	51.0	500.398	2250	2000	426
40	40.0	51.5	387	2250	2000	425
50	40.0	52.5	373	2250	2000	426
1300	40.0	54.0	345	2250	2000	425
10	40.0	52.0	340	2250	2000	426
20	40.0	49.0	345	2250	2000	426
30	40.0	53.0	348	2250	2000	424
40	40.0	52.0	345	2250	2000	422
1350	45.0	57.5	500.330	2250	2000	420
1400	45.0	56.0	320	2250	2000	422
10	45.0	56.0	320	2250	2000	422
20	45.0	56.0	315	2250	2000	422
30	45.0	55.0	320	2250	2000	422

Table 19 (cont'd)

<u>Time</u>	<u>Ambient °C</u>	<u>Rectifier tube comp. °C</u>	<u>Actual Frequency</u>	<u>Power Amplifier Plate Volts</u>	<u>Power amplifier plate curr. mils</u>	<u>Line Volts</u>
1440	45.0	57.5	500.323	2250	2000	422
50	45.0	58.0	332	2250	2000	422
1500	45.0	56.5	325	2250	2000	422
1510	50.0	63.0	500.300	2250	2000	420
20	50.0	65.5	300	2250	2000	419
30	50.0	64.0	300	2250	2000	418
40	50.0	65.0	298	2250	2000	424
50	50.0	66.5	290	2250	2000	426
1600	50.0	63.0	303	2250	2000	428
10	50.0	62.0	312	2250	2000	428
20	50.0	61.5	317	2250	2000	428

\* D.C. line voltage off for five minutes.

Difference between readings taken at 0940 and 1100

Ambient temperature - 5.0°C

Difference in frequency = -39 cycles

Difference in frequency per degree Centigrade = -7.8 cycles, .0015%

Difference between readings taken at 1100 and 1220

Ambient temperature - 5.0°C

Difference in frequency = -121 cycles

Difference in frequency per degree Centigrade = -24.2 cycles, .0048%

Difference between readings taken at 1220 and 1340

Ambient temperature - 5.0°C

Difference in frequency = -68 cycles

Difference in frequency per degree Centigrade = -13.6 cycles, .0027%

Difference between readings taken at 1340 and 1500

Ambient temperature - 5.0°C

Difference in frequency = -20 cycles

Difference in frequency per degree Centigrade = -4 cycles, .0008%

Difference between readings taken at 1500 and 1620

Ambient temperature - 5.0°C

Difference in frequency = -8 cycles

Difference in frequency per degree Centigrade = -1.6 cycles, .00032%

Table 20

## MODEL TAQ-4 TRANSMITTER (PRELIMINARY MODEL)

## Effect of Change in Ambient Temperature

Test as per par.3-9-3 of Specifications RE 13A 351H

500 kilocycles

<u>Time</u>	<u>Ambient °C</u>	<u>Rectifier tube comp. °C</u>	<u>Actual Frequency</u>	<u>Power Amplifier Plate Volts</u>	<u>Power amplifier plate curr. Mils</u>	<u>Line Volts</u>
0820	24.5	39.0	500.410	2325	2000	430
30	25.0	38.5	350	2325	1900	434
40	25.0	39.0	315	2325	2000	432
50	25.0	35.5	290	2350	2000	436
0900	24.0	35.0	275	2325	2000	434
10	25.0	33.5	260	2300	2000	432
20	25.0	33.5	250	2300	2000	429
30	25.0	32.5	250	2300	2000	427
0940	20.5	29.5	500.252	2300	1950	426
50	20.0	27.0	265	2300	1900	426
1000	20.0	35.5	275	2275	1925	426
10	20.0	37.0	285	2300	1900	426
20	20.0	43.0	290	2300	1900	426
30	20.0	41.5	290	2300	1900	425
40	19.5	41.0	298	2325	1900	425
50	20.0	41.5	300	2300	1900	426
1100	15.0	33.5	500.310	2300	1900	426
10	14.6	36.0	330	2275	1900	426
20	15.0	35.0	348	2300	1900	426
30	15.0	32.5	360	2300	1900	426
40	15.0	32.0	375	2300	1900	426
50	15.0	31.5	380	2275	1900	425
1200	14.6	34.0	382	2300	1900	426
10	15.0	39.0	375	2300	1900	426
1220	10.0	33.0	500.382	2300	1900	428
30	10.2	31.5	400	2300	1900	427
40	10.0	29.5	408	2300	1950	426
50	10.0	28.5	420	2300	1950	426
1300	10.0	30.0	420	2300	1950	426
10	10.0	30.0	418	2300	1950	426
20	10.0	30.0	420	2300	1950	426
30	10.0	30.0	420	2300	1950	428

Table 20 (cont'd)

Time	Ambient °C	Rectifier tube comp. °C	Actual Frequency	Power Amplifier Plate Volts	Power amplifier plate curr. mils	Line Volts
1340	5.0	31.0	500.435	2300	1950	426
50	5.0	27.5	455	2300	1950	426
1400	5.0	26.0	470	2300	1975	426
10	5.0	24.0	480	2300	1975	428
20	5.0	24.0	485	2300	1975	426
30	4.5	24.0	494	2275	1950	424
40	5.0	22.5	500	2300	1950	424
50	5.0	22.0	505	2300	1950	426

NOTE: Due to failure of rectifier tubes. this test had to be discontinued before reaching zero degrees Centigrade.

Difference between readings taken at 0930 and 1050

Ambient temperature - 5.0°C

Difference in frequency = +50 cycles

Difference in frequency per degree Centigrade = +10 cycles, .002%

Difference between readings taken at 1050 and 1210

Ambient temperature - 5.0°C

Difference in frequency = +75 cycles

Difference in frequency per degree Centigrade = +15 cycles, .003%

Difference between readings taken at 1210 and 1330

Ambient temperature - 5.0°C

Difference in frequency - 45 cycles

Difference in frequency per degree Centigrade - 9 cycles, .0018%

Difference between readings taken at 1330 and 1450

Ambient temperature - 5.0°C

Difference in frequency = +85 cycles

Difference in frequency per degree Centigrade = +17 cycles, .0034%

Table 21

MODEL TAQ-4 TRANSMITTER (PRELIMINARY MODEL)

Summary of Frequency Variations resulting  
from Temperature Changes in 5° C Steps

(Tables 17 to 20 inclusive)

<u>Temperature Range</u>	355 kilocycles		500 kilocycles	
	<u>Cycles</u>	<u>%</u>	<u>Cycles</u>	<u>%</u>
0 - 5	Rectifier	tubes	failed.	
5 - 10	+10	.0028	+85	.0170
10 - 15	+43	.0121	+45	.0090
15 - 20	+35	.0098	+75	.0150
20 - 25	No test	-	+50	.0100
25 - 30	-50	.0141	-39	.0078
30 - 35	-45	.0125	-121	.0242
35 - 40	-10	.0028	-68	.0136
40 - 45	-45	.0125	-20	.0040
45 - 50	-43	.0121	-8	.0016

Table 23

## MODEL TAQ-4 TRANSMITTER (PRELIMINARY MODEL)

## 25% Variation in Antenna Constants

Test as per par.3-9-5 of Specifications RE 13A 351H

<u>Control Varied</u>	<u>Normal Frequency</u>	<u>Frequency when I<sub>p</sub> increased 25%</u>	<u>Cycles Change</u>	<u>Frequency when I<sub>p</sub> decreased 25%</u>	<u>Cycles Change</u>
Antenna	500.634	500.621	-13	500.632	-2
Antenna	355.810	355.804	- 6	355.810	0
P.A.	500.634	500.624	-10	500.640	+6
P.A.	355.810	355.814	+ 4	355.780	-30

Table 24

## MODEL TAQ-4 TRANSMITTER (PRELIMINARY MODEL)

## Control of Power Output

Test as per par.3-9-6 of Specifications RE 13A 351H

Antenna: 1.65 ohms, 2000 uuf capacity

<u>Tap Switch</u>	<u>Frequency Kc</u>	<u>Plate Volts</u>	<u>Antenna Current</u>	<u>Percent Power</u>	<u>Percent Voltage</u>
6	355.799	2400	36.3	107.5	104
5	355.804	2300	35.0	100.0	100
4	355.815	2100	30.6	76.5	91.4
3	355.830	1825	26.0	55.0	79.4
2	355.859	1510	20.4	34.0	65.8
1	355.875	1200	13.9	16.0	52.2
Maximum frequency change: +76 cycles; 0.021%					
6	500.678	2375	37.0	110.0	104
5	500.683	2300	35.3	100.0	100
4	500.690	2100	31.0	77.0	91.2
3	500.700	1825	26.0	54.0	79.4
2	500.720	1500	20.0	32.0	65.0
1	500.730	1200	14.0	16.0	52.0

Maximum frequency change: +52 cycles; 0.01%

Table 25

## MODEL TAQ-4 TRANSMITTER (PRELIMINARY MODEL)

Change of frequency due to change of tubes

Test as per par.3-9-7 of Specifications RE 13A 351H

<u>Ser.No. of Tubes</u>		<u>Frequency, kilocycles</u>
	(Master Oscillator Circuit)	
57491	(original)	500.720
8374		500.675
41340		500.758
41356		500.685

Maximum frequency change: -45 cycles

	(Intermediate Amplifier Circuit)	
57395)		
57482) 1	(original)	500.750
41340)		
41356) 2		500.700
8374)		
57296) 3		500.757

Maximum frequency change: -50 cycles

Table 26

## MODEL TAQ-4 TRANSMITTER (PRELIMINARY MODEL)

Summary of tests conducted in accordance with par.3-9 of Spec.RE 13A 351H

<u>Test</u>	<u>355 kilocycles</u>		<u>500 kilocycles</u>	
	<u>Max change</u>	<u>Min change</u>	<u>Max change</u>	<u>Min change</u>
1. Errors in Cal.	0	0	0	0
2. Errors in reset	+93	-1	+127	+2
3. Temperature change	-50	-10	-121	-8
4. Line voltage change	-22	-22	-39	-39
5. Antenna change	-6	0	-13	-2
6. Pr Output change	+76	+76	+52	+52
7. Tube change	No data	No data	-45	+38
Algebraic Sum:	91 cycles	43 cycles	39 cycles	43 cycles

Permitted by specifications: 350 cycles

Table 27

## MODEL TAQ-4 TRANSMITTER (PRELIMINARY MODEL)

Variation of Resonant Frequency of Master Oscillator per Division of Marking  
Test as per par.3-16 of Specifications RE 13A 351H

<u>Control "A"</u>	<u>Control "B"</u>	<u>Frequency kcs</u>	<u>Divisions Change</u>	<u>Kcs per Division</u>	<u>Percent per Division</u>
1	490	175			
1	845	200	355	0.070	0.035
2	350	200			
2	690	225	340	0.074	0.033
3	402	250			
3	575	275	173	0.144	0.052
3	755	300	180	0.139	0.046
4	242	300			
4	535	350	293	0.170	0.049
4	755	400	220	0.227	0.057
5	196	400			
5	505	450	309	0.162	0.036
5	737	500	232	0.215	0.043
6	100	500			
6	431	550	331	0.151	0.027
6	675	600	244	0.205	0.034

Width of smallest division of marking - 3/64" (0.05")

Specifications require that the variation of resonant frequency per division of marking shall not exceed 0.05% or be less than 0.02%; the width of the smallest scale division shall not be less than 0.035"

Table 28

## MODEL TAQ-4 TRANSMITTER (PRELIMINARY MODEL)

Frequency variation due to "Adjust-Tune-Operate" Switch

Test as per par.3-20 of Specifications RE 13A 351H

<u>Switch Setting</u>	<u>Frequency</u>
Adjust	500.799
Tune	500.717
Operate	500.683
Maximum change - 116 cycles, 0.023%	
Adjust	355.820
Tune	355.723
Operate	355.680
Maximum change - 140 cycles, 0.039%	

Table 29

## MODEL TAQ-4 TRANSMITTER (PRELIMINARY MODEL)

Tests to determine control of power output; power required from supply lines and voltage control of main rectifier.

Tests as per pars. 3-24, 6-5, and 6-50 of Specifications RE 13A 351H

<u>Rectifier Tap</u>	<u>P.A. Plate Voltage</u>	<u>Percent of full Voltage</u>	<u>Watts Input Power</u>	<u>Percent Overall Eff.</u>	<u>Ant. Cur.</u>	<u>Watts Ant. Power</u>	<u>Percent of full Power</u>
1	1180	50.8	2800	17.3	8.0	486	17.7
2	1510	65.0	3690	24.9	11.0	920	33.6
3	1840	79.3	4820	31.0	14.0	1490	54.4
4	2100	90.4	6000	35.3	16.7	2120	77.2
5	2320	100.0	7100	38.6	19.0	2740	100.0
6	2400	103.5	7800	39.8	20.2	3100	113.0

Par. 3-24 of specifications requires that power be varied between limits of 10% and 100%.

Par. 6-5 of specifications requires that the power drawn from the supply lines shall not exceed 9250 watts.

Par. 6-50 of specifications requires that the rectifier output voltage shall be varied in six approximately equal steps between the limits of 50% and 110% of normal voltage.

Table 30

MODEL TAQ-4 TRANSMITTER (PRELIMINARY MODEL)

Shock test to simulate gun fire.

Test as per par.3-42 of Specifications RE 13A 351H

<u>Shock No.</u>	<u>Frequency Before Shock</u>	<u>Frequency After Shock</u>
1	355.666	355.665
2	355.665	355.666
3	355.666	355.664
4	355.664	355.667
5	355.667	355.668

Maximum frequency change: 3 cycles, 0.001%

1	500.714	500.722
2	500.722	500.725
3	500.725	500.724
4	500.724	500.723
5	500.723	500.723

Maximum frequency change: 8 cycles, 0.0016%

Specification requirements: 0.002%

Table 31

MODEL TAQ-4 TRANSMITTER (PRELIMINARY MODEL)

Efficiency of Conversion of Main Plate Rectifier

Test as per par.6-45 of Specifications RE 13A 351H

Total power input to rectifier - 7100 watts  
 Input power minus main plate - 1700 watts  
 Output power of main plate - 4956 watts  
 Input power to main plate - 5400 watts

Efficiency of Conversion:  $\frac{4956}{5400} = 91.7\%$

Specifications require that the efficiency of conversion shall not be less than 80%.

Table 32

MODEL TAQ-4 TRANSMITTER (PRELIMINARY MODEL)

Voltage Regulation of Rectifiers

Test as per par.6-46 of Specifications RE 13A 351H

<u>Rectifier</u>	<u>No Load</u>	<u>Full Load</u>	<u>% Regulation</u>
Main plate	2420 V	2300 V	5.0%
Auxiliary plate	1460 V	1450 V	0.68%
Bias	240 V	243 V	1.3%

Permitted by Specifications:

Main Plate - 5%  
 Auxiliary - 6%  
 Bias - 6%

Table 33

## MODEL TAG-4 TRANSMITTER (PRELIMINARY MODEL)

## Measurement of Ripple Voltages

Test as per par.6-47 of Specifications RE 13A 351H

<u>Rectifier</u>	<u>DC Voltage</u>	<u>Ripple Voltage at</u>					
		<u>60 cy</u>	<u>120 cy</u>	<u>180 cy</u>	<u>240 cy</u>	<u>360 cy</u>	<u>720 cy</u>
Control	112	2.4	13.0	0	0.55	0	
Bias	257	0.36	0.55	0	0	0	
Auxiliary	1500	0.36	2.7	0	0.12	0	
Mid Tap	1160	0	2.0	3.0	0.65	6.1	0.72
Main Plate	2320	0.4	3.2	2.5	0	2.8	0.1

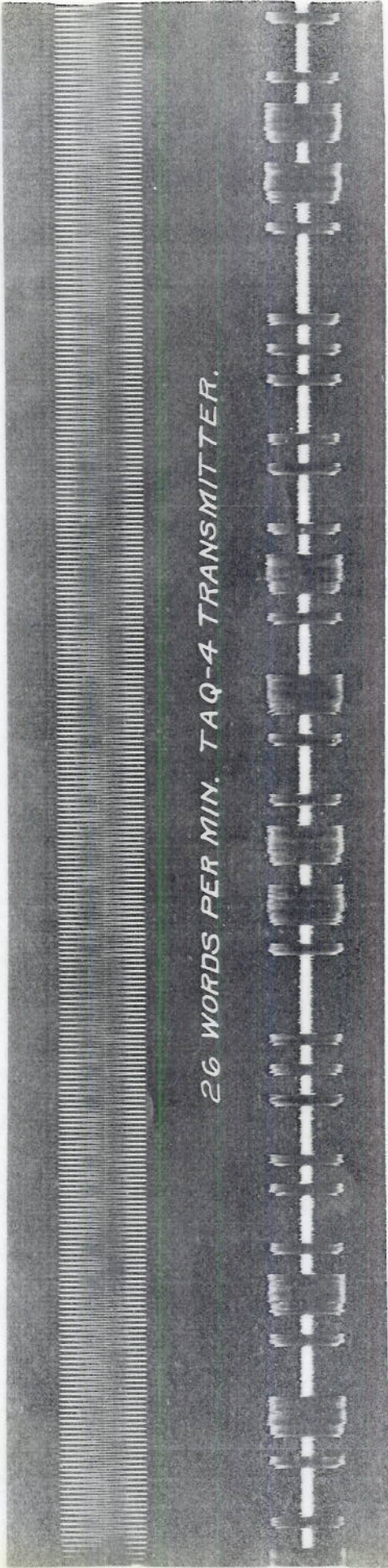
## Summary

<u>Rectifier</u>	<u>Total Ripple</u>	<u>Percent Ripple</u>
Control	13.25 volts	11.8%
Bias	0.63	0.25
Auxiliary	2.72	0.18
Mid Tap	7.14	0.62
Main Plate	4.95	0.21

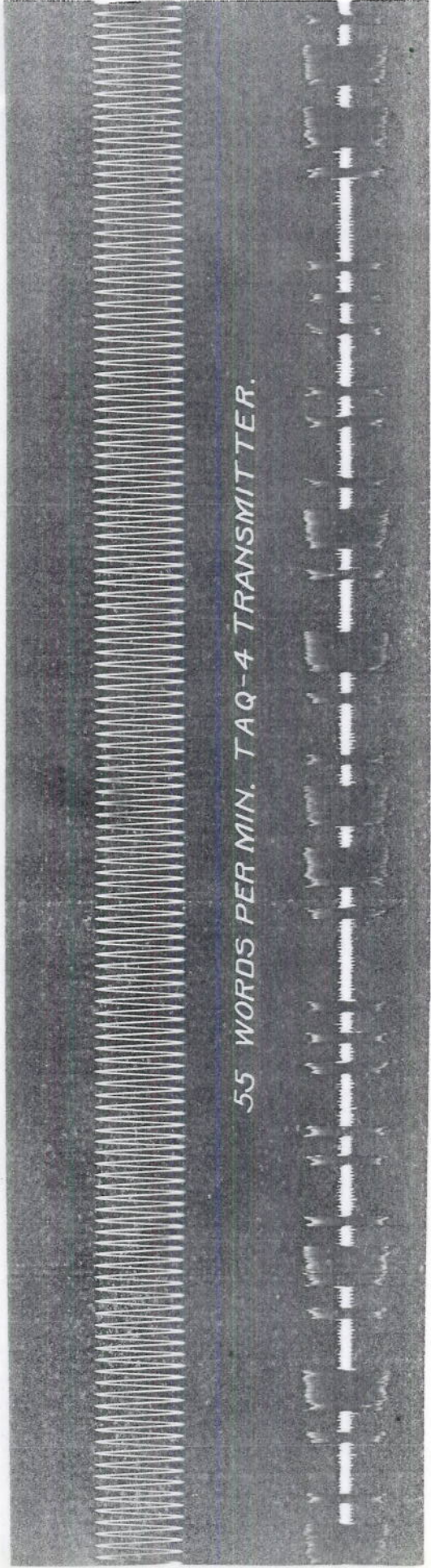
Note: The total ripple voltage is obtained by taking the square root of the sum of the squares at the various frequencies measured.

## Permitted by Specifications:

Main Plate: 0.5%  
 Auxiliary : 0.5%  
 Bias : 0.5%



26 WORDS PER MIN. TAQ-4 TRANSMITTER.



55 WORDS PER MIN. TAQ-4 TRANSMITTER.

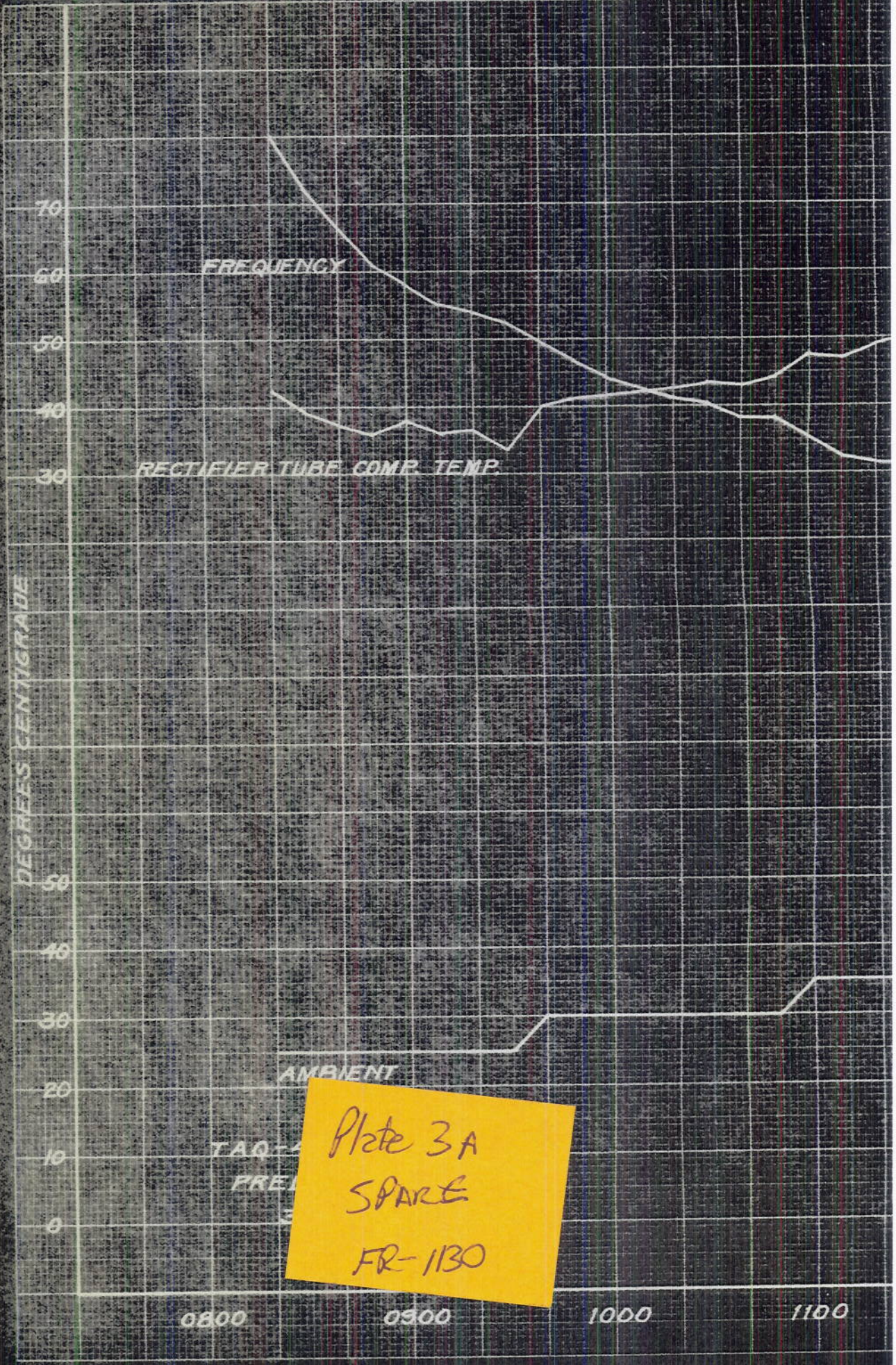
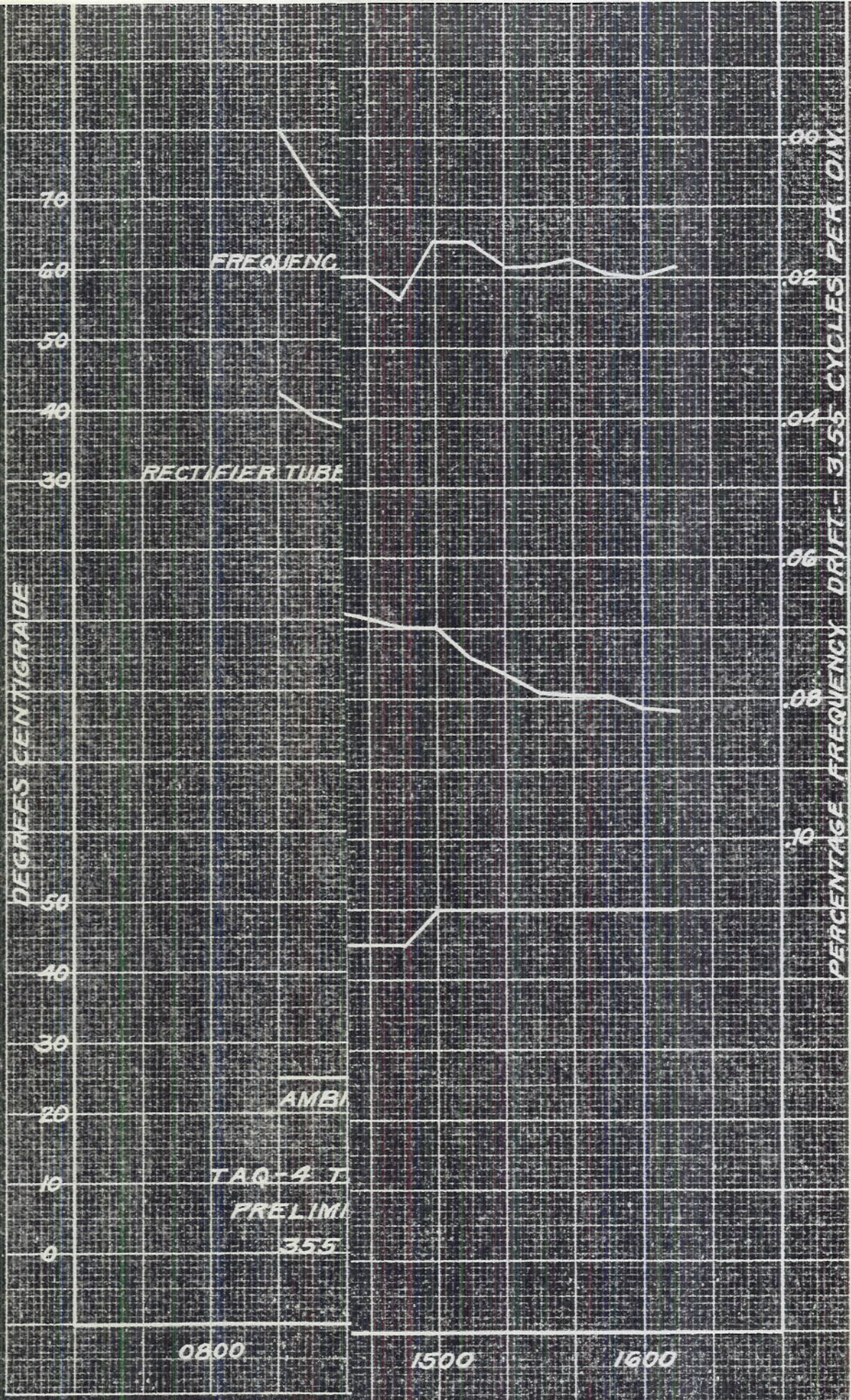
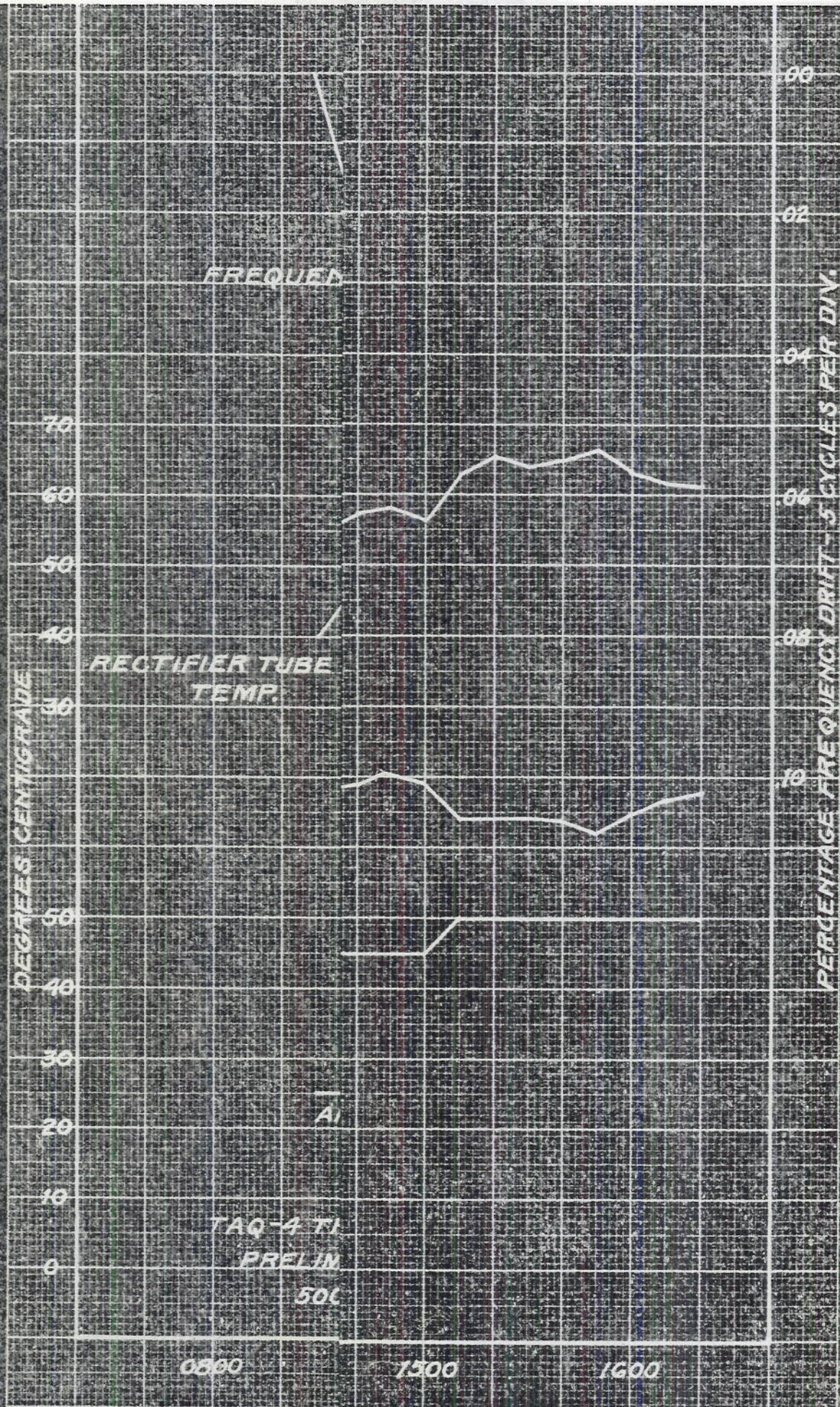
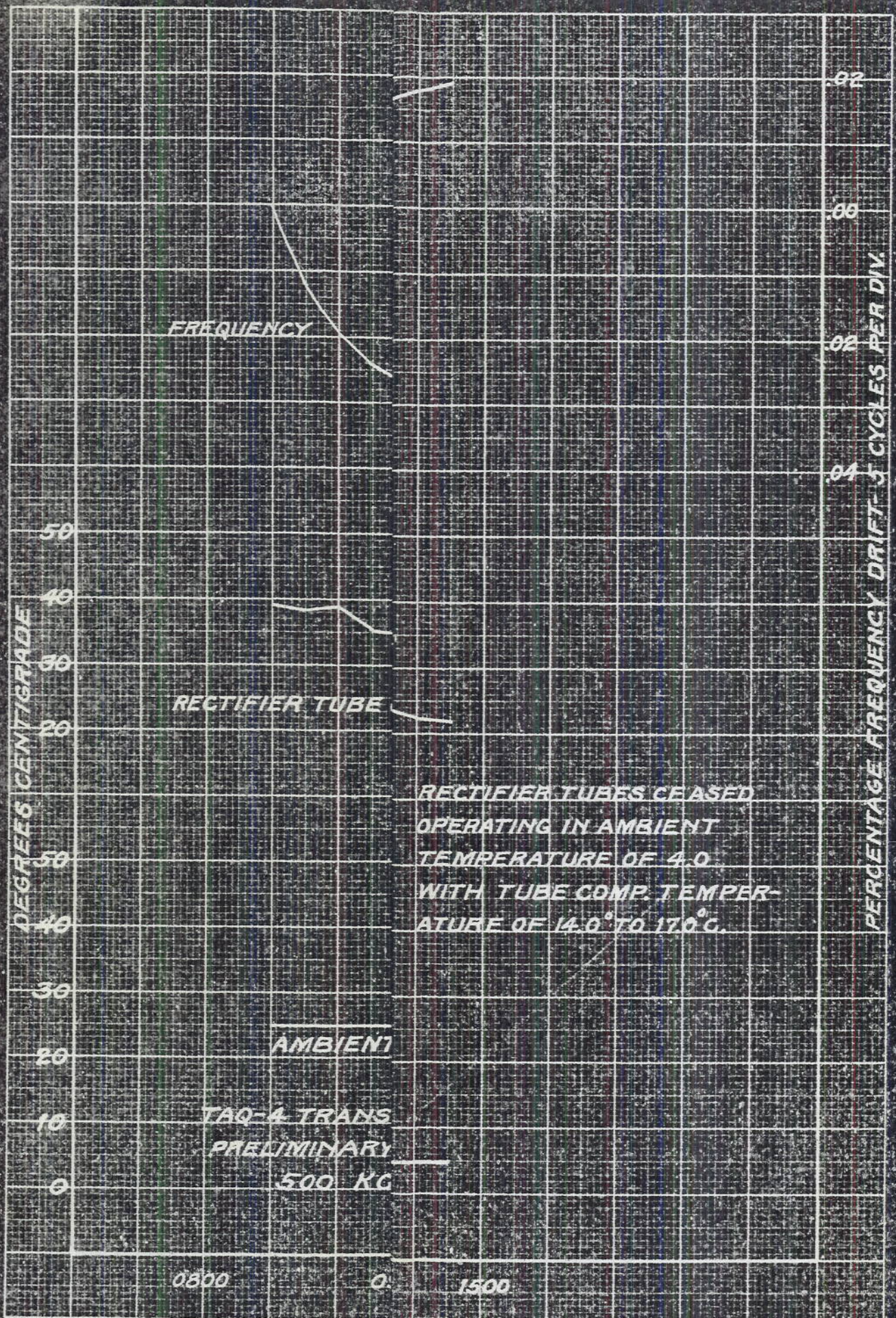


Plate 3A  
 SPARE  
 FR-1130

TAQ-4  
 FREI  
 3

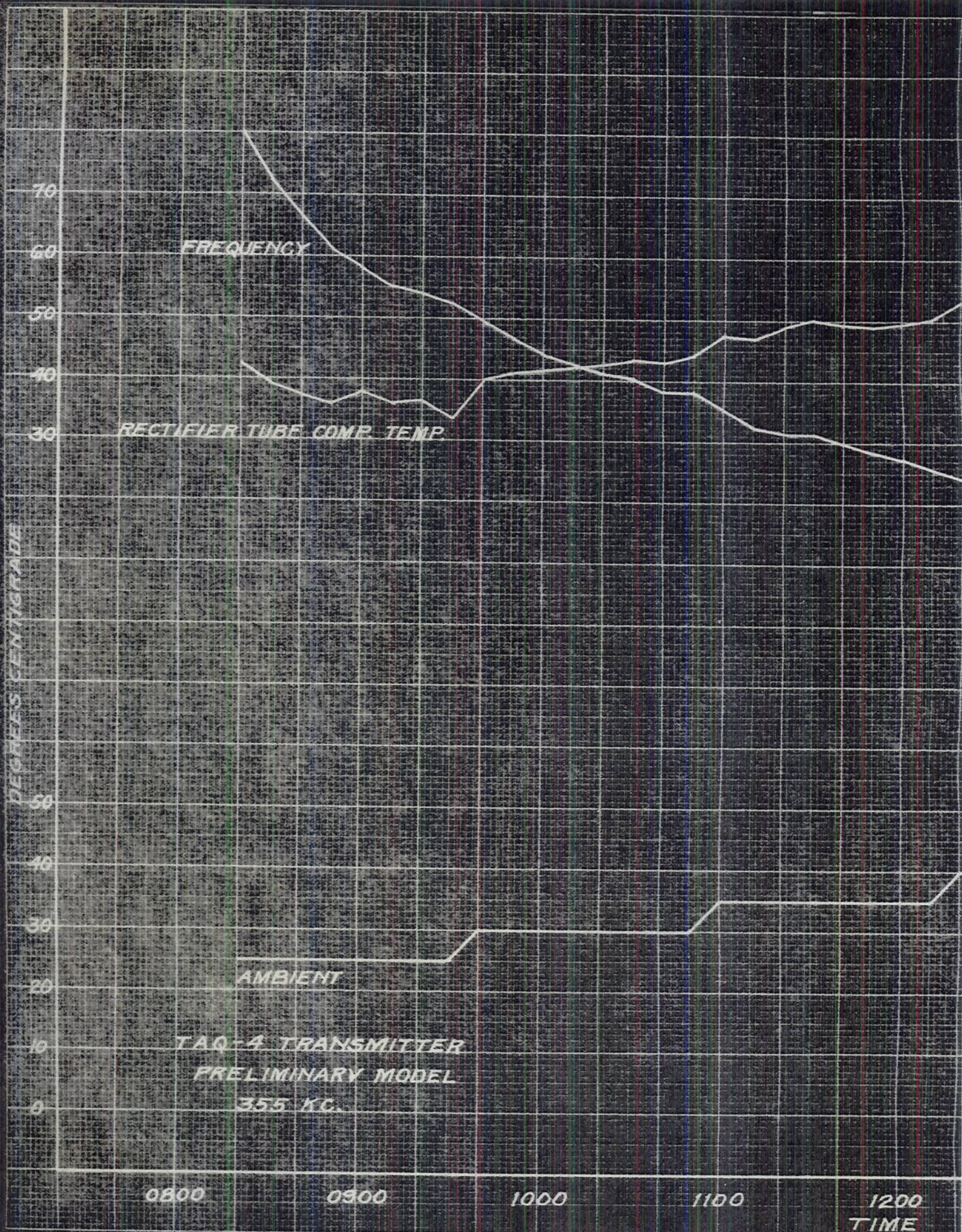






RECTIFIER TUBES CEASED  
 OPERATING IN AMBIENT  
 TEMPERATURE OF 4.0  
 WITH TUBE COMP. TEMPER-  
 ATURE OF 14.6° TO 17.0°C.

TAQ-4 TRANS  
 PRELIMINARY  
 500 KC



FREQUENCY

RECTIFIER TUBE COMP. TEMP.

AMBIENT

TAQ-4 TRANSMITTER  
PRELIMINARY MODEL  
355 KC.

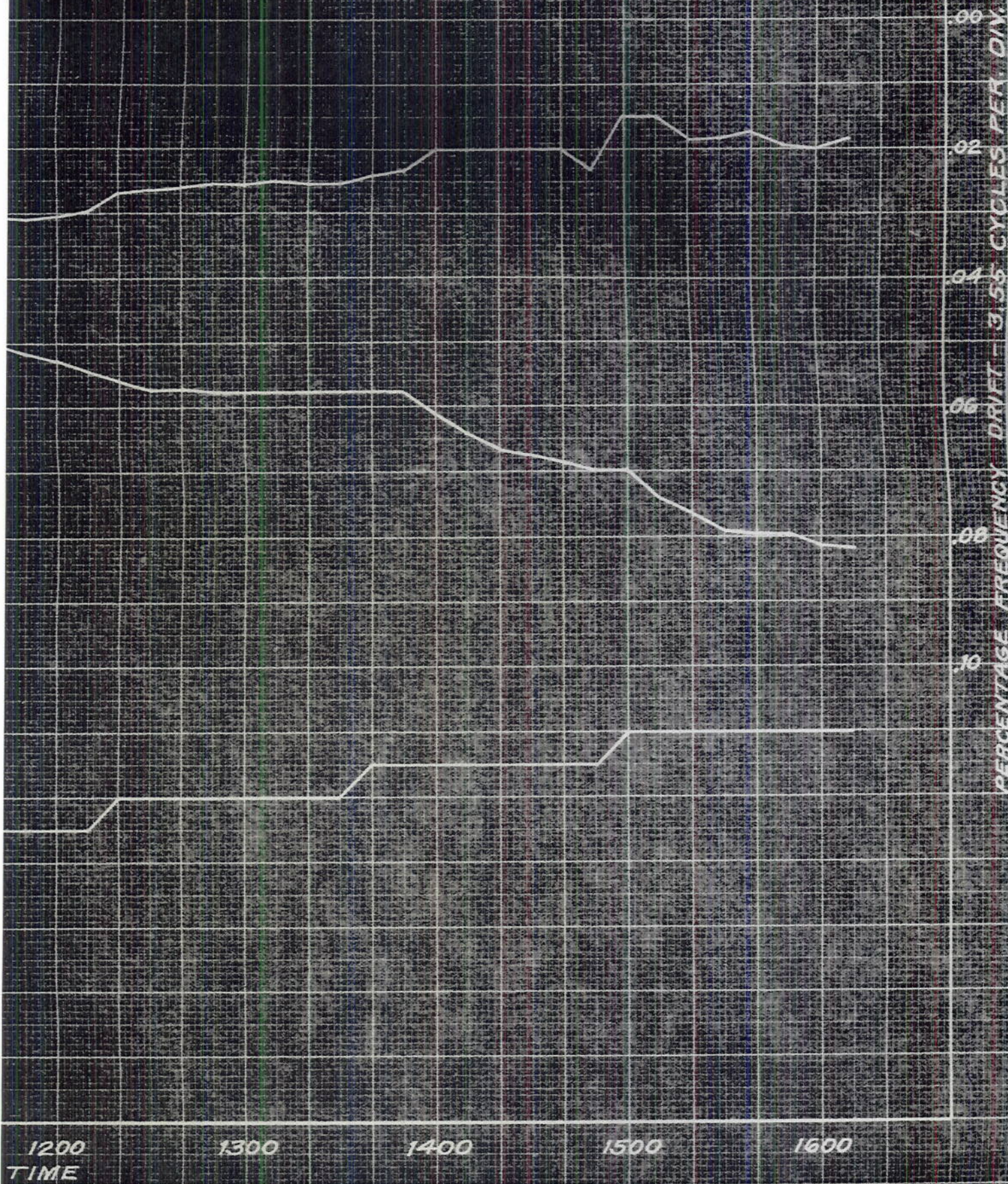
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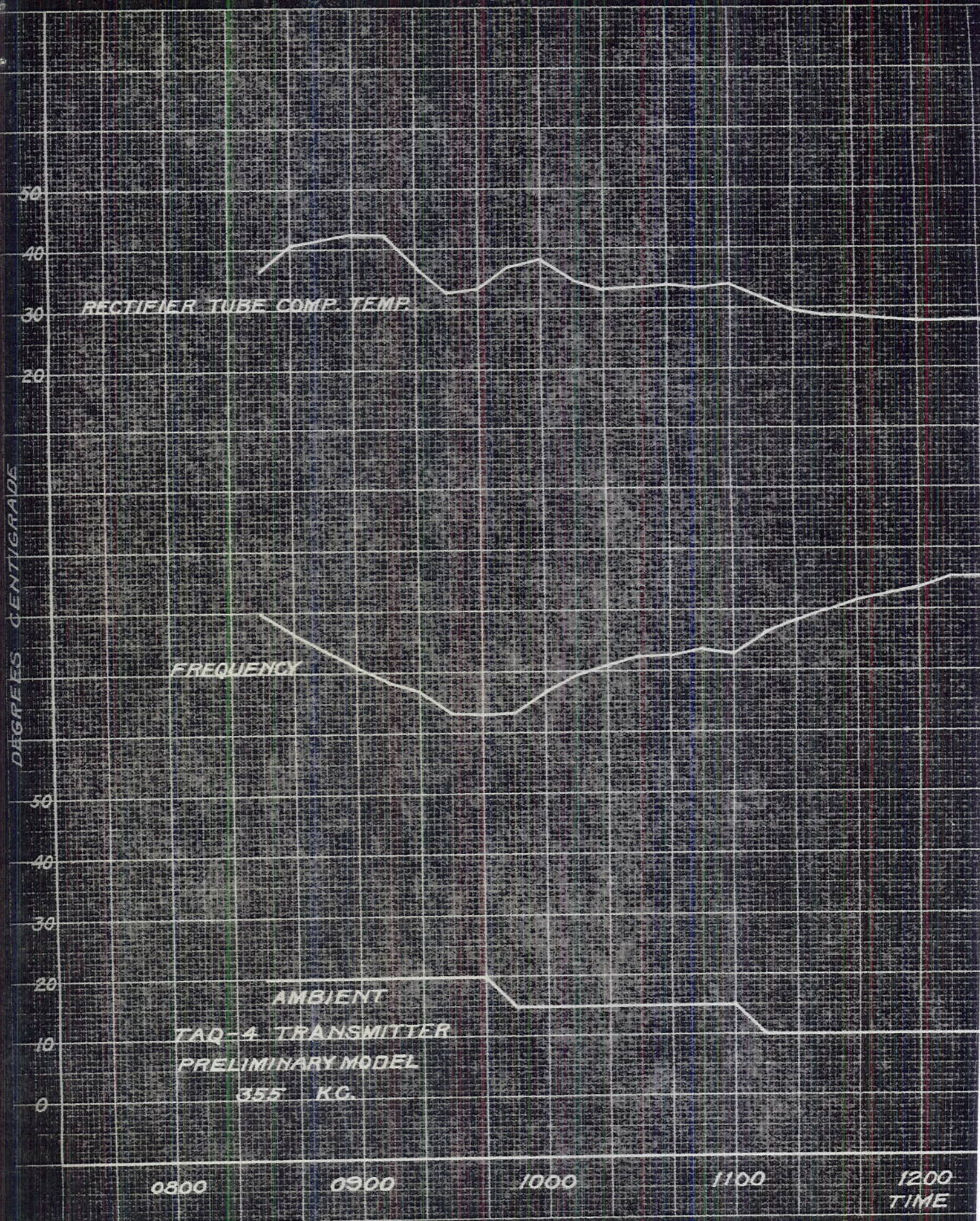
0900

1000

1100

1200  
TIME





RECTIFIER TUBES OILED  
OPERATING IN AMBIENT  
TEMPERATURE OF 3.0°  
WITH TUBE COMP.  
TEMPERATURE OF 15.0° TO 17.0°

PERCENTAGE FREQUENCY DRIFT - 3.05 CYCLES PER DIV.

04  
02  
00  
02

1200  
TIME

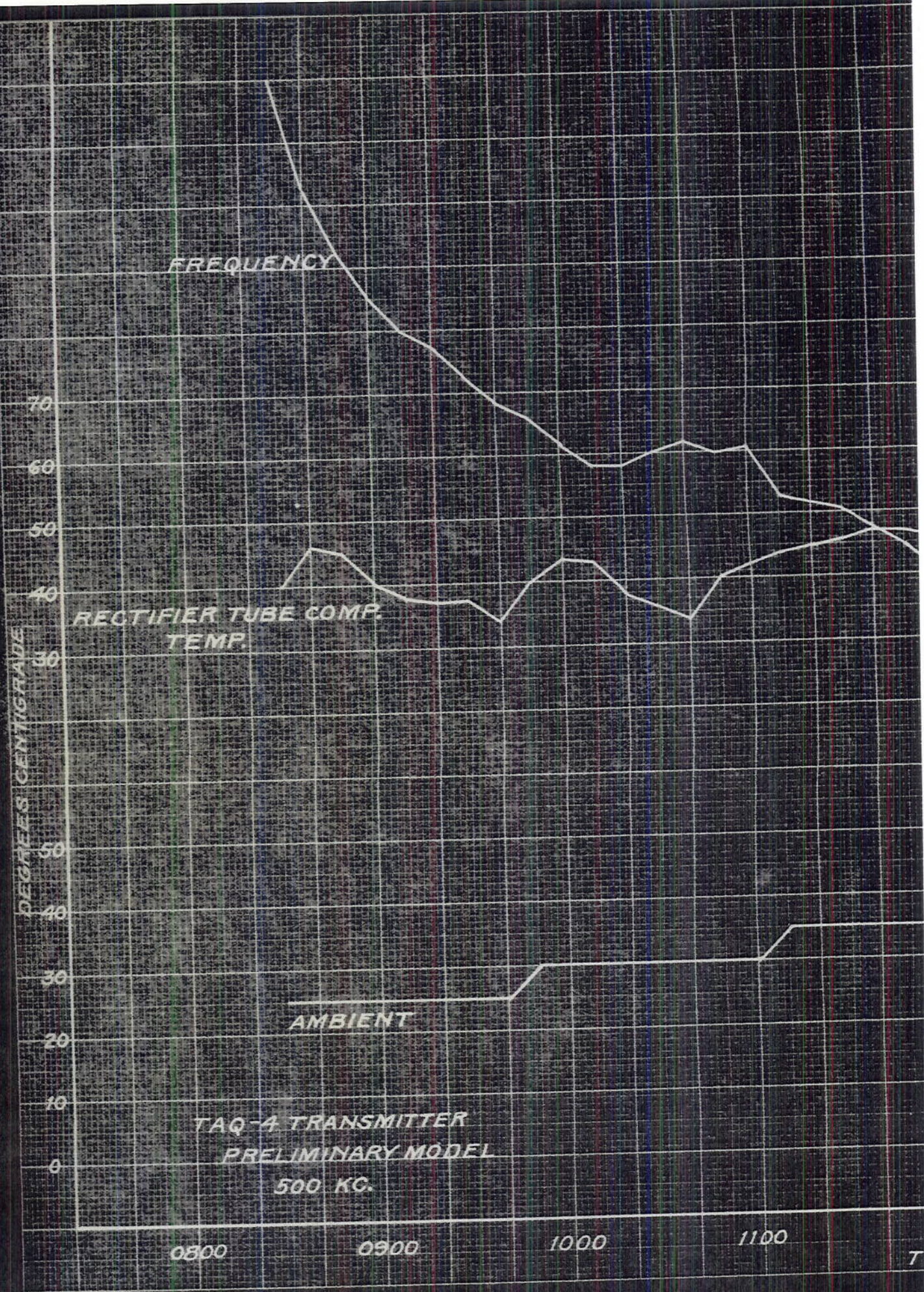
1300

1400

1500

1600

PLATE 4



FREQUENCY

RECTIFIER TUBE COMP.  
TEMP.

AMBIENT

TAQ-4 TRANSMITTER  
PRELIMINARY MODEL  
500 KG.

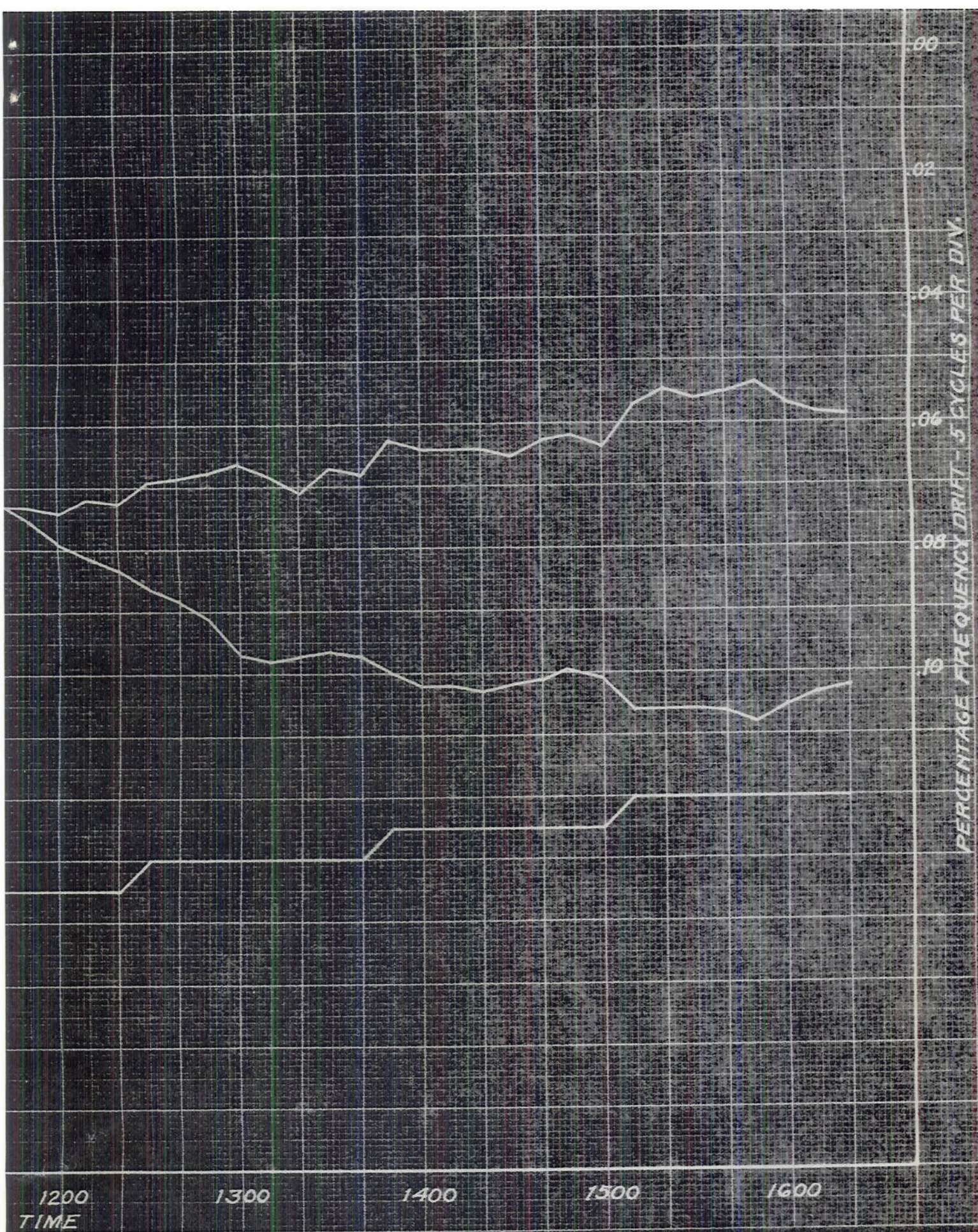
0800

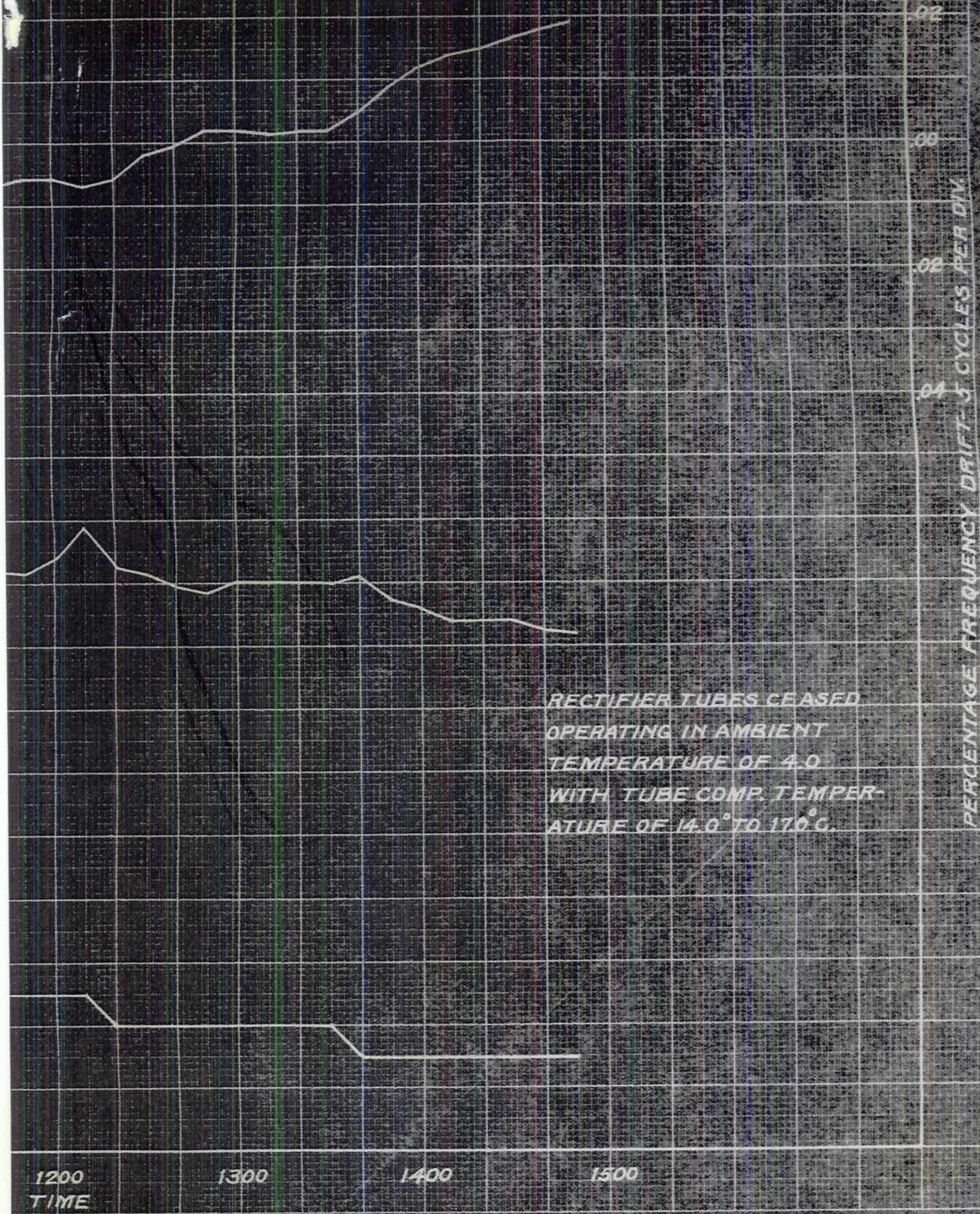
0900

1000

1100

T





RECTIFIER TUBES CEASED  
OPERATING IN AMBIENT  
TEMPERATURE OF 4.0  
WITH TUBE COMP. TEMPER-  
ATURE OF 14.0° TO 17.0° C.

1200  
TIME

1300

1400

1500