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Report on
Preliminary Model GP-1 Equipment

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Naval Air Station, Anacostia, Report RT-6, Flight Tests of
Model GP-1 Equipment.

AUTHORIZATION

1. The tests herein reported were authorized by Bureau of Engineering letter, ref.(a). Additional references pertinent to this problem are listed as refs. (b) to (m).

- Reference:
- (a) BuEng let.NOs-36225(5-9-W8) of 22 June 1934.
 - (b) Specifications RE 13A 490B.
 - (c) Contract NOs-36225.
 - (d) NRL let. F42-1/52 of 9 July 1935 to NAS Anacostia.
 - (e) NRL let. F42-1/52 of 10 Dec.1935 to NAS Anacostia.
 - (f) Western Electric Type Test Data on Model GP-1
Set No. 1 of 4 June 1935.
 - (g) Western Electric Type Test Data on Model GP-1
Set No. 2 of 18 July 1935.
 - (h) BuEng let. NOs-36225 (8-17-W3) of 26 Aug. 1935.
 - (i) BuEng let. NOs-36225 (8-28-W3) of 4 Sept. 1935.
 - (j) BuEng let. NOs-36225 (12-3-W3) of 12 Dec.1935.
 - (k) NAF Specifications T 38a-1.
 - (l) NAS let. F42-1/51/NA6 of 6 Jan.1936.
 - (m) NAS let. F42-1/52/NA6 of 21 Feb.1936.

OBJECT OF TESTS

2. The object of these tests was to determine the compliance of the Model GP-1 equipment with the governing specifications, ref.(b), and the contract, ref. (c), and to determine the suitability of this equipment for use in the Naval aircraft service.

ABSTRACT OF TESTS

3. The Model GP-1 equipment was tested in the Laboratory for compliance with the governing specifications, ref.(b). These tests covered the following points:

- (a) Mechanical, including
 - (1) Workmanship
 - (2) Size and weight
 - (3) Materials
 - (4) Shock mounting
 - (5) Type of controls and backlash
- (b) Frequency range
- (c) Power output into specified antennas
- (d) Frequency stability under conditions of:
 - (1) 30 minutes key locked at full power
 - (2) 30 minutes keyed at 25 w.p.m.
 - (3) Variation of ambient temperature.
 - (4) 10% change in supply voltage.
 - (5) 25% variation of antenna constants.
 - (6) Reset from previous calibration.

Conclusions

As a result of these tests the following conclusions were reached. These conclusions are based on tests of the preliminary and modified models. Conclusions reached due to tests of the preliminary model which were changed by tests of the modified model will not be included herein, since the basis of further action will be the modified model.

(a) The Model GP-1 equipment does not meet the requirements of the specifications, ref.(b), in full.

(b) The frequency drift of the low frequency tuning units exceeds the requirements of the specifications. However, in actual service use, these units should be satisfactory since the drift in cycles is such that the frequency never drifts beyond an audible beat note under the worst conditions.

(c) The power output in the phone position is low. Since operation on phone is a secondary consideration, this should not prove to be a serious defect. The phone power available is in excess of 30 watts.

(d) Poor workmanship is found in wiring and in the alignment of certain dials and inductances. Proper shop technique and inspection should prevent this occurrence in production models.

(e) The ripple in the plate supply exceeds that allowed by the specifications. Tests show the emission to be free from objectionable hum, however, and the present filter is considered adequate.

(f) The microphones supplied by the contractors are unsatisfactory.

(g) The snap slides used for securing the tuning units are too fragile. They should be replaced by thumb screws.

(h) Better and more convenient accessibility to the fuses should be provided. The buffer amplifier shield should be redesigned and strengthened.

(i) Tuning may be expedited by means of an antenna ammeter, particularly when operated by inexperienced personnel.

(j) The Model GP-1 equipment in general exhibits excellent qualities. The equipment should be suitable for the Naval aircraft service if the contractor corrects the deficiencies noted herein. The performance in general is excellent and should be a valuable addition to aircraft communication facilities.

Recommendations

As a result of these tests it is recommended:

(a) That this equipment be considered unsatisfactory for Service use until the manufacturer demonstrates that he can correct the deficiencies herein noted to the satisfaction of the Bureau of Engineering.

(b) That the requirements for power output on phone be waived in order to obtain the saving in weight realized in this equipment over that necessary with other modulation systems.

(c) That an antenna ammeter be required as a separate unit which may or may not be included in a Service installation.

(d) That in specifications for future equipment the following changes be made:

- (1) Specify backlash in terms of frequency change as well as mechanically.
- (2) Change the specification regarding frequency change with respect to a change of antenna constants to read "A change of antenna constants sufficient to change the final amplifier plate current 25% shall not cause a change in the emitted frequency greater than 0.02%."

EQUIPMENT UNDER TEST

5. The preliminary Model GP-1 equipment was submitted by the Graybar Electric Company, Inc., to demonstrate compliance with the specifications, ref.(b), as required by contract, ref. (c). It consists of the following units:

- 1 - Type CW 52039 Transmitter Rectifier Unit
- 1 - Type CW 47080A Tuning Unit
- 1 - Type CW 47080B " "
- 1 - Type CW 47080D " "
- 1 - Type CW 47080E " "
- 1 - Type CW 47080F " "
- 1 - Type CW 66002 External Loading Coil
- 1 - Type CW 23060 Pilot's Control Box
- 1 - Type CW 23061 Operator's Control Box
- 1 - Type 61007 Lead-in Insulator
- 5 - Type 61018 Strain Insulators
- 2 - Type CW 71003 Antenna Weights
- 2 - Type 26003A Keys
- 1 - Type CW 71005 Antenna Reel
- 1 - Type 61083 Fair Lead
- 5 - Type 38282A Vacuum Tubes
- 1 - Type 38050 Vacuum Tubes
- 2 - Type 38222 Rectifier Tubes
- 1 - Set Slip Covers
- 1 - Set Interconnecting Cables

This equipment provides CW, MCW, or voice modulated signals over the frequency range of 300 to 1500 kilocycles and 3000 to 9050 kilocycles. The frequency range is covered by 5 plug-in tuning units. Tuning of the transmitter and selection of the type of emission desired is provided by controls on the front panel of the transmitter-rectifier unit. A pilot's control box and an operator's control box are provided so that actual control of the transmitted signal may be accomplished from either position. The equipment is designed to operate in conjunction with a Model RU-3 receiver and when properly connected allows the pilot to listen in on received signals. Interphone is also provided.

6. The circuit comprises an oscillator, intermediate amplifier and power amplifier utilizing Type CW 38282 tubes. Filament power is supplied through a filament transformer, plate power through a full wave rectifier and filter using Type 38222 tubes. A Type 38050 tube is used as the speech amplifier and modulator. MCW signals are provided by cutting out a portion of the filter in the rectifier circuit. Voice signals are provided by modulating the screens of both amplifier stages.

7. An interesting development for frequency stabilization with temperature variations consists of the special oscillator inductances used. These consist of a spiral deposit of silver on a pyrex glass form. The silver forms the conductor and is tightly bound to the pyrex form. Since pyrex has a small coefficient of expansion with temperature

and the metallic conductor is thin and adheres to the glass, the change of inductance is small.

8. A modified model was also submitted essentially the same as described above, but having a different antenna coupling system and minor changes otherwise. These changes were made as a result of tests on the first model. This report refers to tests on the preliminary and modified models.

METHOD OF TEST

9. The equipment was first given a general inspection of workmanship, type of materials, etc. The component parts were measured and weighed. The equipment was then set up in the Laboratory for electrical tests.

10. Calibration. Manufacturer's figures were checked by use of Model LD-2, Type CAG 74016, serial no. 1 frequency indicator at 50 kilocycle points on the low bands and 400 kilocycle points on the upper bands.

11. Power Measurements. Power measurements were made on three frequencies on Unit I and Unit VI and on two frequencies for the remaining units. On Unit IV and Unit VI measurements were made using antenna constants corresponding to a fixed antenna as well as trailing wire. The procedure in measurement was as follows: The proper antenna constants were selected and a Weston panel type R.F. ammeter of suitable range was connected in the ground return of the dummy antenna. The meter was first checked at 60 cycles to insure its accuracy. The inductance or capacity element of the dummy antenna was connected to the antenna post on the set. Then the transmitter was tuned in the CW position with a plate input of 230 milliamperes at 10.0 volts on the filament voltmeter. After all adjustments had been made, the readings were taken and then the emission selector was turned to the MCW position for a second set of readings and finally the emission selector was turned to phone for a final set of readings. After the set had been properly tuned on the CW position, no further adjustments were made for MCW and phone outputs except changing the emission selector. At the low frequencies, Ward Leonard plaques were used for dummy antenna resistors and zircon rods were used at the upper frequencies.

12. Frequency drift measurements were made by means of the Model LK drift indicator. On the first set tested, two frequencies were selected from each unit, but on the last test only one frequency per unit was tried. The procedure was to tune the Model GP-1 to a suitable frequency which would give a beat note with the Model LK indicator. After all adjustments had been made the Model GP-1 controls were locked and the tuning unit was removed and the entire transmitter and tuning unit were cooled to room temperature. Then the tuning unit was restored and the filaments of the transmitter turned on for five minutes. After five minutes the key was locked and the frequency drift was recorded during the next thirty minutes. These runs were made on full power CW operation; that is, the plate input was 230 milliamperes with 10.0 volts on the filament voltmeter. The frequency drift was considered to be the difference between the maximum and minimum value of the beat note re-

corded during a period of thirty minutes and not the greatest deviation from the starting frequency as a reference point. Careful attention was exercised to keep the filament voltmeter at 10.0 during the entire test.

13. Variation of frequency due to change of antenna constants was measured in those cases where the antenna had a variable capacity in it. By use of a calibrated variable condenser the capacity was shifted 25% above normal and 25% below normal. Frequency was noted at each extreme.

14. The voltage regulator on the NEA-1A had sufficient range to shift the filament voltage from 9.5 to 10.5 volts and the frequency was recorded at each voltage to determine shift due to 10% voltage change.

15. The antenna was open circuited and short circuited at each frequency where drift runs had been made and the plate current recorded. No attempt was made to measure frequency under this condition.

16. Keyed runs at 25 words per minute were made. A Creed automatic keyer was used to send dots corresponding to 25 words per minute. The Model LK recorder could not be used for this run but readings were taken at regular intervals by depressing the key momentarily. In all other respects the procedure was the same as above.

17. For recording reset the Model GP-1 would be adjusted to a frequency which gave a beat with the Model LK. The settings would be carefully noted and then all controls shifted at random. When the controls were returned to their original settings the frequency would be recorded. An average of several trials was taken.

18. Backlash. Again a frequency was selected which gave a beat note with the Model LK indicator. Since there were no stops on the master oscillator control, the master dial was turned clockwise 360° where setting and frequency were recorded. The master dial was then turned anti-clockwise 360° to the same setting and the frequency again recorded. The difference between the two readings is the backlash in terms of frequency.

19. Rectifier conversion factor. A 500 mil D.C. meter was connected in the midtap of the rectifier transformer to record rectifier output. A D.C. voltmeter recorded the voltage. D.C. voltage multiplied by D.C. current gave the rectifier output. This was recorded at full power key locked. The input to the set was read under the same conditions from a wattmeter. Then the plate transformer primary was opened and the input to the set again recorded. The difference between these two inputs is the power fed to the rectifier. The conversion factor is calculated from the equation:

$$\frac{\text{output of rectifier}}{\text{input to rectifier}} = \text{conversion factor.}$$

20. Measurements of ripple voltage in the power supply were determined by means of a "string" oscillograph in connection with suitable auxiliary apparatus. A picture of the ripple voltage is taken, and a

timing wave such as 60 cycles is photographed simultaneously by means of an additional element. By comparisons of the two traces the frequency or frequencies of the ripple in the power supply is determined. The oscillograph is calibrated by means of a source of A.C. and a voltmeter, the deflection of the oscillograph being observed and voltage producing such deflection, thereby expressing its sensitivity in volts per centimeter. The peak value of ripple voltage is readily computed by their distance from the axis by means of the oscillograph sensitivity. Percentage of ripple is expressed as the ratio of half the sum of the peak values to the D.C. output voltage.

21. Measurements of modulation percentage were made by using a cathode ray oscillograph. An audio oscillator was used to supply the modulating voltage to the microphone transformer and also to one set of plates of the cathode ray tube through a suitable mixing panel for control and impedance matching of the circuits. A portion of the radio frequency voltage in the antenna circuit is applied to the remaining pair of plates of the cathode ray tube. With no modulation a rectangular pattern is produced on the screen of the cathode ray tube the dimensions of which are proportional to the peak voltages applied to the plate. With modulation the pattern changes to one having a maximum and minimum dimension which is proportional to the maximum and minimum radio frequency voltage. Thus the percentage modulation may be determined from the formula

$$\frac{\text{max} - \text{min}}{\text{max} + \text{min}} \times 100 = \% \text{ modulation}$$

Photographs of the various patterns were taken.

22. Audio fidelity measurements were taken by measuring the power output of the modulator while maintaining the input constant at various frequencies.

23. Harmonic distortion was measured by means of a linear rectifier and wave analyzer. A portion of the modulated output of the transmitter was rectified and applied to the input of the wave analyzer. The percentage harmonic content was taken as the square root of the sum of the squares of the individual harmonic percentages.

24. Microphones were tested by clamping a standard head phone to the microphone and maintaining a constant voltage across the head phone and measuring the microphone output. They were subjected to several immersion tests after which tests for frequency response and intelligibility were made.

25. Flight tests were made as described in NASA Report RT-6, Appendix B of this report. During flight tests observations on quality of emission and measurements of frequency drift and resets were made by this Laboratory.

26. Table 1 of the appendix gives a list of the instruments and equipment used for these tests.

DATA RECORDED DURING TEST

27. The data recorded during these tests is presented in the form of tables and curves in the appendix. A discussion of the data will be found under RESULTS.

DISCUSSION OF PROBABLE ERRORS

28. Table 1 of the appendix lists the instruments used for these tests with their accuracy. However, the accuracy of the various tests is not necessarily that of the instruments used for the tests. R.F. power outputs should be accurate to $\pm 5\%$. Modulation percentages are accurate to $\pm 2\%$. Harmonic analysis is accurate to $\pm 2\%$. It will be noticed that a very high degree of accuracy is attached to the Model LK frequency drift indicator. This accuracy is for drift measurements only and not for absolute frequency.

29. Very low accuracy applies to the tests on the microphones relative to frequency response. The method of test specified by ref.(k) is such that comparative values only may be obtained. No standard source of sound pressure is available. The greatest weight in these tests should be placed on intelligibility as observed in actual transmission from an airplane in flight until such time as suitable test equipment is made available to this Laboratory.

RESULTS OF TESTS

30. The results of measurements made on this equipment are shown by the data recorded which are tabulated in the appendix. In general, these data agree quite well with the contractor's type test data, references (e) and (f), submitted with the equipments. The results of flight tests are reported in Naval Air Station, Anacostia, D.C., Report RT-6 which forms Appendix B of this report.

31. The results of these tests were discussed at three conferences at the Bureau of Engineering. The contractor's representatives were present at two of these conferences. The discussions at these conferences are summarized in references (g), (h), and (i) and resulted in action by the contractor to correct deficiencies found in the equipment.

32. The following discussion will be based on the specific requirements of the specifications, reference (b). Comments will be made on each paragraph of the specifications except those of a general or informative nature. The numbering of the following paragraphs corresponds to the specification paragraph notation.

33. Par.2-3. Phenolic insulating material was used for the construction of the internal loading coil of the modified model. This was later changed to ceramic material and should be of ceramic material in the production equipments.

34. Par.2-4. Poor workmanship was exhibited as follows:

- (a) Pilot's control box of set #2 was incorrectly wired.
- (b) Screen grid lead to intermediate amplifier not properly soldered.
- (c) Receiver antenna lead touches other parts of the equipment.
- (d) Relay improperly wired in one set.
- (e) Certain controls were rather loose and wobbly.
- (f) Plate current meter in set #2 was loose in its case.
- (g) Loose turns on several coils.

The above defects were corrected by the manufacturer's representatives. Careful inspection should guard against such defects in production.

35. Par.2-7. The results of specific tests under conditions of varying temperatures are discussed later in this report.

36. Par.2-8. No damage resulted to the equipment from electrical overloads.

37. Par.2-9. No failures resulted from continuous operation as a result of overheating.

38. Par.2-10. The side tone condenser for voice broke down during tests. This condenser is designated C14.2 on the diagram of Plate 1 of NASA Report, Appendix B. This condenser has been eliminated in the modified model. C14.1 failed during flight test. Both of these condensers were housed in a single container. The elimination of C14.2 permitted an increase of rating for C14.1 in the same size case formerly housing both capacitors.

39. Par.2-11. No specific tests for acceleration could be given. The equipment operated without failure due to shock or vibration in Naval aircraft.

40. Par.2-13. No spare parts were furnished. All similar parts of the two preliminary equipments were interchangeable. The coil boxes are interchangeable only if recalibrated.

41. Par.2-15. Results of specific tests are discussed later.

42. Par.2-16. Not all wires are securely fastened before soldering. The pyrex oscillator coil forms were not suitably mounted to prevent breakage in the preliminary model. This was corrected in the modified model.

43. Par. 2-17. An interlock switch is provided to cut off the power supply to the equipment when changing tubes, coils, or fuses.

44. Par.2-18. Certain capacitors in the oscillating circuits showed evidence of leaking after being subjected to high temperatures. These capacitors were sealed but apparently require more careful sealing around the terminals.

45. Par. 2-19. Shock mountings of live rubber are furnished.
46. Par. 2-20. The lead from oscillator grid to grid leak is excessively long and not supported against vibration effects. The rectifier plate leads broke repeatedly due to handling and vibration.
47. Par. 2-21. The wiring used has a heavy insulation which is slow burning. No satisfactory flameproof insulation has yet been developed.
48. Par. 2-24. The controls provided are a minimum. The circuit, however, as used in the preliminary models was not easily adjusted and permitted the operator to adjust the output circuits to harmonic frequencies unknowingly. This was corrected by a redesign of the output circuits in the modified model, as shown on Plate 15.
49. Par. 2-27. Controls designated "A" and "C" should be designated in reverse order to maintain sequence of tuning operations.
50. Par. 2-29. No failures occurred due to heating or cooling. No salt water immersion tests were given.
51. Par. 2-31. The operation of the equipment was satisfactory with all tubes furnished by the contractor.
52. Par. 2-33. Instances of unsatisfactory performance are cited elsewhere in this report.
53. Par. 2-36. The dimensions and weights are given in Table 45 of the appendix. The total weight is 82.5 pounds which is 4.5 pounds less than specified. Some variation from these tabulated results is to be expected in production.
54. Par. 2-38. An arc occurred in tuning unit II at 800 kilocycles. Several flashovers occurred during flight tests at high altitudes as reported in NASA Report, Appendix B.
55. Par. 2-40. The phenolic internal loading coil form originally supplied has been replaced with a ceramic form.
56. Par. 2-41. Moisture which collected on the coil and plugs during temperature tests did not interfere with operation. The controls remained operative at all temperatures. The knob on the external loading coil is too small and not operable while wearing heavy gloves. It should be replaced by a knob similar to that used for the master oscillator switch.
57. Par. 2-42. Grounding one side of the 800 cycle supply does not interfere with operation.
58. Par. 2-43. Meters do not have black background. The visibility of the dial on the internal loading coil should be increased. White marking on a black background should be provided for this dial as well as the

master oscillator dial. Meters should be marked with a red line at normal operating values.

59. Par. 3-1(1). All radio frequency circuits, except antenna loading for 300 - 550 kilocycles, with power transformers, relays, etc., are contained in the transmitter unit.

(2). The modulator is supplied integral with the transmitter-rectifier unit.

(3). The circuit consists of a master oscillator, intermediate amplifier, and power amplifier .

(4). The specified frequency range, except range (c) 1500 - 3000 kilocycles, which was not required on the contract, ref.(c), is covered as shown by the calibration, Table 2 of the appendix.

(5). The transmitter delivers the required power into the specified antennas on CW and MCW. The output on phone is low. The measured outputs are shown on Tables 3 to 10 inclusive of the appendix.

(6). The equipment operates from the Type NEA-1 alternator. The A.C. input is less than 850 V.A. as shown by Tables 3 to 10 inclusive, of the appendix. The D.C. required is less than 1.5 amperes at 15 volts as shown by Table 11 of the appendix.

60. Par. 3-2. The equipment will not fit into the mounting box specified, but will fit into the airplanes for which it is intended. The overall size is shown in Table 45 of the appendix. The increased size is due to incorporation of the modulator in the transmitter rectifier unit. Thus the overall space requirement is less than required by these specifications.

61. Par. 3-3. The required range is covered by the tuning units as shown in Table 2 of the appendix. They form an integral part of the transmitter as specified when inserted in the transmitter case.

62. Par. 3-4. The tuning units are rugged and are provided with suitable plug contacts for electrical contact. The snap slides provided are not considered strong enough for service use. A suitable knurled screw locking device should be provided. Covers to protect the tuning units when not in use are provided.

63. Par. 3-5. Access for removing tubes is as specified. However, the buffer amplifier shield is too flimsy and cumbersome. Access for repair is by removing top or bottom of transmitter. Screws on top panel are easily lost. They should be made non-looseable or preferably be replaced by snap slides as suggested in NASA Report, Appendix B. The relay may be adjusted by removing a small access panel on the side.

64. Par. 3-6. The controls are as specified in this paragraph. Backlash is discussed under Par. 3-30.

65. Par. 3-8. The contractor supplied a heavy plug-in cable for antenna connection. This plug necessitates the use of excessively large bowl type insulators for the antenna terminal on the transmitter and antenna loading coil. The NASA report suggests a standard stand-off insulator with screw terminal fitted with a "Rajah" connector which would be preferable to the present terminal.

66. Par. 3-9. The keying relay is designed to function as required by this paragraph. This operation on the preliminary models was not entirely satisfactory. The modified model used an improved relay which gave satisfactory break-in reception at keying speed. A further discussion of this operation will be found in NASA Report, Appendix B. The external loading coil was necessary to resonate a 350 foot trailing wire antenna to 550 kilocycles.

67. Par. 3-10. Side tone for monitoring telegraphic transmission is provided. The side tone level measurements are shown on Table 12 of the appendix. These measurements show 2.8 volts across 600 ohms which corresponds to 16.1 volts across 20,000 ohms.

68. Par. 3-11. All contacts and switches are enclosed in the transmitter cabinet or control boxes.

69. Par. 3-13. Power control is provided by means of a step adjustment of screen voltage.

70. Par. 3-14. Power factor correction condensers are provided which are adjustable in steps from the front panel.

71. Par. 3-15. NASA Report, Appendix B, gives results of break-in operation tests.

72. Par. 3-16. The emission is free from objectionable key clicks, lilt, etc. With the original circuit it was possible to inadvertently adjust the output to the harmonic frequency. Several such instances occurred during test. The modified model incorporates a change in the circuit which eliminates this probability. The note on high frequencies was rather rough and fluttering. This was corrected by the contractor on the modified model by removing a by-pass condenser which inadvertently gave a coupling which led to instability. Plate 10 shows oscillograms of the rectified output and side tones of the transmitter while being keyed at 25 words per minute. From this oscillograph it will be seen that the keying is quite good.

73. Par. 3-17. MCW is provided by removing a portion of the rectifier filter from the circuit.

74. Par. 3-19. The complete frequency range may be covered and adjustment to any frequency may be made by means of the controls on the front panel. No antenna ammeter was supplied. While it is possible to tune the modified model without such a meter, it would be preferable to have such a meter. Tuning operations, especially, by relatively inexperienced personnel would be expedited.

75. Par. 3-20. The calibration chart furnished was not satisfactory. It was not waterproof and could easily be lost. The designation of controls "A" and "C" should be interchanged.

76. Par. 3-21. The preliminary model could not be adjusted to frequency in one man-minute due to the complicated method of adjusting the output circuits. With the modified model the transmitter could be adjusted to frequency in the required time except when the frequency fell at such a point on the dials as to require turning such dials from one extreme to the other.

(1). Reset measurements were made which show that the equipment may be reset to a previous calibration as required. The reset measurements taken in the Laboratory are shown in Table 13 of the appendix. Reset measurements taken during flight are recorded in Table 14 of the appendix. It will be noted that the resets are remarkably good.

(2)(a). Measurements of frequency drift under conditions of full power operation with key locked or keying at 25 words per minute for one-half hour at room temperature are shown in Tables 15 to 21 inclusive. From these results it will be seen that under conditions of keying the drift is less than 0.05% in all cases. The low frequency tuning units do not meet 0.05% in all cases with the key locked. Some variation between the two models is shown by comparing Table 20 with Table 21.

(b). Frequency variation over a wide range of ambient temperature is shown in Tables 23 to 30 inclusive and Plates 1 to 9 inclusive. From this data it will be seen that in some cases the drift for the first 10° C exceeds the specified 0.05%. However, in all cases the average drift for 10° C is less than 0.05%. It is interesting to note that the frequency stability is better at the higher frequencies and also that it is practically independent of power output.

(c). Variation in frequency due to variation of antenna constants is shown in Table 31. In most cases this variation in frequency is not great. This is due largely to the fact that an intermediate amplifier is used between the oscillator and power amplifier.

(d). Table 32 shows frequency variation due to the variation in supply voltage of 10%. In no case does this frequency variation exceed 100 cycles.

(e). Frequency drift measurements were taken during actual flight while the plane climbed to altitudes of 15,000 feet or more. These results are shown on Tables 33 to 37 of the appendix. From these tables it will be seen that only on the lowest frequency of 358 kilocycles did the total drift exceed 0.05%.

If the above frequency variations are added arithmetically for the various conditions, the variations exceed 0.05%. However, some conditions cause an increase in frequency and others a decrease. Also while taking runs at varying ambient temperatures the first half hour drift is included in the temperature run. Under service condi-

87. Par. 3-38. As shown on the oscillographs of Plate 10, the percentage ripple on CW is 0.56% and on phone is 0.95%. This is in excess of that required by these specifications. However, satisfactory signals were produced on CW and voice which were free from hum due to the ripple in the high voltage supply. Therefore, the filter is considered adequate.

88. Par. 3-39. The power factor correction capacitors enable the equipment to operate with less than 2% variation in filament voltage between the key up and key down position when properly adjusted.

89. Par. 3-41. The equipment as delivered did not operate satisfactorily with the standard Navy type aircraft microphone. An adjustment of the resistor in the microphone circuit permitted satisfactory operation.

90. Par. 4-1. The modulator is incorporated in the same case which houses the transmitter and rectifier. By means of the cables from the control boxes it provides the necessary energy from the microphone circuit and supplies it to the transmitter to provide substantially complete modulation of the carrier in the phone position.

91. Par. 4-2. This paragraph is not applicable since the modulator is not a separate unit.

92. Par. 4-3. Tables 41 and 42 show the fidelity of the audio amplifier and modulator from microphone input to modulator output. With a probable accuracy of $\pm 5\%$ for this test it will be seen that the equipment just meets the requirements of this specification. Table 43 shows the voltage necessary at the primary of the microphone transformer to produce 100% modulation.

93. Par. 4-4. The harmonic content of the modulated carrier does not exceed the specified maximum of 10% as shown by the results of Table 44. These measurements were not taken at 85 watts output since this equipment is not capable of such output on phone. Additional analyses of the modulation were made by the cathode ray oscillograph. Photographs of the modulation patterns are shown in Plates 11 to 14 inclusive of the appendix. From these plates it will be seen that there is no phase shift with amplitude but there is a phase shift with frequency. Such a condition produces satisfactory modulation. It will also be seen that there is a somewhat greater degree of modulation in the negative direction than in the positive direction. This, however, does not result in excessive harmonic distortion but does decrease somewhat the effective side band power. This condition exists only at modulation percentages above 80%, and is a characteristic usually found with screen grid modulation. Voice communication was satisfactory at all times.

94. Par. 4-5. Table 12 gives the side tone level on phone which is used for monitoring voice transmission. This level is usually sufficient but should be increased slightly for all conditions encountered in Naval aircraft. The emission selector also selects the proper side tone.

95. Par. 4-7. Detuning the antenna circuit results in no damage to the equipment. However, such detuning has some effect upon the quality of voice signals but not of such magnitude as to seriously affect intelligibility.

96. Par. 4-8. An external loading coil for operation at frequencies between 350 and 550 kilocycles is provided. The inductance is not adequate to load a 350 foot antenna to the lowest frequency.

97. Par. 4-10. As originally supplied only three taps were provided on the external loading coil. This gave insufficient range of control of the inductance and the modified model was provided with five taps as required by this specification.

98. Par. 4-11. Since the case of this coil is being redesigned the dimensions are not available. As originally supplied the overall size was excessive.

99. Par. 4-12. The coil case is being redesigned to permit mounting on the left side of the cockpit with the controls facing aft.

100. Par. 5-1. A pilot's control box functioning as specified is provided.

101. Par. 5-2. An operator's control box functioning as specified is provided.

102. Par. 5-3. The weights of the control boxes are shown in Table 45. The overall dimensions are excessive due to the extension of the plugs and controls. They are being redesigned and a sample was exhibited at the conference of 25 - 26 November 1935 which was satisfactory.

103. Par. 5-4. External connections are by means of shielded plugs. As originally supplied all plugs were excessively heavy due to the cast shells. The modified model uses a stamped shell housing which is satisfactory. The control box covers were hinged for access to the interior. The telephone type jacks were so located that there was a possibility of breaking the plugs when raising the cover. The modified model corrected this fault.

104. Par. 5-11. Details of the microphone tests are given below.

105. Par. 5-13. Defects in the antenna reel encountered during flight tests are enumerated in NASA Report, Appendix B, of this report.

106. Par. 5-16. Fuses are provided which may be replaced by removing the tuning unit and several tubes. They should be relocated to provide better accessibility.

107. Par. 5-17. Suitable slip covers for protection from spray, rain, etc., are provided.

108. The following discussion refers to the tests of the two microphones submitted by the manufacturer. They were tested in accordance with the requirements of NAF Specifications T-38a-1, ref.(k). The paragraph notation refers to corresponding paragraphs of that specification.

109. Par. E. The microphone submitted consists of the switch, mouthpiece, microphone unit. The cord is flexible, 2 conductor, shielded, and rubber covered and the plug is Navy Type No. 49007. There is no hand grip or holder for microphone when not in use.

110. Par. E-2b. The dimensions of the microphone correspond with the drawing in Fig. II of Specification T-38a-1.

111. Par. E-2b(1). The weight of the microphone, complete with cord and plug, is slightly less than seven ounces.

112. Par. E-2c. No hand grip has been supplied.

113. Par. E-2d. The microphone assembly gave efficient and satisfactory operation in the ICS circuit of the Model RU-3 receiver.

114. Par. E-2e. The switch is of the plunger type with an axial movement of exactly 1/8". It provided momentary contact when depressed and continuous contact when rotated 90° in the depressed condition.

115. Par. E-2e(1). The switch can readily be operated by a heavily gloved hand.

116. Par. E-2e(2). Two pounds pressure is sufficient to depress the switch and one pound pressure will suffice to keep it closed.

117. Par. E-2f. The electrical circuit corresponds to the standard Navy microphone circuit.

118. Par. E-3a. Resistance to vibration except for contact trouble was satisfactory.

119. Par. E-3c(1). The microphone unit is constructed with sufficient ruggedness so that it will withstand a direct blow by a blunt instrument on either the face or back.

120. Par. E-3c(2). A cloth screen prevents dust and dirt from getting into the microphone unit.

121. Par. E-3d. The microphones were subjected to extreme temperatures in so far as this was feasible with laboratory equipment. The equipment operated satisfactorily between the limits of -25°C and +50°C. No output runs were taken at those temperatures other than an intelligibility test in which disconnected words were copied by two observers and at all times the results were 95% correct. It was agreed that heating the microphones caused no noticeable difference in the operation of the microphones and cooling the microphones lessened their sensitivity slightly, but this was due probably to the moisture which had collected on the subject equipment during the cooling process.

122. Par. E-3e(1). The center contact of the microphone did not meet the gold plating requirement of this specification but appeared to be made of solder and did not give satisfactory contact at all times.

123. Par. E-3h(1). The length of the cord was 46" as required.

124. Par. E-3h(2). No unnecessary strain was exerted on the electrical connections at the microphone end of the cord.

125. Par. E-5a. Tests were made at 4-1/2 volts and operation was always satisfactory.

126. Par. E-5b. No noticeable packing occurred in the microphones when an 8.5 volt 1000 cycle signal impressed across a 49016 Navy headphone was coupled to the microphone. A 3/4" sponge rubber, doughnut shaped spacer separated the headphone from the microphone and the signal was continued for a period of more than five hours with only a slight deterioration in the operation of the microphone. This deterioration was so small that it could not be detected when listening to the microphone operating through the ICS circuit of the Model RU-3 receiver. During the entire test the microphone was placed in an abnormal position to emphasize any packing that might occur.

127. Par. E-5c. Anti-noise characteristics were entirely satisfactory when compared to a standard microphone during flight tests.

128. Par. E-5d. The sound frequency range is shown in Tables 46 and 47, but it must be remembered that the characteristic of the headphone will affect the curve of the microphone response. The headphone response curve shows a maximum at 1100 cycles and another at 400 cycles: above 1400 cycles the headphone response drops off quite rapidly and in a general way the curves showing the microphone output are similar to the headphone characteristic. Consequently the curves cannot be trusted for absolute value, but they are satisfactory for comparative purposes.

129. Par. E-5e. Switch mechanism did not make satisfactory contact under all conditions.

130. Pars. E-6, E-7, E-8, E-8a. No hand grip, wiring diagram, or microphone holder were supplied to the Laboratory.

131. In addition to the above defects, these microphones were not interchangeable with other Navy aircraft microphones in that the D.C. currents were not the same. Flight tests showed these microphones to be too sensitive and the intelligibility was less than with the Navy microphone. Results of flight tests are discussed further in ref.(1).

132. The following summary of defects includes defects noted in the preliminary models. If such defects were corrected in the modified models, it is so stated.

- (a) Wiring is poor in that some joints depend on solder for mechanical strength.
- (b) Certain dials did not seem true and scraped on the panel.
- (c) Beaded leads to rectifier plates broke during tests. This has been corrected by using a different wire.
- (d) Condensers 14.1 and 14.2 broke down during test. This has been corrected by eliminating condenser 14.2 and increasing the dielectric strength of condenser 14.1.
- (e) A defective plate milliammeter was supplied with one equipment. This was replaced.
- (f) The knob on the external loading coil is too small.
- (g) The loading provided by the loading coils was insufficient.
- (h) The external loading coil had only three adjustment taps. Five taps are required.
- (i) Pilot's control box was incorrectly wired. This has been corrected.
- (j) The hinged covers on the control box may interfere with plugs. This has been corrected.
- (k) Breakdowns of the radio frequency circuits occurred at high altitudes. This was corrected.
- (l) Variometers in the plate circuit of the power amplifier showed an open circuit under torsion.
- (m) The means for securing the coil boxes in the transmitter are inadequate. Thumb screw clamps should be used.
- (n) A fluttering note developed at high frequencies. This was corrected.
- (o) The power output on phone is low.
- (p) It was possible to inadvertently tune the output circuits to harmonic frequencies. This was corrected by a redesign of the output circuit.
- (q) Keying relays failed at 25 w.p.m. This was corrected.
- (r) Frequency drift on the low frequency coil boxes was greater than allowed by the specifications.
- (s) The keying relay was not accessible for adjustment. This has been corrected.

- (t) Fuses are not readily accessible.
- (u) The buffer shield is too flimsy and poorly supported.
- (v) Poor visibility of the internal loading coil dial is provided.
- (w) The master oscillator dial is not provided with white marking on a black background.
- (x) Loose turns were found on some inductances.
- (y) No end stops are provided on controls.
- (z) The dial locks permit the stops to be lost inside the set.
- (aa) Grid lead of master oscillator is not properly supported.
- (bb) No antenna ammeter was provided.
- (cc) Microphones are not satisfactory, neither are they interchangeable with standard Navy aircraft microphones.

CONCLUSIONS

133. As a result of these tests the following conclusions were reached. These conclusions are based on tests of the preliminary and modified models. Conclusions reached due to tests of the preliminary model which were changed by tests of the modified model will not be included herein, since the basis of further action will be the modified model.

134. The Model GP-1 equipment does not meet the requirements of the specifications, ref.(b), in full.

135. The frequency drift of the low frequency tuning units exceeds the requirements of the specifications. However, in actual service use, these units should be satisfactory since the drift in cycles is such that the frequency never drifts beyond an audible beat note under the worst conditions.

136. The power output in the phone position is low. Since operation on phone is a secondary consideration, this should not prove to be a serious defect. The phone power available is in excess of 30 watts.

137. Poor workmanship is found in wiring and in the alignment of certain dials and inductances. Proper shop technique and inspection should prevent this occurrence in production models.

138. The ripple in the plate supply exceeds that allowed by the specifications. Tests show the emission to be free from objectionable hum, however, and the present filter is considered adequate.

139. The microphones supplied by the contractors are unsatisfactory.

140. The snap slides used for securing the tuning units are too fragile. They should be replaced by thumb screws.

141. Better and more convenient accessibility to the fuses should be provided. The buffer amplifier shield should be redesigned and strengthened.

142. Tuning may be expedited by means of an antenna ammeter, particularly when operated by inexperienced personnel.

143. The Model GP-1 equipment in general exhibits excellent qualities. The equipment should be suitable for the Naval aircraft service if the contractor corrects the deficiencies noted herein. The performance in general is excellent and should be a valuable addition to aircraft communication facilities.

Table 1

Instrument and Type	Manufacturer	Ser. No.	Accuracy
Voltmeter, Mod. 341, 0-150 V. A.C.	Weston Instrument Co.	8661	0.25%
Voltmeter, Mod. 45, 0-2500 V. D.C.	" " "	406040	0.5%
Ammeter, Mod. 370, 0-10 amperes, A.C.	" " "	4576	0.25%
Ammeter, Mod. 425, 0-2 amperes, R.F.	" " "	2480	2%
Ammeter, Mod. 425, 0-5 amperes, R.F.	" " "	22205	2%
Wattmeter, Mod. 310, 0-1000 watts	" " "	8922	0.25%
Frequency Meter, Mod. LD-2	General Radio Company	1	0.005%
Beat Frequency Oscillator, Type 513-B	" " "	80	<2% (Harmonics)
Output Meter, Type 583-A	" " "	63	5%
Cathode Ray Oscillograph, Type 687-A	" " "	132	
Wave Analyzer, Type 636-A	" " "	102	0.5%
Oscillograph, style 509823	Westinghouse Mfg. Co.	913659	
Frequency Drift Indicator, Mod. LX	Radio Research Company.	2	0.0002%(drift)
Audio Amplifier	Naval Research Laboratory	Aircraft	± 1 db
Mixing Panel	" " "	"	
Temperature Control Cabinet	Oppenheim Corp.		± 1° C.

Table 2

Calibration of Model GP-1 Transmitter

Test as per paragraphs 3-1(4) and 3-28 of Specifications RE 13A 490B.

Unit I.

Transmitter No. 1					Transmitter No. 2				
<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>Frequency</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	
1	34	1	32	350 kcs	1	41	1	19	
6	77	1	49	400	6	60	1	40	
9	38	1	56	433	9	13	1	50	
1	78	2	55	425	1	25	2	48	
4	19	2	60	450	3	57	2	52	
7	84	2	68	500	7	30	2	59	
9	48	2	70	525	8	74	2	64	
2	76	3	70	525	1	65	3	64	
4	61	3	73	550	3	49	3	65	
7	63	3	79	600	6	57	3	72	
10	0	3	85	640	8	53	3	77	
1	21	4	85	640	0	82	4	77	
4	88	4	90	700	4	31	4	83	
7	21	4	92	750	6	64	4	87	
9	13	4	95	800	8	51	4	90	
9	64	4	96	810	8	86	4	90	

Unit II.

0	42	1	6	790	1	73	1	13	
3	70	1	29	850	4	64	1	37	
5	89	1	42	900	7	65	1	45	
7	71	1	48	950	8	31	1	50	
1	50	2	53	1000	3	96	2	54	
3	56	2	56	1050	5	70	2	59	
5	35	2	60	1100	7	22	2	63	
6	88	2	65	1150	8	52	2	68	
8	20	2	72	1200					
9	47	2	80	1250					
0	30	3	60	1100	1	79	3	63	
2	32	3	64	1150	3	60	3	68	
4	5	3	72	1200	5	05	3	76	
5	57	3	80	1250	6	43	3	81	
6	85	3	84	1300	7	64	3	86	
8	3	3	87	1350	8	67	3	88	
9	11	3	89	1400	4	63	4	91	

Table 2 (continued)

Transmitter No. 1				Unit II	Transmitter No. 2			
<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>Frequency</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>
1	0	4	83	1300 kcs	1	90	4	85
2	63	4	86	1350	3	33	4	88
4	9	4	88	1400	4	64	4	91
5	40	4	90	1450	5	83	4	93
6	54	4	92	1500	6	90	4	94
7	59	4	95	1550	7	88	4	96
8	52	4	100	1600	8	75	4	100
Unit IV.								
0	61	1	11	2940	2	14	1	7
2	86	1	33	3100	3	98	1	28
4	8	1	42	3200	4	98	1	32
5	17	1	44	3300	5	90	1	40
6	13	1	49	3400	6	73	1	45
7	80	1	55	3600	8	18	1	52
9	25	1	63	3800				
0	47	2	50	3400				
2	81	2	55	3600	1	02	2	52
4	73	2	63	3800	2	94	2	58
6	32	2	69	4000	4	58	2	64
7	68	2	77	4200	5	98	2	72
8	82	2	85	4400	7	19	2	79
9	60	2	87	4520	7	82	2	82
				4600	8	23	2	84
				4800	9	21	2	87
Unit V.								
4	33	1	9	4400	3	16	1	48
5	73	1	18	4600	4	18	1	53
6	92	1	37	4800	6	01	1	56
7	96	1	44	5000	7	15	1	59
8	91	1	49	5200	8	11	1	65
1	54	2	44	5000	1	23	2	60
2	97	2	49	5200	2	70	2	64
4	26	2	52	5400	3	98	2	73
5	42	2	56	5600	5	15	2	80
6	41	2	60	5800	6	16	2	85
7	32	2	65	6000	7	08	2	88
8	13	2	73	6200	7	90	2	90
8	90	2	79	6400	8	65	2	92
9	61	2	82	6560	9	27	2	93

Table 2 (continued)

Unit VI.

Transmitter No. 1					Transmitter No. 2				
<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>Frequency</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	
0	31	1	8	6000 kcs	0	59	1	10	
3	13	1	21	6400	3	20	1	22	
5	33	1	44	6800	5	30	1	46	
7	7	1	51	7200	7	00	1	52	
8	48	1	55	7600	8	42	1	57	
9	14	1	58	7800					
1	10	2	53	7400	2	04	2	55	
3	22	2	58	7800	4	03	2	61	
5	2	2	66	8200	5	72	2	69	
6	50	2	77	8600	7	15	2	80	
7	78	2	83	9000	8	36	2	85	
8	87	2	87	9400					
9	67	2	90	9640					

Table 3

Unit I - Original Model GP-1 Transmitter

Determination of Power Output

Tests as per paragraph 3-1(5) of RE 13A 490B.

<u>Control or Meter</u> <u>Transmitter</u>	355 kcs #1	355 kcs #2	544 kcs #1	544 kcs #2	800 kcs #1
A	2	2	6	3	8
B	46.5	00	65	49	91.5
C	1	1	3	3	4
D	31	30	78	68	94
E	25	65	58	33	72
F	40	56	68	15	83
G	3	2	1	1	5
Ca	250	250	250	250	400
Ra	28.6	28.5	24.4	24.4	28.6
Line Volts	120	113	119	111	121
Line Amperes	6.3	6.0	6.5	5.7	6.9
Input Watts	700	650	700	640	740
Ant. Amps.	1.83	1.85	2.15	1.9	2.15
IP	230	200	230	230	230
CW Power- Watts	96	98	113	88	132
Spec. Req.	85	85	100	100	100
MCW Power	111	114	129	118	138
MCW Input	780	750	730	740	800
Phone Power	37.2	25.7	41.2	23	36.5
Spec. Req.	60	60	75	75	85

Table 4

Unit II - Original Model GP-1 Transmitter

Determination of Power Output

Tests as per paragraph 3-1(5) of RE 13A 490B

<u>Control or Meter</u> <u>Transmitter</u>	800 kcs #1	800 kcs #2	1500 kcs #1
A	1	2	6
B	1	25	9
C	1	1	4
D	7	17.5	92
E	20	71	88
F	48	60	88
G	4	3	5
Ca	400	400	300
Ra	28.6	28.5	13.3
Line Volts	119	112	118
Line Amps.	6.5	6.7	6.8
Input Watts	680	690	700
Ant. Amps.	2.3	2.15	3.0
IP	230	230	230
CW Power-Watts	151	132	120
Spec. Req.	125	125	125
MCW Power	165	157	123
MCW Input	740	755	780
Phone Power	48.4	28.5	43
Spec. Req.	85	85	85

Table 5

Unit IV - Original Model GP-1 Transmitter

Determination of Power Output

Tests as per paragraph 3-1(5) of RE 13A 490B.

<u>Control or Meter</u> <u>Transmitter</u>	3475 kcs #1	3475 kcs #1	4235 kcs #1	4235 kcs #1	3500 kcs #2
A	6	6	7	7	7
B	63.5	63.5	75.5	75.5	40
C	1	1	2	2	1
D	53	50	79	78	48
E	74	0	88	7	57
F	0	12	15	57	48
G	5	5	5	5	5
Ca	-	150	-	150	-
Ra	Lamp	4.05	Lamp	4.05	35.2
Line Volts	120	120	123	119	111
Line Amps.	5.5	6.4	5.7	6.8	6.4
Input Watts	650	700	680	700	650
Photo Cell or Ia	200	3.4	195	4.2	2.0
Ip	225	205	230	230	200
CW Power-Watts	150	47	150	71.5	141
Spec. Req.	125	50	125	50	125
MCW Power	155	52.5	155	78.5	155
MCW Input	700	720	730	760	670
Phone Power	72	21.5	65	32	41
Spec. Req.	85	50	85	50	85

Table 6

Unit V - Original Model GP-1 Transmitter

Determination of Power Output

Tests as per paragraph 3-1(5) of RE 13A 490B

<u>Control or Meter</u> <u>Transmitter</u>	5000 kcs #1	5000 kcs #2	6200 kcs #1
A	7	7	8
B	94	15	10.5
C	1	1	2
D	43.5	60	72
E	62	77	79
F	42	35	53
G	5	5	5
Ca	-	-	-
Ra	35.2	35.2	35.2
Line Volts	122	111	122
Line Amps.	6.9	6.6	6.9
Input Watts	750	670	740
Ant. Amps.	2.25	2.0	2.25
Ip	230	200	230
CW Power - Watts	176	141	176
Spec. Req.	125	125	125
MCW Power	202	155	202
MCW Input	760	710	780
Phone Power	59.5	33.7	69
Spec. Req.	85	85	85

Table 7

Unit VI - Original Model GP-1 Transmitter

Determination of Power Output

Tests as per paragraph 3-1(5) of RE 13A 490B

<u>Control or Meter</u> Transmitter	6200 kcs. #1	6200 kcs. #1	7700 kcs. #1	7700 kcs. #1	9050 kcs. #1	9050 kcs. #1	7700 kcs. #2
A	1	1	2	2	7	7	3
B	87	87	69	69	77	77	50
C	1	1	2	2	2	2	2
D	11	15	57	57	83	82	58
E	80	62	91	82	83	75	91
F	12	63	43	87	9	36	42
G	5	5	5	5	6	6	5
Ca	-	-	-	-	-	-	-
Ra	35.2	16.25	35.2	16.25	35.2	16.25	35.2
Line Volts	117	119	120	121	121	119	116
Line Amps.	6.6	6.7	6.8	6.8	6.7	6.8	6.0
Input Watts	680	700	720	740	720	740	640
Ant. Amps.	2.15	3.1	2.25	3.2	2.1	3.0	2.02
Ip	230	230	230	230	230	230	230
CW Power - Watts	163	156	178	166	155	146	144
Spec. Req.	125	50	125	50	125	50	125
MCW Power	203	177	202	177	170	156	155
MCW Input	770	760	740	740	750	800	690
Phone Power	69	72	69	72	69	59	37.0
Spec. Req.	85	50	85	50	85	50	85

Table 8

Resubmitted Model Serial #1, GP-1 Transmitter

Determination of Power Output

Tests as per paragraph 3-1(5) of RE 13A 490B

<u>Control or Meter</u> Unit	355 kcs I	544 kcs I	800 kcs I	800 kcs II	1500 kcs II
A	2	6	8	1	6
B	46.5	65	91	1	9
C	1	3	4	1	4
D	39	76.5	93.5	14	95
E	3	31	98.0	4	87
F	60	62	54	84	60
G	52	52	35	43	19
Ca	310	544	400	400	300
Ra	28.6	24.4	28.6	28.6	13.0
Line Volts	125	124	125	125	124
Line Amps.	5.85	5.7	5.8	5.8	5.8
Input Watts	680	660	670	670	670
Ant. Amps.	1.83	2.1	1.93	2.05	3.0
Ip	230	230	230	230	230
CW Power- Watts	96	108	106	120	117
Spec. Req.	85	100	100	125	125
MCW Power	114	135	118	145	137
MCW Input	780	790	785	770	780
Phone Power	34	41	30.0	48	38
Spec. Req.	60	75	85	85	85

Table 9

Resubmitted Model Serial #1, GP-1 Transmitter

Determination of Power Output

Tests as per paragraph 3-1(5) of RE 13A 490B

<u>Control or Meter</u> <u>Unit</u>	3475 kcs IV	3475 kcs IV	4235kcs IV	4235 kcs IV	5000 kcs V	6200 kcs V
A	6	6	7	7	7	8
B	55	55	75	75	94	10
C	1	1	2	2	1	2
D	50	48	78	78	48	76
E	33	35	71	71	51	79
F	78	25	76	20	85	80
G	7	9	4	6	2	3
Ca	250	150	250	150	250	150
Ra	41.6	4.06	41.6	4.06	41.6	41.6
Line Volts	125	125	124	125	124	123
Line Amps.	5.8	5.7	5.8	5.8	5.8	5.8
Input Watts	670	660	670	670	670	670
Ant. Amps.	1.88	3.7	1.92	4.1	1.91	1.82
Ip	230	230	230	230	230	230
CW Power - Watts	147	55	153	68	153	138
Spec. Req.	125	50	125	50	125	125
MCW Power	166	62	166	79	166	166
MCW Input	725	713	730	730	740	730
Phone Power	48	16	52	21.5	50	46
Spec. Req.	85	50	50	50	50	50

Table 11

Model GP-1 Transmitter (Resubmitted Model)

Current required by Key Relay

	<u>Voltage</u>	<u>Current</u>
Key up	12.30	0.16
Key down	12.25	1.14
Key down + Mic.	12.25	1.22

Generator Started

Key up	14.25	0.19
Key down	14.10	1.32
Key down + Mic.	14.10	1.41

Table 12

Model GP-1 Transmitter (Resubmitted Model)

Side Tone and Voice Monitoring Voltage

Tests as per paragraphs 3-10, 3-37, 4-5 of Specifications RE 13A 490B.

<u>Load</u>	<u>Voltage</u>	<u>Emission Selector</u>
600	2.8	CW
600	2.8	MCW
600	3.5	Phone

583-A Output Meter No. 63

Required by Specifications 5 to 15 volts

Table 13

Model GP-1 Transmitter (Original Model #1)

Reset Accuracy - Bench Test

Test as per paragraph 3-21-1 of Specifications RE 13A 490B

<u>Unit</u>	<u>Freq.Kcs.</u>	<u>Reset Freq. Kcs.</u>	<u>Cycles Dev.</u>	<u>%</u>
I	350.315	350.290	25	0.006
I	802.125	802.100	25	0.003
II	850.500	850.560	60	0.007
II	1500.390	1500.370	20	0.001
IV	3001.700	3002.250	450	0.015
IV	4501.450	4501.500	100	0.002
V	4501.700	4502.200	500	0.011
V	6002.000	6002.500	500	0.008
VI	6503.400	6503.700	300	0.005
VI	9002.300	9002.400	100	0.001

Permitted by Specifications 0.03%

Table 14

Model GP-1 Transmitter (Original Model #1)

Reset Accuracy - Flight Tests

Tests as per paragraph 3-21-1 of Specifications RE 13A 490B

<u>Unit</u>	<u>Freq. kcs</u>	<u>Reset Freq. Kcs.</u>	<u>Deviation</u>	<u>%</u>
I	355.28	355.31	30	0.009
I	793.83	793.75	80	0.01
II	798.56	798.53	30	0.004
II	1478.62	1478.49	130	0.009
IV	3409.96	3410.20	60	0.002
IV	4214.51	4214.36	150	0.004
V	4991.82	4992.05	230	0.005
V	6190.63	6190.88	250	0.004
VI	6203.20	6202.82	380	0.006
VI	7682.5	7682.0	500	0.007
VI	8997.0	8997.3	300	0.003

Permitted by Specifications 0.03%

Table 17

Model GP-1 Equipment (Original Model) #1

Half hour runs, lock key, full power CW, and 25 words per minute
full power CW.

Tests as per paragraph 3-21(2) of RE 13A 490B

Unit IV				
3000 kcs			4500 kcs	
<u>Minutes</u>	<u>Lock Key Freq.</u>	<u>25 W/Min. Freq.</u>	<u>Lock Key Freq.</u>	<u>25 W/Min Freq.</u>
0	3003.000	3002.150	4501.700	4503.025
5	2.450	2.150	1.050	3.025
10	2.325	2.450	1.050	3.025
15	2.200	2.475	1.070	3.250
20	2.100	2.460	1.500	3.325
25	2.150	2.425	1.650	3.325
30	<u>2.475</u>	<u>2.500</u>	<u>1.500</u>	<u>3.300</u>
Variation (cycles)	900	350	650	275
%	0.03	0.012	0.015	0.006

Table 18

Model GP-1 Equipment (Original Model) #1

Half hour runs, lock key, full power CW, and 25 words per minute
full power CW.

Tests as per paragraph 3-21(2) of RE 13A 490B

Unit V				
4500 kcs			6000 kcs	
<u>Minutes</u>	<u>Lock Key Freq.</u>	<u>25 W/Min Freq.</u>	<u>Lock Key Freq.</u>	<u>25 W/Min Freq.</u>
0	4502.125	4502.150	5999.450	6001.800
5	1.200	1.950	5998.925	6000.900
10	1.000	2.060	6000.000	6001.325
15	.850	2.100	.250	.625
20	.700	2.060	.325	.875
25	.340	2.050	.450	6002.000
30	<u>.325</u>	<u>1.900</u>	<u>.800</u>	<u>.225</u>
Variation (cycles)	1800	250	1875	1325
%	0.04	0.006	0.031	0.022

Table 19

Model GP-1 Equipment (Original Model) #1

Half hour runs, lock key, full power CW and 25 words per minute
full power CW.

Test as per paragraph 3-21(2) of RE 13A 490B

Unit VI

<u>Minutes</u>	6500 kcs		9000 kcs	
	<u>Lock Key</u> <u>Freq.</u>	<u>25 W/Min.</u> <u>Freq.</u>	<u>Lock Key</u> <u>Freq.</u>	<u>25 W/Min.</u> <u>Freq.</u>
0	6503.450	6502.800	9004.600	9002.500
5	1.350	1.700	2.800	2.575
10	.730	1.500	2.900	2.850
15	0	1.600	4.000	3.250
20	.250	2.050	4.500	3.550
25	1.100	2.050	4.400	4.150
30	<u>.500</u>	<u>2.300</u>	<u>4.600</u>	<u>5.000</u>
Variation (cycles)	3450	1300	1800	2500
%	0.053	0.02	0.02	0.028

Table 20

Model GP-1 Equipment (Original Model) #2

Half hour runs, full power locked key CW

Unit	I	II	IV	V	VI	VI
Minutes	500 kcs	1500 kcs.	3000kcs	4500kcs	6500kcs	9000 kcs
0	501.750	1502.050	3002.200	4501.000	6500.400	9001.000
5	1.700	1.450	1.400	0.500	6498.850	1.100
10	1.650	1.250	1.000	0.400	6498.250	2.000
15	1.600	1.150	1.050	1.650	6498.000	2.000
20	1.565	1.100	1.260	3.400	6498.500	2.500
25	1.540	1.075	1.750	3.350	6500.750	1.200
30	<u>1.510</u>	<u>1.100</u>	<u>1.730</u>	<u>3.300</u>	<u>.700</u>	<u>0.500</u>
Variation (cycles)	240	975	1200	3000	2750	2000
%	0.048	0.065	0.04	0.067	0.043	0.022

Table 21

Model GP-J Equipment (Resubmitted Model) #1

Half hour runs full power locked key CW

Unit	I	II	IV	V	VI
Minutes	500 kcs	1000 kcs	3500 kcs	5500 kcs	7500 kcs
0	501.975	1001.000	3503.500	5504.250	7502.900
5	1.950	1000.820	2.525	3.000	1.500
10	1.925	.675	2.260	2.650	1.950
15	1.875	.550	1.950	2.400	2.150
20	1.810	.400	1.750	2.100	1.850
25	1.735	.300	2.550	2.500	1.400
30	<u>1.660</u>	<u>.275</u>	<u>2.500</u>	<u>2.450</u>	<u>1.850</u>
Variation (cycles)	315	725	1750	2150	1500
%	0.063	0.073	0.05	0.039	0.02

Table 22

Model GP-1 Transmitter (Original Model) #1

Frequency Variation with Change of Ambient Temperature

Test as per paragraph 3-21(2)(b) of Specifications RE 13A 490B

Unit I, 500 kcs, 64 watts Output

<u>Time</u>	<u>Ambient °C</u>	<u>Frequency</u>
1514	-29.5	502.600 kcs
20	-26.0	2.400
25	-21.5	2.300
30	-17.0	2.300
35	-15.5	2.200
40	+1.0	2.150
45	5.0	2.050
50	9.0	1.950
55	13.0	1.875
1600	17.0	1.775
05	21.0	1.650
10	26.0	1.550
15	29.0	1.450
20	32.0	1.375
25	36.0	1.325
30	39.0	1.200
35	43.0	1.100
40	45.0	1.050
45	47.0	0.950
50	49.0	0.900

54
1 hr. 40 min.

50.0
79.5° C

0.875
1.725

1,725 cycles = 0.345% = 0.043% per 10° C.

See Plate 1.

Table 23

Model GP-1 Transmitter (Original Model) #1

Frequency Variation with Change of Ambient Temperature

Test as per paragraph 3-21(2)(b) of Specifications RE 13A 490B.

Unit II, 1500 kcs, 92 watts output.

<u>Time</u>	<u>Ambient °C</u>	<u>Frequency</u>
1332	-30.5	1504.750 kcs
38	-28.0	3.000
45	-21.0	2.250
50	-10.0	1.850
55	0	1.500
1400	+5.0	1.300
05	9.0	1.000
10	13.0	0.700
15	18.0	0.300
20	21.0	0.150
25	24.0	1499.900
30	28.0	9.650
35	32.0	9.500
40	35.0	9.450
45	39.0	9.250
50	41.0	9.200
55	45.0	9.050
1500	48.0	8.900
<u>05</u>	<u>50.0</u>	<u>8.875</u>
1 hr. 33 min.	80.5°C	5.875

5875 cycles = 0.392% = 0.049% per 10° C. See Plate 2

Table 24

Model GP-1 Transmitter (Original Model) #1

Frequency Variation with Change of Ambient Temperature

Test as per paragraph 3-21(2)(b) of Specifications RE 13A 490B

Unit IV, 3000 kcs, 85 watts output.

<u>Time</u>	<u>Ambient °C.</u>	<u>Frequency</u>
0808	-32	3004.750 kcs
15	-29	2.700
20	-24	2.250
25	-13	2.150
30	-4	2.000
35	+1	1.850
40	5	1.650
45	9	1.200
50	14	0.800
55	18	0.500
0900	21	0.300
05	25	3000.000
10	28	2999.800
15	32	9.500
20	35	9.200
25	38	9.350
30	41	9.650
35	44	9.350
40	47	9.150
45	49	8.900
<u>47</u>	<u>50</u>	<u>8.750</u>
1 hr. 39 min.	82° C.	6.000

6000 cycles = 0.2% = 0.025% per 10° C.

See Plate 3.

Table 26

Model GP-1 Transmitter (Original Model) #1

Frequency Variation with Change of Ambient Temperature

Test as per paragraph 3-21(2)(b) of Specifications RE 13A.490B.

Unit IV, 4500 kcs, 121 watts output

<u>Time</u>	<u>Ambient °C.</u>	<u>Frequency</u>
0805	-32	4505.050 kcs
10	-29	2.450
15	-25	2.050
20	-21	1.500
25	-8	1.400
28	-7	1.400
30	-0	1.400
35	+5	1.500
40	9	1.300
45	13	1.150
50	16	1.000
55	20	0.900
0900	24	0.800
10	31	0.350
15	35	0.300
20	38	0.850
25	40	0.500
30	43	0.150
35	46	4499.850
40	49	9.650
<u>43</u>	<u>50</u>	<u>9.500</u>
1 hr. 38 min.	82° C.	5.550

5550 cycles = 0.123% = 0.015% per 10° C. See Plate 5.

Table 27

Model GP-1 Transmitter (Original Model) #1

Frequency Variation with Change of Ambient Temperature

Test as per paragraph 3-21(2)(b) of Specifications RE 13A 490B.

Unit V, 4500 kcs, 150 watts output

<u>Time</u>	<u>Ambient ° C</u>	<u>Frequency</u>
1405	-30	4504.500 kcs
10	-29	1.350
15	-24	0.800
17	-22	1.000
20	-20	0.900
25	-17	0.800
30	-15	0.600
35	-6	0.700
40	+1	0.650
45	6	0.500
50	11	0.200
55	15	4500.000
1500	19	4499.750
05	22	9.650
10	26	9.400
15	30	9.000
20	33	8.700
25	36	8.450
30	39	8.450
35	42	8.250
40	45	8.000
45	47	8.000
50	49	7.350
<u>52</u>	<u>50</u>	<u>7.800</u>
1 hr. 47 min.	80° C.	6.700

6700 cycles = 0.149% = 0.018% per 10° C. See Plate 6.

Table 28

Model GP-1 Transmitter (Original Model) #1

Frequency Variation with Change of Ambient Temperature

Test as per paragraph 3-21(2)(b) of Specifications RE 13A 490B

Unit V, 6500 kcs, 96 watts output

<u>Time</u>	<u>Ambient °C</u>	<u>Frequency</u>
0925	-29.5	6504.700 kcs
30	28	2.950
35	26	2.500
40	22	2.150
45	18	2.000
50	16	1.950
55	14	1.850
1000	12	1.850
05	10	1.800
10	9	1.650
14	4	2.250
15	2	1.650
20	+7	2.050
25	10	2.000
30	15	1.800
35	19	1.850
40	22	1.800
45	27	1.500
50	30	1.150
55	34	1.100
1100	37	1.300
05	41	6500.750
10	43	0.500
15	46	0.400
20	48	0.350
<u>23</u>	<u>50</u>	<u>0.250</u>
1 hr. 58 min.	79.5° C.	4450

4450 cycles = 0.068% = 0.0087% per 10° C. See Plate 7.

Table 29

Model GP-1 Transmitter (Original Model)#1

Frequency Variation with Change in Ambient Temperature

Test as per paragraph 3-21(2)(b) of Specifications RE 13A 490B.

Unit VI, 6500 kcs, 45 watts output

<u>Time</u>	<u>Ambient °C</u>	<u>Frequency</u>
1008	-30	6504.750 kcs
10	-29	3.100
15	-25	1.450
20	-20	6500.000
25	-17	6499.550
30	-15	8.900
35	-4.5	8.650
40	+3	8.100
45	7	7.500
50	12	6.800
55	18	6.250
1100	20	5.650
05	24	5.200
07	26	5.000
10	27	4.800
15	31	4.200
20	34	3.900
25	37	4.700
30	40	4.800
35	43	3.900
40	46	3.400
45	48	3.100
<u>49</u>	<u>50</u>	<u>3.000</u>
1 hr. 41 min.	80° C.	11750

11750 cycles = 0.18% = 0.022% per 10° C.

See Plate 8.

Table 30

Model GP-1 Transmitter (Original Model) #1

Frequency Variation with Change in Ambient Temperature

Test as per paragraph 3-21(2)(b) of Specifications RE 13A 490B

Unit VI, 9000 kcs, 74 watts output

<u>Time</u>	<u>Ambient °C.</u>	<u>Frequency</u>
1405	-30	9004.600 kcs
10	-27	1.000
15	-22	8999.550
20	-19	8.900
25	-9	8.450
30	0	7.400
35	4	7.350
45	13	6.550
50	17	6.300
55	21	6.200
1500	24	6.000
05	28	5.800
10	31	6.000
15	34	6.600
20	37	6.950
25	40	6.900
30	42	6.500
35	47	6.600
<u>48</u>	<u>50</u>	<u>6.900</u>
1 hr. 43 min.	80	8.800

8800 cycles = 0.098% = 0.012% per 10° C.

See Plate 9.

Table 31

Model GP-1 Transmitter (Original Model) #1

Variation of Frequency due to Change of Antenna Constants

Test as per paragraph 3-21(2)(c) of RE 13A 490B

<u>Unit</u>	<u>Ca</u>	<u>Freq.Kcs</u>	<u>Cycles Variation</u>	<u>%</u>
I	700	500.250		
	900	.200	50	0.01
	540	.150	100	0.02
	400	802.500		
	300	.650	150	0.019
	475	.650	150	0.019
II	400	850.600		
	490	.550	50	0.006
	300	.550	50	0.006
	300	1500.520		
	375	.980	460	0.031
	225	.930	410	0.027
IV	270	3001.900		
	310	3001.800	100	0.003
	230	3002.000	100	0.003
V	300	4502.400		
	375	2.450	50	0.001
	225	2.250	150	0.003
VI	300	9005.000		
	375	.9005.400	400	0.004
	225	9004.600	400	0.004

Table 32

Model GP-1 Transmitter (Original Model) #1

Frequency Change due to Variation of Supply Line Voltage

Test as per paragraph 3-21(2)(d) of RE 13A 490B.

<u>Unit</u>	<u>Freq.</u>	<u>Ef=9.5</u>	<u>Ef=10.0</u>	<u>Ef=10.5</u>	<u>Max. Change</u>	<u>%</u>
I	350	350.300	350.280	350.250	50 cycles	0.014
I	800	802.400	802.350	802.300	100	0.012
II	850	850.210	850.200	850.180	30	0.004
II	1500	1500.260	1500.245	1500.230	30	0.002
IV	3000	3000.900	3000.897	3000.895	5	0.000
IV	4500	4501.000	4500.950	4500.900	100	0.002
V	4500	4500.445	4500.435	4500.420	25	0.001
V	6000	4500.700	4500.710	4500.720	10	0.000
VI	6500	6500.700	6500.650	6500.650	50	0.001
VI	9000	9000.100	9000.125	9000.150	50	0.001

Table 33

Model GP-1 Transmitter (Original Model) #1

Frequency Drift during Actual Flight

Full Power Key Locked CW

<u>Time</u>	<u>Altitude ft.</u>	<u>Temperature °F.</u>	<u>Freq.</u>
1025	2500	80	358.17 kcs
33	3000	77	.18
36	4000	73	.19
38	5000	74	.20
41	6000	72	.21
45	7000	67	.23
48	8000	71	.23
50	9000	71	.23
55	10000	64	.23
59	11000	66	.24
1103	12000	59	.25
07	13000	60	.26
11	14000	59	.27
18	15000	54	.28
30	15000	48	.43

260 cycles =
0.074%

Table 34

Model GP-1 Transmitter (Original Model) #1

Frequency Drift during Actual Flight

Full Power Key Locked CW.

<u>Time</u>	<u>Altitude ft.</u>	<u>Temperature °F.</u>	<u>Frequency</u>
1355	1500	90	1478.97 kcs
1400	2000	87	8.85
04	3000	84	9.01
06	4000	82	8.99
08	5000	76	9.02
11	6000	74	8.94
15	7000	70	9.02
18	8000	68	.04
20	9000	64	.07
23	10000	62	.16
25	11000	60	.21
29	12000	58	.26
32	13000	52	.41
38	14000	50	.49
44	15000	48	.60
52	16000	46	<u>.60</u>

630 cycles =
0.042%

Table 35

Model GP-1 Transmitter (Original Model) #1

Frequency Drift during Actual Flight

Full Power Key Locked CW

<u>Time</u>	<u>Altitude ft.</u>	<u>Temperature °F.</u>	<u>Frequency</u>
1015	1000	90	4213.6 kcs
18	2000	88	13.6
21	3000	85	13.9
24	4000	84	14.1
27	5000	83	14.4
30	6000	78	14.6
33	7000	78	14.6
36	8000	74	14.7
40	9000	67	14.8
43	10000	68	14.7
47	11000	61	14.7
51	12000	57	14.7
56	13000	55	14.8
1102	14000	52	14.9
13	15000	48	15.1
			1.5 kcs =
			0.035%

Table 36

Model GP-1 Transmitter (Original Model) #1

Frequency Drift during Actual Flight

Full Power Key Locked CW

<u>Time</u>	<u>Altitude ft.</u>	<u>Temperature °F.</u>	<u>Frequency</u>
1341	5000	-	6188.5 kcs
43	5000	-	88.5
47	6000	72	89.4
53	7000	72	89.3
1402	8000	67	89.8
07	9000	63	6190.1
12	10000	59	90.2
16	11000	55	90.3
23	12000	53	90.4
28	13000	51	90.6
35	14000	49	90.6
45	15000	45	90.7
53	16000	42	90.8
1506	16800	38	90.9
			2.4 kcs =
			0.039%

Table 40

Model 3P-1 Transmitter (Original Model)

Conversion Factor of Rectifier Circuit

Test as per paragraph 3-35 of RE 13A 490B

$$\text{Efficiency of Conversion} = \frac{\text{Total D.C. Output}}{\text{Input to plate transformer}}$$

Total D.C. output = 1090 volts x 0.382 amps. = 416 watts

Input to plate transformer = 487 watts

$$\text{Efficiency} = \frac{416}{487} = 85.4\%$$

Rectifier filaments require 8 amperes, 2.5 volts each (2)

Efficiency of conversion required by specifications 80%

Table 41

Model GP-1 Transmitter (Original Model) #1

Audio Frequency Characteristic of Modulator

Test as per paragraph 4-3 of Specifications RE 13A 490B

Input voltage adjusted to one volt and output of modulation transformer measured across 600 ohm impedance.

<u>A.F. Input</u> <u>Cycles</u>	<u>Output</u> <u>Milliwatts</u>	<u>Decibels</u>	<u>Variation</u> <u>from average</u>
200	500	19.2	-2.2
300	900	21.7	+0.3
500	950	22.0	+0.6
1000	900	21.7	+0.3
2000	875	21.6	+0.2
3000	825	21.4	0.0
5000	1050	<u>22.4</u>	+1.0

Average = 21.4

Table 42

Microphone Input adjusted to 2.0 Volts

<u>A.F. Input cycles</u>	<u>Output milliwatts</u>	<u>Decibels</u>	<u>Variation from Average</u>
200	1600	24.25	-1.64
300	2400	26.02	+0.13
500	2600	26.36	+0.47
1000	2700	26.53	+0.64
2000	2600	26.36	+0.47
3000	2450	26.10	+0.21
5000	2200	<u>25.63</u>	-0.26

Average = 25.89

Db in above tables calculated with 6 milliwatts as standard signal. Variation permitted by specifications 2.0 db.
1.0 volts input gives modulation of the order of 100%.

Table 43

Microphone Input Volts Required to Produce 100% Modulation.

<u>Audio Frequency</u>	<u>Input Volts for 100% Modulation at 500 kc Carrier</u>	<u>Input Volts for 100% Modulation at 9000 kc Carrier</u>
200	1.36	1.26
300	0.86	0.76
400	0.88	0.80
500	0.88	0.80
1000	0.84	0.88
2000	0.88	0.88
3000	0.84	0.80
4000	0.80	0.70
5000	0.64	0.56

Table 44

Model GP-1 Transmitter (Original Model) #1

Audio Frequency Harmonic Content of Modulated Radio Frequency Carrier.

Test as per paragraph 4-4 of Specifications RE 13A 490B

800 kcs

Audio Input (cycles)	Harmonic Order and Millivolts Content										Harmonic Content %
	1	2	3	4	5	6	7	8	9	10	
200	1000	12	70	27	26	24	15	0	0	6	8.54
300	1000	32	23	23	17	6	5	10	0	5	5.04
400	1000	23	10	35	12	4	3	0	0	3	4.50
500	1000	30	10	38	8	4	5	5	0	0	5.06
1000	1000	60	24	26	5	10	10	4	4	2	7.15
2000	1000	40	44	70	9	22	5	2	0	0	9.50
3000	1000	35	50	58	4	0	0	0	0	0	8.43
4000	1000	16	46	37	0	0	0	0	0	0	6.12
5000	1000	3	34	0	0	0	0	0	0	0	3.4

Coil Box I Phone Position, Modulation between 90% and 100%
Distortion permitted by Specifications 10%

Table 45

Model GP-1 Transmitter Resubmitted Model

Weights and Dimensions

<u>Transmitter</u>	<u>Case</u>	<u>Overall</u>
Length	18"	21-3/4"
Width	11-3/4"	13-1/8"
Depth	10-1/8"	10-1/2"

Approximately 3/4" is required to remove power cable and 6" for removing tuning unit.

	Weight		Weight
Transmitter	53 lbs. 8 oz.	Pilot's Control Box	1 lb. 1 oz.
Tuning Unit IV	8 " 8 "	Operator's " "	2 " 1 "
Set Vacuum Tubes	1 " 8 "	Antenna Load Coil	3 " 2 "
Transmitter	63 lbs. 8 oz.	Two Microphones	13 "
Accessories	12 " 1 "	Two Keys	14 "
Set Cables	6 " 4 "	Antenna Reel	3 " 0 "
Total	81 lbs. 13 oz.	Fairlead	1 " 2 "
		Total weight of accessories	12 lbs. 1 oz.

Table 46

Characteristics of No. 3 Microphone

E_{mc} = 4.1 volts, Output read in milliwatts, Input 17 volts
across standard headphone acoustically coupled
to microphone.

<u>Cycles</u>	<u>Original Characteristic</u>	<u>Characteristic after 1 hr. immersion and 15 min. drying</u>	<u>Characteristic after one hour immersion and thorough drying.</u>
100	8.0	5.0	8.0
200	15.0	4.2	12.8
300	18.0	4.1	14.8
400	17.0	4.8	12.0
500	17.4	4.8	14.0
600	20.0	5.2	12.4
800	20.0	11.0	20.8
1000	25.0	7.2	15.1
1200	21.0	6.0	8.0
1400	16.0	3.8	7.4
1600	11.0	4.0	5.1
1800	8.4	3.6	5.0
2000	4.2	2.0	4.0
2500	2.0	2.2	3.8
3000	4.9	1.4	2.4
3500	6.2	1.4	2.8

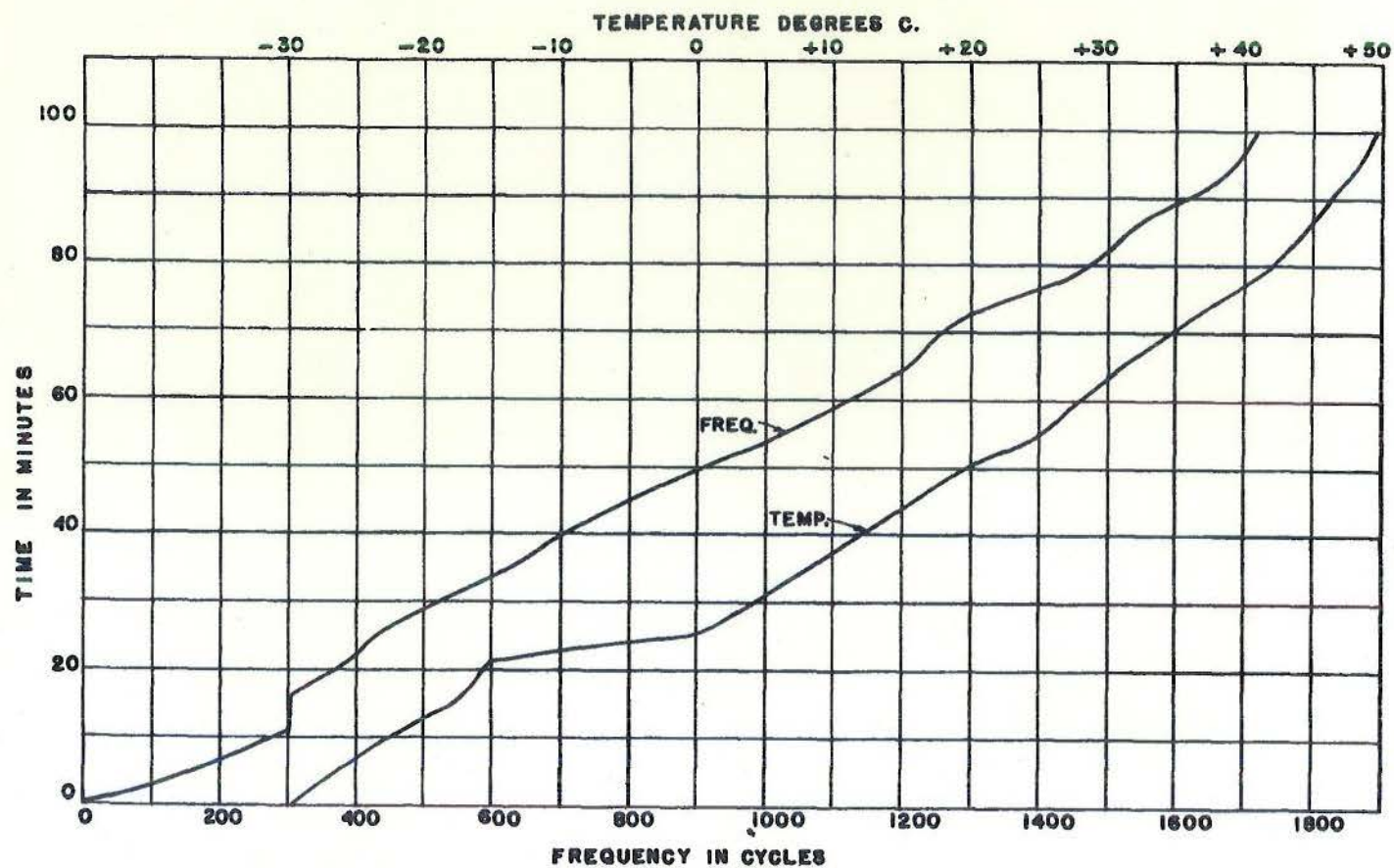
Table 47

Characteristics of No. 4 Microphone

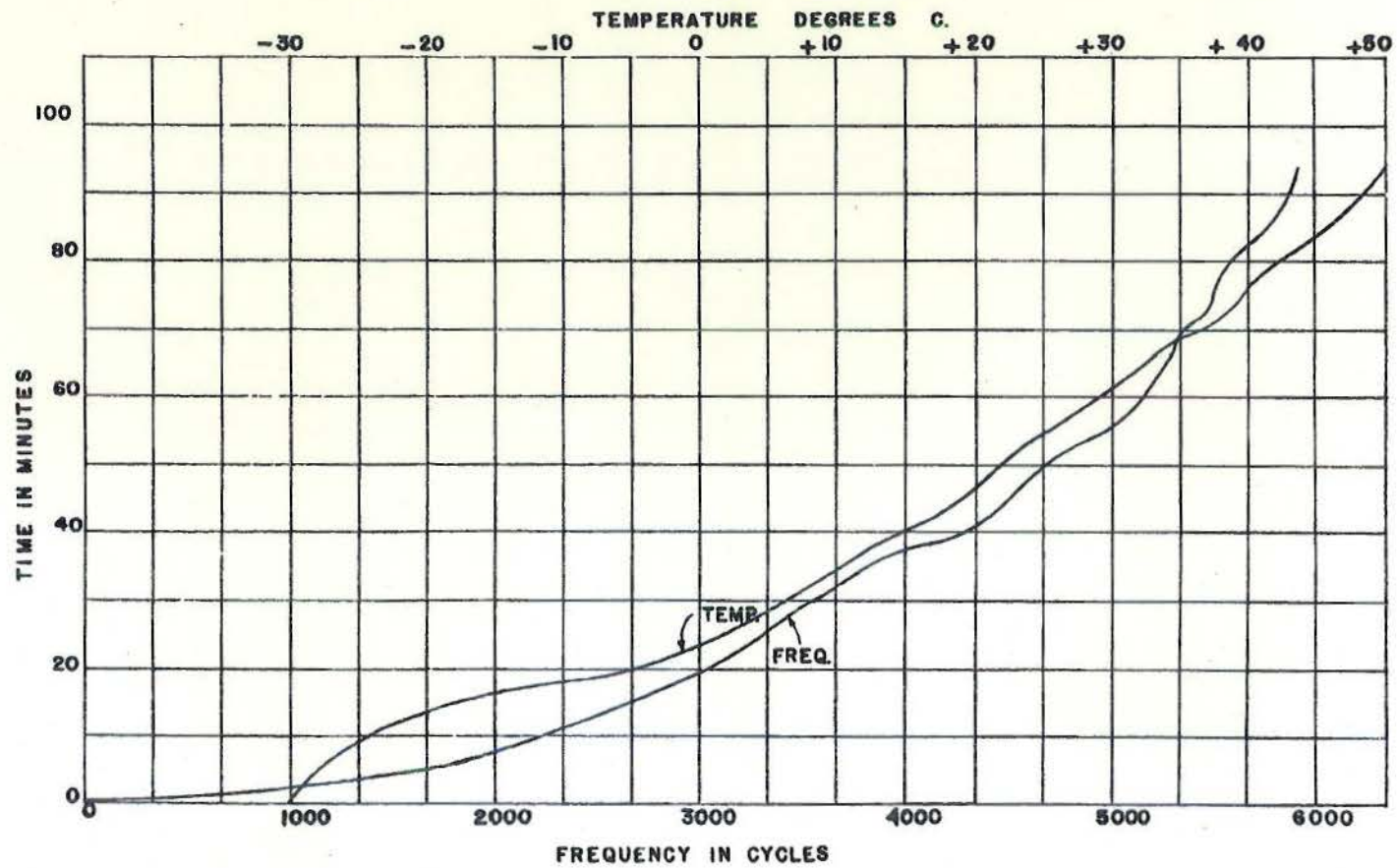
E_{mc} = 4.1 volts, Output read in milliwatts, Input 17.0 Volts
across standard headphone acoustically coupled to
microphone.

<u>Cycles</u>	<u>Original Characteristic</u>	<u>Characteristic 1 hr. immersion and 15 min. drying</u>	<u>Characteristic 1 hr. immersion and thorough drying</u>
100	3.4	3.0	9.6
200	3.0	2.6	10.6
300	6.0	2.6	8.0
400	3.2	3.0	9.0
500	10.0	3.6	12.3
600	9.0	5.0	7.0
800	19.4	10.0	18.8
1000	14.0	7.0	14.0
1200	5.4	4.0	1.2
1400	9.0	5.0	1.8
1600	7.0	4.0	4.4
1800	6.0	3.8	3.8
2000	5.0	3.0	1.4
2500	7.0	2.4	1.0
3000	4.2	2.0	0.8
3500	2.0	1.6	0.6

FREQUENCY DRIFT
OF
GP-I AIRCRAFT TRANSMITTER
COIL I 500 KCS 64 WATTS
TOTAL DRIFT 0.34 %



FREQUENCY DRIFT
OF
6P-1 AIRCRAFT TRANSMITTER
COIL II 1500 KCS. 92 WATTS
TOTAL DRIFT 0.392 %



FREQUENCY DRIFT
OF
GP-1 AIRCRAFT TRANSMITTER
COIL IV 3000 KCS 85 WATTS
TOTAL DRIFT 0.2 %

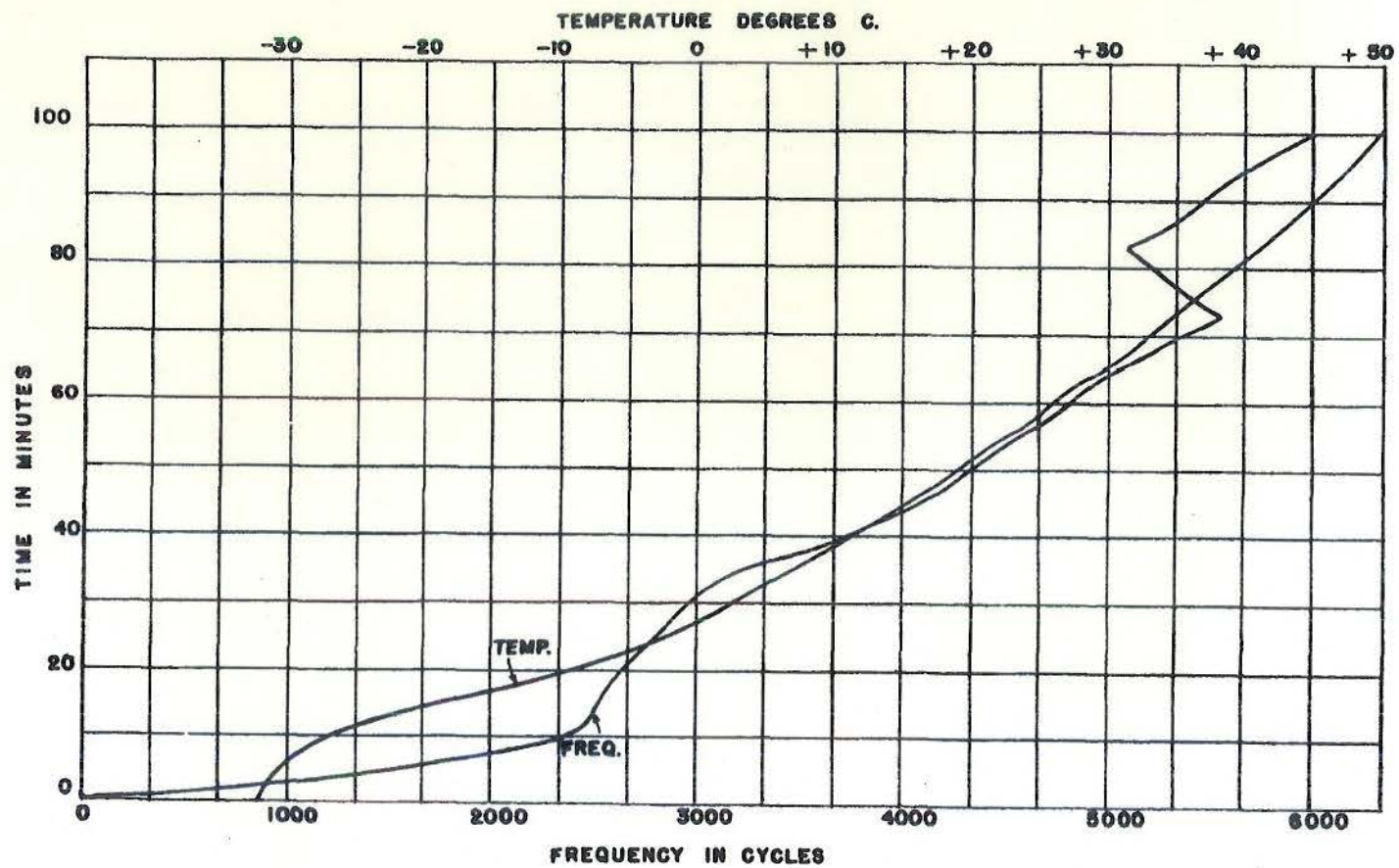
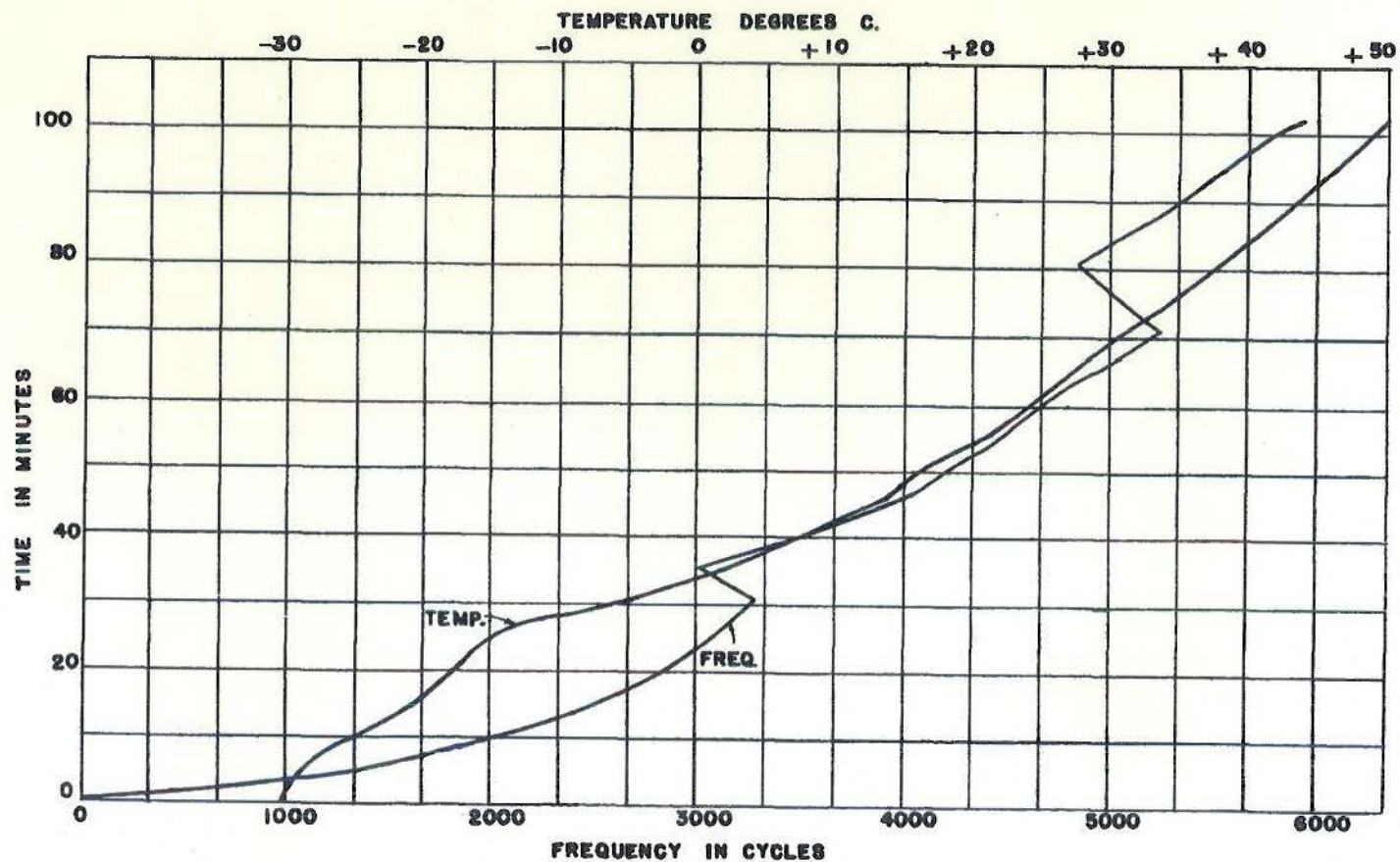
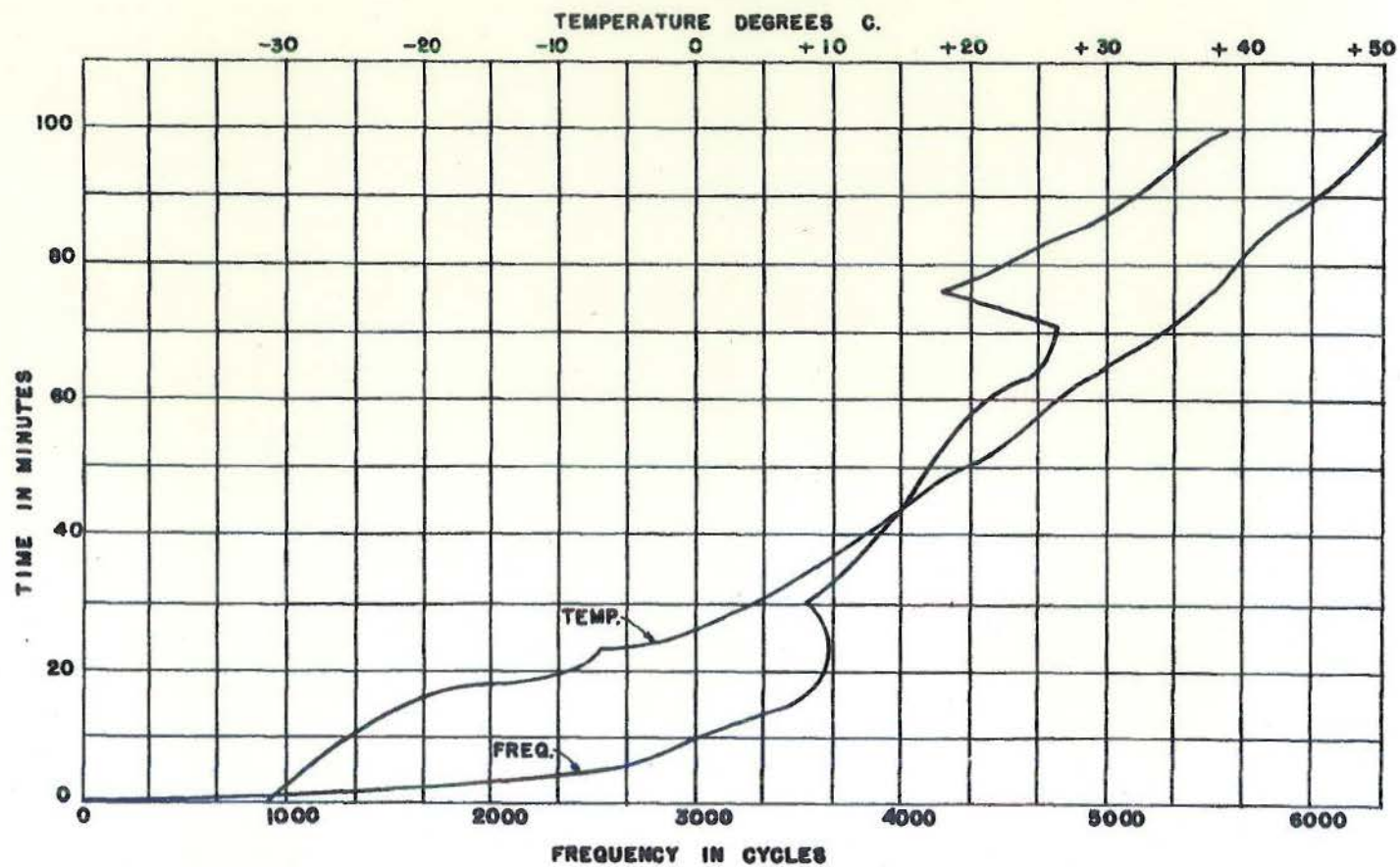


PLATE 3

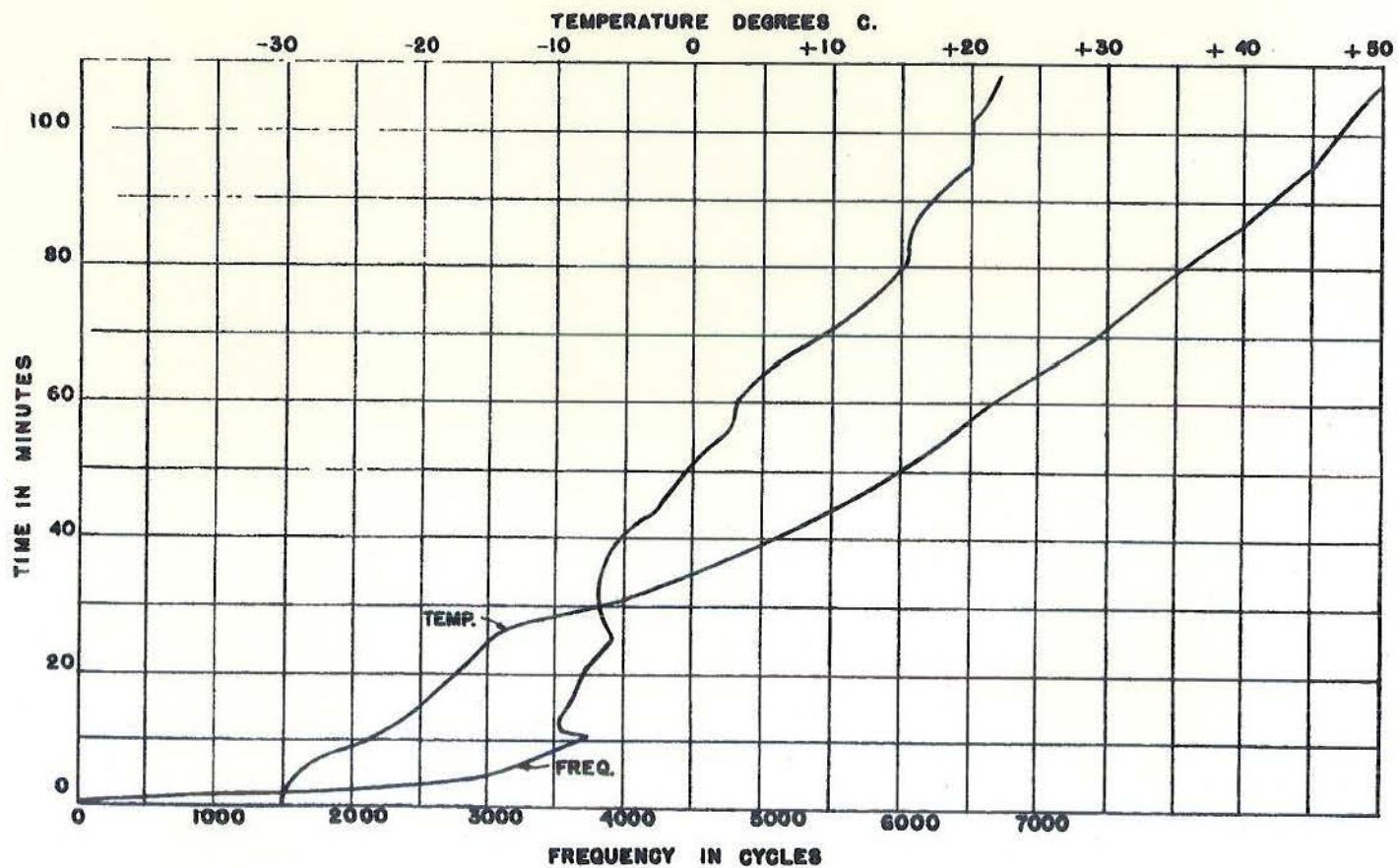
FREQUENCY DRIFT
OF
GP-1 AIRCRAFT TRANSMITTER
COIL IX 3000 KCS. 150 WATTS
TOTAL DRIFT 0.197 %



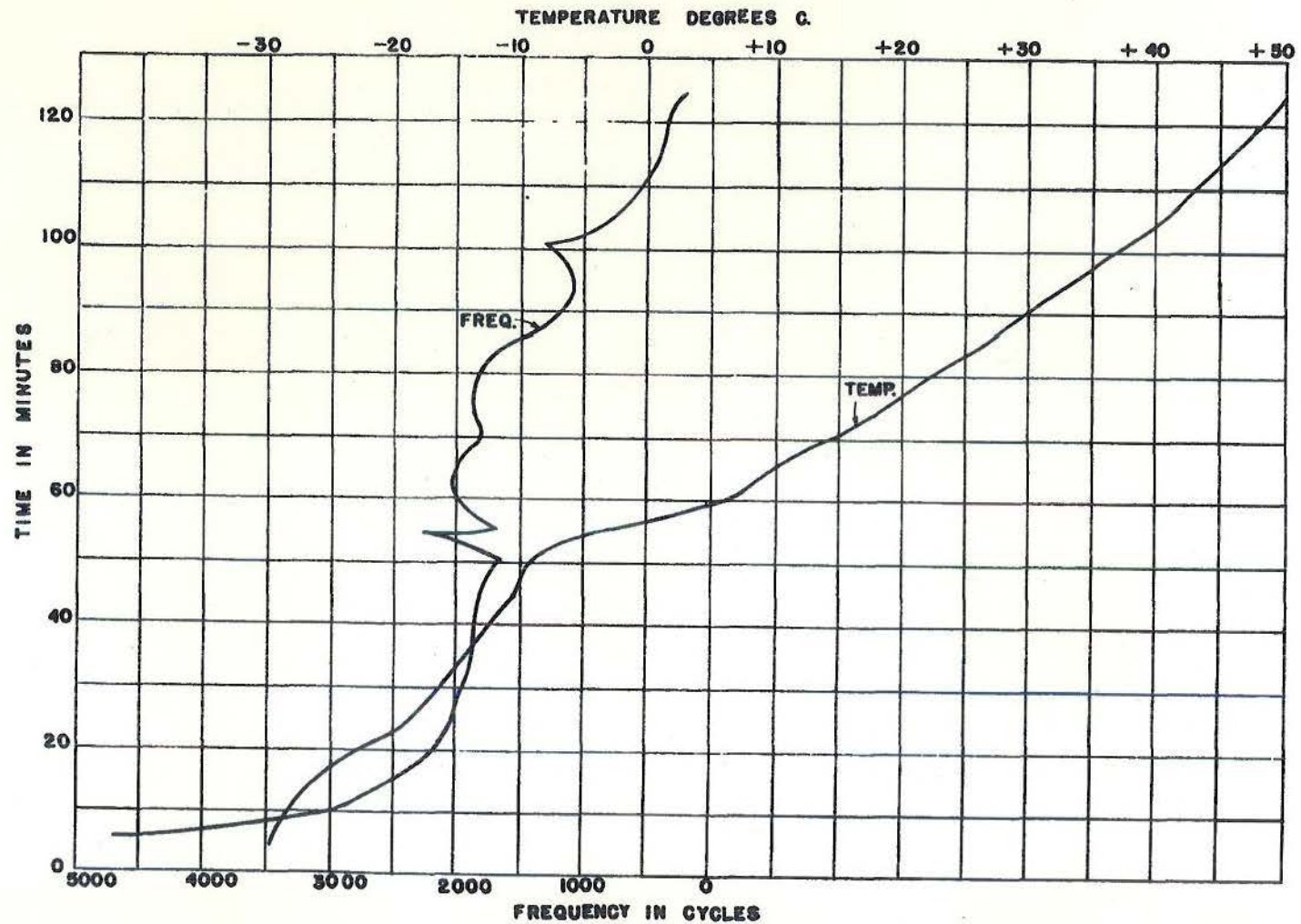
FREQUENCY DRIFT
OF
6P-1 AIRCRAFT TRANSMITTER
COIL IV 4500 KCS. 121 WATTS
TOTAL DRIFT 0.12 %



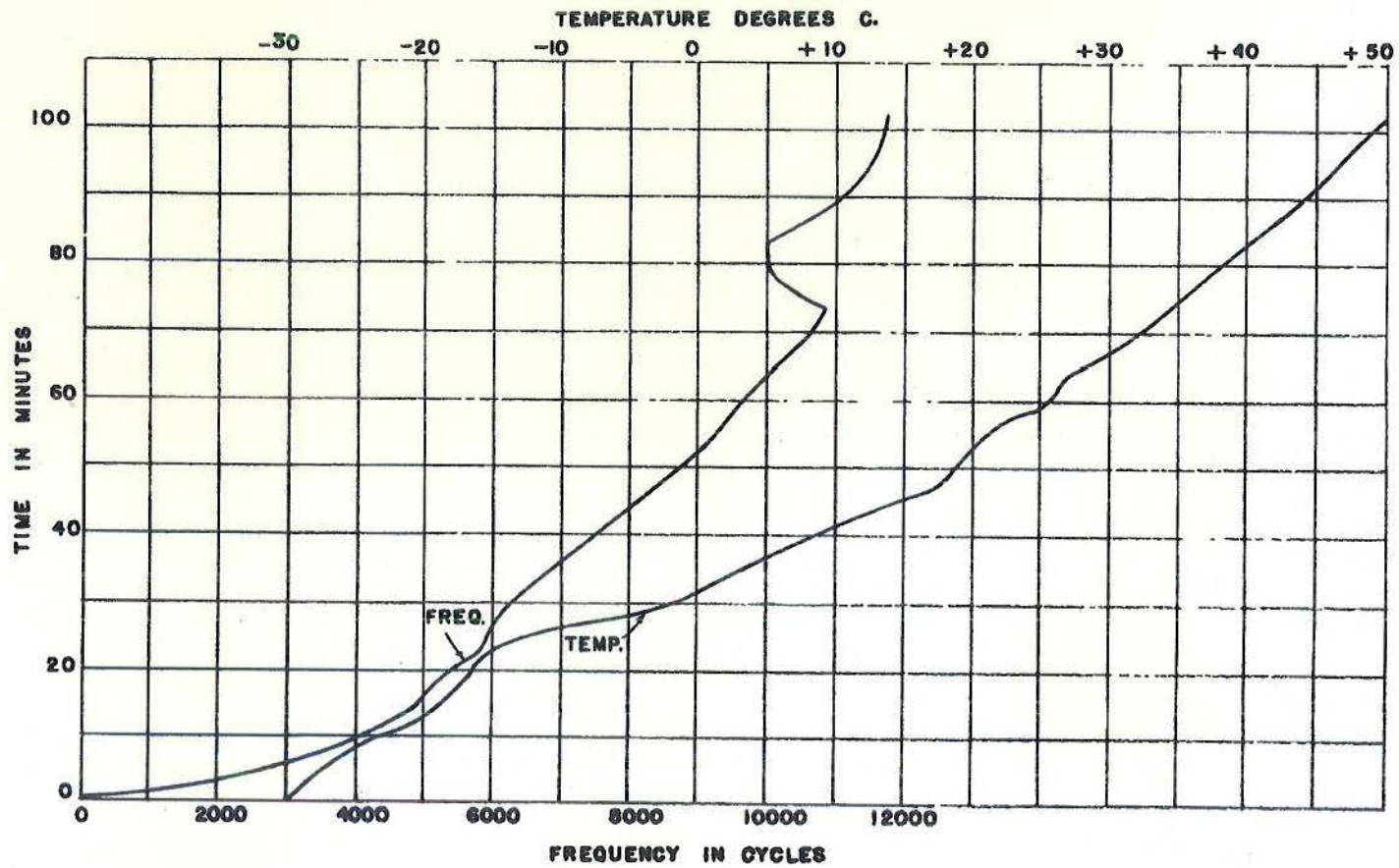
FREQUENCY DRIFT
OF
GP-1 AIRCRAFT TRANSMITTER
COIL X 4500 KCS .150 watts
TOTAL DRIFT 0.148%



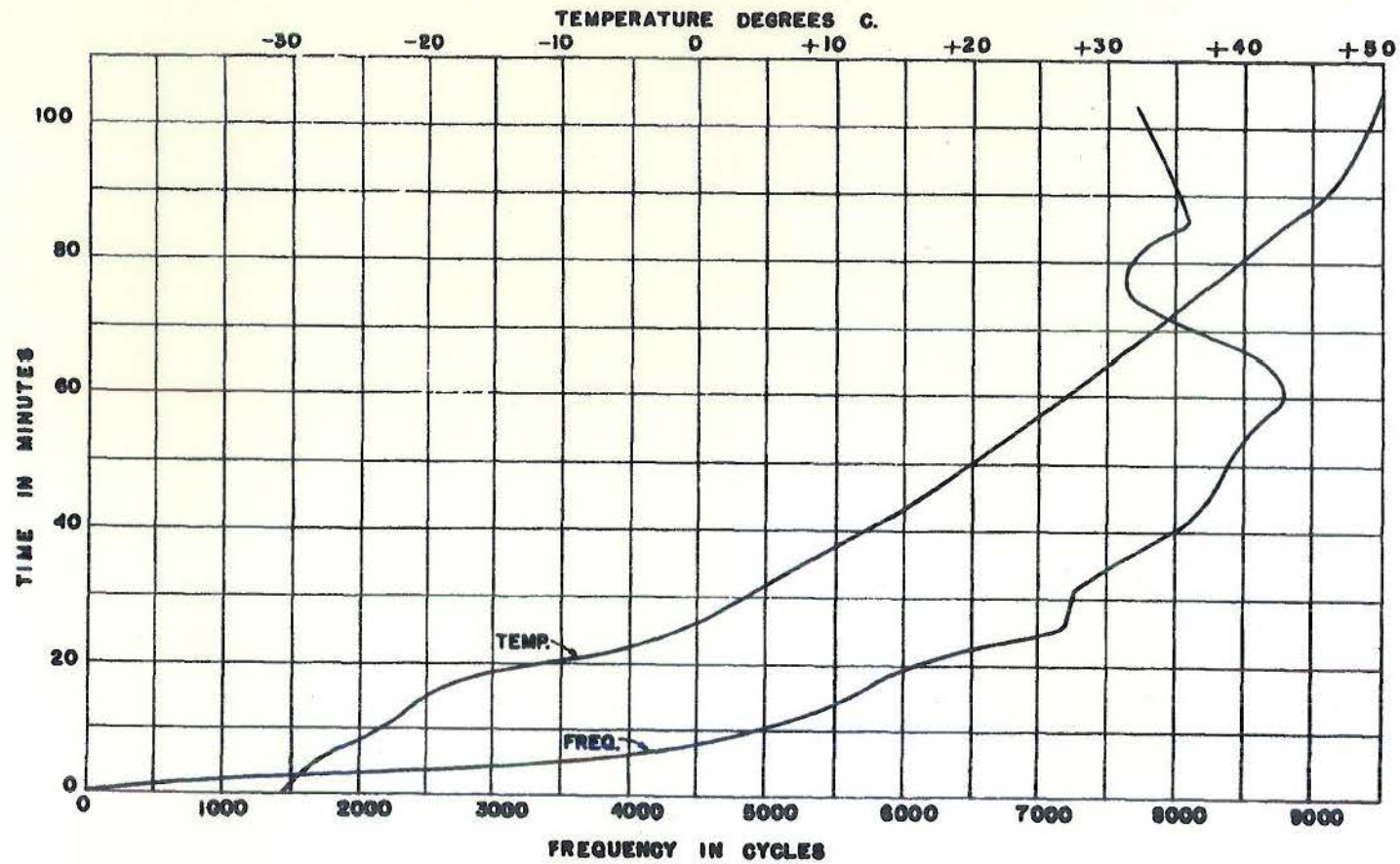
FREQUENCY DRIFT
OF
GP-1 AIRCRAFT TRANSMITTER
COIL V 6500 KCS 96 WATTS
TOTAL DRIFT 0.068 %



FREQUENCY DRIFT
OF
GP-1 AIRCRAFT TRANSMITTER
COIL VI 6500 KCS. 45 WATTS
TOTAL DRIFT 0.18 %



FREQUENCY DRIFT
OF
GP-1 AIRCRAFT TRANSMITTER
COIL VI 9000 KCS 74 WATTS
TOTAL DRIFT 0.098 %



MODEL GP-1
RECTIFIED ANTENNA CURRENT



25 WORD PER MINUTE HAND KEYING
AT 7700 KC., FULL POWER C.W.

$$\frac{1.9 \text{ CM.} \times \frac{1}{2} \times 6.5 \text{ VOLTS / CM.}}{1110 \text{ VOLTS } E_p} \times 100 = 0.56 \%$$



FULL POWER C.W. RECTIFIER RIPPLE



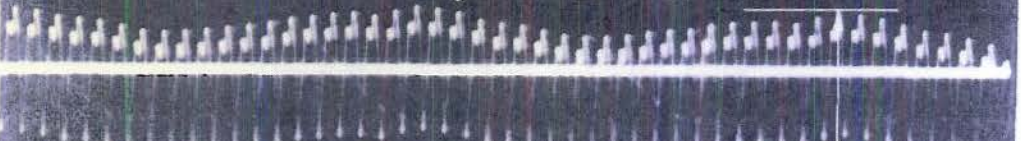
TIMING FREQUENCY 60 $\sim$

1.9 CM.

$$\frac{2.2 \text{ CM.} \times \frac{1}{2} \times 10 \text{ VOLTS / CM.}}{1160 \text{ VOLTS } E_p} \times 100 = 0.95 \%$$



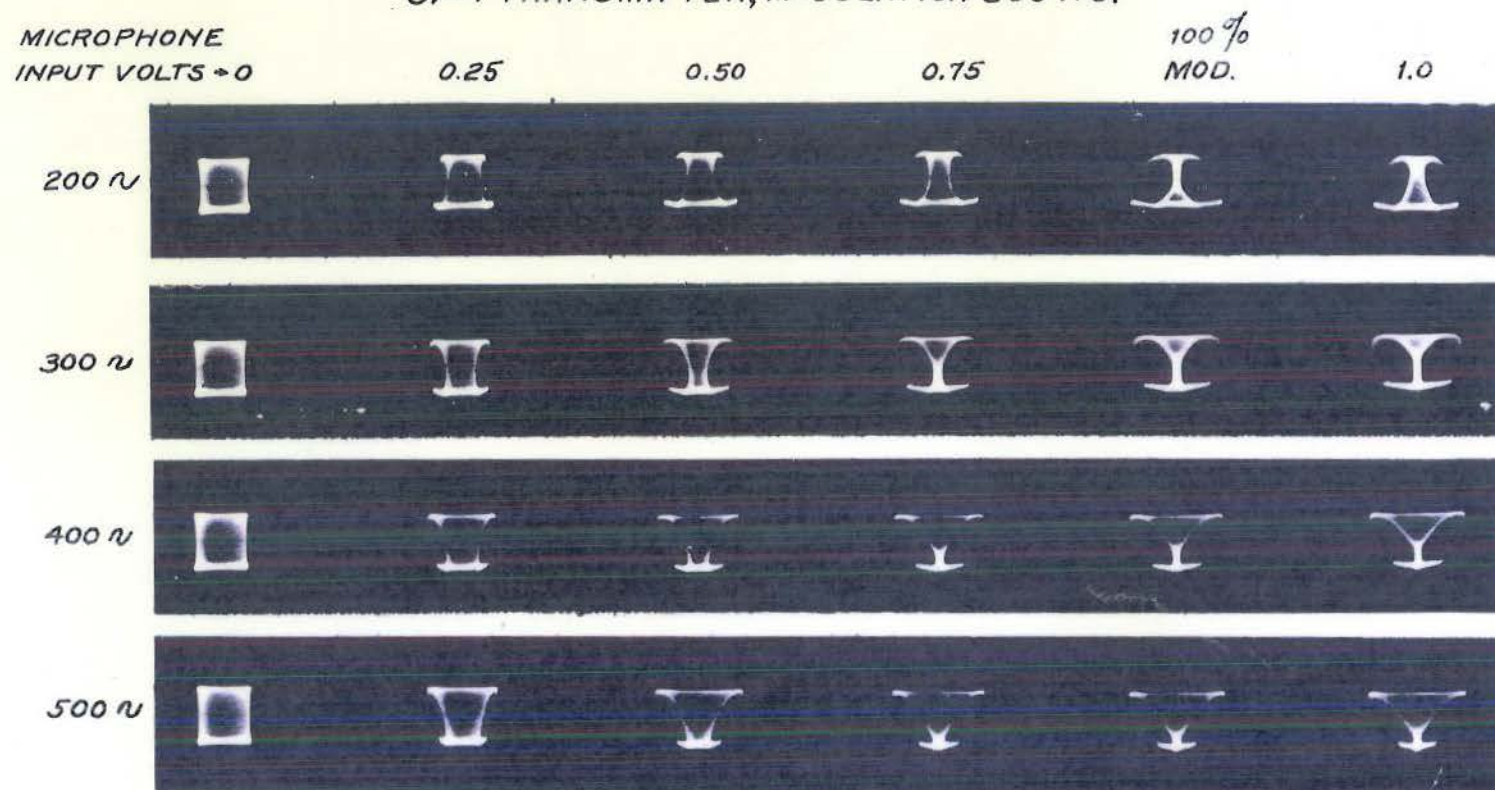
RECTIFIER RIPPLE, PHONE POSITION



TIMING FREQUENCY 60 $\sim$

2.2 CM.

GP-1 TRANSMITTER, MODULATION 500 KC.



GP-1 TRANSMITTER, MODULATION 500 KC.

MICROPHONE
INPUT VOLTS → 0

0.25

0.50

0.75

100%
MOD.

1.0

1000 ν



2000 ν



3000 ν



4000 ν



5000 ν



GP-1 TRANSMITTER, MODULATION 9000 KC.

MICROPHONE
INPUT VOLTS → 0

0.25

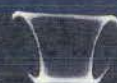
0.50

0.75

100 %
MOD.

1.0

200- ν



300- ν



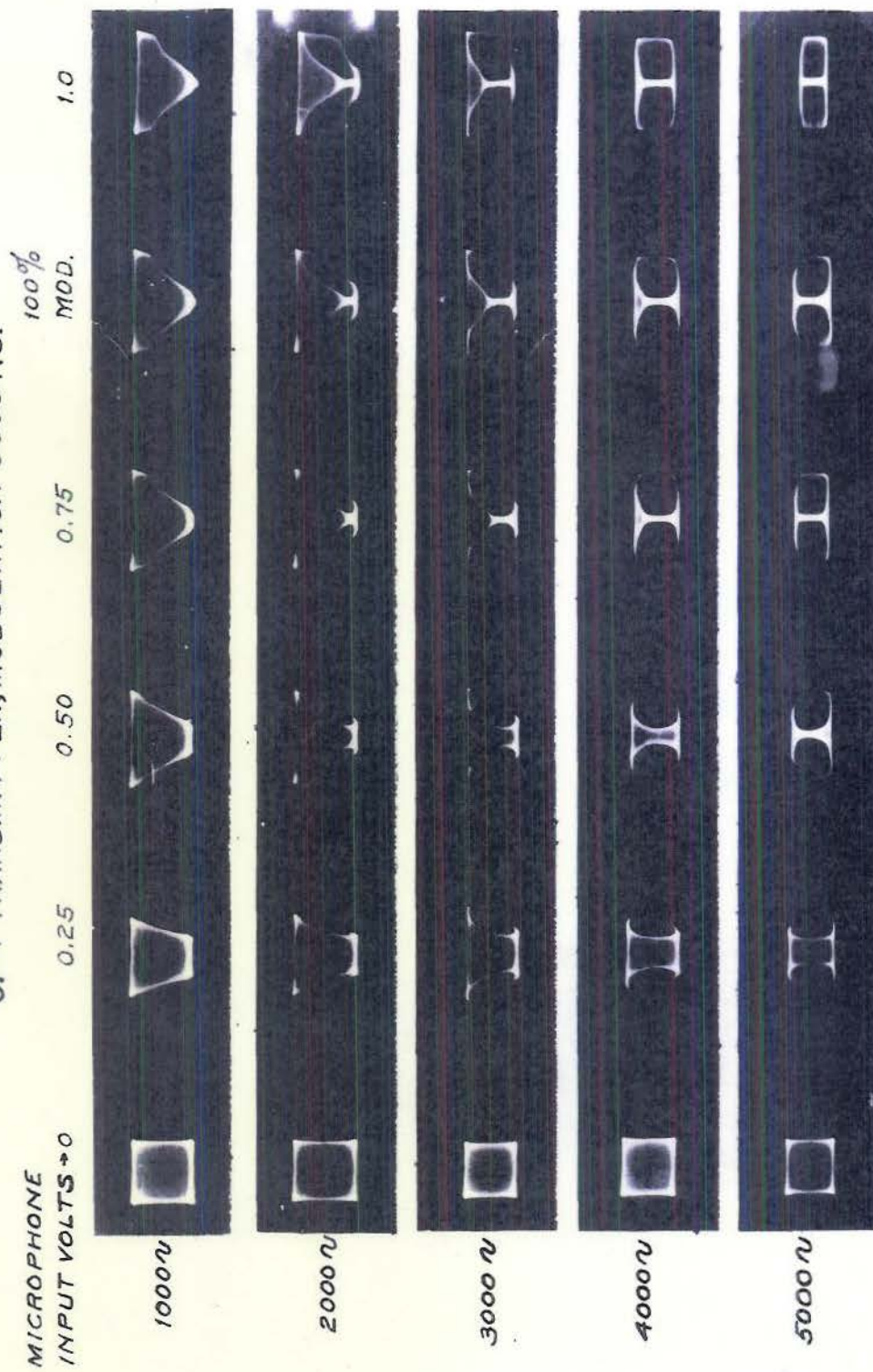
400- ν

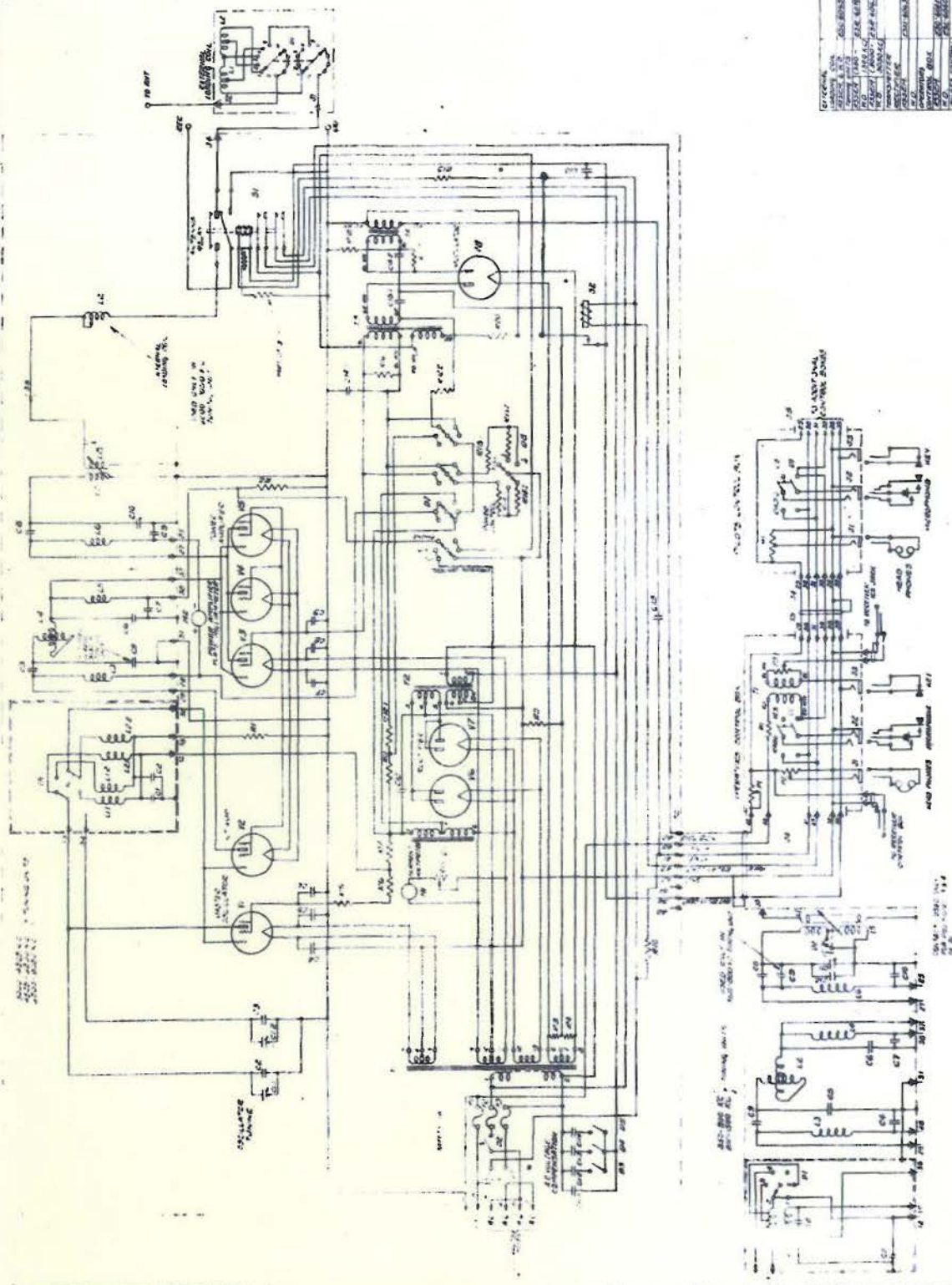


500- ν



GP-1 TRANSMITTER, MODULATION 9000 KC.





Circuit Diagram

Modified Model GP-1

6X4	6AR5	6AV6	6BE6	6BD6	6BE7	6BE8	6BE9	6BE10	6BE11	6BE12	6BE13	6BE14	6BE15	6BE16	6BE17	6BE18	6BE19	6BE20	6BE21	6BE22	6BE23	6BE24	6BE25	6BE26	6BE27	6BE28	6BE29	6BE30	6BE31	6BE32	6BE33	6BE34	6BE35	6BE36	6BE37	6BE38	6BE39	6BE40	6BE41	6BE42	6BE43	6BE44	6BE45	6BE46	6BE47	6BE48	6BE49	6BE50	6BE51	6BE52	6BE53	6BE54	6BE55	6BE56	6BE57	6BE58	6BE59	6BE60	6BE61	6BE62	6BE63	6BE64	6BE65	6BE66	6BE67	6BE68	6BE69	6BE70	6BE71	6BE72	6BE73	6BE74	6BE75	6BE76	6BE77	6BE78	6BE79	6BE80	6BE81	6BE82	6BE83	6BE84	6BE85	6BE86	6BE87	6BE88	6BE89	6BE90	6BE91	6BE92	6BE93	6BE94	6BE95	6BE96	6BE97	6BE98	6BE99	6BE100
-----	------	------	------	------	------	------	------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	--------

RADIO TRANSMITTING EQUIPMENT
PAGE 607001
DESCRIPTION & SCHEMATIC
ESR-607001

18 February 1936

NASA Report RT-6

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

Report on
FLIGHT TESTS OF
MODEL GP-1 RADIO TRANSMITTING EQUIPMENT

Number of pages: Text - 10; Appendices: A - 3;
B - 12; C - 2; D - 4;
Plates - 1.

Authorization: BuAero ltr. Aer-E-31-FAM, F42-1,
F1-5(1) of 27 November 1934.

Dates of Test: 12 July 1935 to 20 December 1935.

Reported by: /s/ M. P. Hanson
M. P. Hanson, Radio Engineer.

Reviewed by: /s/ G.B.H. Hall
G.B.H. Hall, Lieutenant, U.S.N.
Radio Test Officer.

Approved by: /s/ K. McGinnis
K. McGinnis, Lieutenant Commander, USN,
Commanding Officer.

Distribution: N.R.L. (2)
BuAero (2)
N.A.F. (1)

18 February 1936

NASA Report RT-6

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ABSTRACT OF TESTS - - - - -	4
RESULTS OF TESTS - - - - -	6
CONCLUSIONS AND RECOMMENDATIONS - - - - -	8

APPENDICES

N.R.L. letter outlining requested tests - - - -	Appendix A
Preliminary notes on flight tests up to 14 August, 1935 - - - - -	Appendix B
Supplementary Observations up to 20 August 1935 - - - - -	Appendix C
Summary of tests on modified equip- ment, up to 25 November, 1935- - - - -	Appendix D

PHOTOGRAPHS

Original circuit diagram of GP-1 equipment - - - - -	Plate 1
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AUTHORIZATION

1. The tests reported herein were conducted under authority of Bureau of Aeronautics letter, Aer-E-31-FAM, F42-1, F1-5(1) of 27 November, 1934, in accordance with the procedure outlined in Bureau of Engineering letter, F42-1(11-8-W3) of 17 November, 1934, and in conformity with the procedure suggested by NRL under Appendix (A) herewith.

REFERENCES

2. The tests reported herein are based upon the outline contained in Appendix (A) herewith; Appendices (B), (C), and (D) constitute this station's preliminary reports and memoranda prepared during progress of the tests. The following additional references (a) to (e) together with their respective enclosures, constitute resultant correspondence by the Bureau of Engineering pertaining to these tests, while reference (f) transmits the results of this station's tests of sample microphones submitted for the equipment.

- (a) Bu.Eng. Specifications RE 13A 490B.
- (b) Memorandum of Bu.Eng. Conference of 15 August 1935 - NOs 36225 (8-17-W3) dated 19 August 1935.
- (c) Bu.Eng. letter NOs 36225 (8-28-W3) dated 4 September 1935, with enclosure.
- (d) Bu.Eng. letter NOs 36225 (9-6-W3) dated 9 September 1935, to I.N.M., New York.
- (e) Bu.Eng. letter NOs 36225 (12-3-W3) dated 12 December 1935, with enclosure.
- (f) N.A.S. Anacostia letter F42-1/51/NA6, dated 6 January 1936, to N.R.L.

OBJECT OF TESTS

3. The object of these tests was to determine from examination, installation, and actual flight operation, the degree of suitability of the model GP-1

equipment for installation and service use aboard naval airplanes, and to obtain information for the determination of compliance with requirements of the governing specifications.

EQUIPMENT UNDER TEST

4. The equipment tested was the contractor's sample, Serial No. 1, of the model GP-1 radio transmitting equipment, developed and manufactured by the Bell Telephone Laboratories and the Western Electric (Graybar) Company, under contract NOs 36225. The equipment was transferred from the Naval Research Laboratory, where it previously had undergone ground and laboratory tests and general examination.

5. The subject equipment was developed to meet the specification, reference (a). Plate 1 shows the original circuit diagram of the GP-1 equipment, which as a result of the tests, however, has been somewhat modified. Essentially, the circuit comprises a high vacuum type two-tube, full wave rectifier which supplies the necessary high voltages to a master oscillator, an intermediate or "buffer" stage amplifier, a power amplifier utilizing three tubes in parallel, and a speech modulator tube. The M.O. and amplifier tubes are fifty-watt, screen-grid tetrodes, Western Electric Co.'s. type 282-B (CW 38282). For MCW transmission the plates of the power amplifier tubes are supplied with only partially filtered current obtained through a tap on the filter choke, while for voice transmission the output of the modulator tube is coupled to the screens of both the intermediate and final power amplifier tubes, at the same time reducing their screen voltages to effect suitable reduction of the carrier power below the CW and MCW value.

ABSTRACT OF TESTS

6. The equipment was received from N.R.L. 9 July, 1935; after preliminary examination and bench tests, it was installed in O3U-1 airplane No. 8810, together with a preliminary model NEA-2 generator and an RU-2 (later an RU-3) receiver. Commencing 12 July, 1935, the equipment was given extensive flight tests to determine, throughout its frequency range the following performance factors:

- (a) 2-way plane-to-ground communication, with

check on speech intelligibility, both with N.R.L. and N.A.S. Anacostia.

- (b) Altitude flights to 17,500 feet, for frequency drift measurements by N.R.L.
- (c) Frequency re-set and antenna de-tuning tests, for measurement by N.R.L.
- (d) Tuning and coupling adjustments into fixed antenna of 15 feet length, and into trailing antennae of various lengths.
- (e) Altitude break-down tests of electrical insulation in rarified atmosphere up to 18,000 feet.
- (f) Reception tests, including rectifier and break-in noises, and side tone levels, also ICS communication.
- (g) Suitability of shock cushioning, both in flight and during taxiing on ground, and general ruggedness.
- (h) Flight performance with NEA-1, NEA-1A, and NEA-2 types of generator.

7. After giving the test results outlined in Appendix (B) and (C), which involved 46 flights aggregating 60 hours of flying, the equipment was returned to the contractor for modifications on 7 September, 1935, in accordance with reference (d). It was returned to this station by air on 1 November, 1935, and was given further bench tests and 12 additional hours of aggregate flight tests, with results mentioned in Appendix (D). The equipment was then installed in SBU-1 airplane No. 9750 and flown for 4-1/2 hours in conjunction with tests of various fixed antenna systems, and finally reinstalled in O3U-1 airplane No. 8810 for completion of altitude tests at 350 kcs, requiring a flying time of 6-1/2 hours. The equipment was returned to representatives of the contractor 20 December, 1935, after a total of 69 flights aggregating 83 hours of flying time in Navy airplanes.

RESULTS OF TESTS

8. After repeated troubles experienced during the initial tests and outlined in Appendices (B) and (C), the equipment was modified by the contractor in the following major respects:

- (a) All tuning units reconstructed to incorporate P.A. tank circuit and inductive antenna coupling.
- (b) Elimination of internal tap switch which provided fixed steps of antenna loading or series condenser values. Substitution therefor of continuously variable rotating drum type internal loading inductor. (Preliminary modification employed phenol fibre insulation, later replaced by 100% ceramic insulated unit).
- (c) Completely re-designed antenna break-in relay, with fully adjustable contacts; plunger type, with differential solenoid action.
- (d) Addition of auxiliary relay for actuating main relay through microphone switch button.
- (e) Improved antenna reel in regard to operator's protection and locking knob attachment.
- (f) Preliminary model of new operator's control box with bottom-entrant power plugs, and incorporating screw-driver adjustments for side tone and I.C.S. strength.
- (g) Sample interconnecting cable using shielded braid covered cable and stamped cylindrical shell type plugs.

9. The results of the flight tests made with the modified equipment, up to the time of the conferences held on 25 and 26 November, are summarized in Appendix (D) and in reference (e). The following additional comments are based upon the subsequent remaining tests and final examination of the equipment.

10. A 544 kcs altitude test using short (50 ft) resonant antenna, with full external loading at 14,000 feet resulted in breakdown in the antenna reel by burning up of rubber "tire" driving the antenna length counter.

11. After replacement of the reel, a successful altitude test to 18,000 feet was made with the equipment operating at 350 kcs, on all types of emission and including the various possible misadjustments. With full external loading, a trailing antenna length of nearly 500 feet was required to resonate at this frequency.

12. The equipment was found to resonate properly to the standard fixed "Vee" antenna (length of leg 15 feet) over the entire required frequency range except at the extreme high frequency end at and above 9,000 kcs.

13. On the final test flight, complete mechanical failure of the antenna reel occurred by "freezing" of the shaft bearing, necessitating drawing in of the antenna "hand over hand" fashion and finally cutting it so as not to interfere with landing.

14. Progressive electrical breakdown of the phenol fibre insulated internal loading inductor necessitated complete replacement of the latter by a unit with ceramic insulation, near the end of the tests. The latter unit showed no trouble from electrical breakdown, but still required excessive turning operations to vary it over its complete range.

15. The continuously variable internal loading inductor was found of great advantage in resonating the transmitter to various small fixed antenna systems departing considerably in their constants from the standard 15 ft. "Vee" type. Flight tests in the SBU-1 airplane, in which a standard "Vee" was compared with several different fore-and-aft types of fixed antennae (length 17' 3") showed a gratifying flexibility in tuning, with proper resonance and apparent good power output over the entire frequency range from 3000 to 9050 kcs.

16. The two microphones originally submitted with the subject equipment were unsatisfactory in flight, on account of excessive noise level and poor speech intelligibility. After necessary minor modification of the equipment by the contractor's representative it operated in a satisfactory manner with standard Navy type RS-38 microphones, and was employed in conjunction therewith on the majority of test flights. Two additional experimental microphones subsequently submitted by the contractor were given additional flight tests, but proved unsatisfactory both with the subject GP-1 as well as with other types of equipment, as reported in reference (f).

17. Some difficulty was experienced in mounting the revised operator's control box because of its excessive upward projection above the standard mounting hole layout. Likewise, difficulties were experienced in some airplanes (types SOC and SBU) to provide sufficient installation space and accessibility for operation of the external antenna loading unit.

CONCLUSIONS AND RECOMMENDATIONS

18. With reference to Appendix (A), the following itemized summary is submitted:

- 1-2, 3-15. The equipment provides excellent communication with other service units, without causing noticeable weakening or interference in the "Receive" position; the break-in feature operates satisfactorily.
- 1-5. Convenience of installation is satisfactory, except for points mentioned in paragraph 17 above. The mounting holes in the control box should be raised and the arrangement of the external loading unit should be altered by making the present left side of the box the front panel, retaining the mounting holes on the large face which then will become the left side. The convenience of operation is generally satisfactory, except for the time and effort required to vary the internal antenna inductor over any appreciable range.
- 2-3, 2-16, 2-19. With the exception of the observed loosening of knobs, dials, and coil locking latches, the general ruggedness of the equipment, including cabinet, appeared satisfactory. The shockproof mounting should be revised to avoid interference with its attachment nuts and to conform to the standard mounting hole provisions. The rotary combined latch feature as originally supplied does not appear desirable.
- 2-10. Major failures occurred in the antenna reel, keying relay, rectifier tube base, internal antenna inductor, and in minor components as described in this report and appendices.
- 2-11, 2-16, 2-20. No shock or vibration damage to tubes or delicate components was experienced.

- 3-1. The equipment provides satisfactory CW, MCW, and voice emission on the specified antenna systems, except as noted in paragraphs 11 and 12, and Section IIa of Appendix D. Voice intelligibility is satisfactory with Navy standard microphones.
- 3-6. The antenna loading coil switch knob was not operable with heavy gloves.
- 3-8, 3-23, 3-27. Shifting from trailing to fixed antenna was conveniently accomplished in flight without wide difference in power input or apparent power output. With the final modifications incorporated in the equipment, it operated successfully with all types of emission at an altitude of 17,500 feet without damage from short circuit, open circuit, or grounding.
- 3-9. The transmitter, without external loading coil, failed to resonate at 550 kcs even with 500 feet of trailing wire and with full internal loading. With one step of external and maximum internal loading, resonance was established with 111 feet of trailing wire.
- 3-10. Side tone was of suitable order; recommendations under item 17, enclosure (A) of reference (e) are concurred in.
- 3-11. No open spark or arcing was observed; while not completely flame-proof, the equipment is considered to be sufficiently enclosed so as not to offer an appreciable fire hazard.
- 3-21. Changes of operating frequency in flight consumed an average time of less than one minute, except where a wide range of change of both the internal loading inductor and of the antenna length were necessary.
- 4-7. Power reduction by means of loosening the antenna coupling proved satisfactory and did not materially decrease the speech intelligibility.
- 4-8. The external antenna loading coil lacked sufficient inductance to resonate a 350 foot trailing antenna to 350 kcs.

19. No instruction books were supplied with the equipment; it is recommended that, in view of the complexity of the equipment, the instruction books be prepared with considerable care so that average service personnel will be enabled properly to install, operate, and service this equipment. Highly technical terms and phrases unfamiliar to average service personnel should be avoided whenever possible.

20. In view of the complex nature of this equipment and its necessarily poor accessibility when installed in an airplane, extensive need for bench testing and servicing facilities is anticipated. It is recommended that each operating unit be provided with extra sets of cables and control boxes, in order to facilitate rapid bench tests of the transmitter unit without requiring removal of the other components from the airplane.

21. In view of the multiplicity of troubles encountered until the sample equipment finally withstood full power operation at the specification altitude of 17,500 feet, successful service operation of the production equipment at such altitude will be contingent upon perfect alignment and the required high order of workmanship in manufacture.

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D. C.

HFH/mba

9 July 1935

From: Director
To: Commanding Officer, Naval Air Station, Anacostia, D.C.

Subject: Radio Aircraft - Tests of Model GP-1 Transmitting Equipment.

Reference: (a) BuEng let. NOs-36225(5-9-W8) of 22 June 1934.
(b) Specifications RE 13A 490B.

1. It is requested that flight tests be conducted on the Model GP-1 aircraft transmitting equipment in accordance with reference (a).

2. The following tests are outlined in accordance with certain paragraphs of reference (b).

- 1-2, 3-15. Under actual flight conditions, determine by test how effective the communication is with the other units of the Naval service by communicating with the Naval Air Station and the Naval Research Laboratory. Also determine the reliability and absence of interference in the specified receivers called for by specifications RE 13A 471A. Determine the reliability of the break-in feature when the transmitter and receiver are tuned to the same frequency.
- 1-5. Determine the convenience of installation and operation in naval aircraft.
- 2-3, 2-16, 2-19. Note ruggedness of equipment under flight conditions, especially the cabinet. Make note of any parts, nuts or screws that work loose under flight conditions and any joints that work loose. Note suitability of shockproof mountings.
- 2-10. Note any failures of parts during flight tests.
- 2-11, 2-16, 2-20. Note that no damage to the tubes or delicate instruments results from shock or vibration encountered in flight.

Appendix A. p.1

- 3-1. Note that satisfactory CW, MCW, and voice modulated radio frequency, energy can be obtained through any of the antenna systems specified. Transmit a group of 10 disconnected words while the Naval Research Laboratory and the Naval Air Station, Anacostia, are listening to determine the intelligibility in accordance with paragraph 4-4 of reference (b). Note that proper compensation has been provided to insure good voltage regulation of the power supply under flight operating conditions, particularly at 600 cycles. Note generator type and serial number.
- (2) Note that the equipment can be properly installed in the tray provided in O3U type airplanes.
- (4) In checking the performance of the plug-in units and antenna coupling system, make special note of the two following tests:
- (a) Under conditions of locked key, full power, CW, at approximately 1500 kcs; on tuning unit II, note the frequency drift. Arrange to have the frequency checked by the Naval Research Laboratory during this test.
- (b) On tuning unit VI, note the ability to draw full power output at 6200 and 9000 kcs when using a low capacity antenna system. With a trailing wire antenna system not exceeding 350 feet, note that approximately the full power outputs are available and check the frequency drift at the Naval Research Laboratory as per paragraph 3-21(2) of ref.(b). In a fixed antenna on the type O3U airplane, note that the unmodulated carrier is at least 50 watts in the phone positions on the following frequencies: 3300 kcs, 4235 kcs., (6200 kcs. on tuning unit V), and 9000 kcs. on tuning unit VI. Make altitude flight up to 17,500 feet and test the equipment on full power CW, MCW, and voice modulated.

Appendix A. p. 2

- 3-6. Note the ability to operate all controls when wearing heavy gloves during flight.
- 3-8, 3-23, 3-27. Note the convenience of shifting from trailing wire to fixed antenna and also operating characteristics with respect to power inputs and power outputs. Open circuit, short circuit and ground the antenna at 17,500 ft. altitude, and note that no damage occurs to any parts, meters or vacuum tubes when operating on full power.
- 3-9. Note that the transmitter will operate without the loading coil on all frequencies above 550 kcs. Also note how low a frequency the equipment will operate on without the antenna loading coil.
- 3-10. Note that sufficient side tone voltage is supplied under all operating conditions during flight tests.
- 3-11. Note that no open spark or arcing occurs that might ignite gas fumes and cause an explosion. Record the filament voltage and plate current when changing to and from CW, MCW or voice transmission.
- 3-21. Note the time necessary in flight to set the equipment in operation on any frequency by means of a type 74015 frequency meter.
- (1) Note time and accuracy of reset using recorded calibration data.
- 4-7. Note that the method of reducing power by varying the antenna coupling adjustment is satisfactory in addition to the power adjusting device supplied in the screen grid circuit.
- 4-8. Note that the antenna loading coil is suitable for adjusting at any frequency between 350 and 550 kcs. in flight with variable lengths of antenna up to 350 feet as a maximum.
3. Any additional flight tests not outlined above but considered advisable by the Flight Test Section of the Naval Air Station should be included in the flight test report.
4. The Naval Research Laboratory will establish radio communication with the airplane during these flight tests and assist in making measurements.

Copy to: BuEng (2)

H. M. Cooley

Appendix A. p. 3

14 August, 1935

From: Radio Test Section, N.A.S. Anacostia
To: Lt. W.P. Cogswell, Bureau of Engineering.
SUBJECT: Model GP-1 equipment sample - Preliminary notes on flight tests and serviceability inspection, to date.

This Memorandum constitutes a classified summary of miscellaneous notes and data obtained to date during tests of the GP-1 equipment at Anacostia. Due to unforeseen troubles with the equipment it has not been possible to bring these tests to conclusion, and these data are gathered in preliminary form merely for reference and information, for the conferences to be held at the Bureau of Engineering commencing 15 August, 1935.

GROUPING OF NOTES:

1. Summary of Flight Tests, to date.
2. Troubles encountered with GP-1 during Flights.
3. Notes on Performance and Operation.
4. Unsatisfactory Material and Workmanship.
5. Notes on Accessibility.
6. Desirable Designation and Nameplate changes.
7. Recommended Circuit Changes.
8. Tuning Units, Recommended Changes.
9. Transmitter Unit, Recommended Changes.
10. External Loading Unit, Recommended Changes.
11. Operators Control Box, Recommended Changes.
12. Pilot's Control Box, Recommended Changes.
13. Antenna Reel, Recommended Changes.
14. Antenna Weight, Recommended Changes.
15. Microphones, Recommended Changes.

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Subject: Model GP-1 equipment sample - Preliminary notes on flight tests and serviceability inspection, to date.

-
- g. Antenna Loading Switch stuck in position No.1.
 - h. Side-tone on Phone too weak for intelligibility by second plane occupant; becomes strong but very raspy and crackling when transmitting and receiving on same frequency.
 - i. Equipment broke down at 12,500 ft. altitude while transmitting on 6600 kcs., as result of burning off of beaded rectifier plate leads due to flash-over.
 - j. Internal antenna circuit plug flashed over to adjacent condenser at or below 12,500 ft.
 - k. Antenna Tuning Variometer in box 6 broken down and burned insulation.
 - l. Antenna Tuning Variometer in box 4 broken down and damaged insulation so as to withstand only one-quarter power.
 - m. Complete failure of internal intermediate-frequency loading coil as result of sparking from series condenser connecting lead, possibly induced by high-frequency natural resonant period.

3. PERFORMANCE AND OPERATION:

- a. The equipment does not resonate properly into the fixed antenna over the required frequency range, viz. 3000-4525 and 6200-9050 kcs.
- b. The length of trailing antenna, operated as one-quarter or three-quarter wave radiator, is generally confined within narrow limits and critical, for full power output from 3000 kcs. upward. The equipment will generally not couple to deliver normal power into antenna lengths beyond $3/4$ wave.
- c. Non-standard microphones supplied with equipment showed excessive sensitivity with resultant engine noise pick-up, and appeared to cut off the higher audio frequencies excessively.
- d. Phone carrier and or side tone is modulated by receiver feed-back squeal, through a certain useful range of receiver volume control.

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Subject: Model GP-1 equipment sample - Preliminary notes on
flight tests and serviceability inspection, to date.

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- e. Excessive variation in A.C. voltage when power is changed, without change in compensating condenser; thus, when compensating condenser was adjusted to maintain filament key-down voltage at full power at 10.1 volts, shift to quarter power caused a voltage rise to 11.6 volts when key was depressed. Reductions of this effect highly desirable, especially for tuning operations.
 - f. CW telegraph beat note is still somewhat rough and "gargly", probably as result of some remaining vibration or voltage modulation.
 - g. Back covers on tuning units catch inside transmitter when inadvertently inserted with units, and are then difficult to withdraw.
 - h. Transmitting and receiving on same frequency blocks receiver and prevents break-in operation (break between letters) at speeds in excess of 10 or 12 words per minute.
 - i. Side tone levels as adjusted were found too weak in flight; following average (not maximum possible) values of side tone are considered desirable, into EACH of two pairs 600 ohm phones connected in parallel, individual volume controls in Maximum position:
 - CW and MCW side tone, 2.5 volts, r.m.s.
 - Radio Telephone side tone (sustained peaks) 3.5 volts
 - ICS Interphone (sustained peaks) 4.0 volts.
 - j. Tendency to excessive second harmonic radiation.

4. UNSATISFACTORY MATERIAL AND WORKMANSHIP:

- a. Excessively large hook-up wire for low tension wiring, with fraying fabric covering; no color scheme. Color coded Packard cable with stranded and tinned conductors greatly preferable.
- b. High tension hook-up wire has fraying fabric covering; packard cable appears preferable.
- c. Soft copper pigtail wire used for tube cap clips flimsy and excessively long; suggest using stranded phosphor bronze, similar to Navy Model J-1 antenna wire (not model J) and keeping short enough to prevent beads touching other members.

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Subject: Model GP-1 equipment sample - Preliminary notes on flight tests and serviceability inspection, to date.

- d. #16 tinned copper bus bar wire used extensively in R.F. wiring, is insufficiently rigid and exhibits very poor workmanship, partly due to contractor's alterations and repairs. Suggest employing heavier gage wire; avoid common ground wiring lying against or scraping against bulkheads and metallic fittings, to prevent variable circulating currents with resultant modulation effects.
- e. Elastic stop nuts (with fibre inserts) used extensively throughout equipment, have loosened and dropped off frequently during the tests. These nuts are entirely unsuitable as bottoming stops for any rotating motion, such as dial locks, antenna reel knob, etc.
- f. Glass form of M.O. coil has cracked inside a H.F. tuning unit; suggest better cushioning suspension, and thorough annealing.
- g. Many dial shaft bearings are too wobbly, and dials not properly aligned.
- h. Insertion of tuning units scrapes inside of transmitter; suitable slide rails or other protection should be provided.
- i. Clicker (detent) action on antenna loading switch and other switches is not positive.

5. NOTES ON ACCESSIBILITY:

- a. Tubes may be changed entirely through the opening left in the front panel by removal of tuning unit, but only after three or four minutes cooling, and then with some difficulty.
- b. Fuse panel is not accessible for inspection or fuse renewal from the front, but is located inside and requires removal of several tubes, including sliding back of buffer shield, for access.
- c. Buffer shield sliding action objectionable because of flimsy locking latch, easily lost, and because of short circuit to rectifier plate lead against rear edge of shield if operator forgets to draw shield forward before resuming transmission.

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Subject: Model GP-1 equipment sample - Preliminary notes on flight tests and serviceability inspection, to date.

- d. Suggest improving accessibility by securing top cover plate by snap slides rather than loseable machine screws.
- e. Keying relay very inaccessible, has been source of frequent trouble.
- f. Inside terminals very inaccessible.
- g. Servicing requires removal of bottom plate.

6. DESIRABLE DESIGNATION AND NAME PLATE CHANGES:

- a. Suggest all meter scales be white on dull black background, with Filament meter specially marked at 10.0 volts, and plate milliammeter marked at normal full load 230 m.a.; if this special marking impracticable on dial itself, engrave adjacent thereto.
- b. Suggest designation of all tuning units by letter rather than by present roman numeral, letter to correspond with BuEng type number letter.
- c. No calibration charts or frames provided on tuning units.
- d. M.O. Coarse tuning dial "B" is black etch on bright background, should be reverse etched to eliminate glare. Observe that this equipment should be suitable for night flying.
- e. Alter power factor corrector nameplate to indicate bottom mfd's.
- f. For proper recording and operating sequence, dial designations "A" and "C" should be interchanged; "A" dial should be "M.O. Switch", and "C" dial "M.O. Tuning"; designation of "B" window should be changed to "M.O. Tuning Hundreds".
- g. Difficulty of operation by service personnel will be materially reduced by employing designations conventional in the service throughout, and by self-explanatory dial and switch markings, with such additional information on the front panel as will assist the proper manipulation of the equipment; knowledge of the instruction book should be helpful, but not necessarily essential for acceptable operation of the equipment.

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Subject: Model GP-1 equipment sample - Preliminary notes on
flight tests and serviceability inspection, to date.

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- h. Suggest labeling adjustment "D" BUFFER TUNING.
 - i. Suggest Labeling adjustment "E" ANT.CPLG. (Series Cond.), or ANT.CPLG. (Series Varion.), respectively, and engraving dial to increase numerically with increase in effective coupling (rather than frequency) if this can be done consistently.
 - j. Suggest labeling adjustment "F" ANTENNA TUNING, with added caution to re-tune for max.dip in plate m.a. after each change of "E".
 - k. Suggest labeling adjustment "G" ANTENNA LOADING, with the various switch positions designated functionally as well as numerically, thus:
 - 1 - I.F. INDUCTANCE
 - 2 - I.F. IND.TAP
 - 3 - I.F. IND.TAP
 - 4 - H.F. INDUCTANCE
 - 5 - DIRECT
 - 6 - SERIES CONDENSER
 - l. Suggest meter designation "P.A.PLATE CURRENT", instead of Amplifier Plate Current.
7. RECOMMENDED CIRCUIT CHANGES
- a. Highly desirable to alter fundamental circuit and tuning method for easier adjustment by average enlisted personnel, and to eliminate or materially reduce, in power as well as necessary length of time, actual radiation during adjustments.
 - b. Rheostat desirable to give proper filament voltage with plus or minus ten percent generator voltage differential.
 - c. Modify circuit constants and provide greater coupling range for required power output into fixed antenna; suggest requiring tuning unit V also to load into fixed antenna over its frequency range, 4500 to 6200 kcs.
 - d. Addition of Antenna R.F. ammeter appears essential, preferably inside main cabinet; suggest range of approximately 0-7.5 amperes, of newly developed open center scale type, tropically treated and with aircraft type movement. White scale on black background, to match other recommended meters.

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Subject: Model GP-1 equipment sample - Preliminary notes on
flight tests and serviceability inspection, to date.

9. RECOMMENDED CHANGES IN TRANSMITTER UNIT:

- a. Re-design keying relay mechanically and electrically.
- b. Omit special latching base plate.
- c. Provide pair of individual mounting slides, with their mounting arrangement and holes interchangeable with GP transmitters: provide with non-loseable, positive retainer latch device, which does not require tools to operate.
- d. Replace fibre by metal spacer under Ground terminal post, to give better contact with case.
- e. Reduce thickness of insulating spacer on inside of Receiver terminal, and otherwise reduce stray coupling of receiver lead as much as possible.
- f. Antenna terminal insulating bowl prevents access to contact prong: substitute conventional lead-through insulator with threaded binding post and knurled, non-loseable nut, suitable for attachment of RAJAH snap connector fitting.
- g. Question ruggedness of tuning unit retainer snap slides: suggest replacing by more rugged latches.
- h. Make top of transmitter unit detachable, provide snap slides.
- i. Incorporate antenna r.f. ammeter, approx. 0-7.5 amp. scale, must be readily readable down to 1 ampere.
- j. Provide master terminal panels for trouble shooting use.

10. RECOMMENDED CHANGES IN EXTERNAL LOADING UNIT:

- a. Make mounting holes interchangeable with GP equipment.
- b. Locate terminal posts at top rather than bottom, for proper installation arrangement.
- c. Provide screw type terminals with non-loseable knurled nuts, to take RAJAH snap fasteners.

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Subject: Model GP-1 equipment sample - Preliminary notes on
flight tests and serviceability inspection, to date.

-
- d. Add caution to disconnect from circuit at frequencies
above 550 kcs.

11. RECOMMENDED CHANGES IN CONTROL BOXES:

- a. Make mountings fully interchangeable with GP equipment.
- b. Eliminate plugging in from ends, which requires excessive clearance space in mounting and prevents mounting properly in crowded cockpits prevailing in service planes.
- c. Prevent tendency to damage phone plugs when cover is opened.
- d. Enable tests with all plugs inserted, with cover open.
- e. Add series resistor volume control to operators control box, designed for 600 ohm 'phones, about 10 db attenuation range.
- f. Add screwdriver-controlled ICS volume setting in operators control box.
- g. Provide non-slip knobs.
- h. Improve internal accessibility.

12. RECOMMENDED CHANGES IN ANTENNA REEL:

- a. Provide more positive, non-loseable end stop for locking knob.
- b. Reel mounting holes interchangeable with GP and GM (4" square) desirable.
- c. Altitude tests may require further changes.

13. RECOMMENDED CHANGES IN ANTENNA WEIGHT:

- a. Omit "S" hook link.

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Subject: Model GP-1 equipment sample - Preliminary notes on
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b. Desirable to strengthen swivel link.

14. RECOMMENDED CHANGES IN MICROPHONES:

- a. Eliminate excessive cut-off of high frequencies.
- b. Microphones should be fully interchangeable with Navy Standard aviation microphones as regards resistance and sensitivity.
- c. Microphone mounting plates to be interchangeable with Navy std.

15. RECOMMENDED CHANGES IN CABLES AND PLUGS:

- a. Standardize on following lengths:
 - Power supply cable - - - - - 6 ft.
 - Pilot's Extension Control Cable - - - - 8 ft.
 - Any additional Ext. Control Cables - - - 6 ft.
 - Transmitter Main Control Cable - - - - 4-1/2 ft.
 - Cable to receiver switch box- - - - - 4-1/2 ft.
 - Cable to receiver ICS jack - - - - - 4-1/2 ft.
 - Microphone cord- - - - -
 - Key cord- - - - - 6 ft.
- b. Eliminate fabric bakelite antenna plugs: replace by RAJAH solderless snap connectors.
- c. Present angle plug castings excessively large and heavy: recommend pressed sheet metal construction without angle feature, inserting straight from below.
- d. Present control box plugs fit too loosely, won't stand up.
- e. If Breeze type shielding fittings are retained, apply Navy anti-seize compound (metallic zinc dust in vase-line 50/50) before assembling.
- f. Use Flat type plug for receiver ICS connection, to avoid projecting too far and to distinguish from receiver switch box plug.

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(C O P Y)

NASA Report RT-6
Appendix C

N.A.S. ANACOSTIA
20 August, 1935

SUPPLEMENTARY OBSERVATIONS ON GP-1 EQUIPMENT

- a. DIFFICULTY OF TUNING: Required MPH 40 minutes properly to tune 1500 kcs on trailing antenna, after which had no difficulty resonating antenna lengths anywhere from 30 to 135 feet. After landing found discrepancy report from NAA (Arlington) that plane had been blocking communications with interference just below 4500 kcs.
- b. HARMONICS: During above flight test observed initial resonance indication with 30 ft length of antenna, impedance match being better with loading tap 3 than on tap 5; the latter evidently resonates to third harmonic. Flight tests indicate that radiation practically entirely on second or third harmonic is obtainable both intentionally or inadvertently, and also that even with very careful flight adjustments the harmonic content is likely to be excessive. Preliminary bench experiments indicate possibility of improving wave purity by shunting across output terminals (Ant. to Gnd.) of each tuning unit a capacitor, probably large enough to prevent output resonance to second harmonic at the lowest frequency of each unit. This appears to improve tuning facility also, but still leaves question of output power into antenna of practicable dimensions, such as quarter and three-quarter wavelength radiators, etc.
- c. A.C. VOLTAGE COMPENSATION: Change in Power Switch requires change in compensation condenser when using MCW.
- d. SIDE TONE: Side tone and ICS levels of proper order, except Phone side tone of 0.9 volts much too weak. Note that internal impedance of side tone circuits is too high properly to bleed off receiver output when transmitting and receiving on same frequency
- e. ANTENNA REEL: Insufficient insulation around handle to protect operator from burns, especially at altitude.
- f. RUBBER INSULATED R.F. OUTPUT CABLE: Insulation insufficient to prevent breakdown to metal fuselage members etc.

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SUMMARY OF TESTS ON MODIFIED GP-1 EQUIPMENT

The following modifications were incorporated in the equipment by the contractor, and gave a test performance as indicated:

I. INDUCTIVELY COUPLED P.A. OUTPUT CIRCUIT: This circuit modification incorporated in all tuning units proved very successful and has removed all tuning difficulty and tendency toward excessive harmonic radiation. The intermediate amplifier tuning variometer in tuning No. 1 broke down, also the P.A. plate choke; while these troubles were temporarily corrected, the design of these components should be improved.

II. INTERNAL, CONTINUOUSLY VARIABLE LOADING COIL: The working model incorporated in the transmitter demonstrated the practicability of employing such a coil for tuning. It had the following shortcomings which it is believed can (and should) be eliminated in the production model:

- a. Insufficient loading to tune 544 kcs with 350 ft. trailing antenna without external loading unit; consider possibility of additional lumped antenna inductance in unit No. 1 only.
- b. Phenolic insulating material broke down repeatedly and not permissible by specifications; replace by ceramic.
- c. One or two breakdowns were due to insufficient clearance around this inductance unit; suggest reducing inductance to value required for tuning small fixed antenna to 3000 kcs, and cutting down physical dimensions accordingly. This will result in better clearances, and reduce stray capacity.
- d. Tendency of roller contact to short-circuit adjacent turns was observed in certain regions, probably both as result of turns loosening and insufficient clearance between turns. Suggest increasing clearance (pitch) somewhat, and using silver plated bronze (hard) wire applied under tension.
- e. End stops to limit coil travel not sufficiently positive, especially when operator's judgment and touch impaired by cold, rarified air at altitude, and heavy gloves.
- f. Loading coil drive is too stiff and appears weak; consider ball bearings, more substantial gears, and adjustment by crank rather than knob on dial.

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SUMMARY OF TESTS ON MODIFIED GP-1 EQUIPMENT.

- g. Visibility of present indicator dial insufficient; should be white on black background, with figures and divisions of increased size; consider possibility of Veeder counter, or geared pointer dial on panel.

III. PLUNGER TYPE, FULLY ADJUSTABLE KEYING RELAY: Keying oscillograms and flight operation proved this relay suitable for operation at all speeds up to 35 w.p.m., with suitable operating sequence and a minimum of disturbance from the receiver; break-in speeds are now limited chiefly by the blocking characteristics inherent in the receiver, and were not bettered by a fully shielded connecting lead between transmitter and receiver antenna terminal, which was improvised for test at Anacostia. The following approximate telegraphic break-in speeds were determined, to allow breaking in between letters: (RU-2 Receiver)

Frequency of Received Signal:	Incoming Signal 5 microvolts:	Incoming Signal 500 microvolts:
Same as Transmitted:	10 w.p.m.	15 w.p.m.
Differing by 10%:	20 w.p.m.	25 w.p.m.
Differing by 20%:	30 w.p.m.	35 w.p.m.

The following points should be observed in the final model of this relay:

- Eliminate present tendency to bind or stick by careful alignment and by strengthening (stiffening) supporting members.
- Design relay coils for operation on 12-15 volts, to eliminate present power waste in series resistor. To prevent slowing down of action from increased inductance, consider increasing solenoid power slightly.
- Retain suitable access opening for relay in transmitter.
- Supply any required special relay adjusting wrenches, suitably marked to avoid misplacing, with each equipment.

IV. OPERATOR'S CONTROL BOX: The model successfully demonstrates the construction hinged at the top, the use of flexible braid shielded cables with stamped shell plugs, and the incorporation of controls for operator's helmet

SUMMARY OF TESTS ON MODIFIED GP-1 EQUIPMENT

volume, side-tone volume, and ICS volume into this box. Telephone side tone, and ICS levels, while meeting the values suggested to the contractor, are still hardly ample in flight and should be increased about 50% more if practicable. In addition, the following points should be corrected in production:

- a. Volume control knob too large, and works too easily, add friction lock.
- b. Mounting holes still not in accordance with specifications.
- c. Designate plainly ICS plug to receiver; shorten or use angle plug if possible.

V. ANTENNA REEL:

- a. Locking knob retainer link insufficiently positive, resulted in dropping locking knob off during operation.
- b. Projecting edge of phenolic locking knob should be rounded off more, to prevent abrasion of operator's skin during operation.
- c. Reel drum commenced to bind on shaft, as result of abrasion by sharp edges.
- d. Breakdown occurred at 14,000 ft. while transmitting on 544 kcs with 50 ft. trailing wire; flash-over across rubber tire into counter wheel, destroying rubber and damaging counter wheel. To avoid this the counter should be further removed from ground potential, by raising the mounting bracket of counter, providing at least double present clearance to ground.
- e. Errors in antenna length reading caused by disengagement of counter with tire, as result of excessive axial travel when locking knob is loosened against retaining link; reduce travel of locking knob.
- f. Preferable mounting for reel, interchangeable with other Navy standard reels, would provide 4 holes spaced on corners of 4" square, in place of present 3-hole mount.

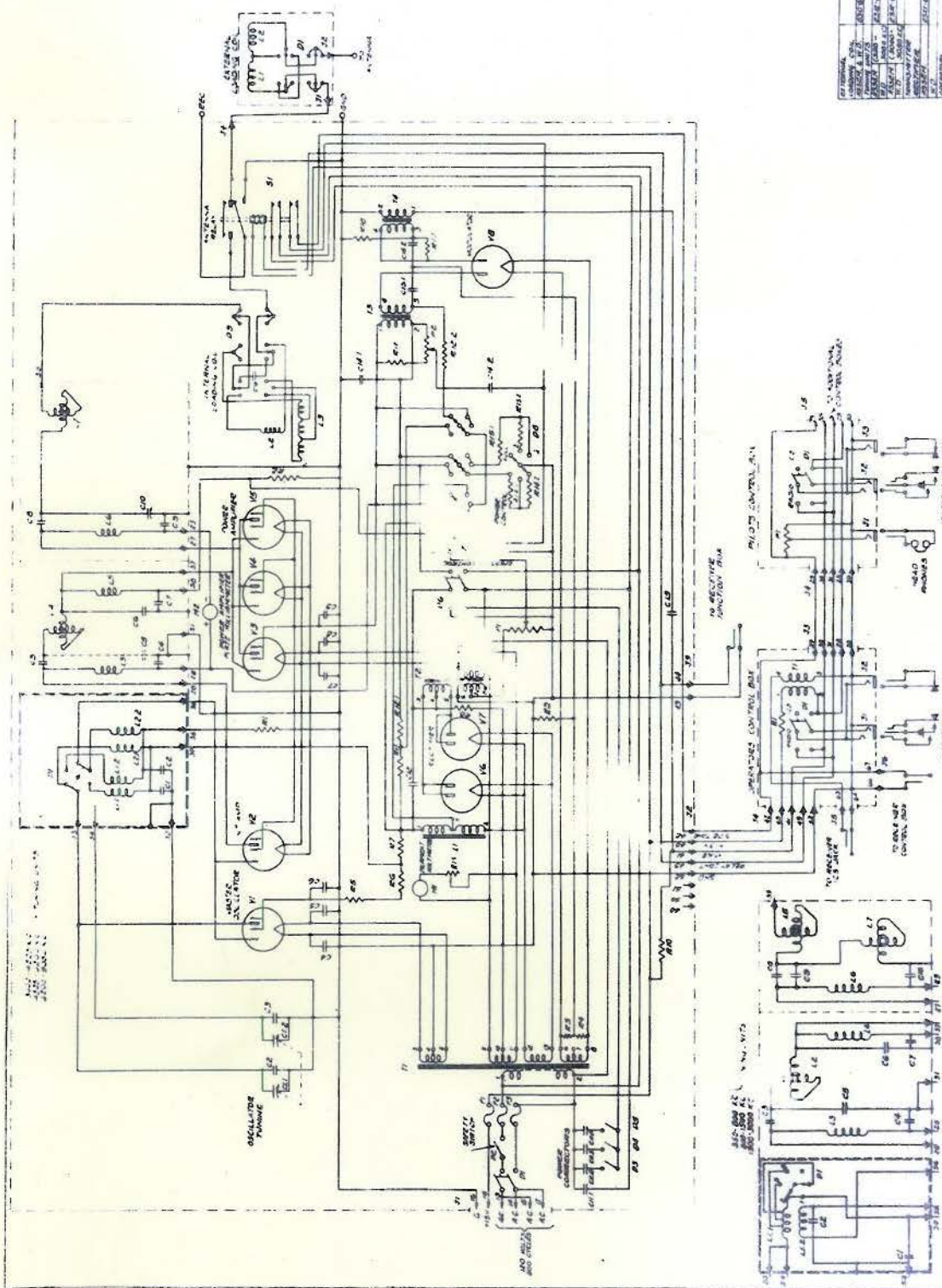
VI. ADDITIONAL OBSERVATIONS AND COMMENTS:

- a. Compensating and power toggle switches should be OFF when in the DOWN position, to conform to standard practice and permit best readability of name plates.
- b. External Antenna Loading Unit should preferably have two additional intermediate steps provided, namely 1/4 and 3/4 of maximum inductance, in addition to present 1/2, Full, and Out settings.

SUMMARY OF TESTS ON MODIFIED GP-1 EQUIPMENT

- c. External Antenna Loading Unit must be decreased in size to overall dimensions given in specifications; present size does not permit of installation in some of latest airplanes.
- d. Decrease capacitance of fixed antenna series condenser in Unit VI to tune specification antenna to 9050 kcs.
- e. Incorporate suitable series condenser in Unit V to tune specification fixed antenna to 6200 (6500) kcs, if such condenser is required therefor. Anacostia to obtain additional test data if needed.
- f. Note that miscellaneous dials, knobs, dial locks, and tuning unit retaining latches have loosened unduly and must be improved, as outlined in notes on last conference.

Remaining Tests at Anacostia: 350 kcs altitude; 3000, 6200 and 9050 kcs into specification antenna; phone sidetone quality.



RADIO TEST SET
U.S. NAVAL AIR STATION
ANALOGUE

6X4	RECTIFIER	6AR5	AF AMPLIFIER	6AV6	DET/AF AMPLIFIER
6X4	RECTIFIER	6AR5	AF AMPLIFIER	6AV6	DET/AF AMPLIFIER
6X4	RECTIFIER	6AR5	AF AMPLIFIER	6AV6	DET/AF AMPLIFIER
6X4	RECTIFIER	6AR5	AF AMPLIFIER	6AV6	DET/AF AMPLIFIER
6X4	RECTIFIER	6AR5	AF AMPLIFIER	6AV6	DET/AF AMPLIFIER
6X4	RECTIFIER	6AR5	AF AMPLIFIER	6AV6	DET/AF AMPLIFIER
6X4	RECTIFIER	6AR5	AF AMPLIFIER	6AV6	DET/AF AMPLIFIER
6X4	RECTIFIER	6AR5	AF AMPLIFIER	6AV6	DET/AF AMPLIFIER
6X4	RECTIFIER	6AR5	AF AMPLIFIER	6AV6	DET/AF AMPLIFIER
6X4	RECTIFIER	6AR5	AF AMPLIFIER	6AV6	DET/AF AMPLIFIER

ESR-607001
RADIO TEST SET
U.S. NAVAL AIR STATION
ANALOGUE