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SUBJECT

Test of Speech Input Equipment for Model TEL-4
Transmitter (Resubmitted Model)

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NAVY DEPARTMENT

Preliminary Report

on

Test of Speech Input Equipment

for

Model TBL-4 Transmitter (Resubmitted Model)

(Contractor: RCA Manufacturing Company)

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ANACOSTIA STATION
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AUTHORIZATION

1. The tests herein reported were authorized by Bureau of Engineering letter, reference (a), and this preliminary report is submitted as requested in paragraph 8 of the reference. Additional pertinent letters or information are listed as references (b) to (f).

- Reference: (a) BuEng. conf.ltr. C-NOs-60970(12-26-DR6) of 4 January 1940.
(b) Contract NOs-60970.
(c) BuEng. Specifications RE 13A 465E.
(d) Modification of Section IV of above specifications of 15 May 1939.
(e) BuEng. conf.ltr. C-NOs-58114(9-20-R6) of 9 October 1939 to INM, Philadelphia.
(f) NRL Report No. R-1525.

OBJECT OF TEST

2. The object of the tests herein reported on the Speech Input Equipment for the Model TBL-4 transmitter, was to determine the following:

- (a) The conformance of the equipment to the specifications as modified by reference (d), and other contractual requirements together with the various contract notes and amendments.
- (b) The discrepancies between contractual requirements and the finished equipment.
- (c) The nature of the changes or improvements necessary to correct any deviations from the contractual requirements.
- (d) The submission of recommendations regarding improvements found necessary or desirable to make the equipment fulfill the various requirements of the Naval Service.

ABSTRACT OF TEST

3. The tests herein reported were conducted in a manner to determine the degree of compliance of the Speech Input Equipment with the mechanical and electrical requirements set forth in references (b), (c), (d) and (e). In particular, tests were conducted to determine the following:

- (1) Check of mechanical workmanship, assembly, materials used, etc.
- (2) Check of the operation of the audio amplifier including the following tests:
 - (a) Amplifier fidelity under various conditions.
 - (b) Action of automatic volume control.
 - (c) Amplifier distortion and noise level.
 - (d) Audio frequency power output of amplifier.
 - (e) Operating power required from 60 cycle line.

(3) Check of operation of Speech Amplifier for operation with Model XTBL-4 and XTBL-2 transmitters in the following respects:

- (a) Overall audio fidelity under various conditions.
- (b) Operation of Speech Amplifier as a voice modulation unit as used with either of the above transmitters.
- (c) Determination of carrier noise level and distortion.
- (d) Check of automatic volume control action on carrier modulation.

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Conclusions

(a) In general, good performance is obtained from the resubmitted model of the Speech Input Equipment. Its operation is much to be preferred to that of an earlier model tested by this Laboratory.

(b) The Speech Input Equipment contains a few electrical and mechanical defects and does not strictly comply with all provisions of the specifications. All defects appear to be either of a kind which are capable of being remedied, or, on the other hand, to be of such nature that they may be tolerated without undue restrictions upon the usefulness of the equipment.

(c) If the necessary remedial action be taken as indicated in this report, the equipment will then be considered suitable for use in the Naval Service.

(d) The antenna systems used for the transmission of intermediate frequencies in modern naval vessels not only present many problems to ordinary radio telegraphic transmission in the lower portion of the intermediate frequency band, but also alter the performance of voice radio transmitting equipment in this frequency region, and introduce other factors which to a certain extent impair the usefulness of voice transmission.

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Recommendations

The information contained in this report has shown that a few changes are necessary to make the equipment comply with the specifications and to meet the demands of the Service. On the other hand, in certain instances it is considered that the equipment, while not conforming to the specifications, will function in a manner necessary to serve all practical purposes. Accordingly it is hereby recommended:

(NOTE: Following each of the subsequent recommendations, there appear the numbers of the paragraphs of this report where each matter is discussed in detail.)

- (1) That resistors R-215 and R-219 be provided with locking devices to prevent their accidental movement, or that suitable fixed units be used in the event that no occasion for their readjustment is contemplated and such an arrangement is practicable. (19)
- (2) That the audio voltage required at the speech input circuit of the transmitter to produce the specified percentage of modulation be considered satisfactory even though it does depart materially from the specified value. (32)
- (3) That the overall fidelity of the combination of the Speech Input Equipment and the Model XTBL-4 transmitter be considered satisfactory even though it does not comply with the specifications in certain instances. (32)
- (4) That the necessary changes be made in the line voltage control circuit to permit a more desirable redistribution of voltage control about the normal value of operating line voltage. (46)
- (5) That the necessary changes be made to assure that no grounds will occur on either radio receiver output lead regardless of what normal circuit combinations are employed in conjunction with the Speech Amplifier Unit. (44, 58)
- (6) That the output of the amplifier be considered satisfactory even though insufficient output is obtainable with AVC "on" to produce 85% modulation in a certain portion of the intermediate frequency band. (49)
- (7) That the change in amplifier output occurring during shift in position of the AVC switch be considered permissible even though the specification limits are exceeded by a small factor. (52)
- (8) That the change in amplifier output with AVC "on" when the input is increased by 12 decibels be considered permissible even though the change exceeds the specification limits. (54)
- (9) That necessary and desirable changes in the numbering system for the terminals on the terminal board of the Speech Amplifier Unit be formulated after all aspects of the situation have been

considered in a conference between representatives of both the Navy and the manufacturer; that any necessary or desirable changes be made in terminal form or arrangement to facilitate the connection of four Remote Telephone Units. (60)

(10) That fuses be employed of a rating capable of protecting the equipment; that suitable miniature nameplates or other durable markings be placed in close proximity to the fuse clips to indicate the type and rating of fuses employed. (61)

(11) That the level indicator be provided with a Navy type number. (63)

(12) That the dimensions of the unit be considered acceptable even though the height is slightly greater than is permitted by the specifications. (65)

(13) That the necessary modifications be made to assure that no undue strains be applied to any control knobs when the hinged front panel is folded back. (66)

(14) That the permanently mounted hand-set be provided with a black wrinkle finish. (67)

(15) That the colors used in coding of cabled leads contrast sufficiently to preclude the possibility of mistakes in connections. (68)

(16) That the cradle switches used in connection with both the permanently mounted and extension hand-sets be modified in a manner to cause them to perform all specified functions; that single contact "push-to-talk" switches be used if feasible. (68, 74)

(17) That all "press-to-talk" switches be replaced with a type which is more comfortable for use during extended periods of communications. (70)

(18) That chest microphones be employed which are not provided with apertures for "press-to-talk" buttons, if it is possible to obtain units of this type; but if such microphones are not available that a plug be used for the aperture which presents a more pleasing appearance. (71)

(19) That the plug and jack arrangement provided for the chest microphone be of specified single circuit type and employ standard Navy plugs and jacks for the purpose. (71)

(20) That the indicator lamp sockets be provided with suitable markings to preclude the possibility of installing an improper replacement bulb; that the indicator lamps be considered capable of performing their specified function even though they are not Navy standard lamps according to Bureau of Engineering drawing 9-S-4222-L-Alt. 22 pertinent thereto. (59, 77)

(21) That the Bureau give consideration to the approval of special resistors R-201 and R-204; that the Bureau also give consideration to approval of special types of resistors R-215 and R-219 provided that they are used in production models of the equipment. (19)

(22) That the Bureau determine if the resistors are provided with correct Navy type numbers. (19)

(23) That the Bureau determine if the nameplates provided are satisfactory; that the Bureau determine if certain additional parts require nameplates. (24)

(24) That approval be given the Speech Input Equipment after all matters mentioned in the foregoing recommendations have been treated in a manner satisfactory to the Bureau.

MATERIAL UNDER TEST

4. The material under test consisted of the following major parts.

- (1) Resubmitted model of Speech Input Equipment for Model TBL-4 transmitter. This amplifier covers a frequency range of from 300 to 3000 cycles and has a power output of 3 watts maximum. No type number for the amplifier is given on the nameplate and its serial number is "MODEL."
- (2) Chest Microphone for operator, Type CRV-51012, serial number "MODEL."
- (3) Extension Telephone Set of the hand-set type together with cradle for securing the phone. This unit contains no markings giving type or serial numbers.

5. The equipment listed above was delivered to this Laboratory on 12 December 1939.

6. The following units were used in conjunction with the tests. However, this report contains no detailed tests on the units listed hereafter, but merely a check of the functioning of the various units mentioned in the previous paragraph with those listed below.

- (1) Model XTBL-4 transmitter, serial number "MODEL."
- (2) Model XTBL-2 transmitter, serial number X-121.
- (3) Two Remote Telephone Units which are provided with no type or serial numbers.
- (4) Two receiver attenuator units which are provided with no type numbers but bear serial number "MODEL."

METHOD OF TEST

7. The equipment when received was carefully examined to determine whether any breakage or other damage had occurred in transit and whether adequate precautions had been taken in preparing the apparatus for shipment. With the aid of the preliminary instructions furnished shortly after its delivery, the equipment was placed in operation.

8. Audio frequency measurements and modulation tests were made by use of a Radio Research Company Model OB Audio Analyzer. In certain instances, the readings of this Analyzer were checked by means of a cathode ray oscillograph.

9. Audio fidelity tests were taken by impressing a constant input voltage across the input circuit of the audio amplifier,

determining fidelity by reading the amplifier output voltage developed across the various specified types of loads. In all cases, precautions were taken to supply the amplifier from an audio oscillator whose output impedance closely approached that of the input circuit of the amplifier. All fidelity characteristics shown herein are taken between the input transformer and output circuit of the Speech Amplifier, or between the same input position and the carrier, and do not include the characteristics of microphone. Fidelity characteristics embodying microphone properties are beyond the scope of these tests.

10. All d-c and a-c power measurements were taken by means of instruments whose accuracy was within 1/2% or greater.

11. The time required for the stabilization to be reached in the output of the amplifier with AVC on during abrupt changes in input level was determined by means of a cathode ray oscillograph.

DATA RECORDED

12. The data recorded in conjunction with the tests are shown in Tables 1 to 30 inclusive, and in Plates 1 to 11 inclusive.

DISCUSSION OF PROBABLE ERRORS

13. Efforts were made to minimize probable errors in all measurements by the selection of the best measuring equipment available for the purpose. The testing equipment used was previously verified as to accuracy. Where a single measurement left doubt as to the results or where the results found exceeded the specification limitations, rechecks of the observed data were obtained.

14. Audio frequency measurements are considered to be accurate to within 1 decibel. Changes in audio level occurring in relatively short periods (such as in shift of a switch or change of control setting) are considered to be accurate to within 0.3 decibel.

15. Sixty cycle power and voltage measurements are accurate to within 1/4%. Various voltage measurements at d.c. are accurate to 1/2%. Audio frequency voltage measurements are considered accurate to within 5%.

RESULTS OF TESTS

16. Inspection of the equipment upon delivery revealed that no damage had occurred in transit.

17. It should be remembered that the particular Speech Input Equipment under test is a resubmitted model and the tests upon the previous model were shown in Naval Research Laboratory Report No. R-1525. A comparison of the information shown in the report referred to with that contained in this report will indicate what improvements or changes have been effected in the later model.

18. ~~Comment will be~~ offered in the following paragraphs as to compliance with the various paragraphs of the governing Specifications RE 13A 465E. Attention is directed to the fact that the basic specifications have been modified in various respects as shown in reference (d). Where a portion of the basic specifications has been modified, a suitable indication will be made when referring to the particular paragraph under discussion. As this report is only preliminary, no reference will be made to all paragraphs contained in Specifications RE 13A 465E. In certain instances data as to operation of the Speech Input Equipment is shown both with Model XTBL-4 and Model XTBL-2 transmitters, but the indicated specification limits apply only to the Model XTBL-4 transmitter.

19. Par. 2-2. Data as to resistors used in the Speech Input Equipment are shown in Table 1. In addition, data as to power dissipation are furnished. It may be noted that all resistors are operated within their specification limits. Attention is directed to the fact that resistors R-201, R-204, R-215 and R-219 are resistors of a type for which there are no governing Navy Specifications. Accordingly, the Bureau of Engineering should give consideration as to whether or not these resistors be approved for use in this equipment. Referring to resistors R-215 and R-219 which are of the variable wire wound type, a study of wiring diagram No. P-717185, which appears in the preliminary instruction book, will show that they are parts of the automatic volume control circuit. No arrangements are provided for adjustment of these resistors on the panel, and it is believed that no occasion will arise which will require their readjustment, except possibly at infrequent intervals. Screw driver slots are provided in the shafts for variation of these resistors. No occasion for their adjustment during the course of the tests arose. In the design provided, other apparatus makes it impossible to gain access to these slots with an ordinary screw driver. No locking devices are provided to hold the correct setting, and they are considered necessary for shock and vibration may cause their settings to become altered. There is a possibility that fixed resistors could be used in lieu of variable types, and it is suggested that the Bureau inquire into the practicability of such an arrangement. The Navy type numbers indicated in Table 1 for the various resistor units were obtained from markings affixed to the unit, and the accuracy of such type numbers can not be verified since the Laboratory has no recent Navy resistor type number list.

20. Par. 2-4. In general, the Speech Input Equipment reflects good design and workmanship. In the few cases where improvements could be effected, pertinent information will appear under the heading of the appropriate paragraph of the specifications.

21. Par. 2-7. The use of ferrous materials for other than electromagnetic purposes has been kept to a practical minimum. Such ferrous parts as are used appear sufficiently well protected to resist the effects of corrosion. Attention is directed to the fact that no tests of the equipment at high humidities have been conducted to date. Should it be shown by these tests that any parts are rusted or corroded, all pertinent information will appear in the final report to be ultimately submitted on the complete Model XTBL-4 transmitter.

22. Par. 2-17. In Table 2 data are shown as to the potentials applied to the various vacuum tube electrodes. It may be seen that all tubes are operated within their specification limits. It may, at first glance, appear that the control grid bias of the Type 38646 tubes exceeds the specifications. However, Specifications RE 13A 800A state that the control grid potential for this type of tube shall be -3 volts or a greater negative value. This comment was included, for it might appear that more bias voltage was applied than permitted. During the course of the tests the rectifier tube, Type 38593, partially lost its emission and had to be replaced. An examination of the data indicates that it is operated well within specification limits. It is presumed that the cause of this failure was due either to a tube which was initially defective, or instead, it is entirely possible that this tube had been used for many hours in various tests conducted at the manufacturer's plant and that upon delivery to this Laboratory, the rectifier tube was approaching the end of its useful life. Accordingly, it is concluded that a satisfactory tube complement has been provided and that all tubes are operated within their specification limits and that approval should be granted to the tube arrangements as provided.

23. Par. 2-23. In Table 3 there is shown a list of controls, meters, and other devices located on the front panel.

24. Par. 2-26. In Table 4 there is shown a list of nameplates affixed to the various units. The nameplates appear entirely suitable for the purposes, provided the necessary information be placed in certain blank spaces left for the purpose. As nameplates are finally subject to approval by the Bureau of Engineering, it is suggested that the information in Table 4 be reviewed to determine if the nameplates meet all Bureau requirements. Attention is directed to the fact that the permanently mounted hand-set on the Speech Amplifier has no nameplate or other means of identification. The same statement applies to the extension hand-set. It is believed that both of these units should have a nameplate or other suitable designation to assist in their identification. Attention is directed to the fact that the specifications require that nameplates be affixed to all "major" units. It is suggested that the Bureau of Engineering consider the matter of identification of the two aforementioned hand-sets and inform the contractor as to the nature of nameplates or markings, etc. desired, provided this is considered necessary.

25. Par. 2-32. Data as to the weights of the various parts of the Speech Input Equipment are shown in Table 5. The specifications place no limit on the weights of these units. The weight provisions of this paragraph apply to the complete Model XTBL-4 equipment, and appropriate information will be submitted in the final report on this apparatus.

26. Par. 2-35(1). All component parts of the Speech Amplifier Equipment, such as resistors, condensers, transformers, etc., are provided with symbol markings. These markings are in the form of ink writing on circular labels approximately 3/4" in diameter which are pasted to the chassis in close proximity to the appropriate component

part. These marking labels appear quite similar to those used in conjunction with the Model TBK-8 equipment, wherein it may be recalled that during the latter part of the tests on that equipment, many of the labels came uncemented. No evidence has yet indicated loosening tendencies of the labels used in the Speech Input Equipment. Should there be any possibility of this, the tests at high humidity will hasten any such tendencies and provide a good means of determining whether or not they are securely affixed. Information will appear in the final report on the equipment as to whether or not these symbol marking labels give any indication of becoming detached after the humidity tests.

27. Par. 2-35(2). All resistors have markings indicating their Navy type number. These markings appear on the same label that shows the symbol number. Refer to Table 1 for list of resistor type numbers.

28. Par. 4-1. Special Speech Input Equipment as described in paragraph 4 of this report was provided to fulfill the requirements for voice transmission.

29. Par. 4-2. With an audio frequency input of 1.6 watts, which corresponds to 28 volts across 500 ohms, applied to the audio input terminals of the Model XTBL-4 transmitter, it is possible to modulate the transmitter output. The application of this voltage does not always produce the specified modulation, but full particulars in this respect will be provided in paragraph 32 of this report.

30. Par. 4-3. The selection of the desired type of emission, that is, cw, mcw, or voice, is accomplished by means of a three-position switch on the front panel of the transmitter. The operation of this switch accomplishes all necessary circuit and potential changes which are required to provide the desired type of emission.

31. Par. 4-4. As indicated elsewhere in this report, the unmodulated carrier power output during voice transmission complies with the specification requirements.

32. Par. 4-5. Before discussing data as to modulation capabilities, a discussion of the character of the modulation afforded by the Model XTBL-4 transmitting equipment will be offered. Means are included in the transmitter to provide voice modulation through the suppressor grid of the power amplifier tube. It is realized that this form of modulation is not as desirable or as free from distortion and other objectionable features as conventional "constant current" modulation. However, the manufacturer selected the best available means of modulation considering other limitations imposed by the specifications. Suppressor grid modulation inherently introduces conditions which depart somewhat from the ideal. It is usually found that such a type of modulation introduces conditions which cause the positive and negative peaks of the envelope of the carrier wave to differ materially in amplitude under certain conditions. As the dynamic operating characteristic of the tubes varies considerably at various operating radio frequencies, it is frequently found that

conditions arise where the relative values of positive and negative modulation peaks vary with the operating radio frequency. It has been found in tests on a number of transmitters employing suppressor grid modulation that at the lower frequencies (up to perhaps 6 or 8 megacycles) that the positive and negative peaks are frequently comparable in value; but if the operating frequency exceeds these aforementioned frequencies, it is usually found that the negative peaks of modulation exceed the positive peaks, and their departure becomes greater as the frequency is increased. It is frequently found that the positive peaks are relatively small, perhaps not more than 10% of the carrier amplitude, whereas the negative peaks may be as great as 80 or 90 per cent of the carrier amplitude. This condition is usually referred to as "downward" modulation. The question naturally arises as to how modulation should be expressed when its character is such that it is essentially downward. The standards set forth by the Institute of Radio Engineers cover such conditions. Therein it is stated that percentage of modulation is defined as the ratio of the peak value of the fundamental component of the modulating frequency to the average value of carrier amplitude found under the particular conditions during modulation. It is obvious that when the modulation is essentially downward that the amplitude of the carrier will be less than when unmodulated. As has been previously indicated, data as to modulation were taken with the Radio Research Company Model OB Audio Analyzer. This instrument provides means of determining both the positive and negative peaks individually, and in addition has means of determining the relative amplitude of the carrier when modulated or unmodulated. However, this instrument provides no means of selection of the fundamental component of the modulating frequency to the exclusion of all harmonics therein. The effective percentage of modulation was taken to be the ratio of the mean of the positive and negative peaks (which included modulating frequency harmonics) to the average level of the carrier under the particular modulation conditions. It may be noted that this does not completely fulfill the I.R.E. definition of modulation, but it is the closest approach to the measurement which is obtainable with existing laboratory apparatus. In Table 6, data are shown as to the modulating characteristics of the Model XTBL-4 Equipment. Therein is shown the values of positive and negative peaks (which materially differ at 18100 kilocycles) together with the effective percentage of modulation resulting from these observations. Hereafter in this report, modulation data will be in the form of effective percentage of modulation. Returning to the requirements of this paragraph of the specifications, data are shown in Table 7 as to the audio voltage required to produce a percentage modulation comparable with the specified value of 85%. Referring to the column headed "% Mod.", it may be seen that all data have not been taken at exactly 85%, but that in most instances, a reasonably close approach is indicated. It may be noted that a considerable difference in input voltage is required to produce the specified modulation at the several radio frequencies indicated. The input voltage departs in some instances as much as 39% or 2.9 decibels from the value of 28 volts as required in paragraph 4-2 of the specifications. In the case of tests at the intermediate frequencies, data as to antenna constants have been provided, for it is readily realized that the sharpness of tuning of the antenna has a great effect upon the transmitter modulation

capabilities, and if the antenna circuit has too much of a "flywheel effect" it nullifies a portion of the modulation. In Table 8 some data are provided regarding nullification of modulation or "clipping" of side bands. Referring to these data, which include the specified band of modulating frequencies and antenna characteristics which are frequently found in Naval shipboard transmitters, it may be seen that instances arise where a good portion of the side bands are clipped. Accordingly, it must be concluded that the relatively high values of input voltage required at 175 kilocycles as shown in Table 7 are due to side band clipping action and little can be done to remedy it since a physical law is the limiting factor rather than a defect in design. Referring again to Table 7, it may be noted that the value of input voltage required for modulation at 18100 kilocycles is higher than at 600 or 2000 kilocycles. This is probably caused by the fact that the dynamic operating characteristic of the power amplifier tube has shifted enough at the higher frequency that a greater modulating signal is required. A review of the information contained in Table 7 regarding the Model XTBL-4 transmitter in the light of the foregoing information leads to the conclusion that the best possible compromise has been attained, that the extreme values of the required input voltage have a mean value of approximately 28 volts, and that the best possible arrangement (although admittedly not entirely desirable) has been provided. Accordingly, the equipment should be considered acceptable in its present form.

33. 4-6. Data as to audio overall fidelity of the equipment from microphone transformers to carrier are shown in Plates 1 to 5 inclusive. All of these curves except those shown in Plate 3 were made by inserting a signal voltage into the panel jack on the speech amplifier. The curves in Plate 3 were made by inserting a signal through the panel jack of a Remote Telephone Unit. It may be seen by comparing the data in Plates 2 and 3 that little difference is produced in the overall characteristic. Also appearing on these aforementioned plates are data as to the fidelity of the Speech Amplifier only, under such conditions, and in addition, information as to the power output of the carrier. If the transmitter possessed perfect modulation characteristics, the carrier fidelity curves and the Speech Amplifier fidelity curves in each instance would be entirely parallel. It may be noted that, in general, the overall fidelity was not quite as flat as that of the Speech Amplifier. Such a condition would normally be expected for it is hardly anticipated that the transmitter would have a perfect modulation characteristic. A review of these curves indicates that the overall fidelity characteristic undergoes less variation when automatic volume control is employed. In Table 9, fidelity data have been extracted from these aforementioned plates and are provided in tabular form. The relatively poor fidelity characteristic noted at 175 kilocycles is due to the side band clipping properties of the antenna as mentioned in the previous paragraph. The specifications require that the overall fidelity in the intermediate frequency band be optimum, and the data indicated in Table 9 show variations in the i-f band not exceeding ± 6 decibels, which is considered optimum. In the case of the high frequency transmitter, it may be noted that at 2000 kilocycles, the specification requirements regarding

fidelity are met. At a frequency of 18100 kilocycles, the specification limit is exceeded with AVC "off", but due to the characteristics of the suppressor grid modulator circuits at frequencies of this order, it is considered that little can be done to improve it. It is believed that the equipment in its present form will function satisfactorily for all practicable purposes in the Naval Service even though it does not entirely comply with respect to this portion of the specifications.

34. Par. 4-7. Data as to distortion in modulation are shown in Tables 10 and 11. Data taken on the Model XTBL-4 transmitter are shown in Table 10 and similar data on the Model XTBL-2 transmitter are shown in Table 11. Referring to the data in Table 10, it may be noted that the greatest distortion observed is less than 10% around 75% modulation (a maximum of 15% distortion is allowed at this modulation level) and, in general, the distortion is much lower than the specified maximum value. Data as to audible noise on the carrier may be also found in Tables 10 and 11. Reference to these tables will indicate that data regarding carrier noise have been stated in two ways: first, regarding decibel relationship to audio signal and, second, regarding the decibel relationship to 85% modulation. The specifications provide no limits as to carrier noise during voice transmission.

35. Par. 4-8 as modified by paragraph 1 of reference (d). The necessary terminals are provided on the terminal board of the transmitter for connection of the speech input and carrier control circuits. Carrier control is effected by "press-to-talk" switches associated with the various microphones used in conjunction with the equipment. These "press-to-talk" switches energize a relay in the Speech Amplifier whose contacts control the normal keying relay. The circuit arrangement provides means of making the telegraph key inoperative when the equipment is adjusted for voice transmission. Paragraph 1 of reference (d) permitted elimination of the antenna transfer relay.

36. Par. 4-9 as modified by paragraph 2 of reference (d). The Speech Input Equipment consists of a suitable two-stage Speech Amplifier and a permanently connected combination hand-set. Accessories provided for use with the Speech Input Equipment consist of one extension combination hand-set, one chest microphone, and two receiver attenuator units.

37. Par. 4-10. The Speech Input Equipment when associated with the basic transmitting equipment and Navy receiving equipment of the RAB type is capable of operation as a two-way radio telephone circuit. Actual tests were conducted using an RAB receiver, but such tests were confined to reception of such voice signals as were available from various stations transmitting speech, and no two-way communication tests were undertaken. No tests were conducted with an RAA receiver for its design features are such as to make it a poor receiver for voice signals. No tests were conducted using RAK or RAL receivers as none were available. It should also be pointed out that laboratory tests of the communication system may not disclose difficulties of a type that may be encountered only on shipboard, for it is realized that grounding, shielding, and other pertinent factors may be far different in the two instances.

38. Par. 4-11(1). The design of the speech amplifier unit is such that the operator is able to control the incoming 60 cycle power circuit. A suitable toggle switch is provided for this purpose which opens or closes both of the incoming power lines.

39. Par. 4-11(2) as modified by paragraph 3 of reference (d). It is possible to transmit or receive signals from any one of the 15 positions as follows:

(1) Positions on Speech Amplifier proper.

- (a) Local combination hand-set.
- (b) Extension combination hand-set.
- (c) Chest microphone and head telephones when plugged into speech amplifier front panel.

(2) Positions on Remote Telephone Unit (of which 4 such units may be used).

- (a) Local combination hand-set.
- (b) Extension combination hand-set.
- (c) Chest microphone and head telephones when plugged into remote telephone unit.

A three-position telephone key or toggle switch is provided on the front panel of the Speech Amplifier unit whose function is described in paragraph 75.

40. Par. 4-11(3). Means have been provided for monitoring the transmitter speech input and receiver output circuits. A tertiary winding on the speech amplifier output transformer is provided for monitoring transmitter speech input circuits and audio side tone may be applied to the earphones by throwing the switch on the front of the speech amplifier panel marked "Amp-Rec" to the "Amp" position. The output of the receiver may be monitored by throwing it to the "Rec" position.

41. Par. 4-11(4). The audio output of the Speech Amplifier may be adjusted to the desired level by means of a suitable, adjustable attenuator. A knob on the front panel is used to control the setting of the attenuator. The attenuator control is provided with a calibration consisting of 12 divisions. A suitable high speed meter for level indication is also provided on the front panel. For more particulars regarding the meter, refer to Table 3.

42. Par. 4-11(5). The automatic volume control circuit of the speech amplifier may be cut in or out by means of a toggle switch on the front panel. Suitable markings indicate the position of this switch, whether "on" or "off."

43. Par. 4-11(6). This paragraph of the specifications refers to receiver input attenuators. Paragraph 7 of reference (a) stated that no tests were to be conducted on the attenuator units. No alterations have been made in the attenuator units since their previous

submission for test and all pertinent details as to their operation may be found in the various sub-paragraphs of paragraph 204 of Naval Research Laboratory Report No. R-1525.

44. Par. 4-11(7) as modified by paragraph 4 of reference (d). Two jacks are provided on the front panel of the Speech Amplifier Unit, one for the chest microphone and the other for a pair of headphones. It is noted that when the headphones are plugged into the jack that a ground is placed upon one of the receiver terminals. As receivers of the RAA and RAB type, as well as most other Naval receivers, are provided with grounded center taps on output transformers, it is obvious that the receiver output transformer is partially short circuited when the headphone plug is inserted into its jack. Obviously this arrangement decreases the receiver signal output by a large factor. It would not be difficult to replace this jack with one of an insulated type which would produce no grounds on the receiver output circuit. In order to make the equipment entirely suitable for the purpose the proper steps should be taken to overcome this condition by use of a suitably insulated jack. An examination of the circuit reveals that in no other cases are grounds applied to the receiver output when connected to the Speech Input Equipment.

45. Par. 4-11(8). Means have been provided for obtaining audio side-tone from the output of the Speech Amplifier Unit or radio link side-tone from the i-f or h-f receiver.

- (a) For details of switches and circuit arrangements used in obtaining the required performance, refer to paragraph 40 of this report.
- (b) With AVC "off" and the attenuator set at maximum value, it is found that a barely perceptible "howl" occurs in the combination hand-sets. This "howl" is caused by acoustical feed-back in the hand-set units. In an arrangement such as a headphone receiver and a microphone unit affixed to a common member (wherein acoustical coupling is inherently present), it is realized that some acoustical feed-back will occur and produce a "howl", if the amplification between the aforementioned units is sufficiently high. As previously mentioned, the level of this "howl" is quite low and measurements indicate that its amplitude is about 15 decibels below the normal amplifier output (1.6 watts) and no noticeable interference with operation is observed. Under conditions similar to those described previously, except that AVC is "on", a similar "howl" occurs, but as would ordinarily be expected it is somewhat higher in amplitude. The level of the "howl" with AVC "on" is approximately 5 decibels below normal amplifier output. A "howl" of greater intensity will normally be expected when the AVC is "on" since the gain of the amplifier with no input signal is much greater with AVC "off". When input signals are delivered to the Speech Amplifier Unit either from the microphones or from the radio receivers, the audible "howl" can hardly be noticed. It is not clear whether or not the

"howl" entirely disappears or whether it is masked by the other signals. It would seem reasonable to believe that the "howl" is substantially eliminated by the application of other signals, for under these conditions the AVC circuits operate in a manner to reduce the gain of the amplifier. This audible "howl" is not at all desirable but no definite means can be suggested, considering all specification requirements, to overcome this difficulty. It is not believed that the "howl" will cause any serious difficulties in the functioning of the equipment in the Naval Service and it is therefore concluded that this feature of the equipment should be considered satisfactory in its present form.

46. Par. 4-12(1). The Speech Amplifier Unit includes everything necessary to take power from 110 volt, 60 cycle, single phase power supply and to transform, convert, and control the power as necessary to provide satisfactory operation. The equipment is designed to function on the specified normal line voltage (110 volts) and provides means for assuring satisfactory operation at line voltages within 10% of the normal value. This is accomplished by means of a variable rheostat, controlled from the front panel, which is inserted in series with the incoming a-c power line. Means to correctly adjust the setting of this rheostat is provided in the form of a plate voltmeter. According to instructions, the rheostat should be adjusted to produce a plate voltage reading of 230 volts, and as variations are encountered in line voltage, this rheostat should be reset to obtain the desired value. It was noted that the rheostat provided sufficient control for line voltage variations between 99 and 136 volts. Although this meets the specified requirement, it is considered that an improvement would be effected by alterations which would make it possible for the rheostat to function between extremes in operating voltage which vary approximately equally above and below the normal value of 110 volts. It is suggested that this refinement be incorporated in the final models of the equipment. Data as to the required operating power are shown in Table 12 and therein it is indicated that in no case does the operating power exceed the specified maximum of 125 watts. Referring to comment on this paragraph of the specifications shown on page 5 of the Contract Note, suitable provision has been made for supplying operating power to the Speech Amplifier from the 110 volt secondary on the distribution transformer inside the transmitter.

47. Par. 4-12(2). The Speech Amplifier Unit includes a suitable two-stage Class A amplifier provided with automatic volume control. Type 38646 tubes are used in the input stage and Type 38213 tubes are used in the output stage. Push-pull circuits are used in conjunction with both stages. For information as to other types of tubes used, refer to Table 2. All tubes used in the Speech Amplifier equipment are of standard Navy type.

48. Par. 4-12(3) as modified by paragraph 5 of reference (d). The input circuit of the Speech Amplifier is suitable for use with the specified types of microphones. Power for operation of the microphone circuits is provided from a copper oxide rectifier. The input transformer to the Speech Amplifier unit contains a winding which suitably serves as the primary of a microphone transformer. The input

transformer has another winding which is provided with four taps for connection to 200 ohm or 600 ohm output circuits of Remote Telephone Units.

49. Par. 4-12(4). Data as to the fidelity of the amplifier only are shown in Table 13. Reference to the footnotes of this table will indicate that the fidelity with three different types of input circuits has been shown. All three of these types of input circuits will be employed under normal operating conditions. It may also be noted that fidelity data appear not only in the case of a 500 ohm resistance load, but also when loaded into the speech input circuit of the transmitter proper. It may be seen that the fidelity is not quite so good when used to energize the modulation circuit of the transmitter as when fed into a 500 ohm resistor. This would normally be expected since the reactive components of Speech Amplifier load, when used to energize the transmitter, do have some effect upon its fidelity. Reference to Plates 6 to 9 inclusive, shows fidelity data in graphic form. These curves were made under slightly different conditions and notes on the various plates indicate the particular condition. In Plate 9, one fidelity curve is shown at the maximum specified amplifier output of 3 watts. Referring again to Plates 6 to 9 inclusive, it may be noted that the use of the automatic volume control appreciably improves the fidelity of the amplifier. Reference to Plates 1 to 5 inclusive, while mainly intended to indicate the overall fidelity of the transmitter, also provides fidelity curves on the amplifier. A comparison of the data in Plates 1 to 5 inclusive, with that shown in Plates 6 to 9, inclusive, again verifies the statement made earlier in this paragraph wherein it was said that the fidelity of the amplifier only when used to supply the transmitter was not quite so good as when loaded directly into a 500 ohm resistor. Considering the pertinent data where the Speech Amplifier Unit is loaded into a 500 ohm resistor or into the speech input circuit of the Model XTBL-4 transmitter (but not that where loaded into the Model XTBL-2 transmitter), it may be seen that the fidelity requirements of ± 2 decibels are exceeded by only 0.25 decibel, and this departure is so small that in allowing for probable error, there is no direct evidence that it does not conform to requirements. Accordingly, the fidelity requirements are met. In Tables 14 and 15, data as to amplifier output and distortion are shown. These data were taken with different input circuit arrangements and a review of the footnotes of each table will indicate the test conditions. It may be noted that the distortion is somewhat greater when the amplifier is fed at the 600 ohm input terminals than when fed at the microphone terminals. No explanation for the difference in values of distortion under the two test conditions can be offered. In all cases the distortion is below the allowed maximum value of 10%. In Plate 10 in graphic form is shown a plot of the data contained in Table 15. It is evident that the amplifier is capable of delivering the specified maximum of 3 watts by reference to Tables 14 and 15. In paragraph 32 it was indicated that in some cases considerably more than the specified 28 volts of audio input was required to produce the desired modulation. An inspection of the data in Table 7, considering also that in Tables 14 and 15, will show that the Speech Amplifier is

capable of producing sufficient output for 85% modulation with AVC "off." When AVC is "on," it was found impossible to speak loudly enough into any microphone to cause the Speech Amplifier to produce enough output to furnish 85% modulation at 175 kilocycles. Because of various specified performance characteristics for the AVC circuit, no means of overcoming this difficulty can be suggested which is compatible with all portions of the specifications.

50. Par. 4-12(5). Data as to noise level of the amplifier are shown in Tables 16 and 17. Footnotes on the tables explain the type of input circuits used in the two instances. A review of the data will indicate that the amplifier noise is well below the allowed minus 50 decibels relative to maximum amplifier output. In fact, in no case is a noise level observed which is greater than half the specified maximum value when considered in terms of per cent noise.

51. Par. 4-12(6). Test data on the accuracy of the gain control calibration are shown in Table 18. The difference between two adjacent settings approaches closely enough to the specified difference of 2 decibels to be satisfactory for most practical purposes. The data shown in Table 18 are taken with automatic volume control "off." In Table 19 similar data are shown with the automatic volume control "on." The specifications provide no limits in connection with the data shown in Table 19.

52. Par. 4-12(7). The design of the amplifier includes an automatic volume control feature which may be employed at will by the setting of a switch on the front panel. Placing this switch in the "off" position allows the equipment to act substantially as a linear amplifier. Data in Table 20 indicate changes in amplifier output voltage produced by operation of the AVC switch. These values, as it may be seen, were taken at audio output levels within 1 decibel of zero level. It may be seen that in this output level region the amplifier complies with this portion of the specifications. In Table 21 data are shown as to the effect of the manipulation of the AVC switch on modulation of the carrier. In this particular case, modulation levels were selected which corresponded approximately to the desired 85% modulation stated in paragraph 4-5 of the specifications. The modulation values approached as near 85% as it was possible to obtain without the expenditure of a great deal of time in adjusting the equipment. The paragraph of the specifications now under discussion states that its requirements apply at "full" modulation, and in view of the provisions of paragraph 4-5 of the specifications, 85% modulation is considered "full" modulation. It may be noted in Table 21 that the change in output of the Speech Amplifier is slightly more than the specification limit at 175 kilocycles, but in other instances the requirements are met. The effect of side band clipping as discussed in paragraph 32 makes it necessary to use greater than normal output level from the Speech Amplifier to obtain the desired modulation, and in so doing there is necessarily introduced the shift of 1.4 decibels. As previously pointed out, a physical law is the limiting factor and not defective design of apparatus, so it is suggested that the equipment be considered satisfactory even though not entirely fulfilling the specified

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requirements. There is further reason to conclude that the equipment should be accepted in its present form after a review of the data in the column of Table 21 headed "Change in Mod.-db.". It may be seen that the change in modulation is less than 1 decibel, and since the aim of this paragraph of the specifications is obviously to prevent too large a change in modulation by manipulation of the switch, it may be seen that the ultimate effect desired was attained. Therefore, it is concluded that while all provisions of the specifications as stated were not met, the overall performance of the equipment is such as to comply with the spirit of the specifications. Additional data relevant to the subject are shown in Table 22. Before discussing these data, a word of explanation will be offered. Referring to Plates 1 to 5 inclusive, it may be seen that the maximum response of the radio telephonic system occurs at a frequency in the region of 400 cycles. Also it has been shown by various investigators that the greater portion of the power in the human voice is at a frequency somewhat less than 400 cycles. In addition, the response of the carbon button microphone is usually better in the lower frequency regions, that is, in the neighborhood of 400 cycles. Actually, the performance of the AVC circuit has been specified at 1000 cycles. As in normal use for the transmission of speech, the equipment will be adjusted to give a modulation somewhere in the region of 85%, in the light of the foregoing statements obviously most of the modulation components of the carrier will be in the region of 400 cycles, and the response of the system will be such that somewhat lower values of modulation components will be produced at a frequency of 1000 cycles. Data obtained at the specified testing frequency of 1000 cycles would be interesting when taken after transmitter and Speech Amplifier adjustments had been made to efficiently transmit normal speech, or where the modulation capabilities of the system at 1000 cycles were somewhat below the specified value of 85%. Such data are shown in Table 22, and as would normally have been expected, changes somewhat greater than 1 decibel are noted both in the output of the Speech Amplifier and in the modulation of the carrier. So, in the normal course of events, changes from manipulation of the AVC switch of an order comparable with those shown in Table 22 will be encountered in normal use. In the light of the provisions on this portion of the specifications (change in gain performance specified at 1000 cycles) as well as normally encountered operating characteristics, no means of overcoming this difficulty can be readily offered. Although the arrangement provided is not entirely desirable, as no suggestions for improving it can be offered, it is considered that the equipment should be accepted in its present form. The specifications also indicate that manipulation of the AVC switch shall not cause the distortion to exceed the limits specified elsewhere. The Laboratory has no facilities for checking distortion in an amplifier at frequencies of 1000 cycles but distortion measurements were taken at a frequency of 400 cycles which may be found in Tables 14 and 15. Reference to those data will indicate that the distortion requirements are not exceeded at 400 cycles.

53. Par. 4-12(8). Plate 11 illustrates the amplifier output characteristics when the AVC circuit is in use. Reference to this plate will indicate that two curves are indicated which were made

under slightly different conditions. Notes affixed to Plate 11 explain the circumstances under which each curve was taken. It may be seen that the characteristic partially exceeds the specification limits. However, when probable error is taken into account, the compliance is close enough to the specified performance to indicate that the equipment will function for all practical purposes as intended.

54. Par. 4-12(9). Performance data for the functioning of the amplifier with AVC "on" when the input voltage is increased by 12 decibels is shown at the foot of Table 20. It may be noted that the output change exceeds the allowed value of 3 decibels by approximately 0.9 decibel. The specification limit is exceeded by such a small value that it is considered that the equipment will function satisfactorily for all practical purposes in its present form. Accordingly, the equipment is considered satisfactory in this respect. It may be also seen in the table referred to above that the distortion is within the specified limit.

55. Par. 4-12(10). An examination of the output of the Speech Amplifier by means of a cathode ray oscillograph when recurrent surges consisting of a few complete cycles of a 1000 cycle sinusoidal input signal were applied showed that the output stabilized within approximately 0.01 second. Obviously this complies with the requirements for stabilization within 0.02 second.

56. Par. 4-12(11). Plate power for the amplifier is supplied by a Type 38593 full wave vacuum tube rectifier. The specifications indicated that a Type 38180 tube should be used, but page 4 of the contract note stated that a Type 38593 tube was preferable. Presumably the contract note supersedes the provisions of the specifications and therefore the equipment is considered to comply with requirements.

57. Par. 4-12(12) as modified by paragraph (6) of reference (d), and as further amended by paragraph (6) of reference (e). Low voltage power is provided by a rectifier of the copper oxide type and the unit used in the particular application is a Westinghouse Rectox unit Style 26-W-293. Pertinent data on the loads and voltage variations encountered under various conditions are shown in Tables 23 to 25 inclusive. A review of these data will indicate compliance with the specifications in all cases. The design used applies no grounds to the copper oxide rectifier circuit. It was found possible to apply a load of 1.2 amperes to the rectifier unit for a period of one minute without damage or other detrimental effects. Referring to the data in Table 24, it may be seen that the copper oxide rectifier circuit has an exceedingly good voltage regulation for such a device. This good regulation characteristic is secured by means of a saturable reactor in the supply circuit. It may appear unusual that when full load is applied that the output voltage of the copper oxide unit increases as the line voltage decreased and this condition is probably due to over-compensation in the saturable reactor.

58. Par. 4-12(13). Reference to paragraph 44 of this report will indicate that a slight modification will be necessary before the Speech Input Equipment will function satisfactorily with receiving.

equipments having balanced output telephone circuits whose center taps are grounded.

59. Par. 4-12(14). Power to the Speech Amplifier unit is controlled by a toggle switch located on the front panel and which is provided with markings to indicate its position. Both of the incoming power lines are broken by this switch. An indicator light is provided for showing whether power is "on" or "off." This light is of the telephone switchboard type with a slide base and is GE Type 6A. This lamp is rated at an operating potential of 6 volts. The base and envelope of this lamp are similar to that of Navy Type T-2 or T-3 lamps. Attention is directed to the fact that its operating voltage differs from that of Navy Type T-2 or T-3 lamps so therefore the power indicator light is not of standard Navy type. Arrangements are made to view light through a small red bull's eye located on the front panel. The bull's eye is labeled "power."

60. Par. 4-12(15) as modified by paragraph 7 of reference (d). A terminal board is provided at the back of the Speech Amplifier for connection of all incoming leads. Thirty terminals are included on this board. In Table 26 is shown which terminals of the various units of the complete Model XTBL-4 transmitter as well as receiver and Remote Telephone Units, etc., are normally interconnected for proper functioning. The terminals are numbered as required by enclosure (F) of reference (a), and presumably meet the specifications. In the interest of convenience, it is suggested that the terminals on the Speech Amplifier could be renumbered so that they correspond with those on a Remote Telephone Unit or vice versa. This would afford considerable convenience in the Naval Service in the installation of the equipment. This same statement applies in conjunction with connecting terminals between the Speech Amplifier and permanently mounted and external hand-sets, although not quite as important as in the case previously mentioned. It is suggested that the Bureau of Engineering review the information contained in this paragraph as well as that shown in Table 26 and by means of a conference with the contractor's representative formulate the necessary or desirable changes in the numbering system in the interest of facilitating installation of the equipment on shipboard. In regard to the terminal board, it is noted that only one group of terminals is provided for connecting the necessary number of Remote Telephone Units. In paragraph 8 of reference (d), it is indicated that as many as four Remote Telephone Units may be connected to the Speech Amplifier. The terminals are located so close together that there is great possibility that considerable inconvenience will be experienced in connecting four conductors to each of the eight terminals used for the purpose. To overcome this difficulty, more spacing should be provided around each of the terminals which connect to a Remote Telephone Unit as well as other changes as found necessary to conveniently connect four conductors to such terminals. On the other hand, should the plan be to use some type of external junction box to attach the four Remote Telephone Units, which would mean that only one conductor will attach to each Speech Amplifier, the present arrangement is satisfactory.

61. Par. 4-12(16). Both incoming power lines are provided with fuses. These fuses are of the renewable type and are rated at 10 amperes.

Reference to Table 12 will indicate that the maximum value of current required under normal operating conditions does not exceed 1.07 amperes. For this reason it is apparent that more complete protection would be provided by a fuse of lower rating. It is suggested that the final models of the equipment be provided with fuses rated at 3, or possibly 5 amperes, or thereabout. The fuse mountings do not include markings to indicate what rating of fuse should be employed. Such markings appear highly desirable for the convenience of Service personnel in making replacements, and should be permanently affixed in close proximity to the fuses.

62. Par. 4-12(17) as modified by paragraph 8 of reference (d). Separate terminals are provided on the Speech Amplifier terminal board for the local combination hand-set and for the extension station hand-set. In addition, terminals are provided for the connection of one Remote Telephone Unit. Some of these terminals are interconnected inside the Speech Amplifier unit. However, separate microphone voltage dropping resistors are provided for each d-c microphone circuit. Refer to paragraph 60 for discussion of Speech Amplifier terminal board and connections thereto.

63. Par. 4-12(18). The level indicator is of the high speed type and a complete description of the level indicator may be found in Table 3. Attention is directed to the fact that no Navy type number appears on the instrument, and this is considered necessary for convenience in securing replacements. The zero point of the level indicator is located at mid-scale and corresponds to an output power of 1.6 watts or 28 volts across a 500-ohm load. The scale of the meter covers a range from -10 to +6 decibels. In Table 27, data as to accuracy of the level indicator are shown and it may be seen that the observed error is reasonably small.

64. Par. 4-13 as modified by paragraph 9 of reference (d). The control of the carrier is provided by "press-to-talk" switches located on the various microphones. The "press-to-talk" switches on the microphones directly associated with the Speech Amplifier Unit energize a d-c control relay in the Speech Amplifier Unit operating from the 12 volt circuit whose contacts control the transmitter keying relay. The control relay in the Speech Amplifier requires approximately 55 milliamperes, whereas 75 milliamperes maximum is allowed. Any of these switches also energize the microphone associated with it. The carrier can also be controlled by means of "press-to-talk" switches affixed to the microphones associated with the Remote Telephone Units. A relay is provided in the Remote Telephone Unit which operates the control relay in the Speech Amplifier Unit which in turn operates the transmitter keying relay. There is a slight delay observed before the carrier goes off after a "press-to-talk" switch of a microphone associated with a Remote Telephone Unit has released because the relay in the Remote telephone Unit appears somewhat sluggish. A higher speed relay in the Remote Telephone Unit appears desirable for otherwise a part of a received word may be "chopped-off" during transition from transmission to reception. The "press-to-talk" switches associated with the microphones attached to the Remote Telephone Units also control the d-c power supply to these microphones.

65. Par. 4-14. Data as to the dimensions of the Speech Amplifier Unit are shown in Table 28. Attention is directed to a footnote which states that the height dimension applies to the cabinet only and does not include the overall height to the top of the permanently mounted hand-set. As the requirement for this permanently mounted hand-set was set forth in a specification modification made after the issuance of the basic specifications, it is considered that the height dimension applies only to the cabinet proper. Actually the height exceeds the specification limits by 1/8" when the added height of the permanently mounted hand-set is ignored. It is not considered that this extra height will make the unit unsuitable for the purposes intended, and it is suggested that the size be considered satisfactory in its present form.

66. Par. 4-14(2). All necessary controls and indicating instruments are provided on the front panel. For a list of controls and other devices located on the front panel, refer to Table 3. The front panel is hinged at the bottom to facilitate access for maintenance purposes and may be withdrawn by loosening the necessary knurl headed thumb screws. The hinge used is non-ferrous. When the hinged front panel is drawn back, it is found that when pulled entirely open and allowed to rest on the shelf to which the Speech Amplifier Unit is affixed (provided the shelf projects a sufficient distance in front of the front bottom edge of the unit), that the weight of the apparatus on the panel (which is considerable) is enough to very likely damage the two variable rheostats mounted behind the panel, for the weight rests upon their control knobs before the stops take effect. No difficulties were encountered during tests, but care was always taken, when the front panel was folded outward, to keep the equipment from resting upon these knobs. In order to overcome this difficulty and prevent damage to any members, the stops should be modified so as to take effect before allowing the application of any strains to control knobs.

67. Par. 4-14(3). All exterior parts of the Speech Amplifier Unit are provided with a black wrinkle finish. The extension combination hand-set is provided with a black wrinkle finish. The permanently mounted combination hand-set has a dark gray finish. For harmonious appearance, the permanently mounted hand-set should be provided with a black finish, and it is suggested that in this case a wrinkle black finish be used to correspond with that on the extension hand-set.

68. Par. 4-14(4) as modified by paragraph 10 of reference (d). The Speech Amplifier Unit has permanently attached thereto a local combination hand-set and desk stand which is connected to the terminal board on the Speech Amplifier by means of a 5-conductor cable. This cable is color coded and below will be shown the color coding and the corresponding terminal numbers to which they are affixed in the Speech Amplifier Unit:

Terminal Number	20	-	brown
	21	-	green
	22	-	black
	23	-	brown
	24	-	brown

There is a slight difference in shade between the three brown colored wires indicated above. However, the difference is so little that some difficulty would be found in following such a code in connecting up the equipment. This 5-conductor cable should be provided with a color coding such that sufficient contrast in colors appears so there will be no doubt as to connections. The permanently mounted desk stand can be detached by removal of the two bolts and can be relocated in some other position, if desired. Lugs are provided at the base of the cradle for securing it either to the top of the Speech Amplifier Unit or any other location, as desired. The desk stand has a double circuit cradle switch which operates as follows: One switch is in series with the head-phone lead and connects the head-phone in the circuit when the unit is out of the cradle and disconnects it when the hand-set is in its cradle. The other switching member in the cradle switch is effectively in series with the control relay in the Speech Amplifier, and when the phone is out of cradle it allows the relay to operate in accordance with the "push-to-talk" switch, and renders the relay inoperative when the phone is in the cradle. Attention is directed to the fact that the specifications require that the cradle switch be capable of opening the microphone circuit when the phone is in its cradle. This provision has not been included as will be indicated by an analysis of wiring diagrams K-855800 and P-717185 of the preliminary instruction book; or otherwise stated, the microphone circuit can be energized by closing the "press-to-talk" switch regardless of whether or not the hand-set is in its cradle. In fact, the hand-set may be removed from its cradle and the cradle switch manually thrown to the position which normally is found when the hand-set is in the cradle, and if the "press-to-talk" switch is closed and the microphone spoken into, the Speech Amplifier will be energized in the normal manner, excepting that the control relay will not function. It appears that a relatively simple rearrangement of switch contacts and electrical connections can be effected to make the equipment comply with this provision of the specifications, and this should be done. Also it appears that a single contact "press-to-talk" switch could be used in lieu of the present double contact arrangement. This comment is offered since the Bureau anticipated that a single contact switch would be used, for such was indicated in enclosure (F) of reference (a). No detailed circuit analysis was made to determine if a single contact switch is entirely practicable, but a preliminary study makes it appear feasible, and any such possible simplifications should be considered. A spring arrangement with plastic ring buffers is provided to secure the hand-set in its cradle and prevent its coming from place during vibration or shock. It is not as convenient to remove the hand-set as would normally be desired, but no suggestions can be offered for an improvement to make it more readily removable and yet able to stay in place during shock and vibration.

69. Par. 4-15. This paragraph of the specifications applies to the receiver attenuator units. Paragraph 7 of reference (a) stated that no input attenuator tests were to be conducted. As the attenuators are the same as submitted with the earlier models of the equipment, full information as to the compliance with this portion of the specifications is contained in paragraph 230 of Naval Research Laboratory Report No. R-1525.

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70. Par. 4-16 as modified by paragraph 11 of reference (d). The combination hand-sets furnished in connection with both the permanently mounted hand-set and the extension hand-set are manufactured by the Automatic Electric Company and are believed to be the equivalent of Western Electric Type E2E. Each is provided with a "press-to-talk" switch. These "press-to-talk" switches are in the nature of metallic buttons permanently mounted to the part of the hand-set which joins the microphone and earphone. It has been found by tests that the extended use of the hand-set provides considerable discomfort to the operator because of the force necessary to keep the button depressed. In fact, after a five-minute conversation, the operator's thumb feels quite sore because of the pressure required to hold the button down. While this appears to be a small matter, it is apparent that considerable annoyance will be encountered in the Service in the case of reasonably long conversations through the hand-set. In conjunction with other equipment, this Laboratory has had occasion to use similar hand-sets provided with "press-to-talk" switches, the switches of which were closed by the rotation of a member having an external form like a wing nut by means of thumb pressure. It was noticed in conjunction with these tests that no discomfort was found in keeping the switch closed for a period of a half hour or more. The preferable type of "press-to-talk" switch was used on apparatus described in Naval Research Laboratory Report No. R-1364. The inclusion of this type of "press-to-talk" switch is considered a highly desirable arrangement.

71. Par. 4-17 as modified by paragraph 12 of reference (d). The operator's chest set provided for use with the equipment is Type CRV-51012. This chest microphone is believed to be similar to Navy Type CW-51005. The microphone furnished was manufactured by the Automatic Electric Company. The chest microphone has presumably been modified and a "push-to-talk" switch originally used has been eliminated and the hole filled with a plug made of some kind of plastic material. While this causes no difficulty, it is considered that an improvement in the appearance of the equipment would be effected by employment of a chest microphone which is provided with no plugged aperture for a "press-to-talk" button. Of course, if it is impossible to commercially obtain such a microphone, an improvement in appearance could be effected by closing the aperture with a fitting which presents a more pleasing and finished appearance. The chest microphone embodies a single circuit. However, a three-conductor plug is provided in conjunction with this member. In order to comply with the specifications, a single circuit plug and jack should be employed for the purpose, insulating the necessary members from the frame to preclude the possibility of grounding the 12-volt circuit. The chest microphone is provided with a 4-foot cord.

72. Par. 4-18. No comment. This paragraph merely states that the head-sets used with the Speech Amplifier will be provided by the Navy.

73. Below will appear comment on certain additional requirements included in reference (d). Hereafter reference will be made to certain paragraphs of the modification of the specifications.

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74. Par. 13. An extension combination hand-set was provided for use with the Speech Amplifier which is similar in structure to the permanently mounted hand-set which was described in paragraph 68 of this report. The extension combination hand-set is arranged for bulkhead mounting and two lugs are provided on its base for securing it by means of bolts. A hole near the bottom of the base is provided for the insertion of an insulated 5-conductor cable whose diameter is approximately 3/8". No provision is made for the connection of an armored cable; however, this was not required by the specifications and is merely pointed out for it is realized that in some installations the use of such a type of cable may be desirable. A terminal board for connection of the five leads is provided and is accessible for connection by removal of the bottom plate of the mounting. The statements made in paragraph 68 of this report, regarding the failure of the cradle switch to comply with the specifications, also apply to this unit, and the necessary changes should be made to make it conform to specified requirements. Simplifications of the "press-to-talk" switch should also be considered in conjunction with this unit. The extension hand-set is secured to its cradle by the same means as previously discussed in paragraph 68, and securing means which will withstand the effects of shock and vibration has been furnished. The improvements in the "press-to-talk" switch mentioned in paragraph 70 of this report also apply to the extension combination hand-set.

75. Par. 14. A three-position switch is provided on the front panel of the Speech Amplifier Unit for controlling the operation of the chest microphone. This switch also connects the hand-set into the circuit. The three positions of this switch have a function as follows: the switch locks "on" when pushed upward, is "off" when in center, and is "on" when held downward. This switch must be manually held in the downward position to maintain contact, and when released automatically returns to the center or "off" position. The requirements of the specifications are therefore met.

76. Par. 15. The control relay in the Speech Amplifier unit is provided with two sets of contacts. One set of contacts controls the operation of the "carrier-on" indicator lights in the Speech Amplifier and in the several Remote Telephone Units and the other pair of contacts control the transmitter keying relay. The requirements of the specifications are therefore met.

77. Par. 16. A "carrier-on" indicator light is located behind the front panel of the Speech Amplifier Unit and may be viewed through a green bull's eye. The arrangement provided is similar to and harmonizes in appearance with the power indicator light discussed in paragraph 59 of this report except as to color of bull's eye. The light used for "carrier-on" indication is a GE Type 12A. This light is the equivalent to the specified Western Electric Type 2F. The "carrier-on" indicator light functions at a potential of 12 volts and is provided with a telephone slide base. It is similar to Navy Type T-2 or T-3 light in base and in envelope, but because of its operating voltage, it is not a Navy standard light. Attention is directed to the fact that the "carrier-on" indicator and "power" indicator are similar except in regard to operating voltage. In the replacement of

indicator lights it is entirely possible that a 6-volt light would be placed in the 12-volt circuit or vice versa. In order to eliminate this possibility, a permanent marking should be affixed near the lamp socket indicating the voltage of the lamp to be used and thereby considerably lessen the possibility of the use of the incorrect indicator light.

78. In reference (a), certain additional tests were requested. Reference will hereafter be made to certain paragraphs of reference (a).

79. Par. 6(a). In Table 25 the information requested has been furnished.

80. Par. 6(b). The information desired has been provided in Table 25.

81. Par. 6(c). Pertinent information on this subject appears in Table 29.

82. In Table 30 there appears certain additional information regarding apparatus associated with the copper oxide rectifier, which is self-explanatory.

83. Attention is directed to the fact that no tests have been conducted as to the ability of the Speech Input Equipment to withstand the effects of high humidities or of shock and vibration. It was not feasible to conduct these tests on the Speech Input Equipment only, but the complete Model TBL-4 transmitter will receive such tests and should any defects be noted in the case of the Speech Amplifier Unit, they will be covered in detail in the final report to be rendered on the equipment.

84. Attention is directed to the fact that the Speech Input Equipment may not be used with certain Model TBL-2 transmitters in its present form without extra equipment. In the case of Model TBL-2 transmitters operated at 230 volts d.c., no provisions are made for supplying 110 volt, 60 cycle operating power to the Speech Amplifier, for a-c power (provided by slip-rings) is furnished at only 220 volts. All tests herein reported were conducted using a commercial power supply to energize the Speech Amplifier as the available Model XTBL-2 transmitter is operated from 230 volts d.c. Should it be desired to use the Speech Amplifier Unit with the Model XTBL-2 transmitter, provision will have to be made for supplying the necessary 110 volt, 125 watts of single phase 60 cycle power for the purpose. Also the Speech Amplifier has insufficient power output for producing 85 per cent modulation in the XTBL-2 transmitter at 175 kilocycles, as Table 7 indicates that 50 volts is required under certain conditions, and the amplifier will produce only 40 volts with AVC "off," the gain control at maximum, and when the microphone is spoken into with a loud voice. The two devices may be used together, but a modulation of approximately 60 per cent is the maximum obtainable. Antenna side band "clipping" is the major cause of this condition. In Table 11, data as to distortion at 18100 kilocycles show results to be obtained which are not at all preferred.

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85. In Naval Research Laboratory Report No. R-1525, several defects were reported in the earlier model of the Speech Input Equipment as indicated in paragraph 292, (bbb) to (kkk) inclusive. Comment will be offered as to whether or not these defects have been overcome in the present model. Hereafter reference will be made to the various paragraphs as applicable in the summary of defects in Naval Research Laboratory Report No. R-1525.

(bbb) This defect called attention to the fact that 28 volts audio input to the transmitter did not provide 85 per cent modulation in all instances. Reference to paragraph 32 of this report will indicate that this defect has not been overcome.

(ccc) In the earlier model it was noted that difficulty was encountered in withdrawing the combination hand-sets because they were gripped so securely in place. It is possible to withdraw the hand-sets in the present model by exercising a reasonable force and the present arrangement is considered satisfactory as indicated in paragraphs 68 and 74 of this report.

(ddd) In the earlier model the "power" switch did not have its function indicated by a suitable marking. In the present model, this switch has been suitably marked.

(eee) It was pointed out in connection with the earlier model that the "press-to-talk" switch on the Speech Amplifier panel fails to lock in the "on" position. No difficulties of this nature were encountered in the present model.

(fff) In the earlier model, the positions of the automatic volume control switch were not designated. Suitable markings have been provided on the front panel to indicate the position in the present model.

(hhh) In the earlier model, it was indicated that a plug for the combination hand-set "bottoms" in the jack and fails to complete the circuit. No such difficulties were encountered with any plugs in the present model.

(iii) Reference to paragraph 45 of this report will indicate that the difficulties found in the earlier model due to acoustical feed-back have not been entirely eliminated, but such disturbances have been reduced to a value sufficiently low to make the equipment entirely workable.

(jjj) In the earlier model it was noted that the output characteristic of the amplifier with the automatic volume control in operation did not meet the specified requirements. Reference to paragraph 53 of this report will indicate that the characteristic provided in the present model is considered satisfactory for the purpose.

(kkk) In the earlier model it was noted that the chassis plate lacked sufficient strength to provide the necessary durability. In this

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respect the construction of the present model has been improved, and the chassis plate appears entirely suitable for the purpose.

86. Below are summarized several matters which will require either the approval of the Bureau of Engineering and the Bureau of Construction and Repair, or further consideration by that Bureau before the contractor is permitted to proceed with production models of the Speech Input Equipment. At the end of each statement there appears the paragraph number of this report where each matter is discussed in detail.

- (1) Certain resistors; namely, R-201, R-204, R-215, and R-219 are of a type for which there is no existing governing specification. It is suggested that the Bureau give consideration to their approval for use in this equipment. But if resistors R-215 and R-219 are replaced, as was suggested to be a possibility, it will be unnecessary to give consideration to the approval of these units. (19)
- (2) As Navy type numbers for various component parts are assigned by the Bureau, and as the Laboratory has no revised type number list, it is suggested that the Bureau determine if the resistors have correct Navy type numbers. (19)
- (3) As nameplates are subject to approval by the Bureau, it is suggested that nameplate data contained herein be reviewed to determine if nameplates of the desired type have been used. (24)
- (4) It has been indicated that certain parts of the equipment may possibly be classed as "major" units, and if so, that nameplates are required. It is suggested that the Bureau decide if these parts are major units and require nameplates. Should it be decided that nameplates are required for these units, it is suggested that the Bureau inform the contractor as to desired form of and markings. (24)

SUMMARY OF DEFECTS

87. Below are summarized the various defects found in the Speech Input Equipment. At the end of each statement there appears the paragraph number of this report where each matter is discussed in detail.

- (1) Resistors R-215 and R-219 should be provided with locking devices to prevent their setting being disturbed, or possibly replaced with fixed units if this is practicable. (19)
- (2) Audio voltage to transmitter speech input circuit in certain cases differs materially from the specified value of 28 volts to produce 85 per cent modulation. (32)
- (3) Overall fidelity of Speech Input Equipment and the Model XTBL-4 transmitter does not comply with specified requirements at 18100 kilocycles. (32)
- (4) The control of line voltage about the normal value (110 volts) should be redistributed in a more desirable manner. (46)

- (5) A ground is applied to one side of receiver output circuit when connected to Speech Amplifier Unit and when the head-set is plugged in. (44, 58)
- (6) Amplifier, when AVC is "on," produces insufficient output to give 85 per cent modulation at 175 kilocycles. (49)
- (7) Change in amplifier output due to shift in position of AVC switch slightly exceeds the specification limits under actual operating conditions at 175 kilocycles. (52)
- (8) Change in output with AVC "on" when the input is increased by 12 decibels, exceeds the specification limits. (54)
- (9) Indicator light in "power" circuit is not of Navy standard type; "carrier-on" indicator light is of specified type, but not of Navy standard type. Indicator lamp sockets should be provided with suitable markings to eliminate confusion in replacement of indicator light bulbs. (59, 77)
- (10) A renumbering of the terminals on the terminal board of the Speech Amplifier Unit would afford some convenience in the installation of the equipment. (60)
- (11) Some difficulty may be found in connecting four Remote Telephone Units to the terminal board of the Speech Amplifier Unit because of proximity of terminals to one another. (60)
- (12) Fuses of a rating suitable to protect the equipment are not employed; suitable miniature nameplates or other markings are not provided to show the type and rating of fuses. (61)
- (13) Level indicator is not provided with Navy type number. (63)
- (14) Height dimension slightly exceeds the maximum allowed value. (65)
- (15) Stops on hinged front panel do not take effect before the weight of equipment on panel is permitted to rest on control knobs. (66)
- (16) Permanently mounted hand-set is not provided with black wrinkle finish. (67)
- (17) Colors used in coding of leads of cable to permanently mounted hand-set do not have sufficient contrast. (68)
- (18) Cradle switch in both the permanently mounted and extension hand-sets does not perform all specified functions; single contact "push-to-talk" switch should be used if feasible. (68, 74)
- (19) "Press-to-talk" switches are uncomfortable to use for periods as long as five minutes. (70)
- (20) Chest microphone has plugged aperture. (71)

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(21) The plug and jack provided for the chest microphone are not of the specified single circuit type. (71)

CONCLUSIONS

88. In general, good performance is obtained from the resubmitted model of the Speech Input Equipment. Its operation is much to be preferred to that of an earlier model tested by this Laboratory.

89. The Speech Input Equipment contains a few electrical and mechanical defects and does not strictly comply with all provisions of the specifications. All defects appear to be either of a kind which are capable of being remedied, or, on the other hand, to be of such nature that they may be tolerated without undue restrictions upon the usefulness of the equipment.

90. If the necessary remedial action be taken as indicated in this report, the equipment will then be considered suitable for use in the Naval Service.

91. The antenna systems used for the transmission of intermediate frequencies in modern naval vessels not only present many problems to ordinary radio telegraphic transmission in the lower portion of the intermediate frequency band, but also alter the performance of voice radio transmitting equipment in this frequency region and introduce other factors which to a certain extent impair the usefulness of voice transmission.

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TABLE 1

Speech Input Equipment for Model XTBL-4 Transmitter

CHECK OF RESISTORS

Test as per par. 2-2 of Specifications RE 13A 465E;
also Specifications RE 13A 372G and RE 13A 346V.

Resistor No.	Rated Ohms	Navy Type No.	Kind	*Watts Allowed	Measured		See Note
					Volts	Watts	
R-201	250,000	-	Var.	-	-	-	(1)
R-202	15,000	63474	Fixed	2	140	1.3	(2)
R-203	47,000	63474	"	2	-	-	(2)
R-204	8	-	Var.	-	-	-	(3)
R-205	150	63288	Fixed	1	10.5	0.74	(2)
R-206	150	63288	"	1	11.5	0.88	(2)
R-207	150	63288	"	1	11.5	0.88	(2)
R-208	100	63474	"	2	13.2	1.74	(2)
R-209	47	63474	"	2	3.0	1.9	(2)
R-210	100	63474	"	2	13.2	1.74	(2)
R-211	110,000	63360	"	1/2	-	-	(2)
R-212	110,000	63360	"	1/2	-	-	(2)
R-213	15,000	63474	"	2	140	1.3	(2)
R-214	20,000	63474	"	2	90	0.4	(2)
R-215	85	-	Var.	-	-	-	(4)
R-216	18,000	63474	Fixed	2	-	-	(2)
R-217	8,200	63474	"	2	-	-	(2)
R-218	270	63474	"	2	5.7	0.12	(2)
R-219	150	-	Var.	-	-	-	(4)
R-220	1,100	63474	Fixed	2	38.5	1.35	(2)
R-221	11,000	63474	"	2	38.5	1.35	(2)
R-222	10,000	63474	"	2	90	0.81	(2)
R-223	100	63474	"	2	13.2	1.74	(2)

Notes: (*) Resistors which are shown to have an allowed wattage of 2 are 2" long and 3/8" in diameter. Two watts is the commercial rating of this size, but not necessarily the Navy rating. Those indicated as other than 2 watts are taken from Navy specifications.

- (1) Attenuator or volume control.
- (2) Composition resistor, pig-tail type.
- (3) 60 Cycle line rheostat or plate voltage control. Hardwick Hindle Type B-50, rated at 1.17 amperes. Maximum operating current under normal conditions is 1.07 ohms. This rheostat is wire-wound.
- (4) These resistors are variable but can be adjusted only from inside unit. They are located in AVC circuit. Possibly an initial factory adjustment is sufficient, and there will be no occasion to vary them in the Service. Both are wire-wound.

TABLE 1 (Continued)

Notes: (Continued)

Resistors were not measured as they were soldered in place and it was not feasible to remove them. Values given above were taken from their markings.

The Navy type numbers were taken from the resistor markings and it is impossible to check the correctness of such numbers for no revised list of type numbers is available at this Laboratory.

The voltage data were taken with control settings (such as AVC "on" or "off") in a position to obtain the maximum impressed potential.

It was not possible to determine the manufacture of the resistor units. It is possible that products of several manufacturers are used as resistors.

TABLE 2

Speech Input Equipment for Model XTBL-4 Transmitter
 POTENTIALS APPLIED TO ELECTRODES OF VACUUM TUBES
 Tests as per par. 2-17 of Specifications RE 13A 465E.

Electrode or Quantity	Operating Potential				Spec. Limit
	Mic. Circuit Off		Mic. Circuit On		
	AVC Off	AVC On	AVC Off	AVC On	
(First audio stage - Type 38646 - two tubes in push-pull)					
E _{g1}	-10	-6	-10	-4	-3
E _{g2}	+90	+84	+90	+96	+100
E _p	+215	+214	+215	+214	+250
E _h	*5.9	*6.0	*5.9	*6.0	6.3
(Output audio stage - Type 38213 - two tubes in push-pull)					
E _g	-39	-39	-39	-39	-60
E _p	+191	+191	+191	+191	+300
E _h	*2.35	*2.35	*2.35	*2.35	2.5
(AVC tube - Type 38184 - one tube used)					
E _p	1.5	1.5	1.5	1.5	350
E _h	*6.0	*6.0	*6.0	*6.0	6.3
(Rectifier tube - Type 38593 - full wave)					
E _f	*4.9	*5.0	*4.9	*5.0	5.0
Pl. to Pl.	*630	*630	*630	*630	-
Inv. Pk. E	#750	#750	#750	#750	1400
I _p (avr.)	44 ma.	44 ma.	44 ma.	44 ma.	125 ma.

* These potentials a.c.; quantities not marked with (*) or (#) are d.c.

This value not measured but determined from inspection of circuit and knowledge of pertinent d.c. and a.c. potentials.

Notes: Plate voltage readjusted to normal operating value (230 volts) under all test conditions.

Microphones were not acoustically energized during tests.

TABLE 3

Speech Input Equipment for Model XTBL-4 Transmitter
 LIST OF CONTROLS, METERS, ETC. ON FRONT PANEL
 Test as per par. 2-23 and 4-11 of Specifications RE 13A 465E.

<u>Control, Meter Switch, etc.</u>	<u>Label</u>	<u>Graduation, positions, function, purpose, marking, etc.</u>
Switch	Power	On, up - - off, down
Switch	AVC	On, up - - off, down
Jack	Mic.	For use with chest microphone.
Jack	Phone	For use with head phones.
Switch	-	Rec., up - - Amp., down
Note: Above switch connects telephone receivers to the speech amplifier output or radio receiver output as desired.		
Switch	-	H.F. Rec., up - - L.F. Rec., down.
Note: Above switch connects telephone receivers to the output of the high frequency or low frequency radio receiver as desired. But the switch listed above the one in question must be in "Rec." position to allow the latter to function.		
Switch	-	Three positions as follows: Talk lock, up Off, center Press to talk, down
Note: Above switch controls the operation of chest microphone.		
Rheostat	Volume	0 to 12 divisions
Rheostat	Plate voltage	Increase (with arrow)
Meters as follows:		
Voltmeter	Plate voltage	0-350 volts, d-c
Westinghouse Style P.H. 56003-9-B, Type NX35, 3-1/2"		
USN Type CAY 22143, 1000 ohms/volt.		
Voltmeter	Level indicator	-10 to +6 db.
Westinghouse Style 56003-10-A, Type NC35, 3-1/2"		
Resistance 15810 ohms, Rectox type		
0 db. = 6 volts = 60 mw. in 600 ohms.		
Note: Meter is high speed type.		
Indicator lights as follows:		
Light	Power	Red lens (7/16" diam.) (60 C. power)
Light	Carrier	Green lens (7/16" diam.) (Carrier "On" Ind.)
Note: Carrier Indicator Light is GE #12A, 12 volt lamp;		
Power Indicator Light is GE #6A, 6 volt lamp.		

TABLE 4

Speech Input Equipment for Model XTBL-4 Transmitter
LIST OF NAMEPLATES
Test as per par. 2-26 of Specifications RE 13A 465E.

(Speech Amplifier)
(Reverse etched - - - - - 2" x 3")

Speech Amplifier Unit
Type CRV
Frequency Range 300-3500 Cycles
Weight Serial MODEL
A Unit of Model XTBL-4 Equipment
Manufactured for
Navy Department Bu. of Engineering

By
R.C.A. Manufacturing Co., Inc.
Camden, N.J. U.S.A.
Contract NOS-60970 Contract Date 3 June 1938

(Chest Microphone)
(Reverse etched - - - - - 2" x 3")
(Microphone housing is labeled: Automatic Electric Co., Chicago, USA)

Operator's Chest Set
Type CRV-51012
Weight Serial MODEL
Manufactured for
Navy Department BU of Engineering

By
R.C.A. Manufacturing Co., Inc.
Camden, N.J. U.S.A.
Contract NOS-60970 Contract Date 3 June 1938

Note: The permanently mounted hand-set on the Speech Amplifier, as well as the extension hand-set, has no nameplate or other means of identification.

(Continued)

TABLE 4 (Continued)

(Receiver Attenuator)
(Reverse etched - - - - - 2" x 3")

Receiver Input Attenuator Unit
Type CRV
Frequency Range 175-600 Kcs. - 2000-18100 Kcs.
A Unit of Model XTBL-4 Equipment
Manufactured for
Navy Department - Bu. of Engineering
by
R.C.A. Manufacturing Co., Inc.
Camden, N.J., U.S.A.
Contract 60970 Contract Date 3 June 1938

TABLE 5

Speech Input Equipment for Model XTBL-4 Transmitter
WEIGHTS OF SPEECH AMPLIFIER AND RELATED PARTS
Test as per par. 2-32 of Specifications RE 13A 465E.

Unit	Weight	
	Lb.	Oz.
Speech Amplifier*	80	8
Chest Microphone	2	0
Extension Hand-set	4	9
Receiver Attenuator	3	12
Receiver Attenuator	<u>3</u>	<u>12</u>
Total	94	9

* Includes weight of permanently mounted hand-set.

Note: The specifications place no weight limitations on Speech Input Equipment.

TABLE 6

Model XTBL-4 Transmitting Equipment
 MODULATION CHARACTERISTICS OF EQUIPMENT
 Test as per par. 4-5 of Specifications RE 13A 465E.

Trans- mitter	Band	Freq. kc	Power Output Watts	Mod. Freq. Cycles	Modulation		Effec. % Mod.
					Pos. Peaks %	Neg. Peaks %	
XTBL-4	I.F.	175	64	0	0	0	0
			92	400	81	82	82
			78	1000	57	60	59
			65	3000	28	33	31
XTBL-4	I.F.	600	62	0	0	0	0
			87	400	94	86	90
			84	1000	85	78	82
			78	3000	60	57	59
XTBL-4	H.F.	2000	109	0	0	0	0
			152	400	92	85	89
			152	1000	86	82	84
			152	3000	85	80	83
XTBL-4	H.F.	18100	156	0	0	0	0
			136	400	45	76	72
			156	1000	48	68	64
			156	3000	43	58	55
XTBL-2	I.F.	175	65	0	0	0	0
			82	400	68	71	70
			73	1000	55	63	60
			65	3000	35	42	39
XTBL-2	I.F.	600	44	0	0	0	0
			59	400	80	77	79
			59	1000	75	71	73
			54	3000	61	55	58
XTBL-2	H.F.	2000	177	0	0	0	0
			238	400	95	87	91
			231	1000	91	81	86
			223	3000	82	75	79
XTBL-2	H.F.	18100	151	0	0	0	0
			86	400	12	72	60
			89	1000	9	65	51
			99	3000	5	41	28

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TABLE 7

Speech Input Equipment For Model XTBL-4 Transmitter
VOLTAGE REQUIRED AT AUDIO INPUT TERMINALS
OF TRANSMITTER TO PRODUCE SPECIFIED
PERCENTAGE OF MODULATION.

Test as per par. 4-2 and 4-5 of Specifications RE 13A 465E.

Input Circuit		Transmitter					
Voltage	Freq. (Cycles)	Model	Freq. kc	Band	% Mod.	Antenna	
						C (μ f.)	R (Ω)
27.5	400	XTBL-4	175	I.F.	85	600	6.34
39.0	1000	XTBL-4	175	I.F.	80	600	6.34
21.0	400	XTBL-4	600	I.F.	82	1400	1.5
21.0	1000	XTBL-4	600	I.F.	81	1400	1.5
22.0	400	XTBL-4	2000	H.F.	83	-	22.5
21.5	1000	XTBL-4	2000	H.F.	82	-	22.5
27.0	400	XTBL-4	18100	H.F.	77	-	18.6
30.0	1000	XTBL-4	18100	H.F.	82	-	18.6
34.0	400	XTBL-2	175	I.F.	82	600	6.34
50.0	1000	XTBL-2	175	I.F.	81	600	6.34
28.5	400	XTBL-2	600	I.F.	83	1400	1.5
27.5	1000	XTBL-2	600	I.F.	82	1400	1.5
23.0	400	XTBL-2	2000	H.F.	84	-	22.5
21.5	1000	XTBL-2	2000	H.F.	84	-	22.5
33.0	400	XTBL-2	18100	H.F.	77	-	18.6
31.0	1000	XTBL-2	18100	H.F.	77	-	18.6

NOTE: Side band "clipping" accounts for the relatively large required audio voltage at 175 kilocycles.

Specification requirements: An audio input voltage of 28 volts shall produce 85% modulation. This requirement applies to Model XTBL-4 equipment only, and not to the Model XTBL-2 equipment.

TABLE 8

Speech Input Equipment for Model XTBL-4 Transmitter
 SIDE BAND "CLIPPING" DATA
 Test as per par. 4-5 of Specifications RE 13A 465E.

<u>Radio Frequency kc</u>	<u>Modulating Frequency kc</u>	<u>"Q" Antenna System</u>	<u>Amplitude of "Clipped" Side Band*</u>
175	300	125	0.92
175	1000	125	0.57
175	3000	125	0.23
175	300	200	0.83
175	1000	200	0.40
175	3000	200	0.14
600	300	75	1.0-
600	1000	75	0.97
600	3000	75	0.80
600	300	200	0.98
600	1000	200	0.83
600	3000	200	0.45

* These data are expressed in the form of the fractional ratio of the value of voltage on side band occurring under indicated condition to that if circuit conditions were such that no clipping occurred.

Note: Above values are computed and the formula shown below was used in the calculation.

Values of modulating frequencies cover extreme ranges required by specifications. Values of "Q" for antenna circuits cover extreme conditions found in various shipboard antennas when operated in conjunction with transmitter antenna loading coils as found in transmitter designs like those of the Model XTBL-4 Equipment.

Formula used in computations:

$$E = \frac{E'}{\sqrt{1 + \left(\frac{2Qf}{F}\right)^2}}$$

where E = voltage of "clipped" side band.

E' = voltage which would be present if side band were not clipped.

f = modulating frequency in cycles.

F = radio frequency in kilocycles.

Q = ratio of reactance to resistance of entire antenna circuit (including loss in loading coil).

TABLE 9

Model XTBL-4 Transmitting Equipment
 OVERALL AUDIO FIDELITY FROM MICROPHONE TRANSFORMER TO CARRIER
 Test as per par. 4-6 of Specifications RE 13A 465E.

Speech Amplifier		Transmitter			
Fidelity (db)	AVC	Freq.	Fidelity (db)	Antenna	
300 to 3000 C	Position	kc	300 to 3000 C	C (μ f.)	R (Ω)
(Model XTBL-4 Transmitter; I.F. Band)					
± 0.25	On	175	± 4.3	600	6.34
± 2.0	Off	175	± 5.8	600	6.34
± 0.25	On	600	± 2.25	1400	1.5
± 2.25	Off	600	± 4.0	1400	1.5
(Model XTBL-4 Transmitter; H.F. Band)					
± 0.25	On	2000	± 0.4	-	22.5
± 2.25	Off	2000	± 2.2	-	22.5
± 0.25	On	18100	± 0.9	-	18.6
± 2.25	Off	18100	± 3.5	-	18.6
(Model XTBL-2 Transmitter; I.F. Band)					
± 0.5	On	175	± 2.6	600	6.34
± 1.75	Off	175	± 3.4	600	6.34
± 0.5	On	600	± 1.6	1400	1.5
± 2.75	Off	600	± 3.2	1400	1.5
(Model XTBL-2 Transmitter; I.F. Band)					
± 0.5	On	2000	± 0.5	-	22.5
± 2.6	Off	2000	± 2.9	-	22.5
± 2.25	On	18100	± 3.3	-	18.6
± 1.2	Off	18100	± 6.3	-	18.6

Notes: Data taken with Radio Research Co. Model OB Audio Analyzer.

Side band "clipping" presumably affects transmitter carrier fidelity in the I.F. Band.

Specification requirements: Audio fidelity of transmitter to be within ± 2 decibels in high frequency band of Model XTBL-4 Transmitter; to be optimum in the intermediate frequency band. The specifications have no requirements for fidelity of the Model XTBL-2 Transmitter.

TABLE 10

Speech Input Equipment for Model XTBL-4 Transmitter
 SIGNAL TO NOISE RATIO AND DISTORTION WHEN
 USED WITH MODEL XTBL-4 TRANSMITTER
 Test as per par. 4-7 of Specifications RE 13A 465E.
 (For comparison see Table 65 of NRL Report R-1525).

Trans- mitter % Modu- lation	R.F. Power Output Watts	S.A. Input Signal Volts	S.A. Level Ind. (Db.)	% Distortion	Carrier Noise Level (Db.)	
					Rel. to Audio Signal	Rel. to 85% Modulation
[Output Frequency, 175 kc; I.F. Band; AVC "off"; See Note (1).]						
50	77	0.073	-5.0	1.3	-32	-37
71	86	0.100	-1.5	2.3	-34	-36
98	96	0.180	+1.8	9.0	-40	-39
[Output Frequency, 175 kc; I.F. Band; AVC "on"; See Note (2).]						
50	77	0.021	-5.0	1.5	-33	-38
75	86	0.074	-2.0	2.3	-38	-39
99	96	0.240	+1.8	9.0	-40	-39
[Output Frequency, 600 kc; I.F. Band; AVC "off"; See Note (3).]						
48	72	0.072	-7.0	0.9	-38	-43
73	80	0.115	-3.5	1.9	-41	-42
96	84	0.160	-0.9	4.3	-43	-42
[Output Frequency, 600 kc; I.F. Band; AVC "on"; See Note (4).]						
49	72	0.019	-7.5	2.0	-38	-43
73	80	0.052	-3.5	2.5	-40	-41
96	84	0.145	-0.3	4.3	-42	-41
[Output Frequency, 2000 kc; H.F. Band; AVC "off"; See Note (5).]						
49	141	0.076	-7.0	1.2	-42	-47
72	150	0.117	-3.1	2.2	-45	-46
95	180	0.170	-0.5	7.0	-46	-45
[Output Frequency, 2000 kc; H.F. Band; AVC "on"; See Note (5).]						
48	141	0.023	-7.0	2.0	-40	-45
72	150	0.068	-3.2	3.0	-42	-43
95	180	0.210	-0.1	7.6	-44	-43
[Output Frequency, 18000 kc; H.F. Band; AVC "off"; See Note (6).]						
46	188	0.135	-3.0	8.4	-33	-38
70	174	0.175	-0.5	9.0	-36	-38
85	160	0.240	+2.3	15.0	-38	-38
[Output Frequency, 18000 kc; H.F. Band; AVC "on"; See Note (7).]						
46	188	0.046	-3.2	8.8	-31	-36
71	174	0.170	-0.1	9.6	-34	-36
87	160	0.290	+1.5	13.5	-36	-36

TABLE 10 (Continued)

Notes: (1) Antenna constants: capacity, 600 $\mu\text{f.}$; resistance, 6.34 ohms.
Step 11 of attenuator used.

(2) Antenna constants as in (1). Step 12 of attenuator used.

(3) Antenna constants; capacity, 1400 $\mu\text{f.}$; resistance, 1.5 ohms.
Step 12 of attenuator used.

(4) Antenna constants as in (3). Step 10 of attenuator used.

(5) Antenna: 22.5 ohm resistor. Step 10 of attenuator used.

(6) Antenna: 18.6 ohm resistor. Step 10 of attenuator used.

(7) Antenna: 18.6 ohm resistor. Step 12 of attenuator used.

Above data taken with Radio Research Co. Model OB Audio Analyzer.

Distortion measured at 400 cycles. Distortion measurements are somewhat affected by Carrier Noise, which means that the Distortion values indicated are somewhat greater than is actually present.

Specification requirements: Distortion on High Frequency Band not to exceed 15% at 75% modulation. Distortion on Intermediate Frequency Band to be reduced to a practical minimum.

TABLE 11

Speech Input Equipment for Model XTBL-4 Transmitter
 SIGNAL TO NOISE RATIO AND DISTORTION WHEN
 USED WITH MODEL XTBL-2 TRANSMITTER
 Test as per par. 4-7 of Specifications RE 13A 465E.

Trans- mitter % Modu- lation	R.F. Power Output Watts	S.A. Input Signal Volts	S.A. Level Ind. (Db.)	% Distortion	Carrier Noise Level (Db.)	
					Rel. to Audio Signal	Rel. to 85% Mod.
[Output Frequency, 175 kc; I.F. Band; AVC "off"; See Note (1).]						
49	77.6	0.11	-3.8	3.5	-39	-44
73	87.8	0.16	0	3.7	-42	-43
98	101.5	0.24	+3.0	4.0	-45	-44
[Output Frequency, 175 kc; I.F. Band; AVC "on"; See Note (2).]						
48	77.6	0.029	-4.0	1.5	-36	-41
73	87.8	0.12	0	2.5	-40	-41
91	96.3	0.27	+2.2	2.4	-42	-41
[Output Frequency, 600 kc; I.F. Band; AVC "off"; See Note (3).]						
50	49.5	0.058	-5.0	1.4	-38	-43
74	58.5	0.09	-1.0	2.2	-42	-43
96	63.5	0.125	+1.7	6.0	-44	-43
[Output Frequency, 600 kc; I.F. Band; AVC "on"; See Note (3).]						
50	49.5	0.025	-5.0	1.8	-37	-42
74	58.5	0.09	-1.0	2.0	-38	-39
97	63.5	0.24	+1.7	6.0	-40	-39
[Output Frequency, 2000 kc; H.F. Band; AVC "off"; See Note (4).]						
48	201	0.094	-6.1	2.3	-40	-45
74	230	0.16	-2.0	2.2	-40	-41
98	260	0.21	+0.3	4.0	-42	-41
[Output Frequency, 2000 kc; H.F. Band; AVC "on"; See Note (4).]						
49	201	0.030	-6.1	3.0	-38	-43
74	230	0.096	-2.0	2.2	-40	-41
98	260	0.22	0	3.0	-42	-41
[Output Frequency, 18100 kc; H.F. Band; AVC "off"; See Note (5).]						
38	99	0.096	-2.0	*30+	-38	-45
64	90	0.13	+0.8	*30+	-40	-43
92	86	0.27	+3.5	*30+	-42	-41
[Output Frequency, 18100 kc; H.F. Band; AVC "on"; See Note (5).]						
39	90	0.064	-2.0	*30+	-37	-44
66	86	0.18	+0.5	*30+	-40	-45
78	82	0.28	+1.5	*30+	-30	-29

* These data are somewhat in excess of 30% distortion and exceed the range of the Model OB Audio Analyzer.

(Continued)

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TABLE 11 (Continued)

Notes: (1) Antenna constants: capacity, 600 $\mu\text{f.}$, resistance, 6.34 ohms.
Step 10 of attenuator used.

(2) Antenna constants as in (1). Step 12 of attenuator used.

(3) Antenna constants: capacity, 1400 $\mu\text{f.}$, resistance 1.5 ohms.
Step 12 of attenuator used.

(4) Antenna: 22.5 ohm resistor. Step 9 of attenuator used.

(5) Antenna: 18.6 ohm resistor. Step 9 of attenuator used.

Above data taken with Radio Research Co. Model OB Audio Analyzer.

Distortion measured at 400 cycles. Distortion measurements are somewhat affected by Carrier Noise, which means that the distortion values indicated are somewhat greater than is actually present.

The specifications have no requirements regarding limits of the above values when the Speech Amplifier is used with the Model XTBL-2 Transmitter.

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TABLE 12

Speech Input Equipment for Model XTBL-4 Transmitter
 POWER REQUIRED FOR OPERATION OF SPEECH AMPLIFIER
 Test as per par. 4-12(1) of Specifications RE 13A 465E.

<u>Volts</u>	<u>60 Cycle Line</u>		<u>P.F.</u>	<u>*Plate Volts</u>	<u>See Note</u>
	<u>Amps.</u>	<u>Watts</u>			
99	0.93	80	87%	230	(1)
99	1.07	98	92	230	(2)
110	0.94	91	88	230	(1)
110	1.07	109	93	230	(2)
121	0.95	102	89	230	(1)
121	1.07	123	95	230	(2)

Notes: (1) Speech equipment as in normal use but no microphone circuits, carrier indicators, control relays, etc. were energized.

(2) "Press-to-talk" switch on one Remote Telephone Unit closed; such relays as are normally operated by this process were energized, and carrier indicators in Speech Amplifier and two RTU's were in operation; a dummy load to approximate conditions of two additional RTU's was also applied.

* Plate voltage set to normal value (230 volts) at each line voltage under conditions indicated under Note (1).

Above data taken with AVC "off." Placing AVC "on" made no measurable difference in above values.

Above data taken with no applied audio signal. An audio input signal sufficient to obtain a reading of zero decibel on level indicator made no measurable difference in the above data.

Specification requirements: Operating power not to exceed 125 watts.

TABLE 13

Speech Input Equipment for Model XTBL-4 Transmitter
 AUDIO FIDELITY CHARACTERISTIC OF AMPLIFIER ONLY
 Test as per par. 4-12(4) of Specifications RE 13A 465E.

<u>Input Circuit</u>	<u>Amplifier Load</u>	<u>Position of AVC</u>	<u>Fidelity in Db. (300 to 3000 Cycles)</u>
See Note (1)	*500 ohms	On	± 0.9
See Note (1)	*500 ohms	Off	± 2.0
See Note (2)	*500 ohms	On	± 0.9
See Note (2)	*500 ohms	Off	± 2.0
See Note (2)	*500 ohms	On	± 0.8
See Note (2)	#500 ohms	Off	± 1.5
See Note (2)	See Note (4)	On	± 0.25
See Note (2)	See Note (4)	Off	± 2.0
See Note (3)	See Note (5)	On	± 0.25
See Note (3)	See Note (5)	Off	± 2.25
See Note (2)	See Note (6)	On	± 0.25
See Note (2)	See Note (6)	Off	± 2.25
See Note (2)	See Note (7)	On	± 0.25
See Note (2)	See Note (7)	Off	± 2.25
See Note (2)	See Note (8)	On	± 0.5
See Note (2)	See Note (8)	Off	± 1.75
See Note (2)	See Note (9)	On	± 0.5
See Note (2)	See Note (9)	Off	± 2.75
See Note (2)	See Note (10)	On	± 0.5
See Note (2)	See Note (10)	Off	± 2.6
See Note (2)	See Note (11)	On	± 1.1
See Note (2)	See Note (11)	Off	± 2.25

Specification requirements: Fidelity characteristic to be flat to within ± 2.0 db. between 300 and 3000 cycles.

Notes: Input circuits to amplifier as follows:

- (1) Input signal applied to 600 ohm terminals in series with 600 ohm resistor holding voltage across combination constant.
- (2) Input signal applied through microphone panel jack on Amplifier, signal voltage being held constant during test.
- (3) Input signal applied through microphone panel jack on Remote Telephone Unit, signal voltage being held constant during test.

(Continued)

TABLE 13 (Continued)

Notes: (Continued)

Load on Amplifier output where not stated above consisted of the audio input terminals of transmitter listed below which was tuned to the frequency indicated:

- (4) Model XTBL-4, frequency 175 kc.
- (5) Model XTBL-4, frequency 600 kc.
- (6) Model XTBL-4, frequency 2000 kc.
- (7) Model XTBL-4, frequency 18100 kc.
- (8) Model XTBL-2, frequency 175 kc.
- (9) Model XTBL-2, frequency 600 kc.
- (10) Model XTBL-2, frequency 2000 kc.
- (11) Model XTBL-2, frequency 18100 kc.

* Power output of amplifier approximately as normally used (1.6 watts).

Power output of amplifier is approximately the maximum specified (3 watts).

TABLE 14

Speech Input Equipment for Model XTBL-4 Transmitter
 DETERMINATION OF AMPLIFIER OUTPUT AND DISTORTION
 WHEN FED FROM MICROPHONE TERMINALS

Test as per par. 4-12(4) of Specifications RE 13A 465E.
 (For comparison see Table 66 of NRL Report R-1525).

Level Indicator <u>Db.</u>	Input <u>Volts</u>	Output <u>Volts</u>	Output <u>Watts</u>	Per Cent <u>Distortion</u>
(AVC "off" -- Step 12 of attenuator used.)				
+2.3	0.35	40	3.3	4.6
+2.0	0.215	35	2.53	2.5
-0.8	0.077	25	1.29	1.4
-2.5	0.04	20	0.83	1.3
-5.2	0.018	15	0.46	1.4
-9.2	0.009	10	0.21	1.2
(AVC "on" -- Step 9 of attenuator used.)				
+3.2	-	40	3.3	4.4
+2.0	-	35	2.53	2.3
+0.8	-	30	1.86	1.3
-0.8	-	25	1.29	1.0
-2.5	-	20	0.83	1.0

Notes: Amplifier terminated in 500 ohm resistance load.
 Signal applied through panel microphone jack.
 Tests made with Model OB Audio Analyzer.
 Measurements made at frequency of 400 cycles.

Specification requirements: Power output to be not less than 3 watts
 into 500 ohm load; distortion not to exceed 10% at full power
 output.

TABLE 15

Speech Input Equipment for Model XTBL-4 Transmitter
 DETERMINATION OF AMPLIFIER OUTPUT AND DISTORTION
 AS FED FROM 600 OHM INPUT TERMINALS

Test as per par. 4-12(4) of Specifications RE 13A 465E.
 (For comparison see Table 66 of NRL Report R-1525).

Level Indicator <u>Db.</u>	<u>Input Volts</u>	<u>Output Volts</u>	<u>Output Watts</u>	<u>Per Cent Distortion</u>
(AVC "off" -- Step 6 of Attenuator used.)				
+3.2	0.70	40	3.26	6.8
+2.0	0.57	35	2.45	3.8
+0.8	0.48	30	1.80	2.0
+0.1	0.45	28	1.57	2.0
-0.9	0.40	25	1.25	1.2
-2.5	0.32	20	0.80	1.0
(AVC "on" -- Step 6 of Attenuator used.)				
+3.5	1.70	40	3.26	8.0
+2.0	1.10	35	2.45	4.2
+0.7	0.68	30	1.80	2.2
+0.2	0.56	28	1.57	2.1
-0.9	0.38	25	1.25	1.3
-2.8	0.17	20	0.80	1.2

Notes: Amplifier terminated in 500 ohm resistance load.
 Signal applied to 600 ohm input terminals through 600 ohm resistor, the above data indicating the voltage across the combination.
 Tests made with Model OB Audio Analyzer.
 Measurements made at frequency of 400 cycles.

Specification requirements: Power output to be not less than 3 watts into 500 ohm load; distortion not to exceed 10% at full power output.

TABLE 16

Speech Input Equipment for Model XTBL-4 Transmitter
 DETERMINATION OF AMPLIFIER NOISE LEVEL AS FED FROM
 600 OHM INPUT TERMINALS
 Test as per par. 4-12(5) of Specifications RE 13A 465E.

<u>Input Volts</u>	<u>Output Volts</u>	<u>Output Watts</u>	<u>Noise Level in Db.</u>	
			<u>Relative to Signal</u>	<u>Relative to 3 Watts Output*</u>
(AVC "off")				
0.7	40	3.26	-57	-56.2
0.57	35	2.45	-60	-61.7
0.48	30	1.80	-58	-62.4
0.45	28	1.57	-57	-62.6
0.40	25	1.25	-57	-64.6
0.32	20	0.80	-54	-65.5
(AVC "on")				
1.70	40	3.26	-60	-59.2
1.10	35	2.45	-59	-60.7
0.68	30	1.80	-57	-61.4
0.56	28	1.57	-57	-62.6
0.38	25	1.25	-55	-62.6
0.17	20	0.80	-53	-64.5

Notes: Amplifier terminated in 500 ohm resistance load.
 Signal applied to 600 ohm input terminals through 600 ohm resistor, the values indicated above being that across combination.
 Tests made with Model OB Audio Analyzer.
 Measurements made at a frequency of 400 cycles.
 Step 6 of attenuator used.

Specification requirements: Noise level to be 50 decibels below maximum amplifier output (3 watts is maximum specified output).
 To determine compliance with specifications refer to data in column marked (*).

TABLE 17

Speech Input Equipment for Model XTBL-4 Transmitter
 DETERMINATION OF AMPLIFIER NOISE LEVEL AS FED FROM
 MICROPHONE TERMINALS

Test as per par. 4-12(5) of Specifications RE 13A 465E.

<u>Noise Level in Db.</u>				
<u>Input Volts</u>	<u>Output Volts</u>	<u>Output Watts</u>	<u>Relative to Signal</u>	<u>Relative to 3 Watts Output*</u>
(AVC "off")				
0.33	40	3.3	-64	-63.6
0.23	30	1.86	-60	-62.1
0.145	20	0.83	-54	-59.4
0.073	10	0.21	-49	-60.6
(AVC "on")				
0.72	40	3.3	-59	-58.6
0.29	30	1.86	-56	-58.1
0.083	20	0.83	-52	-57.4
0.018	10	0.21	-46	-57.6

Notes: Amplifier terminated in 500 ohm resistance load.
 Signal applied through panel microphone jack.
 Step 9 of attenuator used.
 Tests made with Model OB Audio Analyzer.
 Measurements made at frequency of 400 cycles.

Specification requirements: Noise level to be 50 decibels below maximum amplifier output (3 watts is maximum specified output). To determine compliance with specifications refer to data in column marked (*).

TABLE 18

Speech Input Equipment for Model XTBL-4 Transmitter
 CHECK OF GAIN CONTROL ACCURACY
 Test as per paragraph 4-12(6) of Specifications RE 13A 465E
 (For comparison see Table No. 67 of NRL Report R-1525).

<u>Setting of Gain Control</u>	<u>Output Volts</u>	<u>Level Indicator</u>	<u>Difference in Db.*</u>
12	40.0	+3.6	-
11	33.8	+1.9	1.5
10	26.8	+0.2	2.0
9	21.3	-1.8	2.0
8	16.9	-3.7	2.0
7	13.4	-5.8	2.0
6	10.8	-7.7	2.0
5	8.9	-9.8	1.7
4	7.3	Off scale	1.7
3	5.7	" "	1.7
2	4.55	" "	1.9
1	3.7	" "	1.8

Note: AVC off. Audio input voltage, 400 cycles, held constant at 0.153 volt so as to produce an output voltage of 40 volts across 500 ohm load, with gain control on Step 12. Input applied through panel microphone jack.

* Calculated from output volts.

Specification requirements: Approximately 12 steps of 2 decibels each.

TABLE 19

Speech Input Equipment for Model XTBL-4 Transmitter
 EFFECT OF GAIN CONTROL WITH AVC "ON"
 (No specified test of this nature).

<u>Setting of Gain Control</u>	<u>Output Volts</u>	<u>Level Indicator</u>	<u>Difference in Db. *</u>
12	40	3.4	-
11	38	2.9	0.45
10	34.8	2.1	0.75
9	32.5	1.7	0.6
8	30.2	1.0	0.6
7	28.0	0.3	0.7
6	25.8	-0.3	0.7
5	24.2	-0.9	0.6
4	22.5	-1.6	0.6
3	20.8	-2.2	0.65
2	19.3	-2.8	0.6
1	17.8	-3.5	0.65

Note: Audio input voltage, 400 cycles, held constant at 0.345 volts so as to produce an output voltage of 40 volts across 500 ohm load with gain control on Step 12. Input applied through panel microphone jack.

* Calculated from output volts.

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TABLE 20

Speech Input Equipment for Model XTBL-4 Transmitter
 CHECK OF AUTOMATIC VOLUME CONTROL OF AMPLIFIER
 Test as per par. 4-12(7) of Specifications RE 13A 465E.
 (For comparison see Table 68 of NRL Report R-1525).

Input Volts	Position of AVC	Level Indicator Db.	Output Volts	Db. Change	
				Level Ind.*	Calculated#
0.225	Off	-1.0	24.5	-	-
0.225	On	-0.6	25.8	+0.4	+0.3
0.26	Off	0	27.5		
0.26	On	-0.3	26.5	-0.3	-0.3
0.29	Off	+1.0	31.0		
0.29	On	0	27.5	-1.0	-1.0

* Obtained from difference in readings of level indicator.

Obtained from ratios of output voltage.

Notes: Amplifier terminated in 500 ohm resistance load.
 Signal applied through panel microphone jack.
 Measurements made at frequency of 1000 cycles.
 Step 9 of attenuator used.

Specification requirements: When AVC is changed from "off" to "on",
 output shall not change by more than 1 db.

OPERATION OF AUTOMATIC VOLUME CONTROL
 Test as per par. 4-12(9) of Specifications RE 13A 465E.

Input Voltage	Input Level (Db.)	Output Voltage	Level Ind. Reading	** Db. Change (Calculated)	Per Cent Distortion
(Tests at audio frequency of 400 cycles - - AVC "on".)					
0.59	0	28.0	+0.1	-	1.3
2.35	+12	43.5	+4.0	+3.8	9.0
(Tests at audio frequency of 1000 cycles - - AVC "on".)					
0.76	0	28.0	0	-	##
3.03	+12	44.0	+4.0	+3.9	##

** Calculated from output voltage data.

The Model OB Equipment can be used for distortion measurement at 1000 cycles only.

Notes: Step 6 of attenuator used. Amplifier load, 500 ohm resistor.
 Radio Research Co. Model OB Audio Analyzer used in above test.

Specification requirements: At 1000 cycles a change in input of 12 db.
 shall not cause an output change greater than 3 db.; distortion
 not to exceed 20% under same conditions.

TABLE 21

Speech Input Equipment for Model XTBL-4 Transmitter

EFFECT OF AVC SWITCH ON MODULATION OF CARRIER

AT RELATIVELY HIGH MODULATION LEVELS

Test as per par. 4-12(7) of Specifications RE 13A 465E.

Speech Amplifier			Transmitter			
Position of AVC	Level Ind. Reading Db.	Change in Reading Db.*	Output Freq. kc	Modu- lation %	Mod. Rel. to 85% Db.	Change in Mod. Db.
(Model XTBL-4 Transmitter - I.F. Band)						
Off	+3.0	-	175	80	-0.5	-
On	+1.6	-1.4	175	72	-1.4	-0.9
Off	-2.1	-	600	81	-0.4	-
On	-1.1	+1.0	600	90	+0.5	+0.9
(Model XTBL-4 Transmitter - H.F. Band)						
Off	-2.0	-	2000	83	-0.2	-
On	-1.0	+1.0	2000	90	+0.5	+0.7
Off	+0.6	-	18100	82	-0.3	-
On	0	-0.6	18100	81	-0.4	-0.1

Notes: Above data taken as follows: Equipment adjusted with AVC "off" as indicated by above readings, then AVC put "on" and readings were again taken to determine the effect of AVC.

Radio Research Co. Model OB Audio Analyzer used in making measurements.

Modulating frequency during tests: 1000 cycles.

Specification requirements: When AVC is changed from "off" to "on" Speech Amplifier output shall not change by more than 1 db.

The data appearing in the column marked (*) is that to be used in determining compliance with the specifications.

TABLE 22

Speech Input Equipment for Model XTBL-4 Transmitter
EFFECT OF AVC SWITCH ON MODULATION OF CARRIER
AT MEDIUM MODULATION LEVELS

Test as per par. 4-12(7) of Specifications RE 13A 465E.

Speech Amplifier			Transmitter			
Position of AVC	Level Ind. Reading Db.	Change in Reading Db.	Output Freq. kc	Modulation %	Mod. Rel. to 85% Db.	Change in Mod. Db.
(Model XTBL-4 Transmitter - I.F. Band.)						
Off	-1.5	-	175	56	-3.6	-
On	-0.9	+0.6	175	59	-3.2	+0.4
Off	-5.0	-	600	62	-2.8	-
On	-2.0	+3.0	600	82	-0.3	+2.5
(Model XTBL-4 Transmitter - H.F. Band)						
Off	-4.0	-	2000	68	-2.0	-
On	-1.7	+2.3	2000	84	-0.1	+1.9
Off	-3.1	-	18100	51	-4.4	-
On	-1.5	+1.6	18100	64	-2.5	+1.9
(Model XTBL-2 Transmitter - I.F. Band)						
Off	+3.5	-	175	75	-1.1	-
On	+0.5	-3.0	175	60	-3.0	-1.9
Off	-2.0	-	600	67	-2.1	-
On	-1.0	+1.0	600	73	-1.3	+0.8
(Model XTBL-2 Transmitter - H.F. Band.)						
Off	-3.5	-	2000	69	-1.8	-
On	-1.5	+2.0	2000	86	+0.1	+1.9
Off	+0.1	-	18100	64	-2.5	-
On	-0.9	-1.0	18100	51	-4.4	-1.9

Notes: Above data taken as follows: Equipment adjusted with AVC "off" as indicated by above readings, then AVC put "on", but no other alterations made, and readings were again taken to determine the effect of the AVC.

Modulating frequency during tests: 1000 cycles.

Radio Research Co. Model OB Audio Analyzer used in making measurements.

The specifications have no requirements for effect of AVC at percentages of modulation corresponding to the above levels; however, they are at levels fairly well representative of actual operating conditions.

TABLE 23

Speech Input Equipment for Model XTBL-4 Transmitter
 LOAD ON COPPER-OXIDE RECTIFIER - ONE RTU
 Test as per par. 4-12(12) of Specifications RE 13A 465E.
 Test as per par. 6 of modification of above specifications.

60 Cycle Line Volts	Plate Volts	Copper-Oxide Rectifier Data		
		Output Volts	Current to Remote Unit (amps.)	#Total Current Load on Rect. (amps.)

(One Remote Telephone Unit only connected to Speech Amplifier.
 RTU phone out of cradle, and "push-to-talk" switch closed.
 Chest microphone and other auxiliary apparatus attachable
 to RTU not in circuit.)

110	230	13.0	*0.296	0.800
-----	-----	------	--------	-------

Specification requirements: Current to RTU not to exceed 0.3 ampere.

(One RTU only connected to Speech Amplifier. RTU phone in
 cradle and "push-to-talk" switch open. Phone on Speech
 Amplifier out of cradle and "push-to-talk" switch closed.
 The current to RTU shown below is that required by indicator
 light.)

110	230	13.0	0.115	0.797
-----	-----	------	-------	-------

The specifications have no requirements for this condition.

* Includes current to control relay in Speech Amplifier.
 # These data include current to rectifier bleeder.

TABLE 24

Speech Input Equipment for Model XTBL-4 Transmitter
 REGULATION OF COPPER-OXIDE RECTIFIER CIRCUIT
 Test as per par. 4-12(12) of Specifications RE 13A 552B.
 Test as per par. 6 of modification of above specifications
 as amended by par. 3(6) (Ref. par. 4-12-12) of BuEng.
 ltr. C-NOs-58114 (9-20-R6) of 9 October 1939,
 to INM, Phila.

Copper-Oxide Rectifier Data						
60 Cycle Line Volts	Plate Volts	Output Volts	External Load (amps.)	Bleeder Load (amps.)	Total Load (amps.)	Regulation %
(Line voltage at 10% below normal.)						
99	230	13.2	0	0.397	0.397	-
99	228	11.8	1.2	0.355	1.555	11.9
(Line voltage at normal value.)						
110	230	13.2	0	0.397	0.397	-
110	222	11.3	1.2	0.340	1.540	16.8
(Line voltage at 10% above normal.)						
121	230	13.2	0	0.397	0.397	-
121	214	11.0	1.2	0.334	1.534	20.0

Notes: As a bleeder is permanently connected across rectifier output, data as to regulation are made on such a basis.

Plate voltage control was reset to normal value (230 V.) at each line voltage.

External load on rectifier was provided by a suitable resistor, or a dummy load was applied.

Specification requirements: Output voltage of copper-oxide rectifier under any condition to fall between the limits of 11 and 14 volts.

TABLE 25

Speech Input Equipment for Model XTBL-4 Transmitter
LOAD ON COPPER-OXIDE RECTIFIER - 4 RTU'S

Test as per par. 4-12(12) of Specifications RE 13A 465E.
Test as per par. 6, Modification of above specifications.
Test as per par. 6 of BuEng. ltr. C-NOs-60970 (12-26-DR6)
of 4 January 1940, to NRL.

60 Cycle Line Volts	Plate Volts	Copper-Oxide Rectifier Data		
		Output Volts	*Current to Remote Units (amps.)	#Total Current Load on Rect. (amps.)

Test as per par. 6 of modification and par. 6(a) of above letter.

(Two Remote Telephone Units connected to Speech Amplifier. Also a dummy resistance of 56.5 ohms which approximates load of carrier indicator lamps of two additional RTU's, was placed in circuit. One RTU phone out of cradle and its "press-to-talk" switch closed.)

110	225	12.4	0.61	1.1
-----	-----	------	------	-----

Specification requirements: Current to + RTU's not to exceed
0.66 amperes.

Test as per par. 6 of modification and par. 6(b) of above letter.

(Two Remote Telephone Units connected to Speech Amplifier; both phones out of cradle; both "press-to-talk" switches closed. Also a dummy resistance of 27 ohms, which approximates load of two additional RTU's under same condition, was placed in circuit.)

110	225	11.8	0.91	1.37
-----	-----	------	------	------

Note: This combination was maintained for 1 minute without observable voltage variation or other detrimental effects being noted.

Specification requirements: Current to 4 RTU's not to exceed
1.2 amperes; equipment to withstand this load condition
without damage.

* These data include current to control relay in Speech Amplifier
but do not include current to indicator light in Speech Amplifier.

These data include current to rectifier bleeder.

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TABLE 26

Speech Input Equipment for Model XTBL-4 Transmitter
 NUMBERING SYSTEM OF CONNECTORS ON TERMINAL BOARD
 Test as per par. 4-12(15) of Specifications RE 13A 465E.

<u>Number of Terminal on Speech Amplifier</u>	<u>Number of Terminal and Unit to Which Corresponding Number on Speech Amplifier Attaches</u>		
	<u>Unit</u>	<u>Terminal Number</u>	<u>Terminal Board No.</u>
1	Transmitter	14	H
2	"	13	H
3	"	9	H
4	"	10	H
5	Transmitter	11	Y
6	"	12	Y
7	I.F. Receiver	-	-
8	" "	-	-
9	H.F. Receiver	-	-
10	" "	-	-
11	(Connected to S.A. Terminals 21 and 26, but presumably not used normally.)		
12	Remote Tel. Unit	11	-
13	" " "	12	-
14	" " "	7	-
15	" " "	8	-
16	" " "	9	-
17	" " "	10	-
18	" " "	13	-
19	" " "	14	-
20	Local Hand-set	7	-
21	" " "	5	-
22	" " "	4	-
23	" " "	3	-
24	" " "	1	-
25	Ext. Hand-set	7	-
26	" " "	5	-
27	" " "	4	-
28	" " "	3	-
29	" " "	1	-
30	(Ground)		

TABLE 27

Speech Input Equipment for Model XTBL-4 Transmitter
 TEST OF LEVEL INDICATOR METER IN SPEECH AMPLIFIER
 Test as per par. 4-12(18) of Specifications RE 13A 465E.

Speech Amplifier				
Input Volts	Output Volts	Output Db. (Rel. to 28 V.)	Level Ind. Reading (Db.)	Error in Meter (Db.)
(Tests at 300 cycles.)				
0.094	8.8	-10.0	-10	0
0.172	16.8	- 4.4	- 4	+0.4
0.275	27.0	- 0.3	0	+0.3
0.55	43.0	+ 3.7	+ 4	+0.3
(Tests at 1000 cycles.)				
0.100	8.7	-10.2	-10	+0.2
0.195	17.0	- 4.3	- 4	+0.3
0.32	26.8	- 0.4	0	+0.4
0.97	52.2	+ 5.4	+ 6	+0.6
(Tests at 3000 cycles.)				
0.130	8.9	-10.0	-10	0
0.248	17.5	- 4.1	- 4	+0.1
0.395	27.2	- 0.3	0	+0.3
1.78	51.5	+ 5.3	+ 6	+0.7

Notes: Input supplied to 600 ohm circuit of Speech Amplifier. Signal voltage was applied through 600 ohm series resistor and Input Voltage data above is that across the combination,

Load on output circuit: 500 ohm resistor.

Specification requirements: A level indicator shall be provided whose zero level corresponds to 1.6 watts (28 volts across 500 ohms).

TABLE 28

Speech Input Equipment for Model XTBL-4 Transmitter

DIMENSIONS OF SPEECH AMPLIFIER UNIT

Test as per par. 4-14(1) of Specifications RE 13A 465E.

<u>Dimension</u>	<u>Actual</u>	<u>Specifications Allow</u>
Height	16-1/8"	16"
Width	16"	16"
Depth	14-11/16"	16"

Note: Height dimension does not include that of the attached hand-set. The height of the hand-set is 4-7/8", thereby making the overall height from the bottom of unit to top of hand-set in cradle 21".

TABLE 29

Speech Input Equipment for Model XTBL-4 Transmitter
 VOLTAGE REQUIRED FOR OPERATION OF CONTROL RELAY
 AND CARRIER INDICATOR IN
REMOTE TELEPHONE UNIT

Test as per par. 6(c) of BuEng.ltr. C-NOs-60970(12-26-DR6)
 of 4 January 1940 to NRL.

60 Cycle Line
 Voltage

D.C. Voltage to Relay
 and Lamp in RTU

(Data shown below taken under conditions
 where relay just closes. Carrier indicator
 light just visible.)

40

4.0

(Data shown below taken under conditions where
 relay responds rapidly. Carrier indicator
 reasonably bright.)

65

8.5

(Data shown below taken under conditions where
 applied relay voltage had been sufficiently
 great to close it, and then voltage was
 gradually reduced until it opened. Carrier
 indicator light not visible at relay opening
 point.)

20

2.0

Notes: Above data taken by reducing line voltage with a variac.
 Vacuum tube rectifier removed during above test,
 No specification limits are imposed.

TABLE 30

Speech Input Equipment for Model XTBL-4 Transmitter VOLTAGE REQUIRED FOR OPERATION OF CONTROL RELAY AND CARRIER INDICATOR IN SPEECH AMPLIFIER

(No specified test of this nature.)

60 Cycle Line
Voltage

D.C. Voltage to Relay
and Lamp in S.A.

(Data shown below taken under conditions
where relay just closes. Carrier indicator
light just visible.)

50

5.5

(Data shown below taken under conditions where
relay responds rapidly. Carrier indicator
light reasonably bright.)

65

8.5

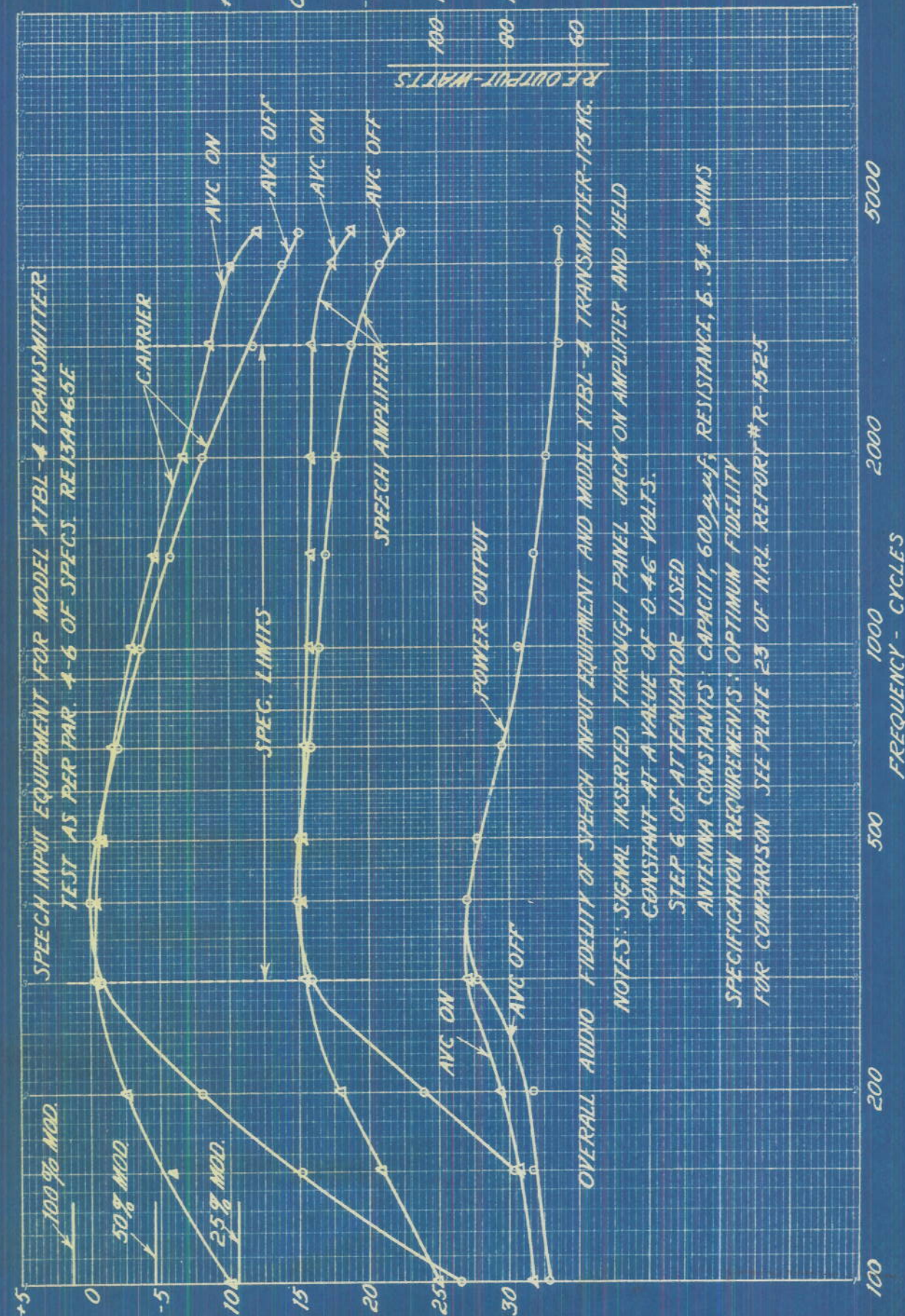
(Data shown below taken under conditions where
applied relay voltage had been sufficiently
great to close it, and then the voltage was
gradually reduced until it opened. Carrier
indicator light not visible at relay opening
point.)

20

2.0

Notes: Above data taken by reducing line voltage with a variac.
Vacuum tube rectifier removed during above test.
No specification limits are imposed.

CARRIER FIDELITY - DB RELATIVE TO 85% MOD.



SPEECH AMPLIFIER FIDELITY
 DB REL. TO 28 VOLTS

NOTES: SIGNAL INSERTED THROUGH PANEL JACK ON AMPLIFIER AND HELD

CONSTANT AT A VALUE OF 0.46 VOLTS.

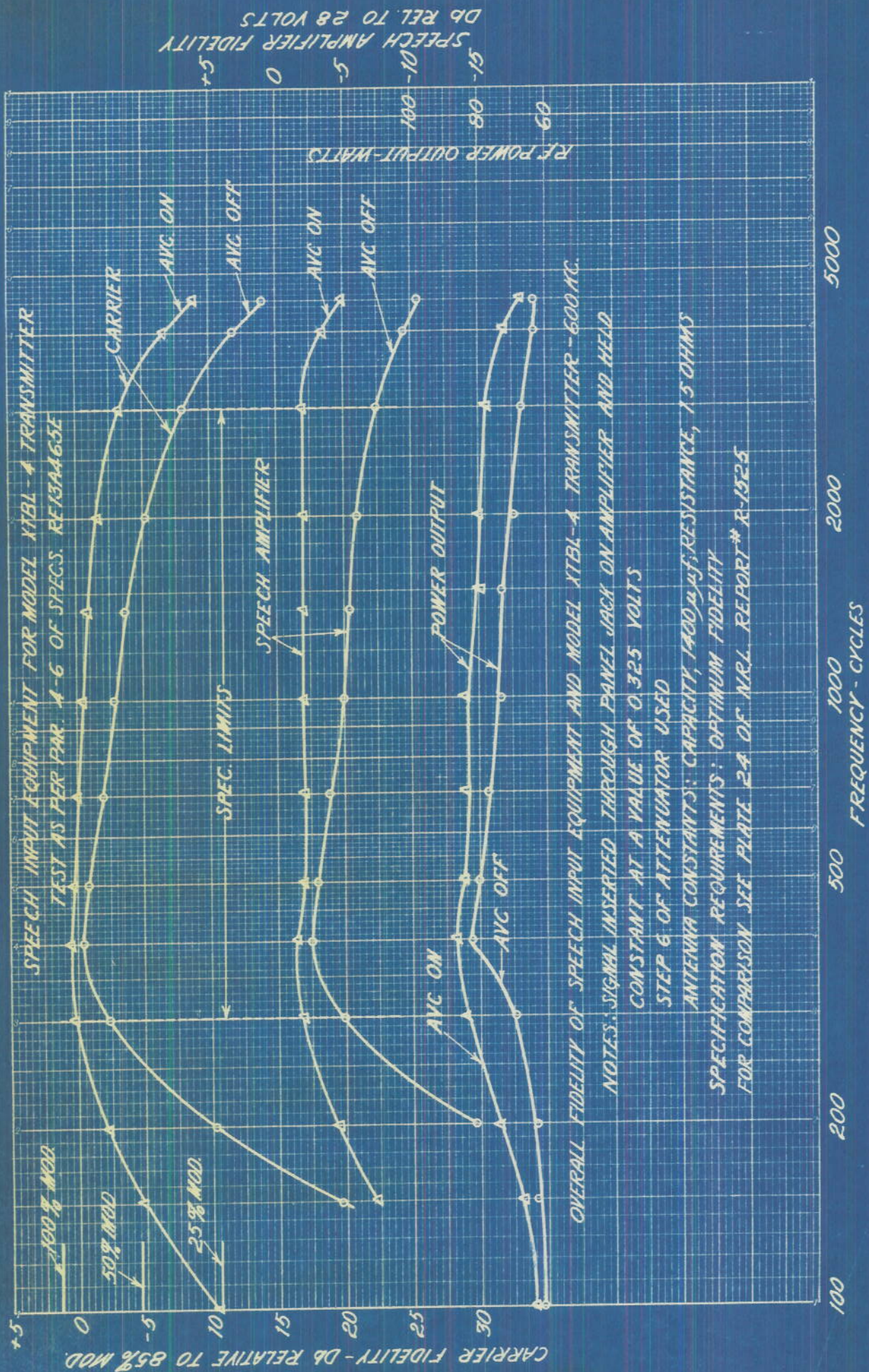
STEP 6 OF ATTENUATOR USED

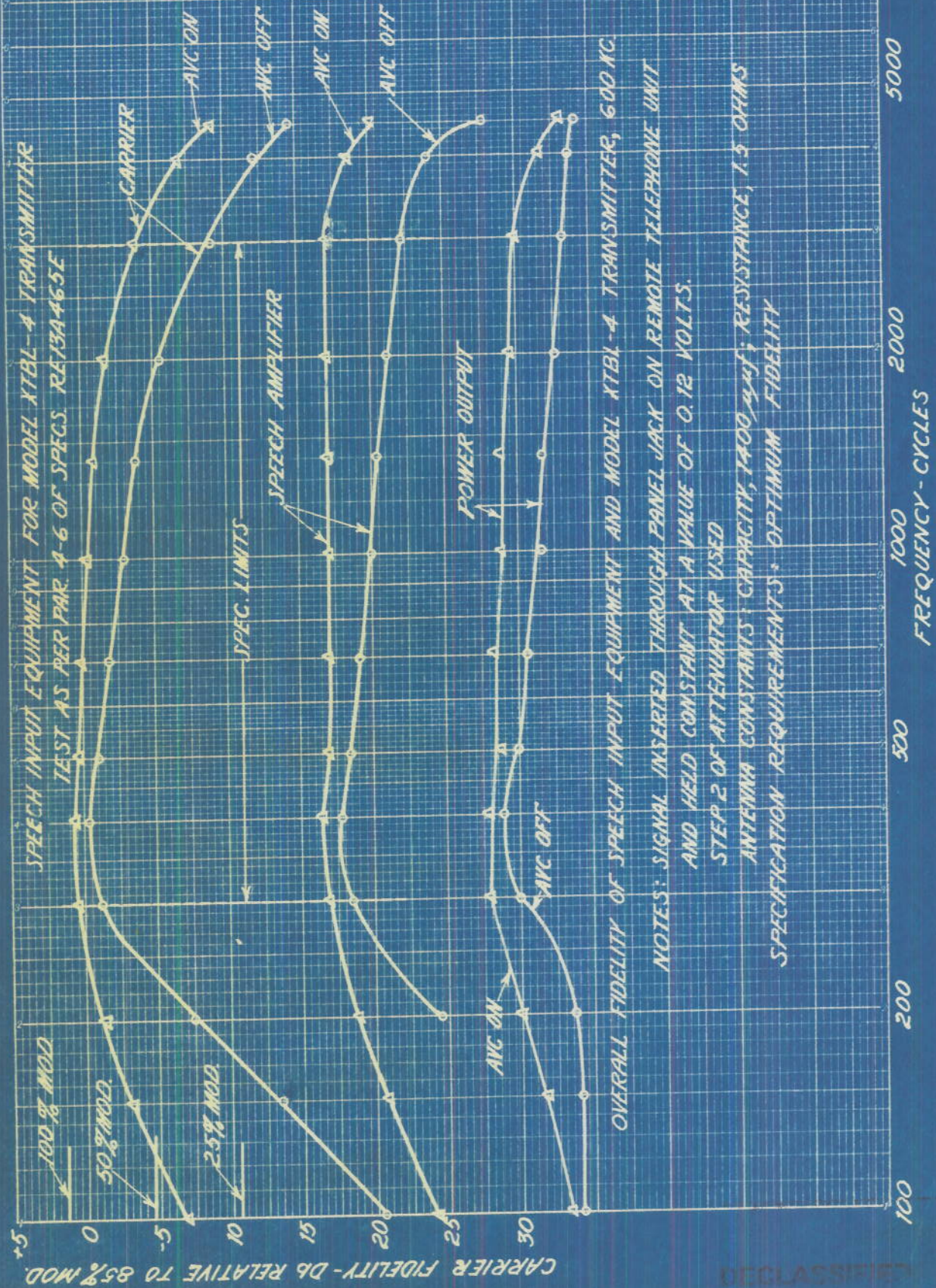
ANTENNA CONSTANTS: CAPACITY, 600 μ mf; RESISTANCE, 5.34 OHMS

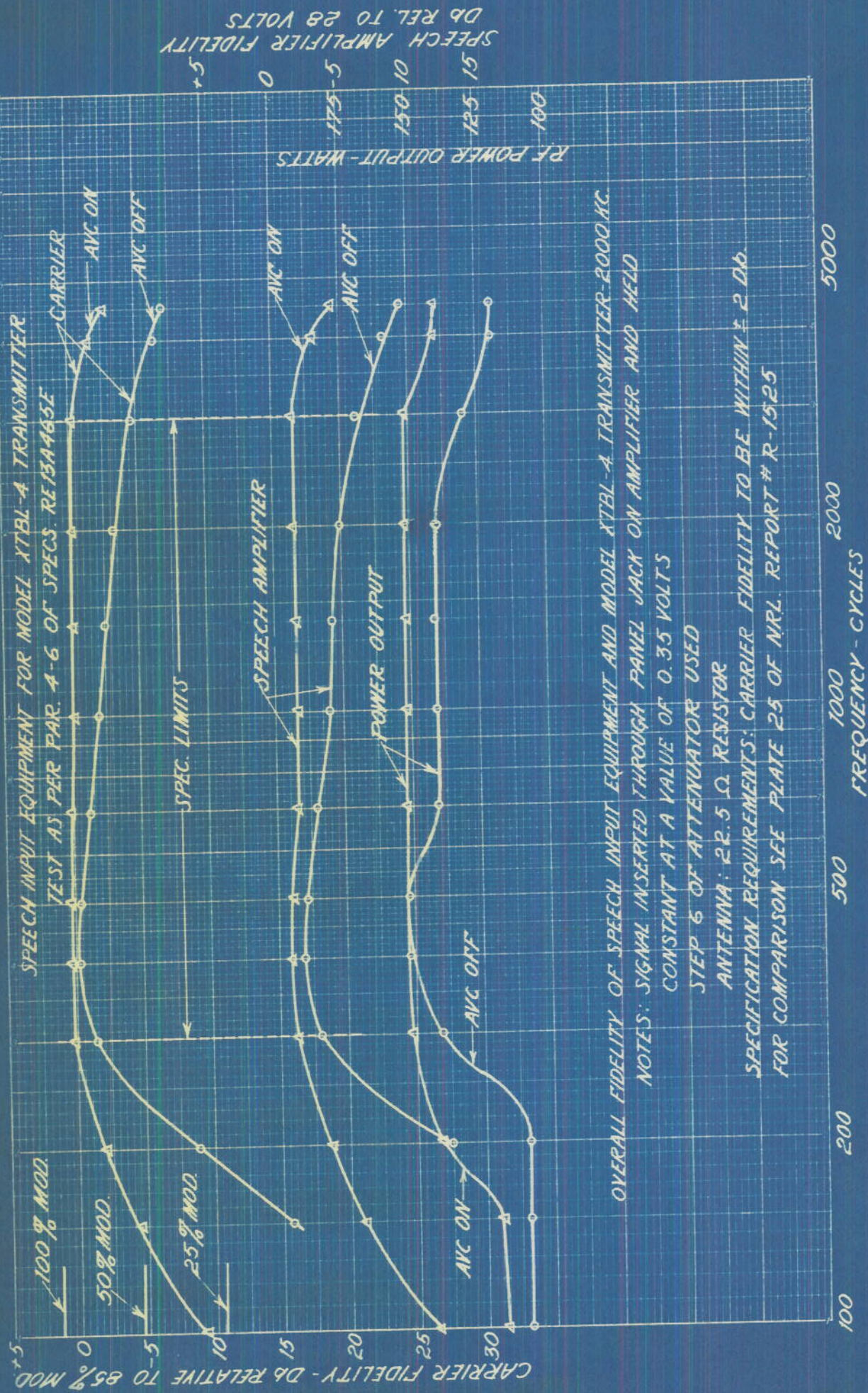
SPECIFICATION REQUIREMENTS: OPTIMUM FIDELITY

FOR COMPARISON SEE PLATE 23 OF NRL REPORT #R-1525

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OVERALL FIDELITY OF SPEECH INPUT EQUIPMENT AND MODEL XTBL-4 TRANSMITTER-2000 KC.

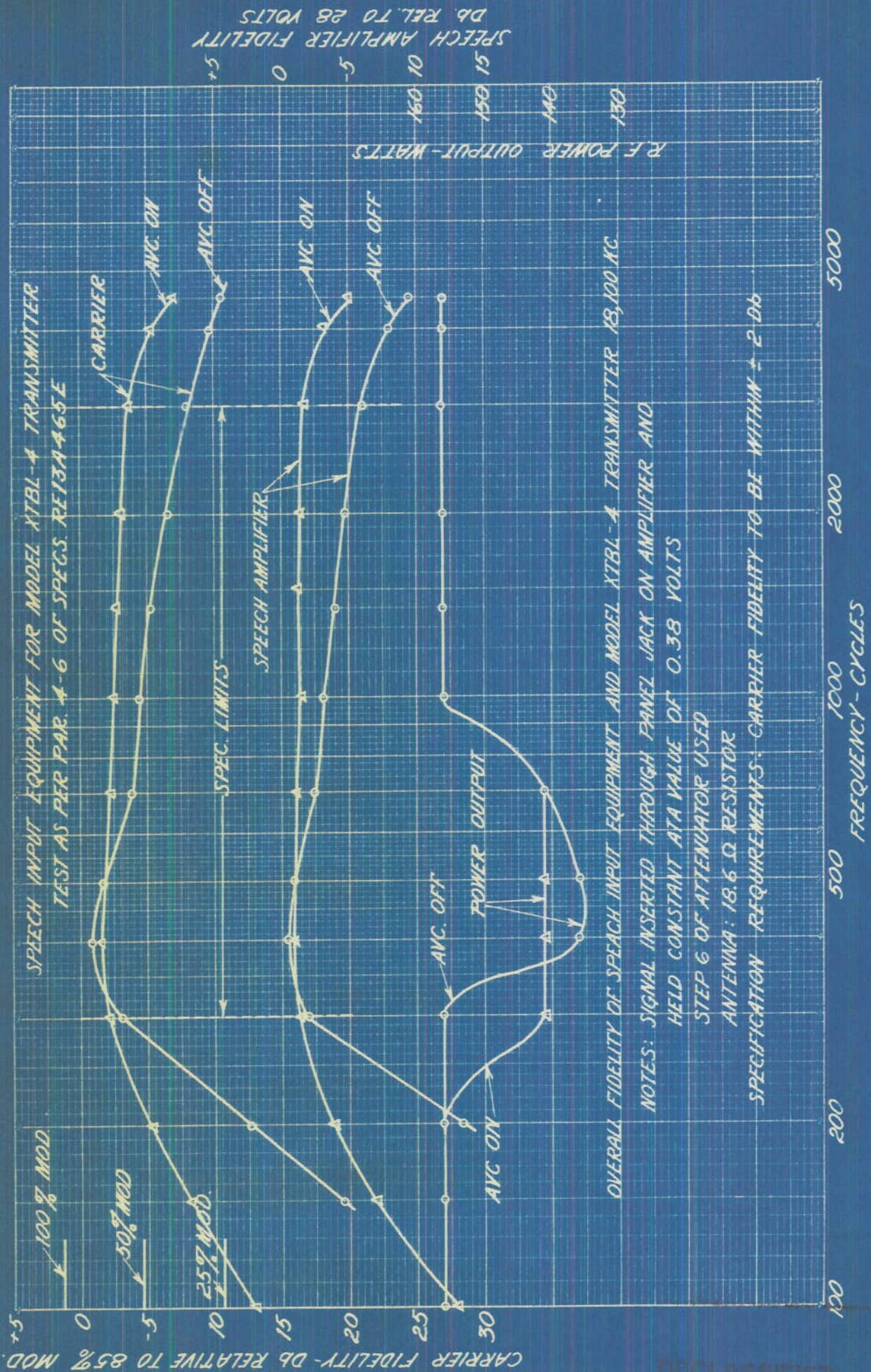
NOTES: SIGNAL INSERTED THROUGH PANEL JACK ON AMPLIFIER AND HELD CONSTANT AT A VALUE OF 0.35 VOLTS

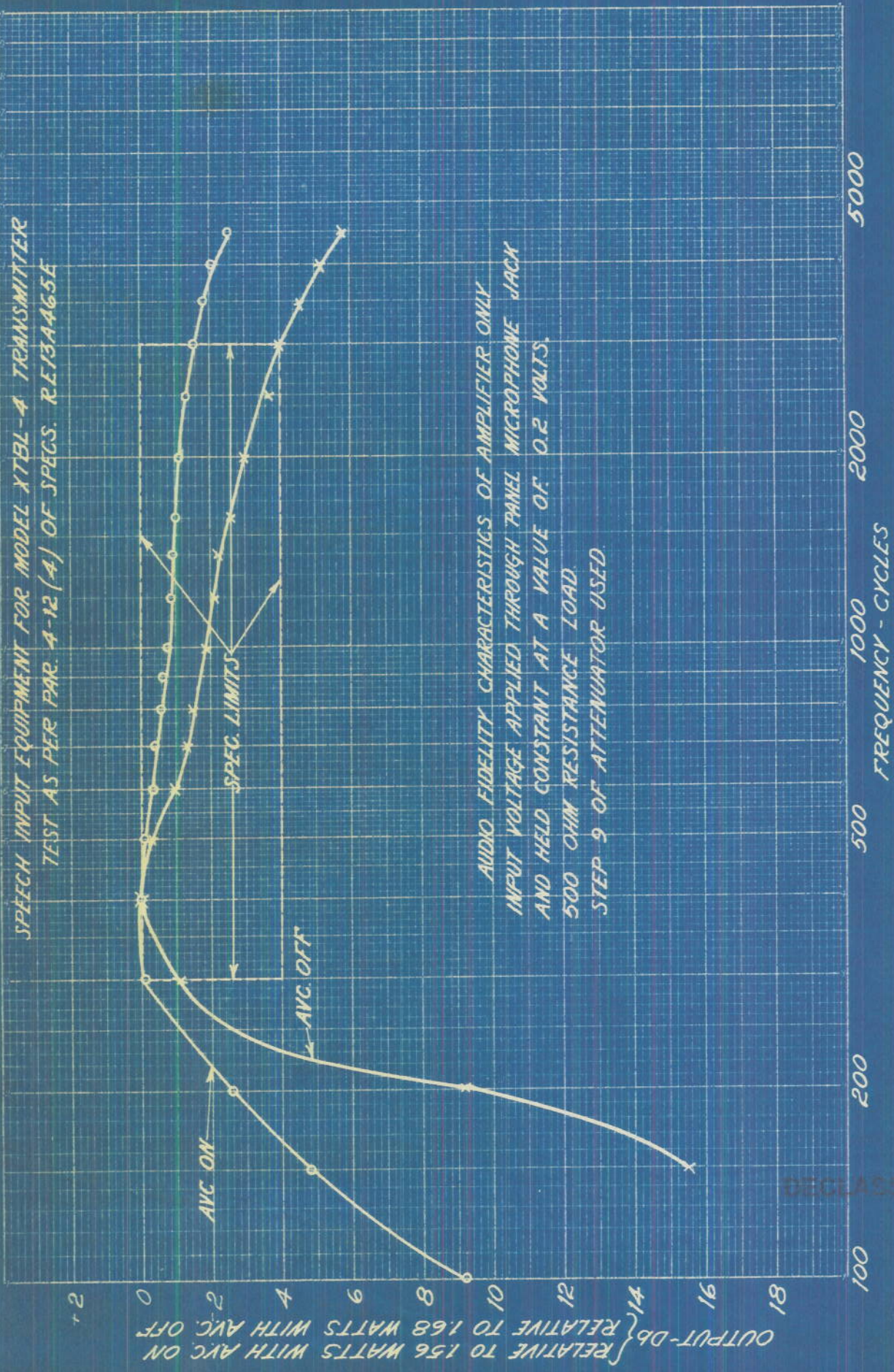
STEP 6 OF ATTENUATOR USED

ANTENNA: 22.5 Ω RESISTOR

SPECIFICATION REQUIREMENTS: CARRIER FIDELITY TO BE WITHIN ± 2 DB.

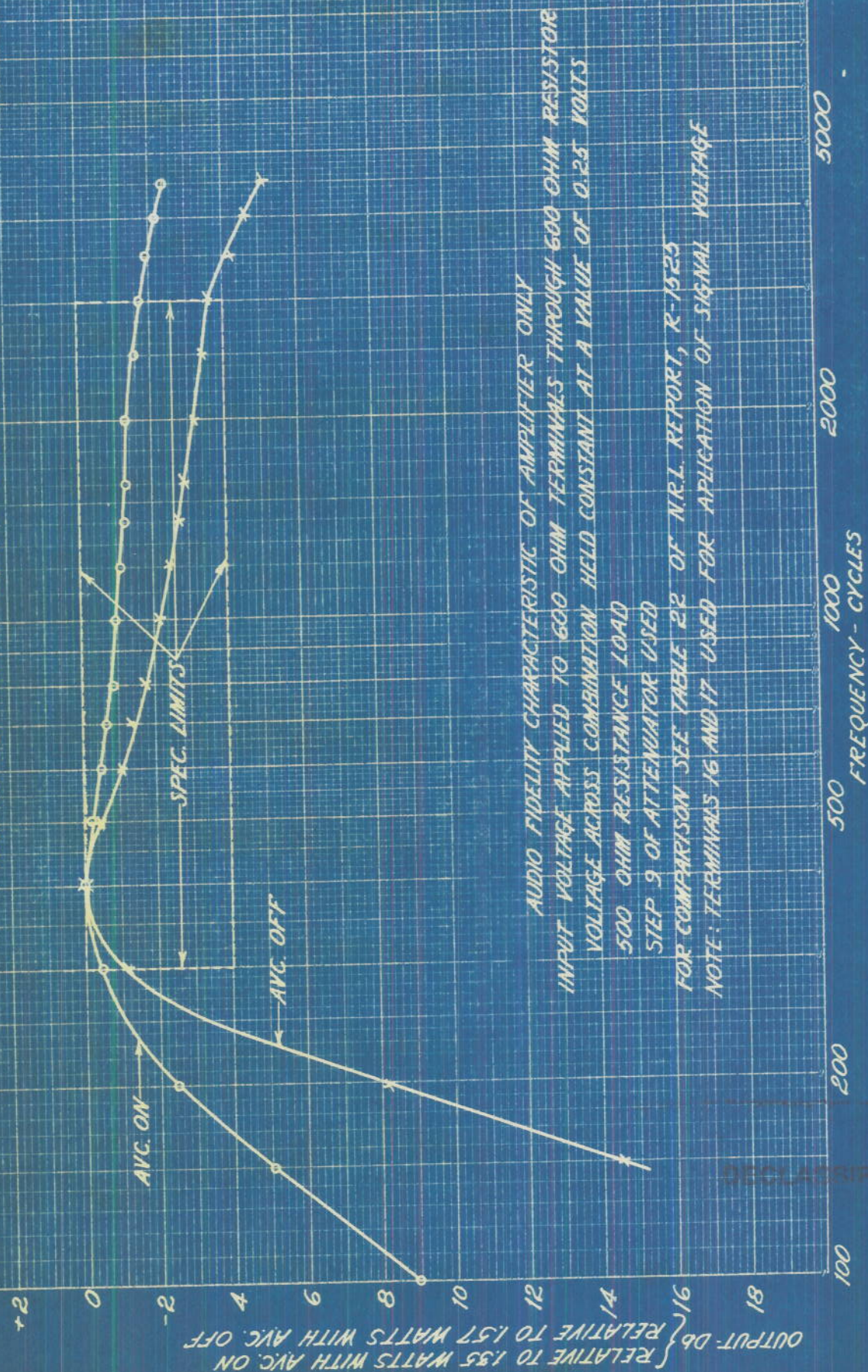
FOR COMPARISON SEE PLATE 25 OF NRL REPORT # R-1525





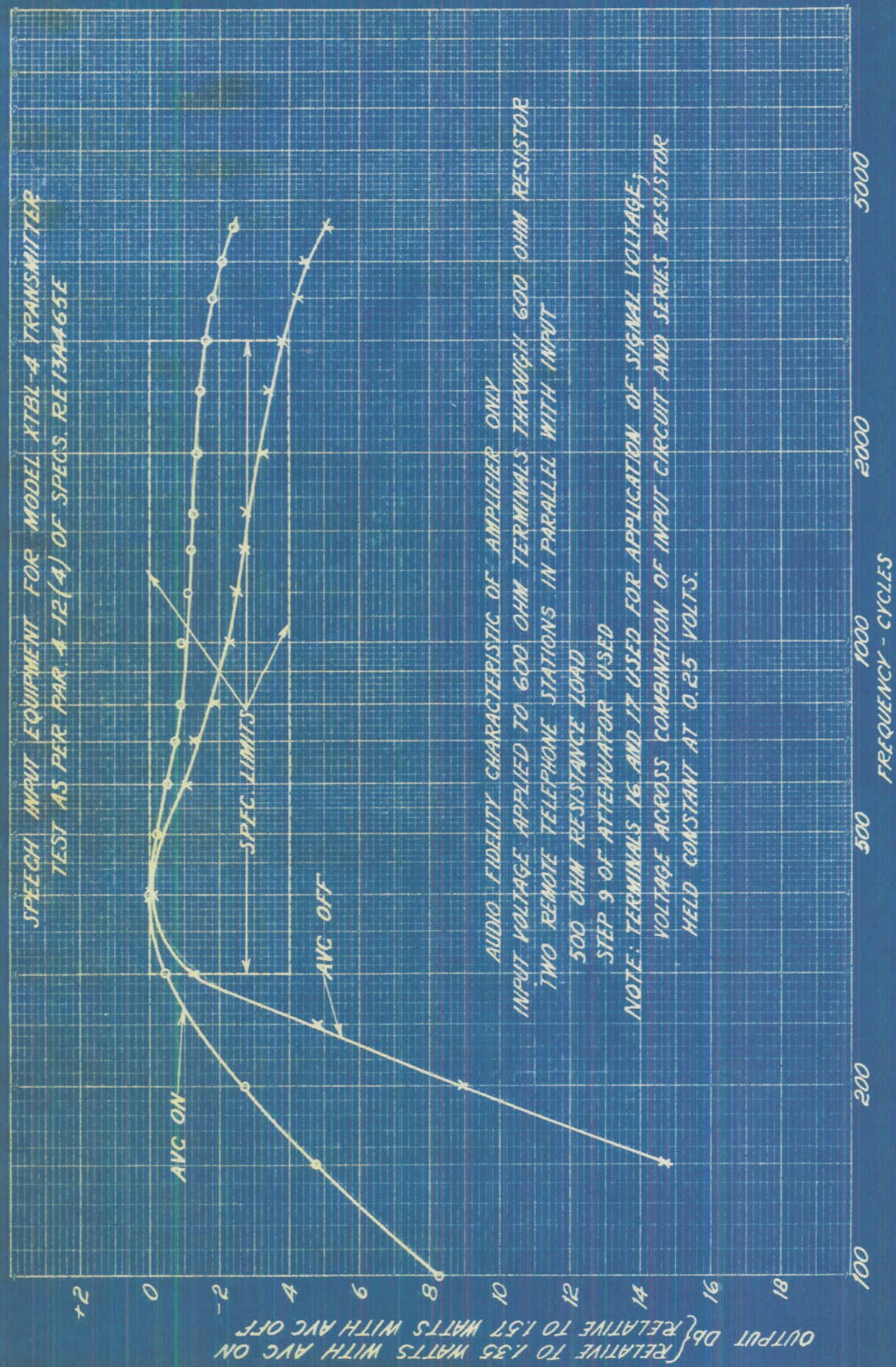
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SPEECH INPUT EQUIPMENT FOR MODEL XTBL-4 TRANSMITTER
TEST AS PER PAR. 4-12(4) OF SPECS. RE 13A 465E



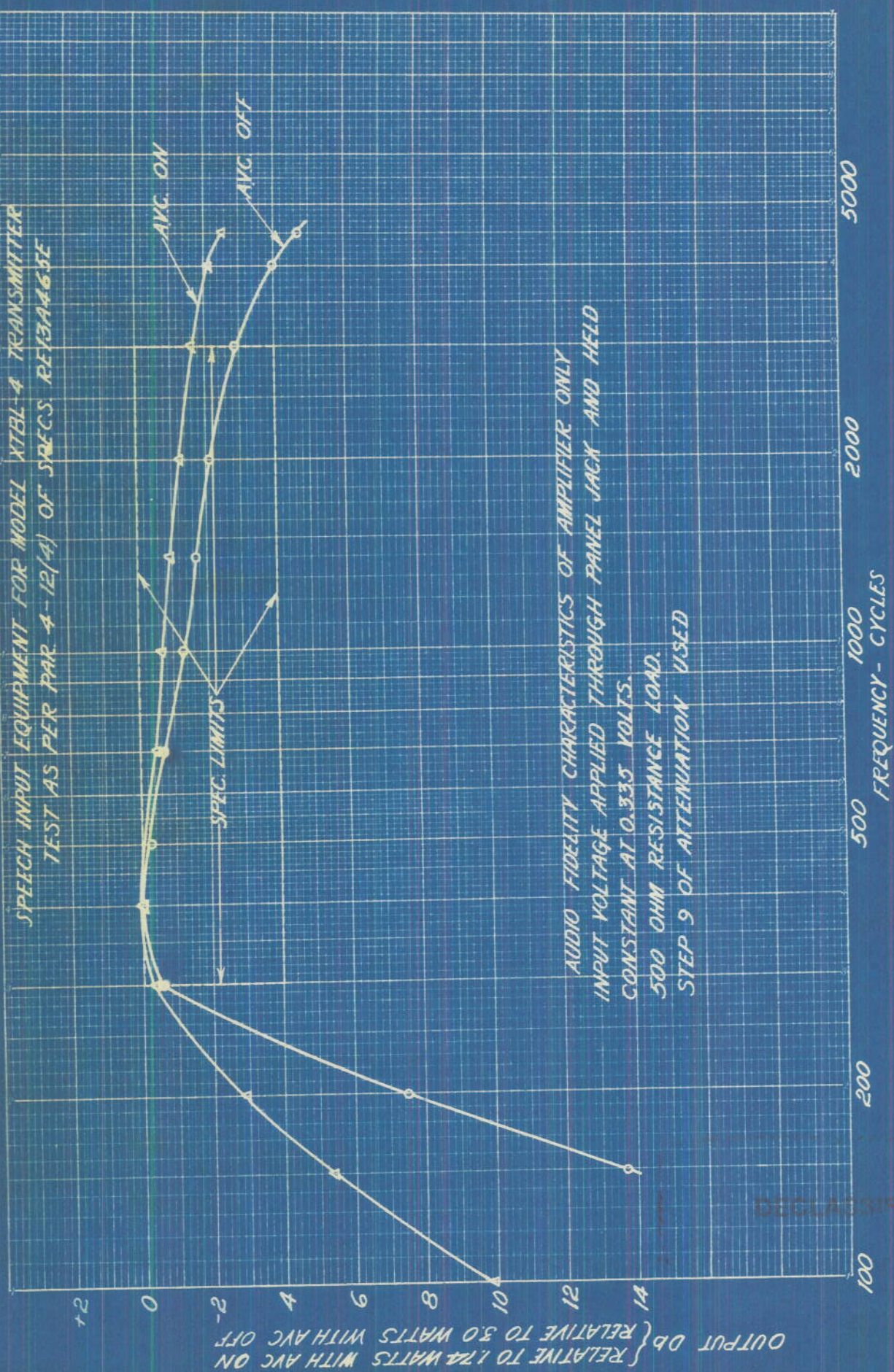
AUDIO FIDELITY CHARACTERISTIC OF AMPLIFIER ONLY
INPUT VOLTAGE APPLIED TO 600 OHM TERMINALS THROUGH 600 OHM RESISTOR
VOLTAGE ACROSS COMBINATION HELD CONSTANT AT A VALUE OF 0.25 VOLTS
500 OHM RESISTANCE LOAD
STEP 9 OF ATTENUATOR USED
FOR COMPARISON SEE TABLE 22 OF N.R.L. REPORT, R-1525
NOTE: TERMINALS 16 AND 17 USED FOR APPLICATION OF SIGNAL VOLTAGE

SPEECH INPUT EQUIPMENT FOR MODEL XTBL-4 TRANSMITTER
TEST AS PER PAR. 4-12(4) OF SPECS. RE13A4465E



OUTPUT Db {
 RELATIVE TO 1.55 WATTS WITH AVC ON
 RELATIVE TO 1.57 WATTS WITH AVC OFF

AUDIO FIDELITY CHARACTERISTIC OF AMPLIFIER ONLY
 INPUT VOLTAGE APPLIED TO 600 OHM TERMINALS THROUGH 600 OHM RESISTOR
 TWO REMOTE TELEPHONE STATIONS IN PARALLEL WITH INPUT
 500 OHM RESISTANCE LOAD
 STEP 9 OF ATTENUATOR USED
 NOTE: TERMINALS 16 AND 17 USED FOR APPLICATION OF SIGNAL VOLTAGE;
 VOLTAGE ACROSS COMBINATION OF INPUT CIRCUIT AND SERIES RESISTOR
 HELD CONSTANT AT 0.25 VOLTS.



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